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August 4, 2016

Petaluma City Schools  
District Office  
200 Douglas Street  
Petaluma, California  
94952

**Re: Adverse Effects of Radiofrequency fields**

I am writing to express my concern over the increasing exposure of children in schools to Radiofrequency Fields (e.g. from wi-fi, as required for cell phones and iPads, and emitted by cell towers) and the lack of concern expressed by many councils, governments and School Boards on this issue. In particular, justification for the “safety” of radiofrequency fields is placed upon the use of outdated safety standards, based upon tissue heating, whereas it has now been well demonstrated that adverse biological effects occur at far lower levels of radiofrequency fields that do not induce tissue heating, including a recent animal study performed by the National Toxicology Program in the United States which found an increased incidence of brain cancers and other cancers in rats exposed to prolonged Radiofrequency fields.

I am a physician and epidemiologist specializing in cancer etiology, prevention, and screening, expert in epidemiology, and particularly causes of human cancer. I have performed research on ionizing radiation and cancer, electromagnetic fields and cancer, and have served on many committees assessing the carcinogenicity of various exposures, including working groups of the International Agency for Research on Cancer (IARC), widely regarded as providing unbiased assessment on the carcinogenicity of chemicals and other exposure to humans.

In 2011, an IARC working group designated radiofrequency fields as a class 2B carcinogen, a possible human carcinogen. Since that review a number of additional studies have been reported. One of the most important was a large case-control study in France, which found a doubling of risk of glioma, the most malignant form of brain cancer, after two years of exposure to cell phones. After five years exposure the risk was five-fold. They also found that in those who lived in urban environments the risk was even higher. In my view, and that of many colleagues who have written papers on this issue, these studies provide evidence that radiofrequency fields are not just a possible human carcinogen but a probable human carcinogen, i.e. IARC category 2A. It would be impossible to ignore such an assessment in regulatory approaches.

It is important to recognize that there are no safe levels of exposure to human carcinogens. Risk increases with increasing intensity of exposure, and for many carcinogens, even more with increasing duration of exposure. The only way to avoid the carcinogenic risk is to avoid exposure altogether. This is why we ban known carcinogens from the environment and why much effort is taken to get people, particularly young people, not to smoke. We now recognize that exposure to carcinogens in childhood can increase the risk of cancer in adulthood many years later. Further, people vary in their genetic makeup, and certain genes can make some people more susceptible than others to the effect of carcinogens. It is the young and those who are susceptible we should protect.

As an epidemiologist who has done a great deal of work on breast cancer, I have been concerned by a series of case reports from California and elsewhere of women who developed unusual breast cancers in the exact position where they kept cell phones in their bras. These are unusual cancers. They are multifocal, mirroring where the cell phone was kept. Thus in these relatively young women the radiofrequency radiation from very close contact with a cell phone has caused breast cancer.

Not only brain and breast cancers but parotid gland tumors, tumors of the salivary gland, have been associated with prolonged exposure to cell phones.

Given the long natural history of cancer and the fact that human populations have not been exposed for a sufficient length of time to reveal the full adverse effects of radiofrequency fields, it is extremely important to adopt a precautionary approach to the exposure of humans to such fields. An individual, if appropriately informed, can reduce her or his exposure to radiofrequency fields from devices that use wi-fi, but in the case of cell towers, smart meters and wi-fi in schools, the exposure they receive is outside their control. Then, with the people who manufacture these devices and those who promote wi-fi failing to issue adequate health warnings, we are reaching a situation where schools, work places and homes are being saturated with radiofrequency fields.

Thus to avoid a potential epidemic of cancer caused by radiofrequency fields from wi-fi and other devices, we should introduce means to reduce exposure as much as reasonably achievable, use hard wire connections to the internet and strengthen the codes that are meant to protect the public.

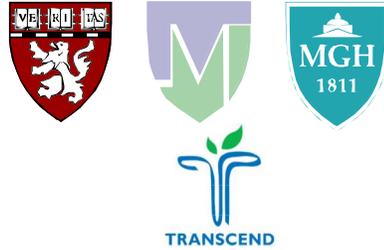
Yours sincerely

A handwritten signature in black ink, appearing to read 'A. B. Miller', written in a cursive style.

Anthony B. Miller, MD, FRCP(C), FRCP, FACE  
Professor Emeritus  
Dalla Lana School of Public Health, University of Toronto, Ontario, Canada

## HARVARD MEDICAL SCHOOL

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9 September 2016

District Office  
200 Douglas Street  
Petaluma, California 94952

Dear Petaluma City School District,

I am a pediatric neurologist and neuroscientist on the faculty of Harvard Medical School and on staff at the Massachusetts General Hospital. I am Board Certified in Neurology with Special Competency in Child Neurology, and Subspecialty Certification in Neurodevelopmental Disorders. I have an extensive history of research and clinical practice in neurodevelopmental disorders, particularly autism spectrum disorders. I have published papers in brain imaging research, in physiological abnormalities in autism spectrum disorders, and in environmental influences on neurodevelopmental disorders such as autism and on brain development and function.

A few years ago I accepted an invitation to review literature pertinent to a potential link between Autism Spectrum Disorders and Electromagnetic Frequencies (EMF) and Radiofrequency Radiation (RFR). I set out to write a paper of modest length, but found much more literature than I had anticipated to review. I ended up producing a 60 page single spaced paper with over 550 citations. It is available at [http://www.bioinitiative.org/report/wpcontent/uploads/pdfs/sec20\\_2012\\_Findings\\_in\\_Autism.pdf](http://www.bioinitiative.org/report/wpcontent/uploads/pdfs/sec20_2012_Findings_in_Autism.pdf) and it was published in a revised and somewhat shortened form in two parts in the peer reviewed indexed journal Pathophysiology (2013).

More recently I published an article entitled "Connections in Our Environment: Sizing up Electromagnetic Fields," in Autism Notebook Spring 2015 edition. In this article I describe how there is a whole series of problems at the cellular, sub-cellular and metabolic levels and immune levels that have been identified in autism. And interestingly, for every single one of those problems, there's literature about how EMFs can create those kinds of problems.

The argument I made in these articles is not that EMF is proven to cause autism, but rather, that EMF can certainly contribute to degrading the physiological integrity of the system at the cellular and molecular level – and this in turn appears to contribute to the pathogenesis/causation not only of autism but of many highly common chronic illnesses, including cancer, obesity, diabetes and heart

disease.. Please see this article on page 24-25 at the link <http://virtualpublications.soloprinting.com/publication/?i=252361>

In fact, there are thousands of papers that have accumulated over decades –and are now accumulating at an accelerating pace, as our ability to measure impacts become more sensitive – that document adverse health and neurological impacts of EMF/RFR. Children are more vulnerable than adults, and children with chronic illnesses and/or neurodevelopmental disabilities are even more vulnerable. Elderly or chronically ill adults are more vulnerable than healthy adults.

Current technologies were designed and promulgated without taking account of biological impacts other than thermal impacts. We now know that there are a large array of impacts that have nothing to do with the heating of tissue. The claim from WiFi proponents that the only concern is thermal impacts is now definitively outdated scientifically.

Radiofrequency electromagnetic radiation from WiFi and cell towers can exert a disorganizing effect on the ability to learn and remember, and can also be destabilizing to immune and metabolic function. This will make it harder for some children to learn, particularly those who are already having learning or medical problems in the first place. And since half of the children in this country have some kind of chronic illness, this means that a lot of people are more vulnerable than you might expect to these issues.

Powerful industrial entities have a vested interest in leading the public to believe that EMF/RFR, which we cannot see, taste or touch, is harmless, but this is not true. Please do the right and precautionary thing for our children.

I urge you to opt for wired technologies in Petaluma City School District classrooms, particularly for those subpopulations that are most sensitive. It will be easier for you to make a healthier decision now than to undo misguided decisions later.

Thank you.

Sincerely yours,

A handwritten signature in black ink, appearing to read 'Martha Herbert', with a long horizontal flourish extending to the right.

Martha Herbert, PhD, MD



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
WASHINGTON, D.C. 20460

JUL 16 2002

OFFICE OF  
AIR AND RADIATION

Ms. Janet Newton  
President  
The EMR Network  
P.O. Box 221  
Marshfield, VT 05658

Dear Ms. Newton:

This is in reply to your letter of January 31, 2002, to the Environmental Protection Agency (EPA) Administrator Whitman, in which you express your concerns about the adequacy of the Federal Communications Commission's (FCC) radiofrequency (RF) radiation exposure guidelines and nonthermal effects of radiofrequency radiation. Another issue that you raise in your letter is the FCC's claim that EPA shares responsibility for recommending RF radiation protection guidelines to the FCC. I hope that my reply will clarify EPA's position with regard to these concerns. I believe that it is correct to say that there is uncertainty about whether or not current guidelines adequately treat nonthermal, prolonged exposures (exposures that may continue on an intermittent basis for many years). The explanation that follows is basically a summary of statements that have been made in other EPA documents and correspondence.

The guidelines currently used by the FCC were adopted by the FCC in 1996. The guidelines were recommended by EPA, with certain reservations, in a letter to Thomas P. Stanley, Chief Engineer, Office of Engineering and Technology, Federal Communications Commission, November 9, 1993, in response to the FCC's request for comments on their Notice of Proposed Rulemaking (NPRM), Guidelines for Evaluating the Environmental Effects of Radiofrequency Radiation (enclosed).

The FCC's current exposure guidelines, as well as those of the Institute of Electrical and Electronics Engineers (IEEE) and the International Commission on Non-ionizing Radiation Protection, are thermally based, and do not apply to chronic, nonthermal exposure situations. They are believed to protect against injury that may be caused by acute exposures that result in tissue heating or electric shock and burn. The hazard level (for frequencies generally at or greater than 3 MHz) is based on a specific absorption dose-rate, SAR, associated with an effect

that results from an increase in body temperature. The FCC's exposure guideline is considered protective of effects arising from a thermal mechanism but not from all possible mechanisms. Therefore, the generalization by many that the guidelines protect human beings from harm by any or all mechanisms is not justified.

These guidelines are based on findings of an adverse effect level of 4 watts per kilogram (W/kg) body weight. This SAR was observed in laboratory research involving acute exposures that elevated the body temperature of animals, including nonhuman primates. The exposure guidelines did not consider information that addresses nonthermal, prolonged exposures, i.e., from research showing effects with implications for possible adversity in situations involving chronic/prolonged, low-level (nonthermal) exposures. Relatively few chronic, low-level exposure studies of laboratory animals and epidemiological studies of human populations have been reported and the majority of these studies do not show obvious adverse health effects. However, there are reports that suggest that potentially adverse health effects, such as cancer, may occur. Since EPA's comments were submitted to the FCC in 1993, the number of studies reporting effects associated with both acute and chronic low-level exposure to RF radiation has increased.

While there is general, although not unanimous, agreement that the database on low-level, long-term exposures is not sufficient to provide a basis for standards development, some contemporary guidelines state explicitly that their adverse-effect level is based on an increase in body temperature and do not claim that the exposure limits protect against both thermal and nonthermal effects. The FCC does not claim that their exposure guidelines provide protection for exposures to which the 4 W/kg SAR basis does not apply, i.e., exposures below the 4 W/kg threshold level that are chronic/prolonged and nonthermal. However, exposures that comply with the FCC's guidelines generally have been represented as "safe" by many of the RF system operators and service providers who must comply with them, even though there is uncertainty about possible risk from nonthermal, intermittent exposures that may continue for years.

The 4 W/kg SAR, a whole-body average, time-average dose-rate, is used to derive dose-rate and exposure limits for situations involving RF radiation exposure of a person's entire body from a relatively remote radiating source. Most people's greatest exposures result from the use of personal communications devices that expose the head. In summary, the current exposure guidelines used by the FCC are based on the effects resulting from whole-body heating, not exposure of and effect on critical organs including the brain and the eyes. In addition, the maximum permitted local SAR limit of 1.6 W/kg for critical organs of the body is related directly to the permitted whole body average SAR (0.08 W/kg), with no explanation given other than to limit heating.

I also have enclosed a letter written in June of 1999 to Mr. Richard Tell, Chair, IEEE SCC28 (SC4) Risk Assessment Work Group, in which the members of the Radiofrequency Interagency Work Group (RFIAWG) identified certain issues that they had determined needed to be addressed in order to provide a strong and credible rationale to support RF exposure guidelines.

Federal health and safety agencies have not yet developed policies concerning possible risk from long-term, nonthermal exposures. When developing exposure standards for other physical agents such as toxic substances, health risk uncertainties, with emphasis given to sensitive populations, are often considered. Incorporating information on exposure scenarios involving repeated short duration/nonthermal exposures that may continue over very long periods of time (years), with an exposed population that includes children, the elderly, and people with various debilitating physical and medical conditions, could be beneficial in delineating appropriate protective exposure guidelines.

I appreciate the opportunity to be of service and trust that the information provided is helpful. If you have further questions, my phone number is (202) 564-9235 and e-mail address is [hankin.norbert@epa.gov](mailto:hankin.norbert@epa.gov).

Sincerely,



Norbert Hankin  
Center for Science and Risk Assessment  
Radiation Protection Division

Enclosures:

- 1) letter to Thomas P. Stanley, Chief Engineer, Office of Engineering and Technology, Federal Communications Commission, November 9, 1993, in response to the FCC's request for comments on their Notice of Proposed Rulemaking (NPRM), Guidelines for Evaluating the Environmental Effects of Radiofrequency Radiation
- 2) June 1999 letter to Mr. Richard Tell, Chair, IEEE SCC28 (SC4) Risk Assessment Work Group from the Radiofrequency Radiation Interagency Work Group

Dear Maryland Children's Environmental Health and Protection Advisory Council Members,

I am writing to add to the comments I provided on September 14 (please see attachment and email below).

I urge you to please issue final recommendations to schools to decrease exposures to Wi-Fi radiation. **Time is of the essence.** Without recommendations such as those in CEHPAC's report, [Wifi Radiation in Schools in Maryland](#), Maryland school districts are opening the floodgates on Wi-Fi technology.

For example, Montgomery County Public Schools (MCPS) has now proposed that elementary school students be allowed to bring cell phones to school, and, with teacher permission, use cell phones in class for instructional purposes. MCPS's justification for this policy is that the school district must keep up with the times and allow "students to use their own devices to augment other technology used for classroom instruction." (See today's Washington Post article at: <http://tinyurl.com/j8xavej>)

The public health implications of having children as young as five years old using cell phones at school were not taken into consideration. The American Academy of Pediatrics (AAP) guidelines on cell phone use clearly state: "Avoid carrying your phone against the body like in a pocket, sock or bra. Cell phone manufacturers can't guarantee that the amount of radiation you're absorbing will be at a safe level." <https://www.healthychildren.org/English/safety-prevention/all-around/Pages/Cell-Phone-Radiation-Childrens-Health.aspx>

MCPS's proposal would mean that my twin sons sitting in their third grade classrooms would now not only have a wireless access point above their head, a Chromebook on their lap, and 23 other Chromebooks on their classmates' laps, but also a smart phone in their pocket, and 23 smart phones in their classmates' pockets.

Moreover, the AAP guidelines advise: "Make only short or essential calls on cell phones" and "If you plan to watch a movie on your device, download it first, then switch to airplane mode while you watch in order to avoid unnecessary radiation exposure." MCPS is proposing that young children use cell phones as educational tools during ongoing instruction. This means students will be using cell phones for a much longer period than a short or essential call and they will be streaming data, rather than turning on airplane mode.

This augmented use of the cell phone is being actively encouraged by MCPS and it is inconsistent with the AAP's guidelines.

As a concerned parent, I am imploring CEHPAC to issue its report, [Wifi Radiation in Schools in Maryland](#), in final form before Wi-Fi use becomes even more entrenched in our schools.

Please do not state that the research on exposures and health effects is "inconclusive," as that is inaccurate and would unnecessarily water down the strength of the report. Rather, the AAP states the following: "The American Academy of Pediatrics (AAP) supports more research into how cell phone exposure affects human health long term, particularly children's health."

CEHPAC's mission is to identify environmental hazards that may affect children's health and recommend solutions. Wi-Fi exposure is an ever-present and growing hazard. Please issue a final report that will clearly state how to mitigate this hazard in what should be our safest public spaces, our schools.

Sincerely yours,

Florence Kao

### What are the health effects of EMFs?

EMF is a possible human carcinogen; reducing chronic exposures may reduce health risks.

Exposures to **electromagnetic fields from electrical appliances and gadgets** (ELF-EMF) are linked to increased risk for cancers including breast cancer, leukemia and brain tumors; plus neurological diseases like Alzheimer's disease and amyotrophic lateral sclerosis (ALS, also known as Lou Gehrig's disease).

**Radiofrequency (RF) radiation** exposure from cell and cordless phones is linked to increased risk for malignant brain tumors and acoustic neuromas. Exposure to RF from cell towers, Wi-Fi and dirty electricity is linked to headache, dizziness, nausea, fatigue, cardiac problems, ringing in the ears (tinnitus), sleep disruption, memory and concentration problems, digestive problems, immune dysfunction, worsened asthma and allergy symptoms including skin rashes and worsening of inflammatory conditions, joint and muscle pain, and disruptions of normal blood sugar levels.

Increased risk of brain tumor (glioma) starts at only 260 hours of cumulative lifetime exposure to cellular/cordless phones. Risks more than double when phones have been used for 10 years or longer, with ipsilateral use (when the phone is used mainly on one side of the head) and 2000 or more hours of lifetime use. Risks are highest for the 20-29 age group. At 1640 cumulative lifetime hours of combined cell and cordless phone use, the risk for glioma is nearly doubled in adults with 10 years or more of use and with ipsilateral use.

*For more information, please see the 2007 BioInitiative Report: A rationale for a biologically-based public exposure standard for electromagnetic fields (ELF and RF), available online from the BioInitiative Working Group, [www.bioinitiative.org](http://www.bioinitiative.org).*

*by Cindy Sage, MA, and Nancy Evans, BS  
for the CHE EMF Working Group, November 2011*

This is a quick guide to the major sources of electromagnetic fields (EMF) in everyday life, as well as some suggestions about how to avoid unnecessary EMF.

### Where do EMFs come from? Should I be concerned?

This fact sheet addresses two types of electromagnetic fields, including dirty electricity:

- **Extremely low frequency electromagnetic fields (ELF-EMF)** are generated from appliances and other items that use electricity (power-frequency fields).
- **Radiofrequency (RF-EMF)** is generated by wireless technologies such as cellular and cordless phones.
- **“Dirty electricity”** is a term used to describe low-kilohertz frequency fields that can be thought of as an unintentional RF pollutant on electrical wiring and into living space. Power is “dirty” or polluted when it contains the high frequency signals flowing through overloaded wires, and not just the clean 60 Hz power that's created at the source.

People with special vulnerability to carcinogenic and neurotoxic exposures can reduce their exposures in the home, at school, at workplaces and in public places.

Vulnerable individuals include

- pregnant women and their developing babies
- children, particularly children with autism spectrum disorders (ASD), attention deficit hyperactivity disorder (ADHD) or attention deficit disorder (ADD)
- the elderly
- individuals with wireless medical devices, including wireless insulin pumps, defibrillators and pacemakers, which can be hacked or disabled by pulsed RF from other wireless sources
- any persons who have become sensitive to

*(Continued on page 2)*

electromagnetic fields in general.

If you can identify sources, you can greatly reduce your exposures to ELF-EMF from power lines, appliances and home wiring; dirty electricity from

compact fluorescent bulbs (CFBs) and other sources; and from high frequency (wireless) sources of radiofrequency radiation.

## Sources of extremely low frequency [ELF-EMF] in the home, workplace and school environments:

- High-voltage transmission lines — large power lines on metal poles or towers — can produce elevated EMF (over 1 milligauss or mG). These elevated fields can extend several hundred to as much as 1000 feet on both sides. That's greater than the length of three football fields. Homes, schools and workplaces near these power lines can be within these high EMF zones.
- Pad-mounted ground transformers — big green boxes labeled "High Voltage" that sit outside buildings.
- Appliances (magnetic induction stovetops, microwave ovens, computers, washers and dryers, televisions, radios, etc.); EMF fields from these appliances penetrate through walls.
- Smart grid or "smart" wireless utility meters for electric, gas and water metering (switch-mode power supply produces ELF-EMF and dirty electricity).
- New appliances with radiofrequency power transmitters for wireless smart meters. Ask before purchase and choose brands without wireless power transmitters built in.
- Plasma televisions, which apparently have some adverse bioeffects on some people that are similar to exposures to wireless devices. LCD screen TVs have low or no EMF and are a better choice.
- Lighting — compact fluorescent bulbs (CFBs) and other fluorescent lighting.
- Electrical main panels, subpanels in the home, and electrical wiring in the walls, if improperly wired.
- Home grid systems that use the home's electrical wiring to transmit RF signal for wireless devices, known as broadband over power line (BPL).
- Electric and hybrid cars — EMF levels vary widely, so check if information on electric field exposure is available from the manufacturer before buying.
- Any transformer for charging power (little black boxes that connect appliances to wall outlets); "boom boxes" for music that plug into an electrical wall socket; power strips into which lots of wires are plugged.
- In classrooms, overhead projectors, slide projectors, and computer hard drives. A teacher standing near or under an overhead projector gets as much exposure as sleeping under an electric blanket.
- Offices or classrooms over or adjacent to switchgear rooms (electrical rooms) can have excessively high ELF-EMF exposures. Working on the first floor of a high-rise often places people directly over a switchgear electric room and excessive EMF.
- Personal digital assistants (PDAs such as BlackBerry and smart phones). These also produce very high bursts of ELF-EMF from the battery switching when on.
- Large electrical systems (electric motors, generators, electric cables).
- Power saws, drills, welding, or any variable-speed induction motor, such as a sewing machine.
- Electric transportation systems (trains) and light rail or magnetic levitation (maglev) trains.

## Sources of RF (radiofrequency, wireless) EMF in the home, workplace and school environments:

- Smart grid / “smart” wireless utility meters (switch-mode power supply; electric, gas or water). Electric utilities that “read” your electric meter remotely will attach a wireless transmitter on your wall. This transmits wireless RF constantly.
- Wireless baby monitors, which produce excessively high ELF-EMF and/or RF.
- Dimmer switches — rheostat lighting produces dirty electricity.
- Cordless phones, but especially iDEN cordless phones, a new US form of the European DECT phone. It emits a strong RF signal, and it radiates full power 24/7, unlike a regular cordless phone, which only radiates when in use.
- Wireless phones (all cellular phones, smart phones, Bluetooth, pagers), which emit pulsed RF. Low-level RF emissions are not necessarily much safer. No one can yet say what a lower safe limit is.
- Microcell wireless cellular boosters which amplify cell signals inside buildings.
- Citywide wireless systems, Wi-Fi hotspots, wireless systems installed by private businesses that can crisscross commercial streets and expose shoppers and pedestrians to invisible beams of pulsed RF.
- Cellular antennas on nearby buildings radiating to you, or cellular antennas on your building, radiating toward a nearby building with glass windows that reflect the RF back to you.
- In schools, cellular towers or antennas on campus or adjacent to campus. These may include hidden or “stealth” cell site installations built on the roof or inside a chimney or church steeple.
- Wireless networks, wireless access points, wireless laptops, plus wireless overhead projectors and white boards that are used for interactive learning in the classroom.
- FM transmitters worn by teachers in schools for hearing impaired students produce excessively high RF exposures for chronic exposure. They can be placed nearby on a desk instead.
- Radiofrequency identification (RFID) and metal detector systems used in airports, stores, libraries and hospitals. RFID scanners are powerful and can disable medical implants.
- Broadband over power line (BPL) – a new technology that will use the existing electrical power grid to transmit an RF signal (wireless) for Internet access. It would expose all buildings with electrical wiring — all buildings with electricity — to constant RF, even if you do not buy the “black box” to decode and use it.
- Wireless headsets in stores; employers may require workers to wear transmitters on their bodies.
- Wireless sensors for transportation, parking and “FastTrack” uses.
- WiMAX, which has a 10- to 20-mile radius and is very strong near the tower antennas.
- Broadcast towers: AM, FM and television towers.
- Radar. Doppler radars for weather are tremendously strong RF sources, creating intermittent, sweeping exposure at very high peak power. This includes radar at airports and military bases.
- Electronic Article Surveillance (EAS) systems in retail stores with security gates -- the flat white panels that are near the doors. These panels have some of the strongest known exposures in daily life. They are for detecting shoplifters who carry RF-tagged articles out of a store.

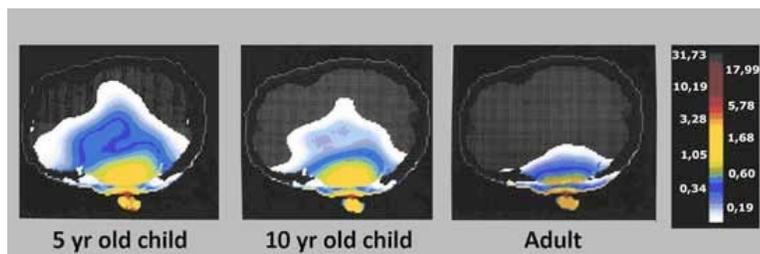
## Making wise choices

We recommend that you use a corded phone (land line) as your regular telephone.

If you need to use a cordless phone or cell phone, use a headset (wired only) whenever possible and/or use your phone on speakerphone. Text rather than talk. Keep your calls very brief, and hold your cell phone away from your head and body, especially when the phone is connecting your call.

**Children should not use cell phones or cordless phones.** Studies show children have a five-fold risk of malignant brain tumors in a shorter time than adults.

*Graphic used with permission from Gandhi OP, Lazzi G, Furse CM. Electromagnetic absorption in the human head and neck for cell telephones at 835 and 1900 MHz. IEEE Transactions on Microwave Theory and Techniques. 6;44(10):1884–1897.*



### Other recommendations:

- Avoid Bluetooth-type wireless headsets because of the chronic exposure from both the wireless headset and the phone you carry.
- Avoid wearing a cell phone or PDA (BlackBerry or smart phone) when “ON” because the battery-switching ELF emissions are excessively high, in addition to the RF emissions.
- Avoid using a cell phone in the car when children occupy the vehicle. RF levels will be unacceptably high in the back seat during cell phone use in the front seat.
- Avoid DECT or iDEN cordless phones. The “base” is always “ON” and transmitting. They are a large, continuous source of RF compared to other cordless phones.
- Promote wired (not wireless) alternatives for Internet access in your city. Citywide Wi-Fi causes involuntary exposures for everyone.
- Avoid hotels that have Wi-Fi (wireless hotspots) if you want to sleep well.
- Avoid wireless hotspots, particularly when with children. Let restaurants, Internet cafes, stores, libraries and hotels know if you object to involuntary exposure from wireless hotspots when you shop or travel.
- Choose wired Internet (Ethernet cable modems) at home instead of wireless systems, if possible. If you do use wireless systems, unplug them during sleeping hours. Install the wireless access points as far as possible from occupied space (your desk) and never in or near a child’s bedroom.
- Be aware of your school district’s facilities – do not support wireless. Since the World Health Organization’s International Agency for Research on Cancer has recently classified RF as a 2B possible human carcinogen, ask your schools to switch to cable and remove wireless Internet and its hot-spot access nodes.
- Classrooms should be fitted with RF filters to remove dirty electricity as a matter of routine hygiene. Educators should avoid standing over or near wireless networks, access points, laptops, overhead projectors and white boards. Stand or sit at least a few feet away from these sources when possible. Move your desk around, or move the devices away from you and your students.
- Wired cable connections are fine. Schools, especially classrooms for special education students, for children with autism (ASD) and

those with ADD and ADHD, should have classrooms that have no wireless exposures and have Graham-Stetzer RF filters to eliminate low-kilohertz frequency (dirty electricity) exposures.

- Educate yourself and your community about alternatives to wireless Internet (see *Wired Child* at [www.wiredchild.org](http://www.wiredchild.org) for more information).
- Do not use a laptop (a notebook computer) in your lap if it has a wireless card (for wireless Internet). The strength of the wireless emission is very high, similar to having a cell phone transmitting in your lap.
- Avoid multiple trips through security gates in retail stores. Never let children play between or linger near the panels. These panels create huge RF exposures.

- Medical MRI and ultrasound scans are sources of EMF and should be used only for diagnostic purposes where clearly indicated. Discuss the necessity of these exposures with your physician if one is recommended for you or your child.
- Use single-pole light switches and avoid dimmer switches (rheostat lighting).
- Avoid compact fluorescent bulbs (even though they are more energy efficient). Use LED or incandescent light bulbs. They emit no dirty power or low-kilohertz frequency RF back onto your electrical wiring.
- Position beds, desks and living space away from electrical panels in your home if possible.
- Check about opting out of “smart meter” service with your local utility if it’s being implemented.

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## What if I am pregnant or have small children?

- Avoid wireless communications devices (cellular and cordless phones, iPhones, BlackBerry and other similar devices); and ask others around you to keep their distance during use of a cell or cordless phone.
- Avoid using a cordless or cell phone or PDA when carrying an infant or small child.
- Avoid using wireless routers and wireless laptops. Cable Internet is fine.
- Avoid Wi-Fi zones for extended periods of exposure (work, home, school).
- Avoid electric heating (radiant ceiling or floor heating that is from electrical wiring); water heating in floors is fine.
- Avoid electric blankets and heating pads; if you use an electric blanket to preheat your bed, you must unplug it before sleeping and not just turn it off — the electric field is still generated whenever the item is plugged in, even if it’s turned off.
- Limit ultrasounds during pregnancy to those deemed medically necessary. Ultrasound uses pulsed sound waves and non-ionizing radiation to produce images, but both can heat tissue (a risk factor for the developing fetus and its nervous system and internal organs). There are studies reporting that the use of a cellular phone during pregnancy increases the risk for a child’s learning and behavior by the time they are in primary school.
- Do not give wireless devices to toddlers or children as pacifiers or distractors. Do not place a cell phone or smart phone in a crib to sooth a baby with music.
- Do not use baby monitors.
- Choose wired cable Internet to make Internet calls (such as through Skype) to the grandparents. Do not hold a wireless iPad or cell phone up to the face or body of an infant or child to talk or call over the Internet.

## What about cell phone use and driving?

In addition to concerns about RF from mobile phones, neither talking nor texting is safe while driving. For the safety of yourself, your passengers, and others sharing the road with you, we strongly encourage you to hang up and drive (laws in many

locations reinforce this). Do not return calls or texts while driving. Do not take calls while driving. Collect messages when you arrive at a safe spot. Get a built-in, hands-free car-phone jack and hook up the antenna outside the car, if possible.

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### **Additional resources**

- [www.bioinitiative.org](http://www.bioinitiative.org)
- [www.emrpolicy.org](http://www.emrpolicy.org)
- [www.emfsafetynetwork.org](http://www.emfsafetynetwork.org)
- [www.healthandenvironment.org/initiatives/emf](http://www.healthandenvironment.org/initiatives/emf)
- [www.ultrasound-autism.org](http://www.ultrasound-autism.org)
- [www.powerwatch.org](http://www.powerwatch.org)
- [www.wiredchild.org](http://www.wiredchild.org)

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### **More information about the scientific basis for this column can be found in these documents:**

- Sage C, Carpenter DO. (Eds.), (2007) *Bioinitiative Report: A rationale for a biologically-based public exposure standard for electromagnetic fields (ELF and RF)*. BioInitiative Working Group, [www.bioinitiative.org](http://www.bioinitiative.org)
- Sage C, Carpenter DO. (2009). Public Health Implications of Wireless Technologies. *Pathophysiology*. 16(2-3): 233-246.

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**For more information or for other Practice Prevention columns, visit the Collaborative on Health and the Environment online at [www.healthandenvironment.org](http://www.healthandenvironment.org) or call 360-331-7904.**



District Office  
200 Douglas Street  
Petaluma, California  
94952  
USA

4 August, 2016

Dear Petaluma City Schools;  
Superintendent Gary Callahan and Board of Trustees

**Regarding: Wireless technology should not be used in schools or pre-schools due to health risks for children and employees**

We have been asked to declare our opinion about wireless technology in schools by parents that are concerned about their children.

Based on current published scientific studies, we urge your administration to educate themselves on the potential risks from wireless technologies in schools, and to choose wired teaching technologies. The well-being and educational potential of children depends on it.

High-speed connectivity to schools is important but it can be a wired connection instead of Wi-Fi. Wireless classroom infrastructure and wireless devices for schoolchildren should be avoided for these reasons:

- Wireless radiofrequency (RF) radiation emissions were classified as a Possible Human Carcinogen (group 2B) by the World Health Organization International Agency for Research on Cancer (IARC) in May 2011. One of the signers, Dr Hardell, was part of the evaluation group.
- The IARC classification holds for *all forms of radio frequency radiation* including RF-EMF emissions from wireless transmitters (access points), tablets and laptops.
- Epidemiological studies show links between RF radiation exposure and cancer, neurological disorders, hormonal changes, symptoms of electrical hypersensitivity (EHS) and more. Laboratory studies show that RF radiation exposure increases risk of cancer, abnormal sperm, learning and memory deficits, and heart irregularities. Foetal exposures in both animal and human studies may result in altered brain development in the young offspring, with disruption in learning, memory and behaviour.
- Recently a report was released from The National Toxicology Program (NTP) under the National Institutes of Health (NIH) in USA on the largest ever animal study on cell phone RF radiation and cancer (<http://biorxiv.org/content/biorxiv/early/2016/05/26/055699.full.pdf>). An increased incidence of glioma and malignant schwannoma in the heart was found. Interestingly our research group and others have in epidemiological studies shown that persons using wireless phones (both mobile phones and cordless phones; DECT) have an increased risk for glioma and acoustic neuroma. Acoustic neuroma or vestibular schwannoma is the same type of tumour as the one found in the heart, although benign.
- The research showing increased brain cancer risk in humans *has strengthened* since the IARC 2011 classification as new research has been published which repeatedly shows a significant association after RF radiation exposure. In addition, tumour

promotion studies have now been replicated showing cancer promotion after exposures at low levels.

- It is our opinion and that of many colleagues that the current IARC cancer risk classification should move to an *even higher* risk group. The carcinogenic effect has been shown in human and animal studies. Several laboratory studies have shown mechanistic effects in carcinogenesis such as oxidative stress, down regulation of mRNA, DNA damage with single strand breaks.
- In summary RF radiation should be classified as Carcinogenic to Humans, Group 1 according to the IARC classification. This classification should have a major impact on prevention.

The evidence for these statements is based on hundreds of published, peer-reviewed scientific studies that report adverse health effects at levels much lower than current ICNIRP and FCC public safety limits. Compliance with government regulations does not mean that the school wireless environment is safe for children and staff (especially pregnant staff).

As researchers in cancer epidemiology and RF radiation exposures, we have published extensively in this area and it is our opinion that schools should choose wired Internet connections. Multiple epidemiological research studies show that exposures equivalent to 30 minutes a day of cell phone use over ten years results in a significantly increased brain cancer risk.

What will be the health effect for a child exposed all day long in school for 12 years? Wireless networks in schools result in full body low level RF radiation exposures that can have a cumulative effect on the developing body of a child. No safe level of this radiation has been determined by any health agency and therefore we have no safety assurances. Cancers can have long latency periods (time from first exposure until diagnosis) and it will take decades before we know the full extent of health impacts from this radiation. The statistics and effects will be borne by the children you serve.

Wi-Fi in schools, in contrast to wired Internet connections, will increase risk of neurologic impairment and long-term risk of cancer in students. Promoting wireless technology in schools disregards the current health warnings from international science and public health experts in this field.

We recommend that your school district install wired Internet connections and develop curriculum that teaches students at all ages safer ways to use their technology devices. If cell phones and other wireless devices are used in the school curriculum (as many schools are now doing with Bring your Own Device Policy) then there should be educational curriculum in place and well posted instructions in classrooms so that the students and staff use these devices in ways that reduce exposure to the radiation as much as possible.

Supporting wired educational technologies is the safe solution in contrast to potentially hazardous exposures from wireless radiation.

Respectfully submitted

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INTERNATIONAL POLICY BRIEFING  
**Radiofrequency Radiation in Communities and Schools  
Actions by Governments, Health Authorities and Schools Worldwide**

Please go to source documents by clicking on the blue underlined hyperlink.

(Please email [info@ehtrust.org](mailto:info@ehtrust.org) for comments/updates as we do our best to ensure accuracy but the policy landscape is always changing. This is a living document.)

## France

[2016 The National Agency of Health Security of Food, Environment and Labour Report](#) recommends

- regulatory changes to ensure "sufficiently large safety margins" to protect the health of young children.
- "ALL wireless devices, including tablets, cordless phones, remote controlled toys, wireless toys, baby monitors and surveillance bracelets, should be subjected to the same regulatory obligations as cell phones."

[National Legislation "Law on sobriety, transparency, information and consultation for exposure to electromagnetic waves" passed in 2015.](#)

- **WiFi Banned in Nursery Schools:** WIFI and Wireless devices will be banned in "the spaces dedicated to home, to rest and activities of children under 3 years".
- **WiFi on "OFF" as Default to Minimize Exposures in Schools:** In elementary schools, WIFI routers should be turned off when not in use.
- **Schools Will be Informed:** The school board should be informed when new tech equipment is being installed.
- **Cell Tower Emission Compliance Will Be Verified:** A decree will define the limits of emission of equipments for electronic communications or transmission to which the public is exposed. These values can be verified by accredited organizations and results will be made accessible to the public through a National Radiofrequency Agency.
- **Citizens Will Have Access to Environmental/Cell Tower Radiation Measurements** Near homes: Every resident may get access to the results of measurements for their living space.
- **Cell Antennae Maps For the Country:** A description and map of the places with atypical (higher than the limits) places will be conducted at regular intervals with follow up of the actions being taken to limit the exposure. A map of all antennas will be produced for each town.
- **Continued Evaluation of Health Effects:** The National Radiofrequency Agency will be in charge of surveillance and vigilance, evaluating potential risks and setting up scientific research, including information on health effects.
- **SAR Radiation Labeling Mandated:** The SAR of cell phones must be clearly indicated on the package.
- **Information on Reducing Exposures Mandatory:** Information on ways to reduce exposure will be detailed in the contents of the cell phone package. .
- **WiFi Hotspots will be Labeled:** Places where WIFI is provided should be clearly marked with a pictogram.

- Advertisements Must Recommend Devices That Reduce Radiation Exposure to the Brain: Advertising for cell phones should clearly indicate the recommendation of hand free kits for protection of the head of the user and it will be included in the package. Advertising for cell phone not accompanied by such a kit is forbidden. Companies in violation will be fined 75,000 Euros.
- **Children Must Be Provided Protections:** At the request of the buyer, equipment reducing cell phone radiation exposures to the head for children less than 14 years should be provided.
- **The Public Will Be Informed:** Within a year, a policy of information on awareness and information on a responsible and reasonable use of cell phones and other apparatus emitting radiofrequencies will be set up.
- **Electrohyper-sensitivity Report To Be Submitted:** Within a year, a report on electrohyper-sensitivity must be given to the Parliament *according to the law*.

France: As of January 2017, new regulations aimed to protect employees from electromagnetic fields emitted by the electronic devices present in the workplace. A decree was issued by the French Government on 6 August 2016:

- Specific precautions will be taken regarding pregnant women.
- It is forbidden to place workers under age 18 in posts where EMF is apt to exceed limit values
- each employer has to evaluate EMF risks.
- When exposure exceeding limit values is detected or when an undesirable or unexpected health effect from exposure to EMF is reported, the worker will benefit from a medical visit.
- The employer must provide information and training to his employees regarding the characteristics of EMF emissions, the direct and indirect biophysical effects that could result from exposure to EMF, etc.
- The employer must adapt as much as possible the post in order to limit exposure to EMF.
- [Read about it here.](#)

#### [2011 French Cell Phone Statute:](#)

- Merchants must display SAR Radiation levels for different phone models, all phones must be sold with a headset, cell phone ads aimed at children younger than 14 are banned and phones made for children under 6 are banned.

#### [2013 French Agency for Food, Environmental and Occupational Health & Safety Report](#)

- Recommends hands free phones, SAR labeling, and “limiting the population's exposure to radiofrequencies... especially for children and intensive users, and controlling the overall exposure that results from relay antennas.”
- [The French National Library](#) along with other libraries in Paris, and a number of universities have removed all Wi-Fi networks.
- [Herouville-Saint-Clair](#) has removed all Wi-Fi equipment installed in municipalities.

The City of Lyon France ran a Campaign “No Cell Phone Before 12 Years old” [See colorful poster here.](#)

## Belgium

[Federal Public Health Regulations](#) passed on March 2013 due to Health Concerns for Children.

- **Phones designed for children under 7 years old are prohibited from sale.**
- **Total Advertising Ban on cell phones aimed at children.**
- Mandatory Radiation SAR levels must be available for consumers at point of sale.
- Warning label on phones: **“Think about your health – use your mobile phone moderately, make your calls wearing an earpiece and choose a set with a lower SAR value.”**
- Recommendations include use of hands-free methods to keep the phone away from the body

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such as text messaging and not making calls when the signal is weak, such as in elevator/vehicle.

- See examples of the posters that shops must display.
- Read Belgium's [frequently asked questions about the new law](#).
- [Powerpoint Presentation IMPLEMENTATION OF the Council Recommendations in Belgium Introduction of new rules for mobile phone sales Presentation by Dr.Marina Lukovnikova \(Ministry of Public Health, Belgium\)](#)
- [Read the Belgium Health Food and Safety Brochure on Wireless devices here.](#)
- [Read Dr. Moskowitz Press Release on the Belgium Law.](#)
- Read the News article [Flanders Today: Belgium bans sale of mobile phones designed for children](#)
- The Belgian Foundation Against Cancer warns that intensive use of a mobile phone can increase the risk of contracting cancer. They suggest that children younger than 12 should not use a mobile phone, and that using a mobile phone as an alarm clock is not desirable because the phone is in close proximity to the head the entire night. The Cancer Foundation also strongly advises people not to use a mobile phone in the car or a train. [Read it here.](#)
- [Read the World Health Organization Belgium Report detailing the Law here.](#)

### **Belgium Health Agency Recommendations to Reduce Exposure**

- [Read Belgium's Statement on Wireless Networks](#): "to reduce your exposure" which includes specific tips for Wi-Fi installations and I quote, " In order to limit the exposure, the following simple measures can be taken: Only switch on your wireless network connection when it is needed. This concerns the wifi adapter in your laptop in particular. Otherwise, your laptop tries to continually connect to the network, and that leads to unnecessary exposure and decreases the life expectancy of the batteries. Place the access point away from places where you spend lots of time."
- Read Belgium's [Tips for Reducing Cell Phone Exposure HERE](#); "Experts – including those on the [Superior Health Council\(link is external\)](#) – advise everyone to limit their exposure to mobile phone radiation. The following simple tips will help you."
- [Children and Cell Phones](#): "The use of the mobile phone by children is a special point of attention. Children may be more sensitive to radio waves. Children absorb twice as much radiation in the brain than adults do, and 10 times more in the bone marrow of the skull. In addition, due to the popularity of the mobile phone, the cumulative exposure of the current generation of children will be much higher by the time they reach their adulthood than that of the current adults."

Belgium [Ghent Municipality](#): Wireless internet is banned from spaces that cater to children between 0 and three: preschools and daycares to reduce exposure to microwave radiation. [Read news article about the ban here.](#)

## **Spain**

- [The Parliament of Navarra voted to urge removal of WIFI in schools](#) and to apply the precautionary principle in relation to exposure limits to electromagnetic fields whose boundaries have become "obsolete".
  - The Parliament voted to adopt a resolution which calls to implement the Parliamentary Assembly of the Council of Europe resolution 1815 of 2011, which recommends to "review the scientific basis for the standards of exposure to electromagnetic fields" and " set thresholds for levels of preventive long-term exposure in all indoor areas not exceeding

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0.6 volts per meter ".

- **2016 The High Court of Madrid recognizes “Electrosensitivity” as grounds for disability:** A telecommunications engineer who worked at Ericsson had his sensitivity recognized. "This is the first we have achieved total disability due exclusively to this syndrome," says attorney Jaume Cortés, the Col·lectiu Ronda. [Read the news article here.](#)
- [The Vitoria City Council unanimously approved](#) a precautionary approach with wireless: Citizens will be informed of the location of wireless transmitters in civic centers and municipal buildings. It is recommended that children's spaces such as playgrounds and family libraries, will be free of WiFi or have decreased wifi and wifi free zones will be established in playgrounds and building entrances.
- **The Basque Parliament** joined the resolution of the Parliamentary Assembly of Council of Europe in 2011, which warns of the "potential risk" of electromagnetic fields and their effects on the environment and urged the promotion of campaigns against "excessive use "mobile phones among children. In a statement, the parliamentary Aralar, Dani Maeztu stated, "To protect children's health, recommends the implementation of information campaigns and portable devices that emit microwaves, and prioritizes the use of cable connections in schools."
- **City of Tarragona Municipal Government (Tarragona is a major city 100 kilometres south of Barcelona) approved the “Institutional Declaration of support for people with Central Sensitivity Syndromes”**
  1. Carry out (with a yearly update) a diagnosis and census of those affected by CSS in the City of Tarragona, showing what is the actual situation and the specific needs of these patients and their families.
  2. An intervention protocol for the staff of the Area of Services to Citizens of the Tarragona City Government to look after those with CSS- including a list of economic subsidies for food, first necessity elements, reduced water bill, and home help specific to the needs of these patients.
  3. Housing protocol for people with CSS, especially those who have MCS and/or EHS, those threatened by eviction or those who are forced to leave their home. This protocol has to include a series of safe social housing (green/white spaces: free of xenobiotics and electromagnetic waves).
  4. Create green/white spaces in all municipal buildings (free of xenobiotics and electromagnetic waves).
  5. Eliminate, as much as possible, the use of pesticides in the whole of the municipality. In the case when this is not possible, establish a communication protocol to contact those affected and the press regarding the places and dates of the interventions with preventive advice.
  6. Training for social workers and educators about CSS, its social, health and economic reality. Elaboration of information and education to increase the knowledge about these illnesses amongst the general population and of the city workers in particular, with the objective of diminishing the stigma that is now present regarding these illnesses.
  7. Protocol for adapting working conditions of the municipal workers who have CSS with specific measures of support when having a flare up. These would be the measures: work schedule flexibility, encourage work from home through internet (teleworking), reserved parking spaces and include in the collective agreement not deduct the salary of the first 20 days of sick leave.
  8. [Read the full article detailing the actions here.](#)

## Canada

- **Health Canada offers “Practical Advice”** on reducing exposure to wireless radiation: 1. Limit the length of cell phone calls, 2. Replace cell phone calls with text, use "hands-free" devices and 3. Encourage children under the age of 18 to limit their cell phone usage. [Read it here.](#)  
*“Health Canada reminds cell phone users that they can take practical measures to reduce RF exposure. The department also encourages parents to reduce their children's RF exposure from cell phones since children are typically more sensitive to a variety of environmental agents. As well, there is currently a lack of scientific information regarding the potential health impacts of cell phones on children.”*
- [Canadian Parliament Standing Committee on Health of the House of Commons issued a report "Radio Frequency Electromagnetic Radiation and the Health of Canadians"](#) on June, 2015 after holding public hearings regarding Health Canada's Safety Code 6 recommended limits. They made 12 recommendations including an awareness campaign on reducing exposures, improved information collecting and policy measures regarding the marketing of radiation emitting devices to children under the age of 14, "in order to ensure they are aware of the health risks and how they can be avoided."
- **2015: National Bill C-648 was Introduced into the House Of Commons.** “An Act Respecting the Prevention of Potential Health Risks From Radiofrequency Electromagnetic Radiation” would require manufacturers of all wireless devices to place specific health warning labels clearly on packaging, or face daily penalties /fines and/or imprisonment. Although the Bill did *not pass*, it made headlines. Press Conference for [Bill C-648 Video.](#)
- Canadian Pediatric Association issued a Position Statement [Healthy active living: Physical activity guidelines for children and adolescents](#) which states:  
For healthy growth and development: screen time (eg, TV, computer, electronic games) is not recommended for children under 2 years old. For children 2-4 years, screen time should be limited to <1 h/day; less is better. [Read the Position Statement Here.](#)

## European Parliament

**Resolution 1815:** In 2011 The Parliamentary Assembly of the Council of Europe issued *The Potential Dangers of Electromagnetic Fields and Their Effect on the Environment.*

*A call to European governments to “take all reasonable measures” to reduce exposure to electromagnetic fields “particularly the exposure to children and young people who seem to be most at risk from head tumours.”* The Resolution calls for member states to:

- Implement “information campaigns about the risk of biological effects on the environment and human health, especially targeting children and young people of reproductive age. “
- “Reconsider the scientific basis for the present standards on exposure to electromagnetic fields set by the International Commission on Non-Ionising Radiation Protection, which have serious limitations, and apply ALARA principles, covering both thermal effects and the athermic or biological effects of electromagnetic emissions or radiation.”

*“For children in general, and particularly in schools and classrooms, give preference to wired Internet connections, and strictly regulate the use of mobile phones by schoolchildren on school premises.”* [Read Resolution 1815](#)

[Read the 2009 Resolution: Health concerns associated with electromagnetic fields calling for a review of the issue.](#)

## Australia

The Australian Radiation Protection and Nuclear Safety Agency has issued a [Fact Sheet](#) titled *How to Reduce exposure from mobile phones and other wireless devices*.

- Reduce the risk from WiFi devices by “keeping them at a distance, for example placing the wireless router away from where people spend time”, and “reducing the amount of time you use them”.
- ARPANSA recommends that parents encourage their children to limit their exposure stating that “It is recommended that, due to the lack of sufficient data relating to children and their long term use of mobile phones, parents encourage their children to limit their exposure by reducing call time, by making calls where reception is good, by using hands-free devices or speaker options, or by texting.” [Read it HERE.](#)

Queensland Department of Education, Training and Employment issued [Your Guide to Safe Technology](#) guide in 2015 to all schools that states:

*It's not only physical hazards you need to consider when thinking about health and safety issues at work or home — you should also think about how you use technology. When using a computer, you need to think about:*

- ergonomics and posture
- radiation
- vision impacts
- harmful lack of exercise (DVT).

*“Wireless devices — smart/mobile phones, tablets, slates, monitors etc — all emit low levels of electromagnetic radiation and should be used correctly. When using electronic devices, the department recommends you follow WiFi/3G/4G best practice:*

- *follow the manufacturer's usage guideline operate from a table or bench — not on your lap*
- *use 'hands-free' devices to keep smart/mobile phones away from your head and body during phone calls limit the number and length of calls*
- *position the device antenna away from your body*
- *do not sit within 0.5 m of a wireless router use smart/mobile phone in areas of good reception to reduce exposure.”*
- [Watch a video on these recommendations here.](#)

## New Zealand

[Rotokawa School implemented steps to minimize RF Exposure](#) on 2/2/2016

After concerns raised about e-learning by a small group of parents from the school, the principal has put some positive procedures in place as follows;

- Children will use ipads in flight mode
- Children using laptops and Chromebooks will work on the desk top
- Parents may request that their child use an Ethernet cord to access the internet
- Children are taught about the health precautions as part of their cyber citizenship
- Digital learning in the one to one Year 5 & 6 environment is kept to less than 2 hours per school day.

- The principal has also stated there are no plans to increase the existing Wi-Fi coverage at this stage.

## Italy

- **2016: Mayor of Borgofranco d'Ivrea has ordered Wi-Fi to be turned off in schools.** “Mayor Livio Tola told the town's high school and elementary school to return to using cables to connect to the internet after reading that the electromagnetic waves given off by wireless routers were especially harmful to young children.” [Read the newspaper article here.](#) [Read the News article here](#) “Ivrea, The Mayor Removes WiFi as it Could Be Dangerous”.
- **On June 10, 2015, the State Parliament of South Tyrol voted to [allow the application of the precautionary principle](#) mandating the state government to:**
  - 1. To replace existing wireless networks whenever possible with networks that emit less radiation at schools, preschools, hospitals, nursing homes, and other public facilities.
  - 2. Establish a working group whose mandate it is to assess these new technologies and their exposure levels. With regard to wireless communication technologies, mobile Internet access, and public health, the working group shall clarify which technologies emit less radiation and provide sustainable technology options and
  - 3. To start an education and awareness campaign that informs about possible health risks, especially regarding the unborn, infants, children, and adolescents and that develops guidelines for a safer use of cell phones, smartphones, and Wi-Fi ...[Discussion at the Plenary Session, 10 June 2015 \(in German\)](#) //Official Files, Resolutions (in German) //Previous Hearing at the Parliament of South Tyrol, 29 April 2015 (in German)
- **The [Italian Supreme Court](#) ruled a man’s brain tumor was caused by his cell phone use in 2012.** The National Institute for Workmen’s Compensation must compensate a worker with head tumor due to cell use. [Read news article with details here.](#) Read Daily Mail article [Mobile phones CAN cause brain tumours, court rules in landmark case.](#)
- **A school In Lecce, Italy, "Istituto Comprensivo Alighieri- Diaz" banned wifi.** Their two resolutions decided: a) to ban wifi in school and install a wired system for the use of internet and b) Reject the request of the local government (Municipality) to install an antenna on the school roof for the wireless signal providing for the "Wireless city" program. The resolution also asks the Municipality to install the antenna at a reasonable distance from school.[Read the official resolutions number 1 here](#) and [Resolution 2 Here.](#)
- **The Piemonte Region has adopted a resolution to limit EMF exposure,** to limit the use of wifi in schools and be considerate to the problem of EHS people. [Read about it here.](#)
- **The Italian Society for Preventive and Social Pediatrics has officially called to prohibit cell phones for children under 10 years old.** Giuseppe Di Mauro, president of the Italian Society of social and preventive pediatrics [Società italiana di pediatria preventiva e sociale ([www.sipps.it](http://www.sipps.it))] “We do not know all the consequences associated with cell phone use, but excessive use could lead to concentration and memory loss, increase in aggressiveness and sleep disturbances.” and he cites electromagnetic fields stating “The damage to health are increasingly evident” [Read it here.](#)

- **Turin Mayor Chiara Appendino laid out plans “to cut back on Wi-Fi in state schools and government buildings over concerns that radiation might damage people's health”**. Read 7/2016 News Report [Turin could slash Wi-Fi over 'radiation' concerns](#)

## Finland

In 2015 the Radiation and Nuclear Safety Authority (STUK) revamped their public information website to recommend reduced exposure to children and state the following:

- The page [Mobile phones are a major source of radio frequency radiation](#) states that, ‘The level of exposure to radiation from a mobile phone held next to user’s ear can approach the exposure limits. *Never before have humans been exposed to equally strong sources of radiation in their living environments.* Identifying any health impacts is highly important because practically everybody uses a mobile phone today.”
- [Read STUK Recommendations to reduce cell phone exposure HERE](#): Use a hands free device, don’t use phones reception is poor, the phone should be kept on a table or similar location instead of in the user’s pocket.
- “STUK recommends that unnecessary exposure to radiation from mobile phones be avoided. In particular, children’s unnecessary exposure should be avoided as their life-long exposure will be longer than that of those who begin using mobile phone as adults and as only scant research exists on health effects to children.”

In 2009 the Radiation and Nuclear Safety Authority (STUK) initially issued recommendations to reduce exposure with more explicit cautionary language.

- [Read the information posted on the STUK website in 2009- now removed.](#)
- [Read a policy position paper by STUK from 2009](#) detailing why “It would be good to restrict children’s use of mobile phones.”
- [Read the 2011 policy position from STUK.](#)
- [Read a news article from 2009](#) when STUK first recommended restricting the use of mobile phones by children.

## Israel

- **2016: Cell Phones are banned in school classrooms as a classroom tool** per a memorandum from the Ministry of Education. [Watch a newsreport on the cell phone action here.](#)
- **Cell Phone Consumer Protection Law:** Compulsory cell phone labeling, radiation information provided to consumers. A mobile phone may not be sold unless they comply with the following:
  - A clearly visible sticker on cell phone packaging that says, “This mobile phone emits non-ionizing radiation; details and information about the radiation levels of this mobile phone model and the maximum permissible level of radiation are included in the attached leaflet.”
  - The packaging must include an **information leaflet** in Hebrew, Arabic and Russian with SAR information.
  - The information must be clearly displayed to the public at points of sale of mobile phones, service provision centers, websites of manufacturers, suppliers and service providers of mobile phones.
  - [Consumer Information leaflet by Forum of Mobile phone Manufacturers \(Hebrew\)](#)
  - [Compulsory Marking/Provision of Information on Non-Ionizing Radiation](#)

- **Israeli Ministry of Health Recommends Reducing Exposure to Cell Phone Radiation.**  
*“These expert committees determined that there are indeed gaps in the knowledge concerning the implications of exposure to this radiation, and therefore they called for further studies on the subjects and recommended to adopt the **“precautionary principle”**. This principle adopts simple and relatively cheap means to reduce exposure to the minimum radiation levels possible with existing technology.”* [Read the Ministry of Health Cell Phone Radiation page.](#)

**Cell Phone Measures that [the Ministry of Health recommends:](#)**

- Using the speakerphone/headset during conversation.
- Keep the phone away from the body.
- Reduce the amount and duration of calls made on a cell phone.
- Areas of low reception equals higher radiation (low cell tower reception, elevator, car, train) Reduce call time in these low reception areas.
- While driving, it is best to talk as little as possible on the mobile phone, and follow the law which bans handheld phones. Inside vehicles, it is advisable to install an antenna outside the vehicle and not inside it, and to prefer wire connections between the phone and the speaker- rather than blue-tooth.
- **The Ministry Health recommends precautions especially for children.**

“In particular, it is recommended to follow precautionary rules in the children population who are typically more sensitive to cancer development due to exposure to cancerous agents...the Ministry of Health advises parents to reduce children’s exposure to mobile phones as much as possible, consider the age they start using them, reduce the amount of time mobile phones are used, and in any event, make sure they use earphones (not wireless) or a speaker when using the mobile phone.”

- [The Israeli Ministry Of Education](#) has issued guidelines limiting WiFi radiation in schools.
  - Wireless networks banned in preschool and kindergartens.
  - 1st. & 2nd. grade internet is limited to max. 3 hr. per week of internet.
  - 3rd grade maximum 8 hours a week.
  - A hard wired direct cable connection is required if the teacher has a computer in the class.
  - Recommendations for reducing magnetic fields to below 4 mG for children under 15 in schools representing the government's position that international guidelines are NOT protective of children.

The Israeli Government created the EMF public education webpage [Israeli National Information Center for Non-Ionizing Radiation](#) (TNUDA) to raise awareness of the public which includes sections on:

TNUDA Recommendations to [Reduce exposure to EMF in the home:](#)

- Home Cordless Phones: Keep the base out of rooms where you spend many hours a day in.
- Laptop: Keep laptop away from the body. Reduce exposure by turning Wi-Fi off when not in use or using ethernet connections - not Wi-Fi.
- Tablets: You can reduce exposure by downloading applications and turning Wi-Fi off.
- Baby Monitors: Since they have RF and ELF Emissions, keep a distance as much as possible from devices.
- Sleeping areas: It is recommended to keep all radiation emitting devices ( home cordless phones, routers) away from sleeping areas or where you spend hours a day.
- [Read more- including floor heating, microwaves and other devices.](#)

Electrical Exposures ELF-EMF: The recommendations of the Ministry of Environment and the Ministry of Health maximum permissible level of exposure to ELF in places of prolonged chronic exposure such as residences is 4 mG. [Read it here](#). Despite this recommendation, regulations are only specific to elementary schools to ensure a 4 mg limit.

**2016: The Mayor of Haifa (Israel's third largest city) calls for the removal of Wi-fi from all schools.**

- Haifa Mayor Yona Yahav, said that "When there is a doubt, when it comes to our children, there is no doubt". Read the News Report [The - Wi-Fi in kindergartens and schools in Haifa](#).
- "The roots of the decision go back to a 2013 petition by parents in four schools who claim that such networks are harmful. The case eventually made its way to the High Court, which has postponed a final decision on the matter...The movement has spread from Haifa to other cities as well, and petitions have been signed by parents in dozens of cities demanding the removal of the networks. Haifa is the first city to take action on the matter. Haifa Mayor Yona Yahav said that the city would replace the wireless network with a wired connection that will provide safer options to students." [Read the news article here](#).
- This action occurred after this Israeli [TV Documentary – "HOW WE ARE KILLING OURSELVES – WIRELESS RADIATION"](#) aired.
- The school system has developed in house ability to ethernet connect computers in schools, however *in practice*, school communities are choosing to continue to use wireless despite the ability to be fully hardwired.

Read the official [ISRAEL 2015 RF Safety Report](#) with actions being taken to reduce ELF and RF EMF.

**Cellular operators must inform consumers about radiation safety instructions.**

According to a settlement agreement accepted by the Tel Aviv-Yafo District Court in February 2014, cellular operators have to inform buyers of new mobile phone about the radiation safety instructions, including the minimum distances from the head and the body. Hand-free kits must be provided with every new mobile phone and each cellular operator has to provide information on the safe use of mobile phones on its website. [Read more](#).

**The Ministry of Health published [Environmental Health in Israel 2014](#)** which states that "Precautions should be strictly enforced with regard to children, who are more sensitive to developing cancer." and that "wireless communication networks in schools be reduced." The Health Ministry recommends "sensible use of cellular and wireless technology, including: considering alternatives like landline telephones, use of a speaker while talking on a cellphone, and refraining from installing the base of wireless phones in a bedroom, work room, or children's room." The Report states that "Findings in Israel clearly indicated a link between cellphone use for more than 10 years and the development of tumors in the salivary glands, particularly among people who held the telephone on the same side where the tumor developed and individuals in the highest category of exposure (heavy use in rural areas)."

- Linda S. Birnbaum, Director, USA National Institute of Environmental Health Sciences and National Toxicology Program wrote in the Israeli Report final chapter that, "*If some of the studies turn out to be harbingers of things to come, we may have major health consequences from the nearly ubiquitous presence of wireless equipment.*"

**Note:** Despite the precautionary recommendations of the Health Ministry and the statements in Education Ministry regulations for the preference of wired (not wireless) networks- the reality is that wireless is still being deployed in schools. The *actual practice* in Israel is different than *the official stance*

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and this has prompted strong outcry from doctors, parents and citizens for the government to be accountable to children's health. [A 2016 News Report shows the complex picture](#) whereby no agency is assuming responsibility for ensuring protections. Although smartphones are banned as an educational classroom tool, the Education Ministry is still [promoting the use of digital tools](#) that are used for Smartphones, such as [Kahoot](#).

### Notable News Stories

[2016 TV Report on Israeli government on WiFi Health Concerns: For english subtitles click CC.](#)

2009 News article on the cell phone guidelines in Israel [Health Ministry.: Limit Kids' Use of Cell Phones](#)

### Notable History

In 2012 Israel's deputy Minister of Health Rabi Litzman [stated](#) that he supports a ban on Wi-Fi in schools. Currently the Health Minister is relying on scientific recommendations of Dr. Sadesky.

[Read the 2012 Israeli National Activity Report on EMF](#) which states that a joint ministerial committee of the Education & Health & Environmental Protection Ministries gave advice to the Education Minister for ethernet connections in schools- not wireless. The Environmental Protection Ministry asked to limit the use of cell phones in buses and to prohibit the use of cell phones in elevators.

In 2013 a court case moved through the [the Israeli Supreme Court](#) on Wi-Fi radiation in classrooms. The 2015 Israeli Supreme court decision was that that the court sees no reason to intervene with the (Israeli) Education Ministry deployments of wireless network at schools.

### Israeli Government Links

[Ministry of Environmental Protection Webpage on Non-ionizing Radiation](#), [Interactive Map of Cell Tower Locations](#)

[Ministry of Health Webpage on Cell Phone Radiation](#)

[Israeli National Information Center for Non-Ionizing Radiation TNUDA](#)

## Switzerland

- **The Switzerland Federal Office for the Environment FOEN** has [a webpage on Wi-Fi](#) which states "caution should be exercised primarily when using devices held close to the body, such as laptops, PDAs and Internet telephones.." and gives recommendations on how to reduce exposure including turning the Wi-Fi off when not in use, installing the access point one metre away from places where you work, sit or rest for long periods of time and keeping laptops off laps.
- **The Switzerland Federal Office for the Environment FOEN** has [a webpage on Cell Phones](#) which details ways to reduce mobile phone radiation. FOEN also has additional EMF factsheets on various EMF sources including on [baby monitors](#) where they state that "it is **advisable to reduce the infant's exposure to emissions as far as possible.**"
- **The 2015 Environmental Report Chapter 17 on Electromog** states "Effects can also be detected for weak radiation intensity. For example, weak high-frequency radiation can alter electric brain activity and influence brain metabolism and blood flow. Whether these effects have an impact on health is still unclear" and recommends the precautionary principle to reduce risk "Because major gaps still exist in our knowledge about the health impacts of long-term exposure to weak non-ionising radiation, the adopted protective strategy should be pursued consistently." [Read it here.](#)

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- [Switzerland FOEN 2012 Radiation of radio transmitters and Health](#) “In view of the fact that there are gaps in the available data, the absence of proof of health risks does not automatically also mean proof of their absence. From the scientific point of view, a cautious approach in dealing with non-ionising radiation is still called for. There remains a need for extensive research into the potential long-term effects”
- [The Governing Council of Thurgau Canton](#) 2008 “The Governing Council recommends for schools to forgo the use of wireless networks when the structural makeup of a given school building allows for a wired network.” [Read a letter by the Council here.](#)

### Swiss Physicians Association of Doctors for Environmental Protection

[2012 Swiss Physicians Letter](#) “the risk of cancer for this type of [wireless] radiation is similar to that of the insecticide DDT, rightfully banned... From the medical point of view, it is urgent to apply the precautionary principle for mobile telephony, WiFi, power lines, etc.”

[2014: Preliminary draft for a federal law on the protection against dangers:](#) Non-ionizing radiation (NIS) is growing steadily. Especially the everyday stress in the area of low-frequency and high-frequency. [Read it here.](#)

[2016: Press Release on the NTP Study and Policy Implications:](#) “There are increasingly clear indications that mobile radio is a health hazard. From a medical point of view it is clear: the scientific results so far show it is clear that prudent avoidance of unnecessary exposures is necessary.”

- Additional Links by Swiss Physicians for the Environment  
Report on [Smartphones- \(OEKOSKOP 1/16\)](#) [AefU-News about Electromog](#)

## Germany

- The Federal Office for Radiation Protection (FORP) provides tips for reducing radiation exposure to smartphones, tablets and wireless devices stating, “*Since long term effects could not be sufficiently examined up to now the Federal Office for Radiation Protection (BfS) recommends to keep exposures to these fields as low as reasonably achievable.*” [Read the precautionary advice here.](#)

“There are uncertainties in the [risk](#) assessment that the German mobile communications research programme has not been able to remove completely. These include in particular:

- possible health risks of the long-term exposure of adults to [highfrequency](#) electromagnetic fields when making mobile telephone calls (intensive mobile use over more than 10 years)
- the question of whether the use of mobile phones by children could have an effect on health.

For these reasons, the BfS continues to consider that precautionary measures are necessary: exposure to electromagnetic fields should be as low as possible.”

- **Smartphones and Tablets:** [Read the webpage with recommendations to reduce exposure here:](#)

“**Smartphones and tablets for children?**

*It is particularly important to minimise children’s exposure to radiation. They are still developing and could therefore react more sensitively in terms of health.*”

- The FORP recommends landline phone instead of mobile phone base stations and that schools

should not connect wirelessly to the internet. [Read a 2015 statement here.](#)  
[See their poster "Less radiation when Telephoning" here.](#)

The German Federal Ministry for Radiation Protection stated in 2007 , "supplementary precautionary measures such as wired cable alternatives are to be preferred to the WLAN system." See original German Bundestag document [here](#), and an English translation [here](#).

**Bavaria: The State Ministry of Education and Cultural Affairs:** "For precautionary reasons the Federal Office for Radiation Protection recommends for schools that if a wireless network is used to place its components in suitable locations and to prefer the use of wired network solutions whenever possible." In 2007 Parliament recommendation to all schools to *not* install wireless LAN networks.

**Frankfurt:** "In Frankfurt's schools there will be no wireless networks in the short or mid term. The Local Education Authority did not wish to conduct a "large scale human experiment," said Michael Damian, spokesperson of the Head of the School Department Jutta Ebeling.

**2013: Four German Federal Agencies issued a guidebook recommending reducing cell phones and Wi-Fi to young children:** "[Parenting Guide: Environmental and Child Health](#)" by the Federal Office for Radiation Protection (BfS), the Federal Institute for Risk Assessment (BfR), the Robert Koch Institute (RKI ) and the Federal Environmental Agency (UBA). It contains practical information including reducing electromagnetic radiation from baby monitors and telephones: Baby monitors should be as far as possible away from the crib. Phones should be banished from the nursery. They are not suitable toys for infants and toddlers. Use of cabled landline phones is preferable. Wi-Fi routers are are not suitable in children's bedrooms, and should be switched off when not in use, especially at night.

- Download [Parenting Guide: Environmental and Child Health](#) here.
- [Read a news article about it by clicking here.](#)

## Austria

**Salzberg: The Public Health Department Advises Against Wi-Fi in Schools:** "The official advice of the [Public Health Department of the Salzburg Region](#) is not to use WLAN and DECT in Schools or Kindergartens." -Gerd Oberfeld, MD.

**The public health department of Salzburg (Landessanitätsdirektion) recommends to evaluate mobile phone base station exposures based on the [EUROPAEM EMF Guideline 2016](#)**

**The Public Health Department of Salzburg lists [Electrosmog studies](#)** highlighting the EUROPAEM EMF guideline 2016 as representing the current state of medical science that it is used by the Landessanitätsdirektion Salzburg for the health assessment of EMF.

**The Vienna Medical Association has issued [cell phone safety guidelines](#)** stating that cell phones should be used for as short of a time as possible and that children under 16 should not use cell phones at all. They also state that "wireless LAN leads to high microwave exposure".

January 2016 : [Vienna Medical Association has issued new Ten Cell Phone Guidelines.](#) They are:

1. Make calls as short and little as possible - use a landline or write SMS. Children and teenagers under 16 years old should carry cell phones *only for emergencies!*

2. Distance is your friend- Keep the phone away from body during connection of Phone. Pay attention to the manufacturer's safer distance recommendation in the manual, keep a distance during the call set-up from the head and body. Take advantage of the built-in speakerphone or a headset!
3. When using headsets or integrated hands-free, do not position mobile phones directly on the body - special caution applies here for pregnant women. For men, mobile phones are a risk to fertility if Mobile is stowed in Trouser pockets. Persons with electronic implants (pacemakers, insulin pumps et cetera) must pay attention to distance. Unless otherwise possible, use coat pocket, backpack or purse.
4. Not in vehicles (car, bus, train) calls - without an external antenna, the radiation in the vehicle is higher. In addition, you will be distracted and you bother in public transport the other passengers!
5. During the car when driving should be an absolute ban on SMS and internetworking - the distraction leads to self-endangerment and endangering other road users!
6. Make calls at home and at work via the fixed corded (not wireless) network - Internet access via LAN cable (eg via ADSL, VDSL, fiber optic) no Radiation, is fast and secure data transfer. Constant radiation emitters like DECT cordless telephones, WLAN access points, data sticks and LTE Home base stations (Box, Cube etc.) should be avoided!
7. Go offline more often or use Airplane mode - Remember that for functions such as listening to music, camera, alarm clock, calculator or offline games an internet connection is not always required!
8. Fewer apps means less radiation - Minimize the number of apps and disable the most unnecessary background services on your smartphone. Disabling "Mobile services" / "data network mode" turns the smartphone again into a cell phone. You can still be reached, but avoid a lot of unnecessary radiation by background traffic!
9. Avoid Mobile phone calls in places with poor reception (basement, elevator etc) as it increases transmission power. Use in poor reception Area a headset or the speakerphone!
10. For buyers of mobile phones, Look out for a very low SAR value and an external antenna connection!

Read the [Press release \(in German\): http://www2.aekwien.at/1964.py?Page=1&id\\_news=8972](http://www2.aekwien.at/1964.py?Page=1&id_news=8972)

See The Poster (in German): <http://www.aekwien.at/aekmedia/Medizinische-Handy-Regeln.pdf>

[See the translated Poster with Tips in English](#)

**Austria's" Highest Health Council of the Ministry of Health"** has a brochure with advice to reduce exposure to cell phone radiation. It states that since the long term research is still not completed, it is advisable to take simple precautions to reduce exposure. [Read the Brochure here.](#) [See the WHO Report on Austria's EMF activities and research studies underway here.](#)

## India

2012 The Ministry of Communications and Information Technology issued [new EMF guidelines](#) with new Exposure Limits *lowered to 1/10 of the ICNIRP level, and SAR labeling on phones.*

- [Official cell phone radiation guidelines](#) *Precautionary Guidelines for mobile users:* 1. Keep distance – Hold the cell phone away from body to the extent possible. 2. Use a headset (wired or Bluetooth) to keep the handset away from your head. 3. Do not press the phone handset against your head. Radio Frequency (RF) energy is inversely proportional to the square of the distance from the source -- being very close increases energy absorption much more. 4. Limit the length of mobile calls. 5. Use text as compared to voice wherever possible. 6. Put the cell phone on speaker mode. 7. If the radio signal is weak, a mobile phone will increase its transmission power.

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Find a strong signal and avoid movement – Use your phone where reception is good. 8. Metal & water are good conductors of radio waves so avoid using a mobile phone while wearing metal-framed glasses or having wet hair. 9. Let the call connect before putting the handset on your ear or start speaking and listening – A mobile phone first makes the communication at higher power and then reduces power to an adequate level. More power is radiated during call connecting time. 10. If you have a choice, use a landline (wired) phone, not a mobile phone. 11. When your phone is ON, don't carry it in chest/breast or pants pocket. When a mobile phone is ON, it automatically transmits at high power every one or two minutes to check (poll) the network. 12. Reduce mobile phone use by children as a younger person will likely have a longer lifetime exposure to radiation from cell phones. 13. People having active medical implants should preferably keep the cell phone at least 15 cm away from the implant.

- [The Parliamentary Standing Committee on Science & Technology, Environment & Forests](#) issued a report in the Rajya Sabha on July 23, 2015, recommending “indigenous methodology and techniques to check the alarming increase in radiation from radio-active signals, RF and Electro-magnetic Fields (EMFs).” The committee said “Indians were more prone to risk from radiations as compared to Europeans because of their low body mass index (BMI) and low fat content. Therefore, comprehensive scientific studies must be conducted to “conclusively establish the level of risks and adverse health effects of electromagnetic radiation (EMR) of cell towers”.
- 2013: [Supreme Court of India](#) upheld the High Court of the State of Rajasthan decision to remove all cell towers from the vicinity of schools, hospitals and playgrounds because of radiation “hazardous to life.” Two hundred and four mobile towers installed on the school premises of Rajasthan have been removed in compliance.
- [A Journey for EMF](#): The Ministry of Communications and Information Technology has developed an [EMF webpage](#).
- [Zilla Parishad orders removal of all cellphone towers](#) near schools citing exposure to “harmful radiation”.
- [Municipal Corporation of Greater Mumbai](#), the civic body that governs the capital city of [Mumbai](#) in [Maharashtra](#) (India's richest municipal organization) in 2016 in its new policy on mobile towers, no longer allows cell towers on playgrounds, recreational grounds, gardens and parks. [Read news article](#).
- Read a [Document prepared by Dr. Sharma, Sr. Deputy Director of the Indian Council of Medical Research on Indian Research Studies](#).
- See the Colorful graphic created by the Government [Ensuring □Safety □from □Radiations□: □Mobile □Towers □and □Handsets](#)
- [Read the 2011 Report: Ministry of Environment and Forest, Government of India's Expert Group study on the possible impacts of communication towers on Wildlife including Birds and Bees](#)
  - *“The review of existing literature shows that the Electro Magnetic Radiations (EMRs) are interfering with the biological systems in more ways than one. There had already been some warning bells sounded in the case of bees and birds, which probably heralds the seriousness of this issue and indicates the vulnerability of other species as well.”*
- Advocates include actress [Juhi Chawla](#) who has won multiple awards for her work: [Global Awards 2016](#), [Indira Gandhi Memorial Awards](#), [Full Speech at Gandhi Awards, 2011 Lecture](#), [Do's and don'ts for using cellphone safely by Juhi Chawla](#)

## Russia

- [The Russian National Committee on Non-Ionizing Radiation Protection](#) in [ELECTROMAGNETIC FIELDS FROM MOBILE PHONES: HEALTH EFFECT ON CHILDREN AND TEENAGERS \(2011\)](#)

has repeatedly [warned](#) about electromagnetic radiation impacts on children and recommended WiFi not be used in schools.

- **Official Recommendations:** The Russian Federation specifically advises that those under the age of 18 should not use a mobile phone at all, recommends low- emission phones; and requires the following: on-device labelling notifying users that it is a source of RF-EMF, user guide information advising that “it is a source of harmful RF-EMF exposure” and the inclusion of courses in schools regarding mobile phones use and RF-EMF exposure issues. “Thus, for the first time in the human history, children using mobile telecommunications along with the adult population are included into the health risk group due to the RF EMF exposure.”
  - “In children, the amount of so-called stem cells is larger than in adults and the stem cells were shown to be the most sensitive to RF EMF exposure.”
  - “It is reasonable to set limits on mobile telecommunications use by children and adolescents, including ban on all types of advertisement of mobile telecommunications for children.”

[Decision of Russian National Committee on Non-Ionizing Radiation Protection](#) 2008, "Children and Mobile Phones: The Health of the Following Generations is in Danger"

[Video of Russian National Committee, 2014 Lecture](#)

## European Environment Agency

- The EEA's issued 2013 *Late Lessons From Early Warnings: Chapter 12: Mobile phone use and brain tumour risk: early warnings, early actions?* which concludes that “Precautionary actions now to reduce head exposures, as pointed out by the EEA in 2007, and many others since, would limit the size and seriousness of any brain tumour risk that may exist. Reducing exposures may also help to reduce the other possible harms...” [Read it here.](#)
- **Precautions Recommended:** 2011 David Gee, EEA Senior Advisor on Science, Policy and Emerging Issues stated in a press release that “We recommend using the precautionary principle to guide policy decisions in cases like this. This means that although our understanding is incomplete, this should not prevent policy makers from taking preventative action.” [Read it here.](#)
- **2009 EEA Recommendations** based on current evidence (2009) The evidence is now strong enough, using the precautionary principle, to justify the following steps: 1. For governments, the mobile phone industry, and the public to take all reasonable measures to reduce exposures to EMF, especially to radio frequencies from mobile phones, and particularly the exposures to children and young adults who seem to be most at risk from head tumours.
- **2007 Professor Jacqueline McGlade, the EEA's executive director issued a statement** that "Recent research and reviews on the long-term effects of radiations from mobile telecommunications suggest that it would be prudent for health authorities to recommend actions to reduce exposures, especially to vulnerable groups, such as children." [Read it here.](#)

## Singapore

Singapore's National Environmental Agency specifically advises precautions. Below is the exact text found on the [Frequently asked Questions About Radiation Protection.](#)

“What is NEA's advice to the public on the proper way of using mobile phones amidst all the concerns?”

While further research is being carried out to study the long-term health effects of RF field, individuals could take precautionary measures to reduce RF exposure to themselves or their children by limiting the length of calls, or using 'hands-free' devices to keep the mobile phones away from the head and body.”

## United Kingdom

The UK National Health Service has changed it's advice. Here is the story. As of 2011 it offered specific [Recommendations](#) to reduce cell phone radiation exposure to children. Precautions are still recommended, however by 2015 additional website material are no longer present on the site.

- [Read the pre 2015 webpage entitled 'Risks of mobile phone use'](#) with recommendations which state; *“Children are thought to be at higher risk of health implications from the use of mobile phones. This is because their skulls and cells are still growing and tend to absorb radiation more easily. It is recommended that children use mobile phones only if absolutely necessary.”*
- [Read the UK Department of Health pre- 2015 brochure](#) on mobile phones and health which reads:  
*“The expert group has therefore recommended that in line with a precautionary approach, the widespread use of mobile phones by children (under the age of 16) should be discouraged for non-essential calls. In the light of this recommendation the UK Chief Medical Officers strongly advise that where children and young people do use mobile phones, they should be encouraged to: • use mobile phones for essential purposes only • keep all calls short - talking for long periods prolongs exposure and should be discouraged The UK CMOs recommend that if parents want to avoid their children being subject to any possible risk that might be identified in the future, the way to do so is to exercise their choice not to let their children use mobile phones.”*
- [Read the 2011 brochure on base stations and health](#) which reads, *“Therefore, as a precaution, the UK Chief Medical Officers advise that children and young people under 16 should be encouraged to use mobile phones for essential purposes only, and to keep calls short. If you are concerned, you can take steps to reduce your exposure such as using hands free kits or texting.”*
- Pre 2011, The NHS also had additional website sections on health effects. The Mobiles and mums-to-be webpage was about the research showing cell phone was linked to behavioral issues in children. [Read it here.](#) The NHS webpage [Mobile effect on sleep](#) detailed research which concluded RF “ is associated with adverse effects on sleep quality within certain sleep stages”. These webpages were deleted from the current site.
- For the public they had “recommendations to help lower any potential long-term risks” which include keeping calls short, keep phone away from the body on standby mode, only use it when the reception is strong and use a phone with an external antenna.
- [2002 The Stewart Report](#) commissioned by the UK Government found that exposure to RF radiation below guidelines has not been “proven” to cause adverse health effects but it is not possible to say “that exposure to RF radiation, even at levels below national guidelines, is totally without potential adverse health effects” as “there is some scientific evidence which suggests that there may be biological effects and gaps in knowledge justify a precautionary approach to the use of mobile phone technologies until much more detailed and scientifically robust information on any health effects becomes available.”
- [Check out a slide presentation on people and wireless radiation by NHS here.](#)

Then, the UK National Health service changed the public advice text. Everything noted *above* was **reworded**. **Now the website states:**

- “If there are any health risks from the use of mobile phones, children might be more vulnerable because their bodies and nervous systems are still developing. Research carried out to date hasn't supported a link between mobile phone use and childhood cancers such as leukaemia. However, if you have any concerns, you can lower your child's exposure to radio waves by only allowing them to use mobile phones for essential purposes and keeping calls short.” [Read this new text here.](#)
- See the brochure (2011) entitled “[Mobile phones and base stations: Health advice on using mobile phones](#)” which states: The body and nervous system are still developing into the teenage years. Therefore, as a precaution, the UK Chief Medical Officers advise that children and young people under 16 should be encouraged to use mobile phones for essential purposes only, and to keep calls short.
- The newly edited section called **Mobile phone safety - FAQs states:**

***Do scientists know everything about mobile phones and health?***  
*No, and research is continuing. Mobile phones have only been widely used for about 20 to 30 years, so it's not possible to be so certain about the safety of long-term use. More research on the effects of mobile phones on children is also needed, as they're known to be more sensitive than adults to many environmental agents, such as lead pollution and sunlight. **Government advice is to be on the safe side and limit mobile phone use by children.***

**2016 The Control of Electromagnetic Fields at Work Regulations 2016 (CEFAW)** requires employers to assess the levels of EMFs their employees may be exposed to, ensure compliance, provide information on risks and take action if necessary. Legislation [http://www.legislation.gov.uk/ukxi/2016/588/pdfs/ukxi\\_20160588\\_en.pdf](http://www.legislation.gov.uk/ukxi/2016/588/pdfs/ukxi_20160588_en.pdf)

- “You must ensure you take workers at particular risk, such as expectant mothers and workers with active or passive implanted or body worn medical devices, into account when appropriate, devise and implement an action plan to ensure compliance with the exposure limits.” [Read news article on regulations.](#)

## Cyprus

“Be Precautionary and reduce exposure to phones, Wi-Fi and other wireless devices,” states the Cyprus National Committee on Environment and Child Health (ECH). Dr. Stella Michaelidou, President of the ECH, states that society should respond by taking precautions because “Documentation of other potential and more serious biological side effects are on the tip of an emerging iceberg.” [This stance was documented in a recent news article](#) that quotes Michaelidou stating that “multiple and frequent exposure to this kind of radiation, which falls below the acceptable levels of thermal effects, pose a health risk to a developing embryo.” and children who use their mobile phone more frequently face a higher risk at having a weaker memory, attention deficit disorder, and similar issues.

[The Cyprus National Committee on Environment and Child Health](#) supported by Cyprus “has as its basic aim the prevention of illnesses, which also are related with the exposure of children in environmental dangers.” The activities of the National Committee are supported by the State of Cyprus. [Read about the](#)

Environmental Health Trust <http://ehtrust.org/>

[Committee and it's mission on their website here \(click on the British flag to get the English translation.\)](#)

### Official Statements and Documents

- [Protecting children from radiation emitted by Wi-Fi, mobile phones and wireless](#) by Dr. Stella Kanna Michailidou of the National Committee Chairman "Environment and Children's Health"
- [See the Commission's EMF brochure](#) on reducing the risks to children from exposure to the Non Ionizing Radiation (mobile phones, Wi-Fi, tablets, etc.).
- The National Committee on Environment and Children's Health Website Information on EMFs can be accessed at <http://www.cyprus-child-environment.org/easyconsole.cfm/id/324>

### PSA Video Children's Health and Wi-Fi

- The Cyprus National Committee on Environment and Child Health created a short PSA for citizens about children and wireless radiation and how to reduce Wi-Fi exposure.
- Watch the greek version here <https://www.youtube.com/watch?v=996vzcCYCnE>
- Watch the video translated into english here <https://www.youtube.com/watch?v=996vzcCYCnE>

### Scientific presentations:

- See the 12/2015 Powerpoint Slide Presentation by the President of the Commission, Dr. Stella Kanna Michaelides on EMFs (in Greek) [by clicking here](#) and Dr Michalis Tornaritis on media use (in Greek) [by clicking here](#).
- [IOANNINA UNIVERSITY COURSES IN PATHOLOGY](#) Neurological and behavior effects of Non Ionizing Radiation emitted from mobile devices on children: Steps to be taken ASAP for the protection of children and future generation by Dr. Michaelidou of the Cyprus National Committee on Environment and Health. [English slides at this link](#).

### News Reports

- Watch the President of the Cyprus National Committee " Environment and Health of the Child" presents the issue of Electromagnetic radiation and its effects on children's health. April 2016
- <https://www.youtube.com/watch?v=DatZGSq3bL4>
- Sigma TV News Report on children and Wi-fi <https://www.youtube.com/watch?v=WumF2qOUKrU>
- Watch the president of the National Committee "Environment and Child Health" with Professor Loukas Margaritis speaking in a news piece. <https://www.youtube.com/watch?v=WumF2qOUKrU>
- 2015 In-Cyprus News Report: [Mobile devices could harm kids](#)
- 9/2015 News Report Cyprus Mail: ['Technology harming our children' MPs say](#)

### Argentina

2016 National law on electromagnetic pollution *proposed*: [The law proposes a regulatory framework](#) to "radio infrastructure with radiant systems, antennas and all installations capable of generating electromagnetic radiation" in order to "ensure the protection of public health" considering "both thermal effects and biological. " In education and health facilities only wired connections to data networks and Internet access may be used. [Translated Article](#). [Original text](#):

### Taiwan

In 2015 the government *Updated their* Protection of Children and Youths Welfare and Rights Act to ban cell phones for young children. [Read it here](#).

- Complete ban on children under the age of two from using electronic devices such as iPads, televisions and smartphones.
- Parents can be fined NT\$50,000 (about \$1600 US Dollars)
- The new law also states that parents must ensure that under-18s only use electronic products for a 'reasonable' length of time.

Environmental Health Trust <http://ehtrust.org/>

- Read a news article: Daily Mail- [Taiwan makes it ILLEGAL for parents to let children under two use electronic gadgets... and under-18s must limit use to 'reasonable' lengths](#)

## Namibia

Namibia's atomic energy review report states that current so called "safety" standards DO NOT protect citizens from long term health effects.

- "ICNIRP guidelines do not guarantee adequate protection against the long term effects of exposure, such as increased risk of cancer. " -Republic of Namibia:Atomic Energy Board: [The Atomic Energy Review](#)

## Turkey

The Ministry of Health has issued public information brochures that recommend limiting exposure especially for pregnant women and children. In addition the Ministry is developing regulation on prohibiting phone use for children. The EMF in schools is monitored and the public can get measurements on EMF levels from cell towers and schools at a national site.

- [See the Ministry of Health Brochure Mobile Phones and Health Effects:](#) The Brochure starts by saying the research on cell phone radiation shows low levels of electromagnetic frequencies "may cause cancer". 13 Recommendations to Reduce Exposure *which include:* Pregnant women and children (under 16) are more vulnerable and they should use the phone only when necessary, Prefer speaker or headset, Decrease time on phones, Use low SAR phone, Keep phone away from the body, Keep phones out of baby and children's bedroom, Turn phone off when you sleep or keep it one meter away from bedside, using phones in cars increases your EMF exposure so it is not recommended.
- **Education on Safer Phone Use:** [A Project funded by Ministry of Internal Affairs](#), accomplished by Temkoder (Prevention, Measurement of Electromagnetic Pollution and Training Organization) resulted in secondary school student training in the safer usage of cellular phones.
- **Development of regulations prohibiting children's cell phone use.** In 2014, the Ministry of Health started working on new regulations to prohibit cellphone usage for children under 14 year-old children. ([See Turkey's 2014 World Health Organization EMF Report here](#)). However by 2016 the regulation was weakened and in the [2016 WHO EMF Report](#) Turkey states that they are developing regulations that only would pertain to children under 7 years old.
- The Ministry of Communications and Maritime Affairs monitors Electromagnetic fields around the schools and homes. See the website here <http://ema-olcum.btk.gov.tr/>.

## Greece

**Greek law mandates lower RF exposures near schools, nurseries and hospitals:** The exposure limits in Greece are the 70% of the official European limits. In areas less than 300 m from schools, hospitals and nurseries the exposure limit is lower at 60% of the official European limits. Cell antennae are prohibited from being on top of schools and nurseries.

**2012: The Greek government website materials recommend reducing cell phone radiation to children under 16 and they inform citizens of non-ionizing radiation power levels in their community.**

- [The National Observatory of Electromagnetic Fields](#) which is an interactive web portal linked to a network of 500 fixed measurement stations throughout Greece that continuously monitor the EMF levels from all kinds of antenna stations in the frequency range 100 kHz – 7 GHz.
- ELF and EMF Site Measurements can be looked up for various locations at [EEAE](#).
- The Greek government funds research as detailed on the [WHO EMF report here](#).
- The Q and A on RF radiation states the following text about children. [Read it here on page 32 and 33](#)

*“Even though it hasn’t been proven conclusively that children are more sensitive/reactive than adults to exposure to radiation, nevertheless, the direct/pointed recommendation of international organizations is that children be discouraged from [literally translated, learn not to trust] using cell phones. The above statement is supported by the following:*

1. *Up to about the age of 16, the nervous system of the human body is in the process of development. Consequently, it’s totally possible (although not conclusively proven by relevant scientific research) that up until this age, human being are more sensitive to any number of factors/elements/determinants.*
2. *Younger people have more years ahead of them than older persons during which the long –term effects of mobile phones can be manifested.*
3. *Environmental factors/elements have a greater general impact on the health of children than on the health of adults.”*

## Chile

**2012, Law No 20.599, The Antennae Law** ‘Regulates the installation of antennas used for the emission and transmission of telecommunications services’ This law limits the power of antennas, reduces urban impact of towers through ‘infrastructure sharing’ opens up a process for citizen participation in the approval or denial process, establishes mitigation measures in areas that are saturated with antennas and prohibits towers near “sensitive areas” institutions serving children, the elderly and medically compromised.

### **Cell antennae/towers are prohibited in “sensitive areas”.**

- Sensitive areas are those areas that demand special protection due to the presence of educational institutions, nurseries, kindergartens, hospitals, clinics, nursing homes or other institutions of similar nature. .
- Read [New communications antenna law in Chile in the International Bar Association Legal Practice Division Newsletter](#) for details on the Law. [Read a Press release with summary.](#)
- Read RCRWireless article [Chilean telecom companies need to comply with new antenna law](#)
- Chile’s Minister of Transportation and Telecommunications Pedro Pablo Kuczynski stated, *“...in addition to protecting the urban landscape and the goodwill of the neighborhoods, the new law takes care of the most important: the health of people in a precautionary*

*manner as recommended by the World Health Organization, setting strict limits on the powers of the antennas. Chile is setting standards in this regard.”*

## Ireland

The Irish Department of the Environment, Community and Local Government has a webpage on Electromagnetic fields which directs people to the advice of the Chief Medical Officer.

“Advice from the Chief Medical Officer on mobile phone use: We may not truly understand the health affects of mobile phones for many years. However, research does show that using mobile phones affects brain activity. There is general consensus that children are more vulnerable to radiation from mobile phones than adults. Therefore the sensible thing to do is to adopt a precautionary approach rather than wait to have the risks confirmed.

In the light of these findings, the Chief Medical Officer of the Department of Health and Children strongly advises that children and young people who do use mobile phones, should be encouraged to use mobile phones for “essential purposes only” All calls should be kept short as talking for long periods prolongs exposure to radiofrequency electromagnetic fields.

All mobile phone users can reduce their exposure to radiofrequency energy by making fewer calls, reducing the length of calls, sending text messages instead of calling, using cell phones only when landline phones are unavailable, using a wired “hands free” device so that the phone need not be held against the head and refraining from keeping an active phone clipped to the belt or in the pocket”.

[Read the Advice of the Chief Medical Officer of Ireland.](#)

### **Irish Doctors Environmental Association**

The Irish Doctors Environmental Association wrote a statement in 2013 concerning health concerns with Wi-Fi in school:

“We urge you to use wired technologies for your own safety and that of your pupils and staff.”

[Read the 2013 Letter](#)

## Denmark

Denmark Board of Health states: “As a precautionary measure, the Board of Health recommends a series of simple steps you should follow to reduce exposure from mobile phones :

- Use the headset or handsfree with earbud, conversation, or use the speakerphone feature
- When possible, use text instead of call
- Limit the duration of calls
- Did not sleep with the phone close to the head
- Limit conversations during low reception and while in transport.
- Do not cover the phone with aluminum foil, special covers, etc.
- Compare phones' SAR value. Lower SAR require less exposure
- [Denmark Board of Health Recommendations on Reducing Cell Phone Radiation](#)

## Tanzania

2014: Director General of Tanzania Atomic Energy Commission (TAEC), Mr Idy Mkilaha publicly endorses precaution.

*"Mr Mkilaha says that when weighing up this convenient tool with the questionable health impact control, caution and measures must be taken to reduce one's exposure from radio frequency (RF) emissions from the cell phone to prevent health hazards."*

*"According to TAEC, we should use hands-free devices or wireless headset to increase the distance between the phone and our heads. This is the best approach because it creates distance between us and the radiating phone..."*

*We should also keep phone away from us when dialling. Phones use more radiation during connection time, says TAEC."*

Read News Report: [Tanzania: We Should Manage Our Cell Phones Properly Otherwise..](#)

Read Tanzania Daily News: [Tanzania: Need to Protect Oneself When Using Cell Phone](#)

[Read the Tanzania Commission for Science and Technology Newsletter detailing how to reduce cell phone exposure \(page 11\)](#)

After complaints were raised by residents about health effects the Commission co-authored a published paper that reviews national RF level profiles of the radiation emitted from base stations. Read [Review on Measured and Calculated Radio Frequency Radiation Emission From The Base Stations](#) which states that

*In 2016, [Director General of Tanzania Atomic Energy Commission \(TAEC\), Mr Idy Mkilaha died under investigated circumstances](#) and at this time EHT is unable to find the Reports or official warnings as mentioned in the news reports on the current [Atomic Commission](#) webpage.*

## Ireland

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Environmental Health Trust <http://ehtrust.org/>

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“We urge you to use wired technologies for your own safety and that of your pupils and staff.”

[Read the 2013 Letter](#)

## **United States**

Legislation has been introduced at the state and national level. Some Communities have issued proclamations, resolutions and started initiatives to inform the public of wireless health issues.

### **CELL PHONE AND WIRELESS LABELING**

**2014 California, Berkeley:** [May 12, 2015 Berkeley Adopted the Cell Phone "Right to Know" Ordinance on a Unanimous Vote.](#) Berkeley is the first city in the nation to require cell phone retailers to provide those who purchase a new phone an informational fact sheet which informs buyers to read the user manual to learn the cell phone's minimum separation distance from the body. The text states:

"The City of Berkeley requires that you be provided the following notice:  
To assure safety, the Federal Government requires that cell phones meet radio frequency (RF) exposure guidelines. If you carry or use your phone in a pants or shirt pocket or tucked into a bra when the phone is ON and connected to a wireless network, you may exceed the federal guidelines for exposure to RF radiation. Refer to the instructions in your phone or user manual for information about how to use your phone safely." [Full text here.](#)

Watch [a video of the historic vote](#) featuring Harvard Law professor Lawrence Lessig.

Watch [a video of testimony to Berkeley](#) from November 8, 2011 on the need for cell phone guidelines.

Watch a video of the [September 2016 Federal Appeals Court Hearing oral arguments CTIA vs. Berkeley as the CTIA tries to strike down the Ordinance.](#) This the hearing considering whether to overturn the district court's decision that denied the CTIA's request for an injunction to block Berkeley's cellphone ordinance.

**2014 New York:** [Wireless Router Labeling in all Suffolk Public buildings:](#) 12/2014 The Suffolk County Legislature passed legislation to require all county buildings to post notices that wireless routers are in use such as, "Notice: Wireless technology in use." The resolution, sponsored by Legis. William Spencer (a physician), warns that every wireless device emits radio frequency radiation or microwave radiation. It notes that studies "that have looked at the effects of low-level RFR radiation on human cells and DNA have been inconclusive." [Read Press Release.](#)

**2011 San Francisco, California: A Passed** 2011 Ordinance by the City of San Francisco required cell phone retailers to distribute an educational sheet created by the San Francisco Department of Environment that explains radiofrequency emissions from cell phones and details how consumers can minimize their exposure. However implementation was blocked after a [three year court battle. The CTIA sued the city](#) and settled with the City to block implementation of the Ordinance in exchange for a

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waiver of attorney's' fees. Although implementation was halted, the [City Cell Phone Radiation Webpage](#) remains online.

- Read the [Open Letter to San Francisco Mayor and Board of Supervisors](#)
- Read [San Francisco's Cell Phone Fact Sheet is Factual](#)
- [Watch video from testimony to the City of San Francisco](#)
- [Watch video of San Francisco Supervisor discussing the Ordinance here.](#)
- [Watch a press conference with survivors speaking on cellphone health risks](#) at the San Francisco Commonwealth Club. Cellphone cancer victims tell their personal stories and those of their lost loved ones.

## **PUBLIC SCHOOLS**

**2016: Petaluma Public Schools, California USA:** Public school district adopts "[iPad Best Practices](#)". Parents raised the issue of wireless health risks with the district for years ([Videos of Parent Testimony to District](#), [Child Testimony](#), [Read Doctors Letters to District](#)). The school is now taking steps to reduce wireless exposure- Ipads off children's laps and Ipads at a distance, wireless turned off the device unless necessary.

[Best Practice Recommendations state:](#)

"Turn on Airplane Mode in Settings whenever you don't need an internet connection. This will prevent wireless transmissions..."

"Keep it on the Desk: The best place for your iPad to sit during use is on a desk, table or other flat surface."

**2016: Onteora School District in New York State USA:** Public School district adopts "Best Practices with Wi-Fi [Read the April 20, 2016 Meeting Minutes Page 2.](#) "Turn off the device when not in use and at the end of each day. If device is to stay on, turn Wi-Fi off when not in use. Always place device on a solid surface. Viewing distance should be a minimum of 12 inches from the screen. Staff was asked by the Principals to post this in areas that contain computers and devices. They are reminding staff to follow it."

**2015: Ashland Public Schools, Mass (USA):** The District has passed "Best Practices" to turn the WiFi off when not in use and keep devices away from the body [Download Slides](#). [Video of parent who initiated this](#). [Video of school board member](#) discussing the process. [Read Magazine article on Ashland's Decision Here](#). [Newspaper Coverage](#), [Watch TV Program of CeCe Doucette and Keith Marciniak discussing the policy changes](#).

### **Los Angeles California Public Schools**

- The LA School District Uses a RF-EMF Exposure Threshold 10,000 Less Than the FCC Limits: Read the RF Report the LA School District Used to recommend a cautionary exposure level. [RADIOFREQUENCY \(RF\) EVALUATION REPORT Use of Wireless Devices in Educational Settings](#)
- 2009 LA School Board Resolution Banning Cell Towers from schools and recommending against WiFi. Read the adopted resolution [HERE](#). 2009 Resolution *Condemning Cell towers NEAR Schools* as was this T-Mobile Cell Tower across the street from an elementary school. [Read it here](#). [Read the motion by Supervisors Zev Yaroslavsky and Michael Antonovich](#)

- **2000 LA School Board Resolution Opposing Cell Tower Placement on Schools** and calling for precautions with wireless. 'Whereas, Recent studies suggest there is evidence that radio-frequency radiation may produce "health effects" at "very low field" intensities' [Read it here.](#)

SEE A FULL LIST OF PUBLIC AND PRIVATE SCHOOLS THAT REMOVED WI-FI LATER IN DOCUMENT

## HEALTH ADVICE TO THE PUBLIC

### 2016: American Academy of Pediatrics Issues Recommendations to Reduce Exposure

The AAP has updated their [Healthy Children Webpage on Cell Phones](#) entitled *Cell Phone Radiation & Children's Health: What Parents Need to Know*. The webpage reiterated children's unique vulnerability to cell phone radiation stating, "Another problem is that the cell phone radiation test used by the FCC is based on the devices' possible effect on large adults—not children. Children's skulls are thinner and can absorb more radiation." The AAP issued the following cell phone safety tips specifically to reduce exposure to wireless radiation:

- Use text messaging when possible, and use cell phones in speaker mode or with the use of hands-free kits.
- When talking on the cell phone, try holding it an inch or more away from your head.
- Make only short or essential calls on cell phones.
- Avoid carrying your phone against the body like in a pocket, sock, or bra. Cell phone manufacturers can't guarantee that the amount of radiation you're absorbing will be at a safe level.
- Do not talk on the phone or text while driving. This increases the risk of automobile crashes.
- Exercise caution when using a phone or texting while walking or performing other activities. "Distracted walking" injuries are also on the rise.
- If you plan to watch a movie on your device, download it first, then switch to airplane mode while you watch in order to avoid unnecessary radiation exposure.
- Keep an eye on your signal strength (i.e. how many bars you have). The weaker your cell signal, the harder your phone has to work and the more radiation it gives off. It's better to wait until you have a stronger signal before using your device.
- Avoid making calls in cars, elevators, trains, and buses. The cell phone works harder to get a signal through metal, so the power level increases.
- Remember that cell phones are not toys or teething items.
- [Press Release: The AAP responds to study showing link between cell phone radiation, tumors in rats May 27, 2016](#)

### [2015 AAP Healthy Child Web Page on Electromagnetic Fields: A Hazard to Your Health?](#)

This webpage states:

"Cell Phones: In recent years, concern has increased about exposure to radio frequency electromagnetic radiation emitted from cell phones and phone station antennae. An Egyptian study confirmed concerns that living nearby mobile phone base stations increased the risk for developing: *Headaches, Memory problems, Dizziness, Depression, Sleep problems*

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Short-term exposure to these fields in experimental studies have not always shown negative effects, but this does not rule out cumulative damage from these fields, so larger studies over longer periods are needed to help understand who is at risk. In large studies, an association has been observed between symptoms and exposure to these fields in the everyday environment.”

[2013 AAP Letter to FCC Commissioner Mignon Clyburn and FDA Commissioner Margaret Hamburg calling for a review of RF guidelines 8/29/2013](#)

[2012 AAP Letter to US Representative Dennis Kucinich in Support of the Cell Phone Right to Know Act](#)  
[Time Magazine \(2012\): Pediatricians Say Cell Phone Radiation Standards Need Another Look](#)

**2012, the AAP published Pediatric Environmental Health, Textbook of Children's Environmental Health 3rd Edition edited by Philip J. Landrigan, Ruth A. Etzel. Chapter 41: Electromagnetic Fields. [Read it on Google Books Chapter 41: Electromagnetic Fields at this link page 383.](#) [Oxford Medicine Chapter 41 Link](#)**

AAP News 2011: [More study needed on risk of brain tumors from cell phone use by Ruth A. Etzel, AAP News, Oct 2011](#)

#### **The California Medical Association, USA**

The California Medical Association (CMA) passed a Wireless Resolution in 2014 that states :

“Whereas scientists are increasingly identifying EMF from wireless devices as a new form of environmental pollution ...

Whereas peer reviewed research has demonstrated adverse biological effects of wireless EMF including single and double stranded DNA breaks, creation of reactive oxygen species, immune dysfunction, cognitive processing effects, stress protein synthesis in the brain, altered brain development, sleep and memory disturbances, ADHD, abnormal behavior, sperm dysfunction, and brain tumors; and...Resolved, That CMA support efforts to implement new safety exposure limits for wireless devices to levels that do not cause human or environmental harm based on scientific research.” [Read the full CMA Resolution here.](#)

[Read a the Santa Clara Medical Bulletin article by Dr. Cindy Russell that explains the CMA resolution and gives recommendations for schools.](#)

**2014: The Connecticut Department of Public Health has issued specific recommendations to reduce exposure to cellphone radiation.** It is notable that the Department has provided information more in depth than the CDC, EPA and FDA in detailing 7 steps on *how* people can reduce exposure. Furthermore, the Department states *“It is wise to reduce your exposure to radiofrequency energy from cell phones whenever possible.”* [Read the Connecticut Department of Public Health Cell Phone Q and A about Cell phones here.](#)

#### **2016: Massachusetts Department of Health: Minimizing Exposure to RF**

“Below are common recommendations and include those for both cell phone and non-cell phone sources:

- Use wired communication devices instead of wireless devices

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- Limit children’s use of cell phones except for emergencies
- Keep cell phones and other sources at a distance
- If using wireless devices like computers, laptops, tablets, and printers, place the wireless router away from where children and adults usually spend time.

[Read these recommendations from the Department of Health in full at this link.](#)

**2014 Maryland, Greenbelt:** [The Greenbelt Maryland City Council voted unanimously on November 24, 2014](#) to do the following:

1. Alert citizens about the fine print warnings and possible health risks of cell phones and wireless devices By sharing the Environmental Health Trusts 10 Steps to Safe Tech and Doctors Advice on Cell Phones Brochure in City health fairs and city centers.
2. To send the FCC Chairman a letter urging the adoption of “radiation standards that will protect human health and safety.” [Download the letter here.](#)
3. To oppose cell towers on school grounds and write a letter to the local school board and County Executive.

**2011 San Francisco, California:** [Cell Phone Radiation \(How to Reduce Exposures\)](#) Webpage launched with public information on [how to reduce exposures](#) to cell phone radiation. San Francisco developed the following public health information resources:

- Answers on [How to reduce exposures](#) to cell phone radiation.
- A [Poster](#) on Cell Phones and RF Radiation
- A [Factsheet](#) for the Public
- [Display stickers](#) for Cell Phone packaging.

**2012 Wyoming: Jackson Hole issued a [Proclamation of Cell Phone Awareness](#)** which cites concern over long term health effects as well as the increased risk that the radiation poses to children.

**2012 Florida: Pembroke Pines, passed Resolution [3362](#)** expressing the City's "Urgent Concerns" about Wireless Radiation and Health and which encourages citizens to read their manuals and presents information on how to reduce exposure by using a headset or speakerphone. Jimmy Gonzalez, an attorney who had developed brain cancer after heavy cell use, initially petitioned the Commission. [Watch the Video of his powerful testimony here.](#)

**2010 California, San Francisco:** [Cell Phone Radiation \(How to Reduce Exposures\)](#) Webpage launched. Answers on [how to reduce exposures](#) to cell phone radiation. The City developed a poster, factsheets and display stickers with public health information.

**2010 California: Burlingame California City Council** voted to include cell phone safety [guidelines](#) in their Healthy Living in Burlingame initiative (WHO classification and consumer precautions).

**2010 Maine, Portland :**Mayor Mavodenes, Jr. declared October “Cell Phone Awareness Month”

**Colorado 2009 The Governor of Colorado issued a Proclamation on Electrical Hypersensitivity.** *"Electromagnetic Sensitivity is a painful chronic illness of hypersensitive reactions to electromagnetic radiations.*

*WHEREAS, the symptoms of EMS include, dermal changes, acute numbness and tingling, dermatitis, flashing, headaches, arrhythmia, muscular weakness, tinnitus, malaise, gastric problems, nausea, visual*

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*disturbances, severe neurological, respiratory, speech problems, and numerous other physiological symptoms.*

*WHEREAS, Electromagnetic Sensitivity is recognized by the Americans with Disabilities Act, the US Access Board and numerous commissions;" [Read the Proclamation HERE.](#)*

**May 2009 The Governor of Connecticut issued a Proclamation on Electrical Hypersensitivity.**

*"WHEREAS, the health of the general population is at risk from electromagnetic exposures that can lead to illness indicted by electromagnetic radiations; and, WHEREAS, this illness may be preventable through the reduction or avoidance of electromagnetic radiations, in both outdoor and indoor environments and by conducting further scientific research; and, "* [Read the Proclamation HERE.](#)

**Broward County Florida May 2009, The Mayor issued a Proclamation on Electrical Hypersensitivity.**

*"WHEREAS, as a result of global electromagnetic pollution, people of all ages in Broward County and throughout the world have developed an illness known as Electromagnetic Sensitivity; and, "* [Read it all HERE.](#)

## US Proposed Legislation

**2012 National Law** [The Cell Phone Right to Know Act H.R. 6358](#) was introduced receiving strong support from many organizations including the American Academy of Pediatrics. (AAP Letter [here.](#)) This legislation called for labels on mobile devices at point of sale, a comprehensive national research program to study whether exposure to wireless devices causes adverse biological effects directed by NIEHS and the EPA and exposure level regulation.

HR 6358 received strong support from the American Academy of Pediatrics Read the AAP Letter [here.](#) Congressional hearings in 2009 provided expert testimony to Congress. [Watch CSPAN VIDEO.](#)

**Library of Congress Summary:** Written by the Congressional Research Service

Cell Phone Right to Know Act - Requires the Director of the National Institute of Environmental Health Sciences and the Administrator of the Environmental Protection Agency (EPA) to:

1. conduct or support a comprehensive research program to determine whether exposure to electromagnetic fields from mobile communication devices causes adverse biological effects in humans, including vulnerable subpopulations such as children, pregnant women, those with compromised immune systems and hypersensitivity reactions, men and women of reproductive age, and the elderly;
2. disseminate research results to the general public; and
3. report findings and conclusions to Congress.

Directives:

- Directs the Federal Communications Commission (FCC) to promulgate regulations to allow a subscriber to access personally or to give consent to allow researchers with institutional review board approval to access specific usage data required to investigate the link between electromagnetic radiation exposure and potential adverse biological effects in humans.
- Directs the EPA to promulgate regulations establishing maximum exposure level goals and maximum exposure levels for exposure to electromagnetic fields generated by mobile communication devices.
- Directs the Commissioner of Food and Drugs (FDA) to promulgate regulations to provide for labeling (including exposure ratings and the maximum allowable exposure levels and goals) on

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mobile communication devices, packaging, instruction manuals, and at points of sale in stores and on websites.

- Requires the Secretary of Health and Human Services (HHS) to increase: (1) the number and size of grants to institutions for training scientists in the field of examining the relationship between electromagnetic fields and human health; and (2) the number of career development awards for such training for health professionals pursuing careers in pediatric basic and clinical research, including pediatric pharmacological research.

Amends the Public Health Service Act to establish a graduate educational loan repayment program and authorize national awards for researchers in such fields.

Amends the Communications Act of 1934 with respect to the prohibition on state or local government zoning regulation of personal wireless service facilities on the basis of the environmental effects of radiofrequency emissions. Excludes from such prohibition state or local regulation based on the adverse human health effects of emissions of radiofrequency electromagnetic fields.

**2015 NEW Massachusetts** proposed MA [Senate Bill 1222](#): An Act creating a special commission to study the health impacts of electromagnetic fields and [Bill H2007](#): An Act relative to a special commission to study electric and magnetic fields. *Bills Still in Process as of August, 2015.* [Watch a view of the statehouse briefing on RF here.](#)

**2015 Nassau County will have a proposed Wireless Router Labeling Act** that would place visible warning signs in all county buildings and facilities where a wireless router is located.. [Please read recent coverage of the initiative here.](#)

2014 [The Maine LD 1013 "The Wireless Information Act"](#) passed the State Senate and House but then failed to pass the second vote. The Bill requires manufacturer's information on radio-frequency exposure be visible on the outside of the cell phone's product packaging.

- [Please a video of State Representative Andrea Boland on how the legislation was thwarted.](#)
- [Read Maine's "Cellular Telephone Labeling Act" -April 17, 2015](#)
- Read [Cell Phone Radiation Label Bill Passes Maine Legislature Before Dying](#)

The [San Francisco Cell Phone Right to Know Ordinance](#) was signed in 2011 requiring cell phone retailers to distribute an educational sheet created by the San Francisco Department of Environment that explains radiofrequency emissions from cell phones and how consumers can minimize their exposure. The CTIA sued the city and settled with the City to block implementation of the Ordinance in exchange for a waiver of attorneys' fees. The City [Cell Phone Radiation Webpage](#) remains online.

**2015 Oregon HB 3350: This proposed legislation** directs the Department of Education to prepare statement that discloses potential health risks of wireless technology and requires public and private schools to distribute statement to employees and parents of students. It declares an emergency effective July 1, 2015. [Read the Bill here.](#)

**2015 Oregon HB 3351:** This proposed legislation states that cell phones must have a visible written label that advises consumers of possible risks and steps that consumers can take to reduce the risk of radio-frequency radiation exposure from cellular telephone use. [Read it here.](#)

2014 [Hawaii Senate Bill SB 2571](#) was introduced calling for a warning label encouraging consumers to follow the enclosed product safety guidelines to reduce exposure to radiation that may be hazardous to their health.

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**[SB 932 California](#):** This 2011 legislation would have required retailers to include notices on product packaging that cell phones emit radio frequency (RF) energy. A second notice would be posted at the point of sale when purchasing online or in a physical store.

**[HM 32, New Mexico](#):** This 2011 proposed law request the Department of Health and the Department of Environment to study and review all available literature and reports on the effects of cell phone radiation on human health.

**[HB 1408 Pennsylvania](#):** This 2011 proposed law would require warning labels on cell phones “to inform all citizens about possible health dangers that have been linked to microwave radiation that is emitted by cellular telephones and the steps that can be taken to mitigate those dangers, especially as they relate to children and pregnant women.”

- Dr. Ronald B. Herberman, former director of the University of Pittsburgh Cancer Institute (UPCI) and the UPMC Cancer Center offered testimony at a PA House Democratic Policy Committee hearing. CBS Local coverage of hearing [HERE](#). Philadelphia Tribune News coverage [Here](#).

**[SB 679 Oregon](#):** This 2011 proposed law would require warning labels for all new cell phones and cell phone packaging. [Watch a news video about the law here](#).

**[H.R. 2835](#)** In 1999 Congressman Bernie Sanders sponsored [H.R. 2835 \(106th\): To require an assessment of research on effects of radio frequency emissions on human health](#).

(Note: This document does not cover ALL EMF policy but is simply a sampling. Please feel free to contact EHT to send documentation of other policy actions. )

## Schools Worldwide Removing the WiFi/Taking Action

**2016: Haifa, Israel:** Haifa Mayor Yona Yahav( of Israel's 3rd largest city) ordered all schools to have wireless removed and replaced with wired connections. [Read Krayot article](#). [Hamodia article](#). Related [Reshet TV Report](#) [Watch News Report with unofficial English translation](#) [Watch News Report on Supreme Court Case in Israel](#)

**2016 Lowell School, Washington DC:** In the kindergarten wing, the Wi-Fi hotspots were removed and the teachers are given ethernet and adapters so that computers and class technology can be ethernet connected (corded) to reduce RF-EMF exposure.

**2016 Italy:** Turin Mayor Chiara Appendino laid out plans “to cut back on Wi-Fi in state schools and government buildings over concerns that radiation might damage people's health”.  
Read 7/2016 News Report [Turin could slash Wi-Fi over 'radiation' concerns](#)

**2016: Onteora School District in New York State USA:** District adopts “Best Practices with Wi-Fi [Read the April 20, 2016 Meeting Minutes Page 2](#).” “Turn off the device when not in use and at the end of each day. If device is to stay on, turn Wi-Fi off when not in use. Always place device on a solid surface.

Environmental Health Trust <http://ehtrust.org/>

Viewing distance should be a minimum of 12 inches from the screen. Staff was asked by the Principals to post this in areas that contain computers and devices. They are reminding staff to follow it.”

**2016 Italy:** [Mayor of Borgofranco d'Ivrea \(Italy\) orders Wi-Fi to be turned off in schools](#). “Mayor Livio Tola told the town's high school and elementary school to return to using cables to connect to the internet after reading that the electromagnetic waves given off by wireless routers were especially harmful to young children.” [Read the newspaper article here](#). [Read the News article here “Ivrea, The Mayor Removes WiFi as it Could Be Dangerous”](#).

**2016:** [Rotokawa School New Zealand, implemented steps to minimize RF Exposure](#) Children use ipads in flight mode on desk and parents may request that their child use an Ethernet cord. Children are taught about the health precautions as part of their cyber citizenship.

**2016:** [Istituto Comprensivo Alighieri- Diaz in Lecce Italy](#) has banned wifi. Their two resolutions decided: a) to ban wifi in school and install a wired system for the use of internet and b) Reject the request of the local government (Municipality) to install an antenna on the school roof for the wireless signal providing for the "Wireless city" program. The resolution also asks the Municipality to install the antenna at a reasonable distance from school. [Read the official resolutions number 1 here](#) and [Resolution 2 Here](#).

**2016: The Piemonte Region has adopted a resolution to limit EMF exposure, to limit the use of wifi in schools** and be considerate to the problem of EHS people. [Read about it here](#).

2015: [Ashland Public Schools, Mass \(USA\)](#): "Best Practices" to turn the WiFi off when not in use, [Download Slides](#) . [Video of parent who initiated this](#). [Video of school board member](#) discussing the process. [Read Magazine article on Ashland's Decision Here](#).

2016: [Shearwater The Mullumbimby Steiner School](#), Australia, 100% Wi-Fi Free School

2016: [Yallingup Steiner School](#) Australia , WiFi Free Classrooms

2016: Linuwel School , Australia ,WiFi in some classrooms, Can accommodate children with EHS.

2016: Cairns Hinterland Steiner School , Australia, WiFi Free Classrooms (may be available in other areas)

2016: Wild Cherry School, Australia , 100% Wi-Fi Free

2015: St. Cajetan School, Belgium: Wired Internet installed and wireless removed.

2015: Washington Waldorf School, Maryland, USA: Removed Wi-Fi Routers from Buildings, Ethernet installed.

2015: Freshwater Creek School, Australia, 100% Wi-Fi Free

2015: Lorien Novalis School, Australia, 100% Wi-Fi Free School Preschool to 12th grade.

2015: Cairns Hinterland School, Australia, WiFi Free Classrooms for EHS

2014: Acorn Hill School, Maryland: Wi-Fi Networks removed.

2014: Friends Community School: Wi-Fi turned off in wing for lower elementary school students. WiFi routers moved OUT of classrooms into hallways for older grades to reduce EMF exposure. Ethernet wires made available in classrooms for families who want children on corded (not wireless) computers.

2014: [DearCroft Montessori](#): Hardwired internet to younger grades, limited Wi-Fi Router exposure to older grades.

2014: [Portland Waldorf School](#), Portland Oregon, USA, WiFi removed.

2014: [Meeting House Montessori](#), Braintree Massachusetts, USA, WiFi replaced with ethernet.

2014: Ghent, Finland, [Wi-fi banned from pre-schools and day care](#).

Environmental Health Trust <http://ehtrust.org/>

2014: [UPPER Sturt Primary School](#), Australia. [Read article.](#) [Read “No WIFI” LOW EMF School Policy.](#)

2014: The [St. Augustine School](#) in Italy turned off Wifi and goes back to Wires.

2013 [Winlaw Elementary School](#), B.C. Canada turned off WiFi.

2013 [Te Horo Primary School](#) New Zealand Replaced WIFI with cable-based internet.

2013 [Kootenay Lakes District](#) School Board BC (One school without Wi-Fi)

2013 [Blaise-Cendrars High School](#), Switzerland. Teachers vote to remove WiFi.

2012 [Kivioja primary school](#) in Ylivieska Finland bans phones and minimizes Wireless.

2012: [Halton Waldorf](#), in Burlington Vermont: Remaining free of Wireless Radiation

2011 [City of Lakes Waldorf School](#), WiFi taken out. Minneapolis, Minnesota USA

2011 Aurora School in Ontario removed Wifi and replaced with hardwired.

2011 [North Cariboo Christian School](#) in Quesnel, B.C., removed Wi-fi .

2011 [Pretty River Academy](#) in Ontario no WiFi.

2011 Wayside Academy, Peterborough, Ontario no Wi Fi.

2010 Surrey, [BC Roots and Wings Montessori](#) removed Wi-Fi.

2010 Ontario St. Vincent Euphrasia elementary school: Parents voted to turn off Wi-Fi.

2009 HEROUVILLE-SAINT-CLAIR wi-fi networks removed.

## Teacher Unions and Parent Teacher Organizations

**2016:** [New Jersey Education Association \(NJEA\)](#) publishes [“Minimize health risks from electronic devices”](#) in the September 2016 NJEA Review. *Adrienne Markowitz and Eileen Senn detail how to reduce physical health risks from devices including risks from radiation exposure*

- *“Keep devices away from the body and bedroom.*
- *Carry phones in briefcases, etc., not on the body.*
- *Put devices on desks, not laps.*
- *Hard wire all devices that connect to the internet.*
- *Hard wire all fixed devices such as printers, projectors and boards.*
- *Use hard-wired phones instead of cell or cordless phones.*
- *Text rather than call.*
- *Keep conversations short or talk in person.*
- *Put devices in airplane mode, which suspends EMF transmission by the device, thereby disabling Bluetooth, GPS, phone calls, and WiFi.*
- *Use speaker phone or ear buds instead of holding the phone next your head.*
- *Take off Bluetooth devices when not using them.”*

**2016: Phoenicia Elementary School Onteora School District, New York State**

- The PTA wrote a letter to the Onteora School District calling for the Wi-Fi to be turned off as a precautionary action . [Watch a video of the School Board Meetings where letter is read here.](#) [Watch videos of parents and students calling for Wi-Fi removal here.](#)
- Read News Report: [Some Onteora parents fear Wi-Fi signals in schools are harming their children.](#)

**2016: Ontario Secondary School Teachers Federation**

Environmental Health Trust <http://ehtrust.org/>

- A new call for a moratorium on WIFI and in the Limestone School District and they have taken the issue to the school trustees in that District. “The Teacher Union’s president says there is a growing mountain of evidence that WIFI can pose health risks.” Andrea Loken/OSSTF District President stated in a 3/2016 news interview that, “There are thousands of published peer reviewed papers that are indicating adverse health effects from WIFI and we are seeing an increased awareness around this issue worldwide.” Watch [the video of the news piece with Union members here](#) . [Read the National Post article here](#). [Radio Canada International article here](#).

#### 2016: Elementary Teachers Federation of Ontario

- A 3/2016 News Report states that they are calling for a “WIFI moratorium until further health studies are done, and lawmakers can catch up with new regulations.” Watch [the video of the news piece with Union members here](#) . [Read the National Post article here](#). [Radio Canada International article here](#).

#### 2014 United Federation of Teachers (Teachers, nurses and professionals working in New York City).

- In 2014 their [Wireless Radiation Webpage stated](#) “Wireless radiation is emitted by the myriad of wireless devices we encounter every day. It was once thought to be relatively harmless. However, we now know that wireless radiation can cause non-thermal biological effects as well, including damage to cells and DNA, even at low levels. Curiously in March of 2016, this statement was removed and replaced with [new text mimicking FCC verbiage](#). However the site *still posts* how to reduce exposure.
- Resources posted on their site include Dr. Moskowitz’ [Reducing Your Exposure to Wireless Radiation](#) and the BabySafe Project brochure [What You Need to Know About Wireless Radiation and Your Baby](#). “Taking certain precautions around wireless radiation is appropriate for our most vulnerable populations, including pregnant women.”

#### 2014 New York State Teachers Union NYSUT: A federation of more than 1,200 local unions.

- *“We have enough evidence to justify taking action and we are not willing to wait until our members, their children and the students suffer health consequences from not doing anything,”*  
-Paul Pecorale, Vice President of the New York State United Teachers Union.
- [Read the Press Release on Best Practices For Schools prepared for NYSUT](#)
- Download the [Guidelines for Safer Use of Wireless Technology in Classrooms](#) Published for NYSUT
- NYSUT hosted a [Webinar: Risks of wireless technologies and protecting children and staff in schools](#).

#### 2014 National Education Association

“The National Education Association believes that all educational facilities must have healthy indoor air quality, be smoke-free, be safe from environmental and chemical hazards, *and be safe from hazardous electromagnetic fields.*”

“Students and/or their parents/guardians, education employees, and the public should be notified of actual *and potential hazards.*”

“School districts should conduct periodic testing for harmful water *and airborne particles/agents* that are detrimental to the health of students and education employees and shall report the results publicly.”

“The Association also believes in the development and enforcement of health and safety standards specifically for children.” [Read Section C-19 of the NEA 2013-2014 Resolutions](#)

**2013 [Canadian Teacher Federation’s Brief](#) (200,000 elementary and secondary school teachers)**

- “CTF is concerned about the lack of definitive research regarding the adverse health effects of Wi-Fi.
- “We propose a prudent approach to the use of Wi-Fi, especially where children are present.”
- “We recommend an education program regarding the relative safety of Wi-Fi exposure and that appropriate resources be developed to educate the public regarding ways to avoid potential exposure risks of Wi-Fi access points and devices.”
- “Pedagogical needs could be met in schools with an approach that limits exposure to Wi-Fi.”
- Read the Briefing [The Use of Wi-Fi in Schools - Briefing Document](#)

2015: Canadian Teacher's Magazine published [CTF Sounds the Alarm on Wi-Fi](#)

**2013 [United Teachers of Los Angeles](#), representing 40,000 teachers and staff**

- Resolution passed: “I move that UTLA will abide by current National NEA Policy for Environmentally Safe Schools which states that all employees and stakeholders should be informed when there are changes in their exposure to environmental hazards including electromagnetic radiation and that all stakeholders and the public should be notified of any actual and potential hazards. UTLA will advocate for technological solutions that maintain technology upgrades while not increasing employees exposure to electromagnetic radiation.”
- Health and Human Services Committee 3-6-13 #1: Moved by Kevin Mottus, seconded by John Cabrera.
- See UTLA Newsletter [editorial by social worker Kevin Mottus](#).

**2013 [Elementary Teacher's Federation of Ontario](#) - over 76,000 teachers**

"There is cause for concern for members' health and safety, especially women," said Sandra Wash, a teacher representing the Peel district when the Federation issued [a 2014 position statement](#) supporting an Expert Panel recommendation that Health Canada provide the public with more information about radiofrequency energy, and the safe use of wireless technology. [ETFO voted](#) to:

- Turn cell phones off in classrooms
- Label the location Of Wi-Fi access points.
- Research Radio Frequency radiation.
- Develop a hazard control program related to wireless microwave radiation through JHSC.

**2012 [The Ontario English Catholic Teachers Association](#) (45,000 Ontario teachers)**

- Recommends a wired infrastructure as WIFI “may present a potential Health and Safety risk or hazard in the workplace...The safety of this technology has not thoroughly been researched and therefore the precautionary principle and prudent avoidance of exposure should be practiced.”
- [Read the Position Statement here](#). “Controls for WiFi would best be guided by the ALARA principle (As Low As Reasonably Achievable), as well as by applying the concept of prudent avoidance (of non-ionizing radiation).”
- [Read CBC News article](#)

**2013 [BC Teachers Federation adopted Wireless Resolutions and Proposed Resolutions](#)**

- “The BCTF supports members who are suffering from Electromagnetic Hypersensitivity by ensuring their medical needs are accommodated in the workplace.”
- Proposed Resolutions “the World Health Organization's classification of radiofrequency/electromagnetic fields emitted by wireless devices as a 2B possible cancer risk to humans; that the BCTF ensures all teachers have the right to work in a safe environment,

including the right to work in a Wi-Fi/ wireless-free environment.”

- Recommendation to the Ministry of Education that school boards “begin immediate installation of on/off switches for Wi-Fi routers in schools, thereby reducing microwave radiation exposure and reducing health risks to members, and/or provide safer Ethernet cables or fibre optics”. Read the [Wireless Resolutions and Proposed Resolutions](#)
- Read Daily News Coverage: [Merritt teachers demand protection from wi-fi radiation 'Evidence is piling up that wi-fi radiation may in fact be harmful'](#)
- Read the Vancouver Sun News [Report Here](#).

### **2013 [The BC Confederation of Parent Advisory Councils \(BCCPAC\)](#) of 821 Advisory Councils representing over 500,000 parents in British Columbia passed two resolutions.**

- Resolution 17 "calls on each Board of Education to have one public school at each education level that is free of Wi-Fi, cordless phones and cell phones. This school will only be equipped with wired computers and wired telephones for personal, educational and administrative purposes."
- Resolution 18 calls on Boards of Education to "cease to install Wi-Fi and other wireless networks in schools where other networking technology is feasible." passed with a clear majority.
- Read Resolution [On/Off switches for WiFi Routers and Protocol for the Use of Wireless Devices](#)

### **2010 [UK VOICE ;The Union for Education Professionals-](#) 20,000 members**

- "Voice has advocated that new Wi-Fi systems should not be installed in schools, that existing systems should be turned off when not required and that schools should consider whether they really need to use Wi-Fi, which was developed to facilitate Internet access on the move rather than to be used as a convenient alternative to cables in dedicated IT facilities."
- " In the light of what has happened to one of our members [*who has developed sensitivity to electro-magnetic radiation*], I am concerned that so many wireless networks are being installed in school and colleges without any real understanding of the possible long-term consequences." - Voice General Secretary Philip Parkin
- Read their [Position Statement](#) read their [Blog post](#).

### **Los Angeles California Public Schools**

- The LA School District Uses a RF-EMF Exposure Threshold 10,000 Less Than the FCC Limits: The OEHS supported a precautionary threshold level that is 10,000 times lower than the current Federal Communications Commission standard. Read the RF Report the LA School District Used to recommend a cautionary exposure level. [RADIOFREQUENCY \(RF\) EVALUATION REPORT Use of Wireless Devices in Educational Settings](#)
- 2009 LA School Board Resolution Banning Cell Towers from schools and recommending against WiFi.
  - "The Board supports responsible deployment of fiberoptic broadband technology which is superior to wireless in speed, reliability, security, durability and protections it affords people and the environment from the potential hazards of exposure to radio frequency radiation."
  - Read the adopted resolution [HERE](#).
  - [Read the Press Release here LOS ANGELES BOARD OF EDUCATION MEMBERS VOTE TO PROHIBIT CELL PHONE TOWERS NEAR SCHOOLS](#)
- 2009 December Resolution *Condemning Cell towers NEAR Schools* as was this T-Mobile Cell Tower across the street from an elementary school. [Read it here](#).  
"As long as questions exist as to the adequacy of these federal regulations, local governments should have the ability to include consideration of health and environmental effects of these

*facilities.*" (referring to cell towers) [Read the motion by Supervisors Zev Yaroslavsky and Michael Antonovich](#)

**2000 LA School Board Resolution Opposing Cell Tower Placement on Schools** and calling for precautions with wireless. 'Whereas, Recent studies suggest there is evidence that radio-frequency radiation may produce "health effects" at "very low field" intensities' [Read it here.](#)

### **2010 Greater Victoria Teachers' Association**

"The GVTA recommends a precautionary approach to the School District with regard to provision of wireless internet in schools. The precautionary approach comes from the environmental movement and has been adopted as common practice in areas regarding potential environmental, ecological or biodiversity damage. It suggests that the lack of significant evidence is not enough of a reason to be unconcerned. The fact that many other countries have instituted regulations to protect children, seniors, pregnant women and other susceptible populations should be the guide for a District policy on WiFi installation and use in the worksites."

The [GVTA Wireless in Schools Webpage](#) states now that:

- Wi-Fi free zones should be available.
- On/Off routers recommended and record any adverse Wi-Fi health effects.
- Minimal or non-use within elementary schools.

**2008** Lucerne Elementary Secondary Arrow Lakes District SD 10 New Denver BC, Canada Opts for "No WIFI

### **2001 Fletcher Hills PTA Resolution submitted to the California State PTA**

- "RESOLVED, that the California PTA supports local municipal zoning setback rules of at 1000 feet or more from an operating wireless transmitter and a school or residential area; and be it further
- RESOLVED that the California PTA supports encouraging schools to use cable lines for all communications services on campus and to avoid the endorsement, purchase or use of wireless local area network systems on campus; and be it further
- RESOLVED that the California PTA recommend that teachers and students should limit use of cellular phones or other mobile devices on school property to emergencies and that cellular phones, pagers and other mobile phones be turned off and placed out of sight while the individual is on school property"
- Resolution on Wireless Equipment/Cellular Phones and Antennas [Read it here.](#)

## **DOCTORS AND SCIENTISTS APPEAL FOR STRICTER WIRELESS TECHNOLOGY REGULATION**

<a href="#">Vienna Resolution</a> 1998 <a href="#">Salzburg Resolution</a> 2000 <a href="#">Stewart Report, UK</a> 2000 <a href="#">Declaration of Alcalá</a> 2002 <a href="#">Catania Resolution</a> 2002	<a href="#">Helsinki Appeal</a> 2005 Parish Kirchner Appeal 2005 Saarlander Appeal 2005 <a href="#">Stockacher Appeal</a> 2005 <a href="#">Vancouver School Resolution</a>	<a href="#">Potenza Picena Resolution</a> 2011 <a href="#">World Health Organization</a> 2011 <a href="#">Austrian Medical Association</a>
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<a href="#">Freiburger Appeal</a> 2002 <a href="#">Bamberger Appeal</a> 2004 <a href="#">Maintaler Appeal</a> 2004 <a href="#">International Association of Fire Fighters Resolution on Cell Towers</a> 2004 <a href="#">Coburger Appeal</a> 2005 <a href="#">Oberammergauer Appeal</a> 2005 <a href="#">Haibacher Appeal</a> 2005 <a href="#">Pfarrkirchener Appeal</a> 2005 <a href="#">Freienbacher Appeal</a> 2005 <a href="#">Lichtenfelser Appeal</a> 2005 <a href="#">Hofer Appeal</a> 2005	2005 <a href="#">Benevento Resolution</a> 2006 <a href="#">Allgäuer Appeal</a> 2006 WiMax Appeal 2006 Schlüchterner appeal Brussels Appeal 2007 <a href="#">Venice Resolution</a> 2008 <a href="#">Porto Alegre Resolution</a> 2009 <a href="#">European Parliament EMF Resolution</a> 2009 Dutch Appeal 2009 <a href="#">Int'l Appeal of Würzburg</a> 2010 <a href="#">Copenhagen Resolution</a> 2010 <a href="#">Seletun Consensus Statement</a> 2010 <a href="#">Russian National Committee on Non-Ionizing Radiation Protection</a> 2011	2012 <a href="#">Resolution on Electromagnetic Health</a> 2012 <a href="#">British Doctor Initiative</a> 2013 <a href="#">BabySafe Project: Joint Statement on Pregnancy and Wireless Radiation</a> 2014 <a href="#">Canadian Doctors Declaration to Health Canada</a> 2014 <a href="#">Scientific Declaration to Health Canada (International Doctors)</a> 2014 <a href="#">International Scientists Appeal to U.N. to Protect Humans and Wildlife from Electromagnetic Fields and Wireless Technology</a> 2015 <b>Over 200 Scientists</b>
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## INTERNATIONAL ASSOCIATION OF FIRE FIGHTERS

DIVISION OF OCCUPATIONAL HEALTH, SAFETY AND MEDICINE

*"The IAFF opposes the use of fire stations as base stations for towers and/or antennas for the conduction of cell phone transmissions until a study with the highest scientific merit and integrity on health effects of exposure to low-intensity RF/MW radiation is conducted and it is proven that such sitings are not hazardous to the health of our members."*

The IAFF Official Position *Against* Cell Towers on Fire stations passed in 2004

[iaff.org/HSFacts/CellTowerFinal.asp](http://iaff.org/HSFacts/CellTowerFinal.asp).

- This Position was initiated after increasing complaints among firefighters with cellular antennas on their stations coupled with the California study showing neurological damage in California firefighters conducted by Dr. Gunnar Heuser. [Read the Press Release on the Resolution and Research Study here](#)

### L.A. County Firefighters Local 1014

- Local 1014 has a webpage dedicated to stopping towers because of a plan to install them on over 200 of their stations. <http://www.stopcellphonetowers.com/index.html>
- "As firefighters and paramedics, we live in these firehouses. What effect will these towers have on us? What are the risks to our neighbors? It's a no-brainer that LA County should at least have done a proper study before before putting 200-foot high-power microwave antennas on top of our heads."

**- Dave Gillotte, Active Duty Fire Captain**  
President, LA County Firefighters Local 1014  
[Watch him testify on this issue here.](#)

- *The Firefighter's Website in 2015* <http://www.stopcellphonetowers.com/index.html>

### **United Firefighters of Los Angeles City Local 112 IAFF-CIO-CLC**

#### **Opposes Cell Towers on Their Stations.**

- “ It is inexcusable that once again our firefighters in the field were the last to know about a massive 150 million dollar project that could jeopardize their health and safety. ... nobody talked to us and we have not heard from one single expert who has told us that this project will be safe.”
- “UFLAC will strongly oppose the use of Fire Stations as base locations for cell towers and/or antennas “

Download the letter from this [LA Firefighters Union Local 112 asking for an immediate halt to cell towers](#) on fire stations.

[Watch videos the these Firefighter Union Presidents testifying to the LA Board of Supervisors on the Issue here.](#)

See list of Medical Doctor Consensus Statements at this link

<http://ehtrust.org/science/medical-doctors-consensus-statements-recommendations-cell-phoneswireless/>

## RF Studies Reporting Biological Effects and Adverse Health Effects for Exposures Similar to Wireless Devices (iPads and WI-FI)

Author/Date	SAR W/kg	Power Density uW/cm <sup>2</sup>	RFR effects at Low-Intensity Exposures
Akoev (02)		0.8 - 10	RFR caused emotional behavior changes (free-radicals)
Belyaev (05)	0.037	92.5	RFR caused genetic changes in human white blood cells
Boscolo (01)		5	RFR caused drop in NK lymphocytes (immune function decreased)
Capri (04)	0.07	175	RFR affected cell proliferation and membrane chemistry
Chiang (89)		4.0 - 15	RFR slowed memory/altered immune function in children
D'Inzeo (88)	0.008	2.0 - 4.0	RFR changed cell membrane acetylcholine-induced ion channels
Dolk (97)		1.3 - 5.7	RFR caused doubling of leukemia in adults
Dumansky (74)		5.0 - 10	RFR caused impaired nervous system activity
Dutta (89)	0.005	12.5	RFR caused calcium-efflux in cells - affects many cell functions.
Fesenko (99)		1	RFR caused significant effect on immune function (mice)
Forgacs (06)	0.018	45	RFR affected serum testosterone levels in mice
Hocking (96)		0.2 - 8	RFR caused two-fold increase in leukemia in children
Hocking (00)		0.2 - 8	RFR decreased survival in children with leukemia
Hutter (06)		.01 - .05	RFR caused headaches, concentration problems, sleeping problems
Ivaschuk (99)	0.026	65	RFR affected a gene related to cancer
Kolodynski (96)		0.16	RFR negatively affected memory, attention, motor function
Kesari (08)	0.0008	2	RFR induced double-strand DNA damage in rat brain cells
Khurana (2010)		0.05 - 0.1	RFR related to adverse neuro, cardio symptoms and cancer risk
Kundi (2009)		0.05 - 0.1	RFR related to headache, concentration and sleep problems, fatigue
Kwee (01)	0.0021	5.25	20 minutes of RFR at cell tower frequencies induced stress response
Lerchl (08)	0.08	200	RFR caused metabolic changes in hamsters
Magras (97)		0.17	RFR caused irreversible infertility (in mice at 5 generations)
Marinelli (04)	0.0035	8.75	RFR at 900 MHz fo 2-12 hours caused DNA breaks in leukemia cells
Navarro (03)		0.01 - 0.11	RFR from cell towers caused fatigue, headaches, sleeping problems
Novoselova (99)		1	RFR affected functions of the immune system
Oberfeld (04)		0.01	RFR (cell tower) = sleep disorders, poor concentration, fatigue
Nitby (07)		1.5	RFR reduced memory function in rats
Perssson (97)		1	RFR induced pathological leakage in blood-brain barrier
Phillips (98)	0.0024	6	RFR induced DNA damage in cells
Pyrpasopoulou (04)	0.0005	1.25	RFR exposure affected kidney development in rats (in utero exposure)
Salford (03)	0.02	50	RFR caused pathological leakage in blood-brain barrier
Sarimov (04)	0.0054	13.5	RFR affected human lymphocytes - stress response in cells
Schwartz (90)	0.00015	0.38	RFR affected calcium metabolism in heart cells
Somoso (91)	0.24	60	RFR caused structural changes in cells of mouse embryos
Stagg (97)	0.0059	14.75	RFR increased biomarker for cell division in glioma brain tumor cells
Stankiewicz (06)	0.24	60	RFR affected immune function of white blood cells
Tattersall (01)	0.0016	4	RFR caused changes in hippocampus, part of brain memory, learning.
Velizarov (99)	0.00002	0.0005	RFR decreased cell proliferation
Veyret (91)		37.5	RFR affected immune function
Wolke (96)	0.001	2.5	RFR affected calcium concentrations in heart muscle cells
Yurekli (06)	0.011	28.2	RFR affected production of free radicals in rat cells
Zwamborn (03)	8E-06	0.13	RFR from 3G cell towers decreased cognition, well-being

# RF Studies Reporting Biological Effects and Adverse Health Effects for Exposures Similar to Wireless Devices (iPads and WI-FI)

All of the studies expressed in W/kg above (SAR) are reporting bioeffects or adverse health effects at levels below the iPad's 0.99 watt/kilogram SAR level. All of the studies expressed in power density (uW/cm<sup>2</sup>) report effects at lower levels than the iPad's emission levels.

Read the iPad Users Guide in full. It reports:

*"Discontinue use of iPad and consult a physician if you experience headaches, blackouts, seizures, convulsion, eye or muscle twitching, loss of awareness, involuntary movement, or disorientation. To reduce risk of headaches, blackouts, seizures, and eyestrain, avoid prolonged use, hold iPad some distance from your eyes, use iPad in a well-lit room, and take frequent breaks."*

	<u>Model</u>	<u>SAR</u>	<u>Frequency</u>
SAR Emission from iPad Owners Guide, iPad 2.	A 1395	0.99 W/kg	2400-2483 MHz wireless exposure from iPad

to me, jlibber, dveisenberg

## Comments from Maryland Smart Meter Awareness on the WiFi in Schools Draft Report by CEHPAC:

Thank you very much for allowing us to comment on the CEHPAC Draft Report. We appreciate all the hard work that went into producing this well-written document, and we fully support the recommendations it contains.

We recognize that the report focuses on WiFi in schools. Since the radiation emitted from other wireless devices poses the same risks as that coming from WiFi, we urge CEHPAC to consider as expeditiously as possible addressing the following areas of concern:

1. Children and pregnant women should sleep as far away from wireless smart meters as possible. Better yet, families should consider opting out of a wireless smart meter whenever possible.
2. With the Internet of Things (IoT) evolving, everything that can possibly be connected to the Internet will be. It is therefore essential now to be vigilant about all products that we purchase. This includes toys, clothing, toothbrushes, lamps, diapers, toasters, refrigerators etc. Any and all “things” connected to the Internet will become sources of wireless radiation emissions. MSMA urges CEHPAC to include in their recommendations a directive to, whenever possible, purchase products that are not wirelessly connected to the Internet.

Finally, MSMA feels it’s critical to address the physiologic and psycho-social effects of screen time on children, as well as the problem of Internet Addiction Disorder (IAD). In a Medscape Medical News article following the American Psychiatric Association’s 2014 annual meeting, [Brain Abnormalities Linked to ‘Internet Addiction’](#), author Pauline Anderson states that about 26.3% of American youth have IAD. According to [Dr. Jadapalle](#), this is more than alcohol and illicit drug use disorders.

[Victoria L. Dunckley, MD](#), licensed psychologist and [internationally known expert](#) on Internet addiction spells out some of the changes in the physiology of the brain in her article, [Gray Matters: Too Much Screen Time Damages the Brain](#):

“Multiple studies have shown atrophy (shrinkage or loss of tissue volume) in gray matter areas (where “processing” occurs) in internet/gaming addiction ([Zhou 2011](#), [Yuan 2011](#), [Weng 2013](#), and [Weng 2012](#)). Areas affected included the important frontal lobe, which governs executive functions, such as planning, prioritizing, organizing, and [impulse control](#) (“getting stuff done”). Volume loss was also seen in the striatum, which is involved in reward pathways and the suppression of socially unacceptable impulses. A finding of particular concern was damage to an area known as the insula, which is involved in our capacity to develop [empathy](#) and compassion for others and our ability to integrate physical signals with emotion. Aside from the obvious link to violent behavior, these skills dictate the depth and quality of personal relationships.”

Again, we appreciate the opportunity to comment on this draft report and urge you, for the sake of the children of Maryland, to approve the report as soon as possible.

Sincerely,

Kate Kheel, Director of Maryland Smart Meter Awareness  
Jonathan D. Libber, Esq., Counsel to Maryland Smart Meter Awareness  
Ruthie Eisenberg, Treasurer of Maryland Smart Meter Awareness



December 8, 2016

Dear Maryland Children's Environmental Health and Protection Advisory Council Members,

I am writing as a concerned parent of an elementary school student of Montgomery County Public Schools (MCPS). I also have a middle school student in MCPS and serve as a para-educator for MCPS high school students. My professional background is in instructional systems technology and have held positions in several learning institutions as an educational technology specialist and instructional designer.

I am writing to urge CEHPAC to finalize its guidelines "Wifi Radiation in Schools in Maryland." Without the benefit of your guidelines, MCPS has now proposed allowing cell phone use in elementary schools.

I am opposed to allowing elementary school students to bring cell phones to school for several reasons:

1/Cell phones serve as a distraction, not an enhancement, to instruction in the classroom. Students at the elementary school level do not need to have additional access to technology via the cell phone. In my opinion, it does not have any educational benefit at this age. (In fact, in my opinion, MCPS has overextended the use of chrome books for grades 2-4 and has not had enough faculty training as it stands). The cell phone would add another layer of discipline for the teacher to control the students' use of the cell phone. I have seen first hand, in two separate high schools, how cell phones are a major distraction and major disciplinary issue for teachers to deal with and are not used as an instructional/learning tool. In the high schools that I have served as a Para educator, right under the teachers' noses, students are utilizing their cell phones and most teachers that I've worked with do not have a system in place that truly prevents the students from using the phones during instruction (the only system that works is for the teacher to hold onto all cell phones until the end of the classroom; yet, another time management issue for the teacher).

2/Cell phones that are brought to and from school by other students are shared with those students who do not have a cell phone. As a parent of young children, I do not want my child utilizing their free time with a cell phone on the bus, walking to school, while sitting at school waiting for the bus or on a field trip. These are times for children to relax, read, do homework or socialize with peers without the use of technology. My husband and I control in our own home the amount of technology that our children have due to our belief that it is not beneficial for a child's neither social nor intellectual development. There is no feasible way to prevent students' that brings cell phones to school to not share their phones with their peers. I've seen this already happening daily at our elementary school bus stop. A child will play with their parent's cell phone (i.e., Pokemon game) and other children at the

bus stop immediately run over to play with this apparatus. It is impossible, even as the parent, to tell the other child to not share their cell phone and/or to ask my own child to not play with the phone. Also, at school, there would be minimal control, i.e., when children are in the hallways waiting for the bus as they do in our school. Our patrols are mostly monitoring the hallways and these are 5<sup>th</sup> graders who as much as they try, can't necessarily control the students. The patrols should not be asked to control technology use of their peers when even as adults it is a challenge.

3/Health and Safety is also a major concern. We do not fully understand the health hazards from using cell phones or Chrome books that utilize Wi-Fi. But we do know that other countries are limiting, or completely not allowing, use of wireless access in the classroom due to the health hazards so why would MCPS want to add to this issue potentially creating serious medical issues for all students and teachers. In addition, it is bad enough that adults can't control themselves with cell phones while walking in the street, imagine a child with their cell phone talking and walking. I've seen it happen. We've heard of several incidents of people getting hit by cars while crossing the street and using their cell phone. We can't depend on a young child (or an adult for that matter) under the age of 11 to truly pay attention and understand the hazards of using a cell phone.

In this instance, MCPS needs to look at the serious issues of allowing cell phones (and chrome books,) for elementary students as a serious detriment to learning, safety and socialization in school and beyond.

I am asking that CEHPAC be a leader in this challenge and issue final guidelines that will encourage limiting cell phone use in the elementary schools.

Thank you.

Sincerely,

Katherine Kerxton  
kkerxton@gmail.com

This is an addendum of sorts to my just submitted comments opposing Wi fi in schools.

Please pass the draft as final not a draft to go online for more comments.

I forgot to mention the WHO classified wireless radiation (non ionising) as a Class 2 B carcinogen in 2011 and new research adds more evidence showing not just carcinogenicity but other health damage such as brain damage and reproductive damage.

Thank You,

Lynn Beiber

To the Maryland Children's Environmental Health and Protection Advisory Council,

I urge the Council to support any and all actions Maryland schools can take to reduce wifi radiation under their roofs.

- Hardwiring to an internet connection is less harmful to growing bodies and brains.
- It is more cost efficient, as wifi requires multiple times the energy cost.
  
- Many municipalities are removing black rubber crumbles from their athletic field. Wifi radiation and carbon black (from said fields) BOTH sit on the same list of World Health Organization Group 2b carcinogens.

Minimizing exposure also protects our teachers and staff. These heroes of society deserve ever protection possible.

Schools set an example for the communities they serve. This is an opportunity to show caring and concern for the whole child. Our pediatrician, for example, has shared with us that exposure to wifi radiation should be minimized — hard to do when the schools pulse it out all day long.

Further, parental consent should be required (as it is for Halloween parties) and exposure levels revealed (as it is for pesticide applications). To involuntarily subject children to radiation unnecessarily needs addressing. This is urgent and international schools are do far more than we are. I am counting on you to take steps so schools are as safe as possible.

Kindly,

Lisa Cline  
420 Upshire Circle  
Gaithersburg, MD 20878



## Medical Doctors and Public Health Organizations

### **Consensus Statements and Doctor's Recommendations on Cell Phones/Wireless**

It is a fact that *not a single medical organization* states that cell phone/wireless radiation is safe. There is no proof of safety.

### **American Academy of Pediatrics**

The American Academy of Pediatrics (AAP), is a non-profit professional organization of 60,000 primary care pediatricians, pediatric medical subspecialists, and pediatric surgical specialists dedicated to the health, safety and well-being of infants, children, adolescents, and young adults.

[2016: American Academy of Pediatrics Website: Healthy Children.org Cell Phone Radiation & Children's Health: What Parents Need to Know](#). In response to the National Toxicology Program Cell Phone Radiation Study results, the AAP issued the following cell phone safety tips specifically to reduce exposure to wireless radiation in 2016:

- Use text messaging when possible, and use cell phones in speaker mode or with the use of hands-free kits.
- When talking on the cell phone, try holding it an inch or more away from your head.
- Make only short or essential calls on cell phones.
- Avoid carrying your phone against the body like in a pocket, sock, or bra. Cell phone manufacturers can't guarantee that the amount of radiation you're absorbing will be at a safe level.
- Do not talk on the phone or text while driving. This increases the risk of automobile crashes.
- Exercise caution when using a phone or texting while walking or performing other activities. "Distracted walking" injuries are also on the rise.
- If you plan to watch a movie on your device, download it first, then switch to airplane mode while you watch in order to avoid unnecessary radiation exposure.
- Keep an eye on your signal strength (i.e. how many bars you have). The weaker your cell signal, the harder your phone has to work and the more radiation it gives off. It's better to wait until you have a stronger signal before using your device.
- Avoid making calls in cars, elevators, trains, and buses. The cell phone works harder to get a signal through metal, so the power level increases.
- Remember that cell phones are not toys or teething items.

[Press Release: The AAP responds to study showing link between cell phone radiation, tumors in rats May 27, 2016](#)

“They’re not toys. They have radiation that is emitted from them and the more we can keep it off the body and use (the phone) in other ways, it will be safer,” said Jennifer A. Lowry, M.D., FAACT, FAAP, chair of the AAP Council on Environmental Health Executive Committee.

[2015 AAP Healthy Child Web Page on Electromagnetic Fields: A Hazard to Your Health?](#)

This webpage states:

“Cell Phones: In recent years, concern has increased about exposure to radio frequency electromagnetic radiation emitted from cell phones and phone station antennae. An Egyptian study confirmed concerns that living nearby mobile phone base stations increased the risk for developing: *Headaches, Memory problems, Dizziness, Depression, Sleep problems*”

[2013 AAP Letter to FCC Commissioner Mignon Clyburn and FDA Commissioner Margaret Hamburg calling for a review of RF guidelines 8/29/2013](#)

“The AAP urges the FCC to adopt radiation standards that: Protect children’s health and well-being. Children are not little adults and are disproportionately impacted by all environmental exposures, including cell phone radiation. Current FCC standards do not account for the unique vulnerability and use patterns specific to pregnant women and children. It is essential that any new standard for cell phones or other wireless devices be based on protecting the youngest and most vulnerable populations to ensure they are safeguarded throughout their lifetimes.”

[2012 AAP Letter to US Representative Dennis Kucinich in Support of the Cell Phone Right to Know Act 12/12/2012](#)

“ The differences in bone density and the amount of fluid in a child’s brain compared to an adult’s brain could allow children to absorb greater quantities of RF energy deeper into their brains than adults. It is essential that any new standards for cell phones or other wireless devices be based on protecting the youngest and most vulnerable populations to ensure they are safeguarded through their lifetimes.”

[Time Magazine \(2012\): Pediatricians Say Cell Phone Radiation Standards Need Another Look](#)

**2012, the AAP published Pediatric Environmental Health, Textbook of Children's Environmental Health 3rd Edition edited by Philip J. Landrigan, Ruth A. Etzel. Chapter 41: Electromagnetic Fields.**

“Exposures can be reduced by encouraging children to use text messaging when possible, make only short and essential calls on cellular phones, use hands free kits and wired headsets and maintain the cellular phone an inch or more away from the head.”

[Read it on Google Books Chapter 41: Electromagnetic Fields at this link page 383.](#)  
[Oxford Medicine Chapter 41 Link](#)

AAP News 2011: [More study needed on risk of brain tumors from cell phone use by Ruth A. Etzel, AAP News, Oct 2011](#)

Environmental Health Trust <http://ehtrust.org/>

## **The BabySafe Project**

As of August 2016 over 200 physicians, scientists and public health professionals from around the world have signed onto this Project “to express their concern about the risk that wireless radiation poses to pregnancy and to urge pregnant women to limit their exposures.”

- “We call on our elected leaders to support such research and to advance policies and regulations that limit exposures for pregnant women. We call on industry to implement and explore technologies and designs that will reduce radiation exposures until such research is carried out.”
- The BabySafe Project Brochure [“Ten Ways to Reduce Your Wireless Exposure”](#) which includes “Whenever possible, connect to the internet with wired cables”.
- [The BabySafe Project Website](#)
- EPA Award: The BabySafe Project was recognized in the [US EPA’ 2016 Children’s Environmental Health Excellence Award from the EPA’s Office of Children’s Health Protection](#). Patricia Wood was awarded based on three distinct initiatives including “the creation and development of the BabySafe Project, a program designed to inform doctors, neonatal health professionals and parents about the potential risks that wireless radiation poses to pregnancy”.

## **The California Medical Association**

The California Medical Association (CMA) passed a Wireless Resolution in 2014 that states :

“Whereas scientists are increasingly identifying EMF from wireless devices as a new form of environmental pollution ...

Whereas peer reviewed research has demonstrated adverse biological effects of wireless EMF including single and double stranded DNA breaks, creation of reactive oxygen species, immune dysfunction, cognitive processing effects, stress protein synthesis in the brain, altered brain development, sleep and memory disturbances, ADHD, abnormal behavior, sperm dysfunction, and brain tumors; and...Resolved, That CMA support efforts to implement new safety exposure limits for wireless devices to levels that do not cause human or environmental harm based on scientific research.”

[Read the full CMA Resolution here.](#)

[Read a the Santa Clara Medical Bulletin article by Dr. Cindy Russell that explains the CMA resolution and gives recommendations for schools.](#)

## **The Vienna Medical Association**

The Vienna Medical Association has issued [Ten Medical Rules for Cell Phones](#) which includes:

“Make calls as short and little as possible, Do not position mobile phones directly on the body , Fewer apps means less radiation, Make calls at home and at work via the fixed corded (not wireless) network - Internet access via LAN cable, Constant radiation emitters like DECT cordless telephones, WLAN access points, data sticks and LTE Home base stations (Box, Cube etc.) should be avoided! Avoid Mobile phone calls in places with poor reception ”

“The radiation from mobile phones or smartphones is most likely not as safe as cell phone providers claim it to be. Therefore, the Vienna Medical Association has decided to do the responsible thing and inform the Austrian public about possible adverse effects from a medical perspective.”

### **The Connecticut Department of Public Health, USA**

Public Health Department recommendations to reduce exposure to cellphone radiation. 7 steps on *how* people can reduce exposure.

*“It is wise to reduce your exposure to radiofrequency energy from cell phones whenever possible.”* [Read the Connecticut Department of Public Health Cell Phone Q and A about Cell phones here.](#)

### **The Massachusetts Department of Health, USA**

[BEST PRACTICES IN THE USE OF WIRELESS TECHNOLOGY](#) Dr. Robert S. Knorr Director, Environmental Epidemiology Program Bureau of Environmental Health, Massachusetts Department of Public Health

“Below are common recommendations and include those for both cell phone and non-cell phone sources:

- Use wired communication devices instead of wireless devices
- Limit children’s use of cell phones except for emergencies
- Keep cell phones and other sources at a distance
- If using wireless devices like computers, laptops, tablets, and printers, place the wireless router away from where children and adults usually spend time.

[Read all of the recommendations from the Mass Department of Health in full at this link.](#)

### **The French National Agency of Health Security of Food, Environment and Labour**

**2016 Report** [“Radiofrequency Exposure and the Health of Children”](#) recommends reducing exposures to young children and strengthening regulations to ensure “sufficiently large safety margins” to adequately protect the health of young children.

- All wireless devices, including tablets, cordless phones, remote controlled toys, wireless toys, baby monitors and surveillance bracelets, should be subjected to the same regulatory obligations as cell phones.
- Compliance with regulatory exposure limits should be insured for the ways that devices are customarily used, such as positioned in contact with the body.
- Exposure limits for radiofrequency electromagnetic fields should be tightened to ensure sufficiently large safety margins to protect the health and safety of the general population, particularly the health and safety of children.
- Reliance on the specific absorption rate (SAR) to set human exposure limits should be re-evaluated and replaced through the development of an indicator to assess real exposures for mobile phone users that applies to various conditions: signal type, good or bad reception, mode of use (call, data loading, etc.), location device is used on the body.

- ANSES reiterated its recommendation, as previously stated, to reduce exposure to children: minimize use and prefer a hands-free kit.

**2013 Report** [“Radiofrequency Electromagnetic Fields and Health” Expert Appraisal:](#) hands free phones, SAR labeling, and “limiting the population's exposure to radiofrequencies... especially for children and intensive users, and controlling the overall exposure that results from relay antennas.”

### **The American Cancer Society (ACS)**

#### [2016 ACS Responds to New Study Linking Cell Phone Radiation to Cancer](#)

“The NTP report linking radiofrequency radiation (RFR) to two types of cancer marks a paradigm shift in our understanding of radiation and cancer risk. The findings are unexpected; we wouldn’t reasonably expect non-ionizing radiation to cause these tumors. This is a striking example of why serious study is so important in evaluating cancer risk. It’s interesting to note that early studies on the link between lung cancer and smoking had similar resistance, since theoretical arguments at the time suggested that there could not be a link.” -Otis W. Brawley, M.D., The American Cancer Society Chief Medical Officer in [ACS Responds to New Study Linking Cell Phone Radiation to Cancer](#) posted on May 27, 2016 after the NTP results were released.

[2009 Lecture at Cell Phones and Health Conference:](#) In 2009 Michael Thun, Vice President of the American Cancer Society, lectured on cell phone radiation and cancer risk and detailed how it would take decades before definitive evidence is found in the general population due to the slow growing nature of brain cancer but that early signs would be seen in increases in gliomas [Watch the lecture by Dr. Thun here.](#)

### **Canadian Parliament Standing Committee on Health of the House of Commons**

**2015 Canadian Parliament Report** ["Radio Frequency Electromagnetic Radiation and the Health of Canadians"](#) has 12 recommendations including “That the Government of Canada develop an awareness campaign relating to the safe use of wireless technologies, such as cell phones and Wi-Fi, in key environments such as the school and home to ensure that Canadian families and children are reducing risks related to radiofrequency exposure.”

### **Environment and Human Health, Inc.**

#### [Cell Phones: Technology, Exposures, Health Effects by Environment and Human Health, Inc.](#)

John Wargo, Ph.D., professor of Environmental Risk and Policy at Yale University and lead author of the report, said, *“The scientific evidence is sufficiently robust showing that cellular devices pose significant health risks to children and pregnant women. The weight of the evidence supports stronger precautionary regulation by the federal government. The cellular industry should take immediate steps to reduce emission of electromagnetic radiation (EMR) from phones and avoid marketing their products to children.”*

- [Download Full Text of Report](#)
- [Summary](#)

Environmental Health Trust <http://ehtrust.org/>

- [Recommendations](#)
- [Press Release](#)

### **The Council of Europe**

In 2011 The Parliamentary Assembly of the Council of Europe issued Resolution 1815: [The Potential Dangers of Electromagnetic Fields and Their Effect on the Environment](#). A call to European governments to “take all reasonable measures” to reduce exposure to electromagnetic fields “particularly the exposure to children and young people who seem to be most at risk from head tumours.”

*“For children in general, and particularly in schools and classrooms, give preference to wired Internet connections, and strictly regulate the use of mobile phones by schoolchildren on school premises.” [Read the 2011 Resolution 1815](#)*

(Note: This is a follow up to the 2009 European Parliament’s [Health concerns associated with electromagnetic fields](#)).

### **2015 International Scientists Appeal to U.N. to Protect Humans and Wildlife from Electromagnetic Fields and Wireless Technology**

In May 2015, a group of over 200 scientists from 39 nations who have authored more than 2,000 articles on this topic appealed to the United Nations to address “the emerging public health crisis” related to cell phones and other wireless devices. These scientists state that “the ICNIRP guidelines do not cover long-term exposure and low-intensity effects, and are “insufficient to protect public health.”

- They state that “the various agencies setting safety standards have failed to impose sufficient guidelines to protect the general public, particularly children who are more vulnerable to the effects of EMF.”
- See the [International Scientists Appeal to U.N. to Protect Humans and Wildlife from Electromagnetic Fields and Wireless Technology](#).

### **The World Health Organization’s International Agency for Research on Cancer**

The WHO/IARC classified all radiofrequency electromagnetic fields as “possibly carcinogenic to humans” in 2011 based on the opinion of a Working Group of 31 international experts who met in Lyon, France in May, 2011 based largely on positive associations have been observed between exposure to radiofrequency radiation from wireless phones and glioma, and acoustic neuroma.” ([p. 421](#))

- Read article in [The Lancet IARC 2011 on the classification](#),
- Read the [The 2011 IARC Press Release by the WHO IARC](#) in which precautions are recommended:

“Given the potential consequences for public health of this classification and findings, it is important that additional research be conducted into the long- term, heavy use of mobile phones. Pending the availability of such information, it is important to take pragmatic measures to reduce exposure such as hands-free devices or texting.” said IARC Director Christopher Wild.

- Read the [published the IARC Monograph on Non-Ionizing Radiation, Part 2: Radiofrequency Electromagnetic Fields](#) (April 2013) with scientific basis for classification.
  - “Due to the closer proximity of the phone to the brain of children compared with adults, the average exposure from use of the same mobile phone is higher by a factor of 2 in a child’s brain and higher by a factor of 10 in the bone marrow of the skull.” ([p. 408](#))

### **Swiss Physicians Association of Doctors for Environmental Protection**

[2012 Swiss Physicians Letter](#) "the risk of cancer for this type of [wireless] radiation is similar to that of the insecticide DDT, rightfully banned... From the medical point of view, it is urgent to apply the precautionary principle for mobile telephony, WiFi, power lines, etc.”

[2014: Preliminary draft for a federal law on the protection against dangers:](#) Non-ionizing radiation (NIS) is growing steadily. Especially the everyday stress in the area of low-frequency and high-frequency. [Read it here.](#)

[2016: Press Release on the NTP Study and Policy Implications:](#) “There are increasingly clear indications that mobile radio is a health hazard. From a medical point of view it is clear: the scientific results so far show it is clear that prudent avoidance of unnecessary exposures is necessary.”

- Additional Links by Swiss Physicians for the Environment  
Report on [Smartphones- \(OEKOSKOP 1/16\)](#) [AefU-News about Electrosmog](#)

### **Dr. Eitan Kerem, Chairman, Department of Pediatrics at Hadassah Hebrew University Hospital**

In response to the 2016 NIH/NIEHS/NTP Study results finding a link between RF-EMF and Cancer, Dr. Kerem issued a statement which includes:

*“It is well known that children are more sensitive to radiation than adults; many of them are using cellphone and other radiating media more frequently than adults. The effect of radiation is accumulative and this may have long term effect on the growing child. Such findings in the pharma industry may prevent further developing of a drug until safety is proven, and until the findings of this study are confirmed parents should be aware of the potential hazards of carcinogenic potential of radiofrequency radiation.”* [Read the Statement by Dr. Eitan Kerem, Hadassah Hebrew University Hospital](#)

### **The American Academy of Environmental Medicine**

[The American Academy of Environmental Medicine's Open Letter to the Superintendents of the School Districts of the United States](#)

"Adverse health effects, such as learning disabilities, altered immune responses, headaches, etc. from wireless radio frequency fields do exist and are well documented in the scientific literature. Safer technology, such as using hard-wiring, must be seriously considered in schools for the safety of those susceptible individuals who may be affected by this phenomenon. "

[Wireless Radiofrequency Radiation in Schools](#)

[American Academy of Environmental Medicine Recommendations Regarding Electromagnetic and Radiofrequency Exposure](#)  
[Letter to the FCC regarding Radiofrequency Exposure Limits.](#)

### **International Society of Doctors for the Environment**

ISDE has made the following recommendations: Avoid Wi-Fi in home or work if possible, particularly in schools or hospitals and Use wired technology whenever possible.

- “Because of the potentially increased risks for the foetus, infants and young children due to their thinner more permeable skulls and developing systems, particularly the immune and neurological systems, based on the precautionary principle and on the mounting evidence for harm at the sub-cellular level, we recommend that EMR exposure should be kept to a minimum.”
- [Read the Statement Here.](#)

### **Irish Doctors Environmental Association**

The Irish Doctors Environmental Association wrote a statement in 2013 concerning health concerns with Wi-Fi in school:

“We urge you to use wired technologies for your own safety and that of your pupils and staff.” [Read the 2013 Letter](#)

### **Bioinitiative Working Group**

[Bioinitiative 2012 Report](#): **A report by 29 independent scientists and health experts from around the world\* about possible risks from wireless technologies and electromagnetic fields.**

“The science, public health, public policy and global response to the growing health issue of chronic exposure to electromagnetic fields and radiofrequency radiation in the daily life of billions of people around the world. Covers brain tumor risks from cell phones, damage to DNA and genes, effects on memory, learning, behavior, attention; sleep disruption and cancer and neurological diseases like Alzheimer’s disease. Effects on sperm and miscarriage (fertility and reproduction), effects of wireless on the brain development of the fetus and infant, and effects of wireless classrooms on children and adolescents is addressed. Mechanisms for biological action and public health responses in other countries are discussed. Therapeutic use of very low intensity EMF and RFR are addressed.”

[Henry Lai’s Research Summaries](#): These abstracts (data-based to be searchable) cover the RFR scientific literature from both RFR and ELF on research published between 1990-2012.

[The Bioinitiative RF Color Charts](#) summarize many studies that report biological effects and adverse health effects relevant for cell towers, WI-FI, 'smart' wireless utility meters, wireless laptops, baby monitors, cell phones and cordless phones. The reader can compare the level of EMF used in specific research studies relative to the health effect.

[Bioinitiative Letter to Education Super Highway CEOs](#) the Co-Editors of the Bioinitiative Report Cindy Sage and David Carpenter sent a letter on behalf of the Bioinitiative Working Group to the CEO's on the health risks of wireless infrastructure in US schools stating:

*"WiFi in schools, in contrast to wired internet connections, will increase risk of neurologic impairment and long-term risk of cancer in students. Corporations cannot avoid responsibility simply by asserting compliance with existing legal, but outdated and inadequate FCC public safety limits. Today, corporations that deal with educational technology should be looking forward and helping school administrators and municipal leaders to access safe, wired solutions."* [Read the Letter to Education Super Highway CEOs](#),

### **Austrian Medical Association**

[Guidelines of the Austrian Medical Association for the diagnosis and treatment of EMF related health problems and illnesses \(EMF syndrome\):](#) The Austrian Medical Association, on March 3, 2012, released their guide for diagnosing and treating people with EMF-related health problems.

"Wi-Fi environments will lead to high microwave exposure for students and teachers which might increase the burden of oxidative stress. Oxidative stress might slow down the energy production especially in brain cells and may lead e.g. to concentration difficulties and memory problems in certain individuals. The Austrian Medical Association recommends Wi-Fi free school environments."

Dr Gerd Oberfeld, MD, Public Health Department, Salzburg, Austria, on behalf of the Austrian Medical Association stated, "Schools should provide the best possible learning environments. In this context low noise levels, good air quality and low radiofrequency / microwave radiation are crucial. Wi-Fi environments will lead to high microwave exposure for students and teachers which might increase the burden of oxidative stress. Oxidative stress might slow down the energy production especially in brain cells and may lead e.g. to concentration difficulties and memory problems in certain individuals. The Austrian Medical Association recommends Wi-Fi free school environments".

### **Pittsburgh Cancer Institute**

Dr. Ronald B. Herberman, Director of the University of Pittsburgh Cancer Institute, issued a [Memo to PCI Staff: Important Precautionary Advice Regarding Cell Phone Use](#)

"Do not allow children to use a cell phone, except for emergencies. The developing organs of a fetus or child are the most likely to be sensitive to any possible effects of exposure to electromagnetic fields".

- [Prominent Cancer Doctor Warns About Cellphones](#): New York Times article
- [Statement Of Ronald B. Herberman, MD Director University of Pittsburgh Cancer Institute and UPMC Cancer Centers](#) to the Domestic Policy Subcommittee Oversight and Government Reform Committee Thursday, September 25, 2008 2154 Rayburn HOB 11:00 a.m. "Tumors and Cell Phone use: What the Science Says"

## **The Cancer Association of South Africa (CANSA)**

“In order to prove that the use of cell phones can cause cancer, many thousands of cell phone users would need to be studied over many years. Such studies are now in progress in many countries and it is expected that definitive results will be forthcoming in the near future. However, just because there is no definite evidence at this stage, does not mean that there is no potential danger.”

Recommendations to reduce Exposure: [CANSA has issued a Fact Sheet and Position Statement on Exposure to Radiofrequency Electromagnetic Fields](#)

“CANSA proposes that exposure to cell phone radiation be kept to a minimum by:  
Limiting the number and duration of calls  
Texting rather than making calls  
Switching the sides of the head when a call is long – one should, however, avoid long conversations  
Making use of hands-free kits or speaker phone mode to keep the phone a distance from the head. Instructing children and teenagers to limit calls to emergencies only as they are more vulnerable to electro-magnetic radiation because of the thickness of their skulls and their brains are still developing  
Not sleeping with one’s cell phone close to one’s bed or under one’s pillow  
Women not to keep their cell phones in their brassiere  
Men not to carry their cell phones in the pockets of their pants (close to their testicles).”

## **The Canadian Medical Association**

2011 Resolution on Cell Phone Radiation

*“The Canadian Medical Association will educate and advise the profession and the public on methods of cellphone operation that will minimize radio frequency penetration to the brain.”*

[Read the 2011 General Council of the Canadian Medical Association Proceedings \(page 54\)](#)

Canadian Medical Association Journal reports Health Canada's wireless limits are "A Disaster to Public Health" [Read the article here.](#)

## **Canadian Doctors**

[2014 Letter by 55 Canadian Doctors](#)

The Doctors wrote Health Canada calling for more protective limits stating, *“There is considerable evidence and research from various scientific experts that exposure to microwave radiation from wireless devices; Wi-Fi, smart meters and cell towers can have an adverse impact on human physiological function”*.- [Canadian Doctors Declaration to Health Canada,](#)

**International Group in Support of Safer Standards for Canadians**

[53 Doctors sign a Scientific Declaration on Health Canada EMF Limits July 9,2014](#)

## **The Russian National Committee on Non-Ionizing Radiation Protection**

[ELECTROMAGNETIC FIELDS FROM MOBILE PHONES: HEALTH EFFECT ON CHILDREN AND TEENAGERS \(2011\)](#) warns about electromagnetic radiation impacts on children and recommended WiFi not be used in schools.

Environmental Health Trust <http://ehtrust.org/>

- **Official Recommendations:** Those under the age of 18 should not use a mobile phone at all, recommends low- emission phones; and requires the following: on-device labelling notifying users that it is a source of RF-EMF, user guide information advising that “it is a source of harmful RF-EMF exposure” and the inclusion of courses in schools regarding mobile phones use and RF-EMF exposure issues. “Thus, for the first time in the human history, children using mobile telecommunications along with the adult population are included into the health risk group due to the RF EMF exposure.”
  - “In children, the amount of so-called stem cells is larger than in adults and the stem cells were shown to be the most sensitive to RF EMF exposure.”
  - “It is reasonable to set limits on mobile telecommunications use by children and adolescents, including ban on all types of advertisement of mobile telecommunications for children.”

[Decision of Russian National Committee on Non-Ionizing Radiation Protection](#) 2008, "Children and Mobile Phones: The Health of the Following Generations is in Danger"

### **The Cyprus National Committee on Environment and Child Health**

This Health Committee was created by the Cyprus government to advise on children’s environmental health issues and is comprised of pediatricians. They have issued strong recommendations to reduce exposure to children.

- [Protecting children from radiation emitted by Wi-Fi, mobile phones and wireless](#) by Dr. Stella Kanna Michailidou of the National Committee Chairman "Environment and Children's Health"
- [See the Commission’s EMF brochure](#) on reducing the risks to children from exposure to the Non Ionizing Radiation (mobile phones, Wi-Fi, tablets, etc.).
- The Cyprus National Committee on Environment and Child Health created [a short PSA for citizens](#) about children and wireless radiation and how to reduce Wi-Fi exposure. <https://www.youtube.com/watch?v=996vzcCYCnE>

### **British Medical Doctors**

In 2014 a group of **British Medical Doctors** issued [Health and safety of Wi-Fi and mobile phones](#):

*“We wish to highlight our concern over the safety of exposure to microwave radiation from wireless technology, particularly for vulnerable groups like children, pregnant women, the elderly and those with compromised health”.*

### **U. S. President’s Cancer Panel, 2009**

The 2009 U.S. President’s Cancer Panel pointed to cell phones and other wireless technologies as potential causes of cancer. In its recommendations, the panel stated:

“Several steps can be taken to reduce personal exposure to RF fields from cell phones. Landlines or text messaging should be used whenever possible. If a mobile phone must be used, a headset is preferable to holding the phone to the ear. Children should be prohibited from using mobile phones except in emergencies. Active phones should not

be kept on belts or in pockets. Phones should not be kept in close proximity during sleep.

Reduction of exposure to other sources of RF can be accomplished by keeping AM, FM, television, and mobile phone towers far from homes, schools, and businesses. Wireless networks should not be used in schools; wired connections should be used instead. There should be resistance to the general trend toward making everything wireless without consideration of negative consequences.”

[DR. MARTHA LINET: CELLULAR \(MOBILE\) TELEPHONE USE AND CANCER RISK](#)  
[DR. DAVID CARPENTER: ELECTROMAGNETIC FIELDS AND CANCER: THE COST OF DOING NOTHING Page 15](#)

“Since latency for brain cancer from environmental exposures is thought to be 20 to 30 years, comprehensive studies looking at longer-term human exposure are needed. Participants urged that a precautionary approach be taken with respect to the use of cell phones by children, who are more susceptible than adults to radiation risks.”

- [Summary of of the President's Cancer Panel 2009 January 27 Phoenix, AZ](#)

### **Israel Dental Association**

Israeli Dental Association issued a recommendation to decrease exposure after their research showed links to salivary gland tumors.

“One in every five rare malignant tumors of the cheek occurs in someone under age 20 Young people should limit direct exposure of the head to microwave radiation from cell phones.” [News Article:Israeli Study Sees Link Between Oral Cancer, Cell Phones Israel Dental Association: Number of cases of parotid salivary cancer rose dramatically in past five years.](#)

### **The Seletun Scientific Statement**

In November, 2009, a scientific panel met in Seletun, Norway, for three days of intensive discussion on existing scientific evidence and public health implications of the unprecedented global exposures to artificial electromagnetic fields (EMF). EMF exposures (static to 300 GHz) result from the use of electric power and from wireless telecommunications technologies for voice and data transmission, energy, security, military and radar use in weather and transportation. The Scientific Panel recognizes that the body of evidence on EMF requires a new approach to protection of public health; the growth and development of the fetus, and of children; and argues for strong preventative actions. New, biologically-based public exposure standards are urgently needed to protect public health worldwide.

The report and Consensus Statement, published in the journal Reviews on Environmental Health (<http://www.ncbi.nlm.nih.gov/pubmed/21268443>),  
[Seletun Consensus Statement](#)

### **Potenza Picena Resolution 2011**

Environmental Health Trust <http://ehtrust.org/>

On April 20th , 2013 the International Congress of Potenza Picena entitled “[Radar, radiofrequency and health risk](#)” concluded that stricter safety standards for EMF needs to be adopted by governments and public health agencies because the existing ones are obsolete and they are not based on recent literature about biological effects.” [Potenza Picena Resolution 2011](#)

### **Porto Alegre Resolution, Brazil**

Dozens of Doctors, (primarily from Brazil) have issued recommendations

“We are deeply concerned that current uses of non-ionizing radiation for mobile phones, wireless computers and other technologies place at risk the health of children and teens, pregnant women, 2 seniors and others who are most vulnerable due to age or disability, including a health condition known as electromagnetic hypersensitivity. We strongly recommend these precautionary practices: 1. Children under the age of 16 should not use mobile phones and cordless phones, except for emergency calls;” Read more at [Porto Alegre Resolution](#)

Even as far back as 1997, dozens of Boston Doctors and Health experts signed onto a petition with concerns about Sprint's Wireless Rollout.

### **[1997 Boston Physicians' and Scientists' Petition To Avert Public Exposures to Microwaves](#)**

“We the undersigned physicians and scientists call upon public health officials to intervene to halt the initiation of communication transmissions employing ground level, horizontally transmitting, pulsed microwaves in Boston.”

## **MORE RECOMMENDATIONS TO KNOW**

### **Consumer Reports**

**May 2016 Consumer Reports Recommendations in article:** [Does Cell Phone Use Cause Brain Cancer? What the New Study Means For You: Groundbreaking study reveals the strongest link yet between cell phone radiation and cancer. Important advice for all consumers.](#)

- Try to keep the cell phone away from your head and body. Keeping it an arm's distance away significantly reduces exposure to the low-level radiation it emits. This is particularly important when the cellular signal is weak—when your phone has only one bar, for example—because phones may increase their power then to compensate.
- Text or video call when possible, because this allows you to hold the phone farther from your body.
- When speaking, use the speakerphone on your device or a [hands-free headset](#).
- Don't stow your phone in your pants or shirt pocket. Instead, carry it in a bag or use a belt clip.

### **May 2016 Consumer Reports Recommendations to Government and Industry**

Environmental Health Trust <http://ehtrust.org/>

“The substantial questions and concerns raised by this and previous research regarding cell phones and cancer requires swift and decisive action by the government and industry. Specifically, Consumer Reports believes that:

- The National Institutes of Health should commission another animal study using current cell phone technology to determine if it poses the same risks as found in this new study.
- The Federal Communications Commission should update its requirements for testing the effect of cell phone radiation on human heads. The agency's current test is based on the devices' possible effect on large adults, though research suggests that children's thinner skulls mean they may absorb more radiation. The FCC should develop new tests that take into account the potential increased vulnerability of children.
- The Food and Drug Administration and the FCC should determine whether the maximum specific absorption rate of 1.6 W/kg over a gram of tissue is an adequate maximum limit of radiation from cell phones.
- The Centers for Disease Control and Prevention should repost it's advice on the potential hazard of cell phone radiation and cautionary advice that was taken down in August 2014.
- Cell phone manufacturers should prominently display advice on steps that cell phone users can take to reduce exposure to cell phone radiation.”

**September 2015 Consumer Reports Recommendations in article [Does Cell-Phone Radiation Cause Cancer?: As the debate over cell-phone radiation heats up, consumers deserve answers to whether there's a cancer connection](#)**

“We feel that the research does raise enough questions that taking some common-sense precautions when using your cell phone can make sense.”

### **New Jersey Education Association (NJEA)**

The September 2016 NJEA Review recommends staff and students “*Minimize health risks from electronic devices*” and issues these steps to reduce radiation exposure:

- *Keep devices away from the body and bedroom.*
- *Carry phones in briefcases, etc., not on the body.*
- *Put devices on desks, not laps.*
- *Hard wire all devices that connect to the internet.*
- *Hard wire all fixed devices such as printers, projectors and boards.*
- *Use hard-wired phones instead of cell or cordless phones.*
- *Text rather than call.*
- *Keep conversations short or talk in person.*
- *Put devices in airplane mode, which suspends EMF transmission by the device, thereby disabling Bluetooth, GPS, phone calls, and WiFi.*
- *Use speaker phone or ear buds instead of holding the phone next your head.*
- *Take off Bluetooth devices when not using them.”*
- [Read the article on the NJEA Review here. Download a PDF of the article here.](#)

### **The Israeli Psoriasis Association**

Environmental Health Trust <http://ehtrust.org/>

2016: The Israeli Psoriasis Association started selling retro headsets to reduce exposure from cell phones with the logo of the association on the headsets.



[See the link at the Israeli Psoriasis Association.](#)

### **National Center for Health Research**

[2015: Children and cell phones: is phone radiation risky for kids?](#) Article explains what we know, what we do not know and what we can do.

“By the time we find out, many people will have been harmed if cell phones are found to be dangerous. Here are some precautionary tips on how to protect your children from the health issues that could be connected to cell phone radiation.[9](#)

1. Turn airplane mode on when giving a child a technology device or when a cell phone is near a pregnant abdomen, to prevent exposure to radiation.
2. Turn off wireless networks and devices to decrease your family’s radiation exposure whenever you aren’t actively using them. As an easy first step, turn your Wi-Fi router off at bedtime.
3. Decrease use of phones or wifi where wireless coverage is difficult, in order to avoid an increase in radiation exposure.”

### **Over 17 Government Health Agencies**

Health agencies of countries worldwide have issued recommendations to reduce exposure to cell phones and wireless devices because of the lack of safety data. Please see a full list of the recommendations of health agencies at

<http://ehtrust.org/policy/international-policy-actions-on-wireless/>

## **Letters by Medical Doctors to Schools on Wireless Installations in Schools**

### **Letters to Petaluma Public Schools California, 2016**

(Note: These letters are important as they were written after the NTP study release and include an analysis of how the research impacts an understanding of the risk to children).

- [Letter from Dr. Carpenter to Petaluma Public Schools 8/3/2016](#)
- [Letter from Dr. Anthony Miller to Petaluma Public Schools 8/4/2016](#)
- [Letter from Dr. Martha Herbert to Petaluma Public Schools 9/2016](#)
- [Letter from Dr. Lennart Hardell to Petaluma Public Schools 8/4/2016](#)

Environmental Health Trust <http://ehtrust.org/>

### **Letters to Montgomery County Public Schools Maryland, 2015**

- [Lennart Hardell, MD, PhD, and Michael Carlberg, MSc, Department of Oncology, Orebro University Hospital, Sweden to Montgomery County Schools 11/30/2015](#)
- [Dr. Olle Johansson, Karolinska Institute to Montgomery County Schools 12/8/2015](#)
- [Dr. Martha Herbert, Harvard Pediatric Neurologist to Montgomery County Schools 12/12/2015](#)
- [Anthony B. Miller, MD FACE, Professor Emeritus Dalla Lana School of Public Health, University of Toronto, World Health Organization Advisor to Montgomery County Schools](#)
- [Dr. David O. Carpenter, M.D. University of Albany to Montgomery County Schools](#)
- [Dr. Martin L. Pall, Professor Emeritus, Biochemistry and Basic Medical Sciences, Washington State University to Montgomery County Schools](#)
- [Devra Davis, PhD MPH, President and Founder Environmental Health Trust to Montgomery County Schools](#)
- [Mikko Ahonen, PhD, Finland, Institute of Environmental Health and Safety, Mrs. Lena Hedendahl, MD Practitioner, Luleå, Sweden, Mr. Tarmo Koppel, MSc., PhD to Montgomery County Schools December 13, 2015](#)
- [Cindy Sage, MA, Sage Associates, Co-Editor, BioInitiative 2007 and 2012 Reports and Prof. Trevor Marshall, PhD, Director, Autoimmunity Research Foundation, Senior Member IEEE, Founding chair \(retired\) IEEE EMBS \(Buenaventura Chapter\) Fellow, European Association for Predictive, Preventive and Personalised Medicine \(Brussels\) International Expert Council, Community of Practice: Preventative Medicine \(Moscow\) to Montgomery County Schools](#)
- [Dr. Ronald Powell, retired U.S. Government scientist \(Ph.D., Applied Physics, Harvard University\) to Montgomery County Schools](#)
- [Cris Rowan, BScBi, BScOT, SIPT, to Montgomery County Schools](#)
- [Lloyd Morgan, Engineer, Scientific Advisor, Environmental Health Trust to Montgomery County](#)

### **Q: Why do federal regulations allow cell phones to be sold to children if Doctors are so concerned?**

A: As history shows, federal protections are usually implemented **decades after** research shows an environmental exposure is harmful. In the United States, for example, the American Academy of Pediatricians recommends reducing exposure to cell phones *and at the same time*, the federal government's FCC - lead by a former Chief of the Wireless Industry- is rolling out more and more wireless infrastructure. Not a single US federal health agency has done a systematic research review on the issue and -as far as we know- there are currently no plans to do so. Therefore, it is important for people to be made aware of these issues and take precautions *now*- in their homes, work, school and community.

**Medical Doctors and Public Health Organizations  
Consensus Statements and Recommendations on Cell Phones/Wireless**

It is a fact that *not a single medical organization* states that cell phone/wireless radiation is safe. There is no proof of safety.

**American Academy of Pediatrics**

The American Academy of Pediatrics (AAP), is a non-profit professional organization of 60,000 primary care pediatricians, pediatric medical subspecialists, and pediatric surgical specialists dedicated to the health, safety and well-being of infants, children, adolescents, and young adults.

[2016: American Academy of Pediatrics Website: Healthy Children.org Cell Phone Radiation & Children's Health: What Parents Need to Know](#). In response to the National Toxicology Program Cell Phone Radiation Study results, the AAP issued the following cell phone safety tips specifically to reduce exposure to wireless radiation in 2016:

- Use text messaging when possible, and use cell phones in speaker mode or with the use of hands-free kits.
- When talking on the cell phone, try holding it an inch or more away from your head.
- Make only short or essential calls on cell phones.
- Avoid carrying your phone against the body like in a pocket, sock, or bra. Cell phone manufacturers can't guarantee that the amount of radiation you're absorbing will be at a safe level.
- Do not talk on the phone or text while driving. This increases the risk of automobile crashes.
- Exercise caution when using a phone or texting while walking or performing other activities. "Distracted walking" injuries are also on the rise.
- If you plan to watch a movie on your device, download it first, then switch to airplane mode while you watch in order to avoid unnecessary radiation exposure.
- Keep an eye on your signal strength (i.e. how many bars you have). The weaker your cell signal, the harder your phone has to work and the more radiation it gives off. It's better to wait until you have a stronger signal before using your device.
- Avoid making calls in cars, elevators, trains, and buses. The cell phone works harder to get a signal through metal, so the power level increases.
- Remember that cell phones are not toys or teething items.

[Press Release: The AAP responds to study showing link between cell phone radiation, tumors in rats May 27, 2016](#)

"They're not toys. They have radiation that is emitted from them and the more we can keep it off the body and use (the phone) in other ways, it will be safer," said Jennifer A. Lowry, M.D., FAACT, FAAP, chair of the AAP Council on Environmental Health Executive Committee.

[2015 AAP Healthy Child Web Page on Electromagnetic Fields: A Hazard to Your Health?](#)

This webpage states:

“Cell Phones: In recent years, concern has increased about exposure to radio frequency electromagnetic radiation emitted from cell phones and phone station antennae. An Egyptian study confirmed concerns that living nearby mobile phone base stations increased the risk for developing: *Headaches, Memory problems, Dizziness, Depression, Sleep problems*”

[2013 AAP Letter to FCC Commissioner Mignon Clyburn and FDA Commissioner Margaret Hamburg calling for a review of RF guidelines 8/29/2013](#)

“The AAP urges the FCC to adopt radiation standards that: Protect children’s health and well-being. Children are not little adults and are disproportionately impacted by all environmental exposures, including cell phone radiation. Current FCC standards do not account for the unique vulnerability and use patterns specific to pregnant women and children. It is essential that any new standard for cell phones or other wireless devices be based on protecting the youngest and most vulnerable populations to ensure they are safeguarded throughout their lifetimes.”

[2012 AAP Letter to US Representative Dennis Kucinich in Support of the Cell Phone Right to Know Act 12/12/2012](#)

“ The differences in bone density and the amount of fluid in a child’s brain compared to an adult’s brain could allow children to absorb greater quantities of RF energy deeper into their brains than adults. It is essential that any new standards for cell phones or other wireless devices be based on protecting the youngest and most vulnerable populations to ensure they are safeguarded through their lifetimes.”

[Time Magazine \(2012\): Pediatricians Say Cell Phone Radiation Standards Need Another Look](#)

**2012, the AAP published Pediatric Environmental Health, Textbook of Children's Environmental Health 3rd Edition edited by Philip J. Landrigan, Ruth A. Etzel. Chapter 41: Electromagnetic Fields.**

“Exposures can be reduced by encouraging children to use text messaging when possible, make only short and essential calls on cellular phones, use hands free kits and wired headsets and maintain the cellular phone an inch or more away from the head.”

[Read it on Google Books Chapter 41: Electromagnetic Fields at this link page 383.](#)  
[Oxford Medicine Chapter 41 Link](#)

AAP News 2011: [More study needed on risk of brain tumors from cell phone use by Ruth A. Etzel. AAP News, Oct 2011](#)

**The BabySafe Project**

As of August 2016 over 200 physicians, scientists and public health professionals from around the world have signed onto this Project “to express their concern about the risk that wireless radiation poses to pregnancy and to urge pregnant women to limit their exposures.”

- “We call on our elected leaders to support such research and to advance policies and regulations that limit exposures for pregnant women. We call on industry to implement and explore technologies and designs that will reduce radiation exposures until such research is carried out.”
- The BabySafe Project Brochure [“Ten Ways to Reduce Your Wireless Exposure”](#) which includes “Whenever possible, connect to the internet with wired cables”.
- [The BabySafe Project Website](#)
- EPA Award: The BabySafe Project was recognized in the [US EPA” 2016 Children's Environmental Health Excellence Award from the EPA’s Office of Children's Health Protection.](#) Patricia Wood was awarded based on three distinct initiatives including “the creation and development of the BabySafe Project, a program designed to inform doctors, neonatal health professionals and parents about the potential risks that wireless radiation poses to pregnancy”.

### **The California Medical Association**

The California Medical Association (CMA) passed a Wireless Resolution in 2014 that states :

“Whereas scientists are increasingly identifying EMF from wireless devices as a new form of environmental pollution ...

Whereas peer reviewed research has demonstrated adverse biological effects of wireless EMF including single and double stranded DNA breaks, creation of reactive oxygen species, immune dysfunction, cognitive processing effects, stress protein synthesis in the brain, altered brain development, sleep and memory disturbances, ADHD, abnormal behavior, sperm dysfunction, and brain tumors; and...Resolved, That CMA support efforts to implement new safety exposure limits for wireless devices to levels that do not cause human or environmental harm based on scientific research.”

[Read the full CMA Resolution here.](#)

[Read a the Santa Clara Medical Bulletin article by Dr. Cindy Russell that explains the CMA resolution and gives recommendations for schools.](#)

### **The Vienna Medical Association**

The Vienna Medical Association has issued [Ten Medical Rules for Cell Phones](#) which includes:

“Make calls as short and little as possible, Do not position mobile phones directly on the body , Fewer apps means less radiation, Make calls at home and at work via the fixed corded (not wireless) network - Internet access via LAN cable, Constant radiation emitters like DECT cordless telephones, WLAN access points, data sticks and LTE Home base stations (Box, Cube etc.) should be avoided! Avoid Mobile phone calls in places with poor reception ”

“The radiation from mobile phones or smartphones is most likely not as safe as cell phone providers claim it to be. Therefore, the Vienna Medical Association has decided to do the responsible thing and inform the Austrian public about possible adverse effects from a medical perspective.”

### **The Connecticut Department of Public Health, USA**

Public Health Department recommendations to reduce exposure to cellphone radiation. 7 steps on *how* people can reduce exposure.

*"It is wise to reduce your exposure to radiofrequency energy from cell phones whenever possible."* [Read the Connecticut Department of Public Health Cell Phone Q and A about Cell phones here.](#)

### **The Massachusetts Department of Health, USA**

[BEST PRACTICES IN THE USE OF WIRELESS TECHNOLOGY](#) Dr. Robert S. Knorr Director, Environmental Epidemiology Program Bureau of Environmental Health, Massachusetts Department of Public Health

"Below are common recommendations and include those for both cell phone and non-cell phone sources:

- Use wired communication devices instead of wireless devices
- Limit children's use of cell phones except for emergencies
- Keep cell phones and other sources at a distance
- If using wireless devices like computers, laptops, tablets, and printers, place the wireless router away from where children and adults usually spend time.

[Read all of the recommendations from the Mass Department of Health in full at this link.](#)

### **The French National Agency of Health Security of Food, Environment and Labour**

**2016 Report** "[Radiofrequency Exposure and the Health of Children](#)" recommends reducing exposures to young children and strengthening regulations to ensure "sufficiently large safety margins" to adequately protect the health of young children.

- All wireless devices, including tablets, cordless phones, remote controlled toys, wireless toys, baby monitors and surveillance bracelets, should be subjected to the same regulatory obligations as cell phones.
- Compliance with regulatory exposure limits should be insured for the ways that devices are customarily used, such as positioned in contact with the body.
- Exposure limits for radiofrequency electromagnetic fields should be tightened to ensure sufficiently large safety margins to protect the health and safety of the general population, particularly the health and safety of children.
- Reliance on the specific absorption rate (SAR) to set human exposure limits should be re-evaluated and replaced through the development of an indicator to assess real exposures for mobile phone users that applies to various conditions: signal type, good or bad reception, mode of use (call, data loading, etc.), location device is used on the body.
- ANSES reiterated its recommendation, as previously stated, to reduce exposure to children: minimize use and prefer a hands-free kit.

### **2013 Report** "[Radiofrequency Electromagnetic Fields and Health](#)" **Expert Appraisal:**

hands free phones, SAR labeling, and "limiting the population's exposure to radiofrequencies... especially for children and intensive users, and controlling the overall exposure that results from relay antennas."

## **The American Cancer Society (ACS)**

### [2016 ACS Responds to New Study Linking Cell Phone Radiation to Cancer](#)

“The NTP report linking radiofrequency radiation (RFR) to two types of cancer marks a paradigm shift in our understanding of radiation and cancer risk. The findings are unexpected; we wouldn’t reasonably expect non-ionizing radiation to cause these tumors. This is a striking example of why serious study is so important in evaluating cancer risk. It’s interesting to note that early studies on the link between lung cancer and smoking had similar resistance, since theoretical arguments at the time suggested that there could not be a link.” -Otis W. Brawley, M.D., The American Cancer Society Chief Medical Officer in [ACS Responds to New Study Linking Cell Phone Radiation to Cancer](#) posted on May 27, 2016 after the NTP results were released.

[2009 Lecture at Cell Phones and Health Conference](#): In 2009 Michael Thun, Vice President of the American Cancer Society, lectured on cell phone radiation and cancer risk and detailed how it would take decades before definitive evidence is found in the general population due to the slow growing nature of brain cancer but that early signs would be seen in increases in gliomas [Watch the lecture by Dr. Thun here](#).

## **Canadian Parliament Standing Committee on Health of the House of Commons**

**2015 Canadian Parliament Report "[Radio Frequency Electromagnetic Radiation and the Health of Canadians](#)"** has 12 recommendations including “That the Government of Canada develop an awareness campaign relating to the safe use of wireless technologies, such as cell phones and Wi-Fi, in key environments such as the school and home to ensure that Canadian families and children are reducing risks related to radiofrequency exposure.”

## **Environment and Human Health, Inc.**

### [Cell Phones: Technology, Exposures, Health Effects by Environment and Human Health, Inc.](#)

John Wargo, Ph.D., professor of Environmental Risk and Policy at Yale University and lead author of the report, said, “*The scientific evidence is sufficiently robust showing that cellular devices pose significant health risks to children and pregnant women. The weight of the evidence supports stronger precautionary regulation by the federal government. The cellular industry should take immediate steps to reduce emission of electromagnetic radiation (EMR) from phones and avoid marketing their products to children.*”

- [Download Full Text of Report](#)
- [Summary](#)
- [Recommendations](#)
- [Press Release](#)

## **The Council of Europe**

In 2011 The Parliamentary Assembly of the Council of Europe issued Resolution 1815:

[\*The Potential Dangers of Electromagnetic Fields and Their Effect on the Environment.\*](#) A call to European governments to “take all reasonable measures” to reduce exposure to electromagnetic fields “particularly the exposure to children and young people who seem to be most at risk from head tumours.”

*“For children in general, and particularly in schools and classrooms, give preference to wired Internet connections, and strictly regulate the use of mobile phones by schoolchildren on school premises.” [Read the 2011 Resolution 1815](#)*

(Note: This is a follow up to the 2009 European Parliament’s [\*Health concerns associated with electromagnetic fields\*](#)).

### **2015 International Scientists Appeal to U.N. to Protect Humans and Wildlife from Electromagnetic Fields and Wireless Technology**

In May 2015, a group of over 200 scientists from 39 nations who have authored more than 2,000 articles on this topic appealed to the United Nations to address “the emerging public health crisis” related to cell phones and other wireless devices. These scientists state that “the ICNIRP guidelines do not cover long-term exposure and low-intensity effects, and are “insufficient to protect public health.”

- They state that “the various agencies setting safety standards have failed to impose sufficient guidelines to protect the general public, particularly children who are more vulnerable to the effects of EMF.”
- See the [\*\*International Scientists Appeal to U.N. to Protect Humans and Wildlife from Electromagnetic Fields and Wireless Technology.\*\*](#)

### **The World Health Organization’s International Agency for Research on Cancer**

The WHO/IARC classified all radiofrequency electromagnetic fields as “possibly carcinogenic to humans” in 2011 based on the opinion of a Working Group of 31 international experts who met in Lyon, France in May, 2011 based largely on positive associations have been observed between exposure to radiofrequency radiation from wireless phones and glioma, and acoustic neuroma.” ([p. 421](#))

- Read article in [The Lancet IARC 2011 on the classification](#),
- Read the [The 2011 IARC Press Release by the WHO IARC](#) in which precautions are recommended:

“Given the potential consequences for public health of this classification and findings, it is important that additional research be conducted into the long- term, heavy use of mobile phones. Pending the availability of such information, it is important to take pragmatic measures to reduce exposure such as hands-free devices or texting.”said IARC Director Christopher Wild.
- Read the [published the IARC Monograph on Non-Ionizing Radiation, Part 2: Radiofrequency Electromagnetic Fields](#) (April 2013) with scientific basis for classification.
  - “Due to the closer proximity of the phone to the brain of children compared with adults, the average exposure from use of the same mobile phone is higher by a factor of 2 in a child’s brain and higher by a factor of 10 in the bone marrow of the skull.” ([p. 408](#))

## **Swiss Physicians Association of Doctors for Environmental Protection**

[2012 Swiss Physicians Letter](#) "the risk of cancer for this type of [wireless] radiation is similar to that of the insecticide DDT, rightfully banned... From the medical point of view, it is urgent to apply the precautionary principle for mobile telephony, WiFi, power lines, etc."

[2014: Preliminary draft for a federal law on the protection against dangers:](#) Non-ionizing radiation (NIS) is growing steadily. Especially the everyday stress in the area of low-frequency and high-frequency. [Read it here.](#)

[2016: Press Release on the NTP Study and Policy Implications:](#) "There are increasingly clear indications that mobile radio is a health hazard. From a medical point of view it is clear: the scientific results so far show it is clear that prudent avoidance of unnecessary exposures is necessary."

- Additional Links by Swiss Physicians for the Environment  
Report on [Smartphones- \(OEKOSKOP 1/16\)](#) [AefU-News about Electrosmog](#)

## **Dr. Eitan Kerem, Chairman, Department of Pediatrics at Hadassah Hebrew University Hospital**

In response to the 2016 NIH/NIEHS/NTP Study results finding a link between RF-EMF and Cancer, Dr. Kerem issued a statement which includes:

*"It is well known that children are more sensitive to radiation than adults; many of them are using cellphone and other radiating media more frequently than adults. The effect of radiation is accumulative and this may have long term effect on the growing child. Such findings in the pharma industry may prevent further developing of a drug until safety is proven, and until the findings of this study are confirmed parents should be aware of the potential hazards of carcinogenic potential of radiofrequency radiation."* [Read the Statement by Dr. Eitan Kerem, Hadassah Hebrew University Hospital](#)

## **The American Academy of Environmental Medicine**

[The American Academy of Environmental Medicine's Open Letter to the Superintendents of the School Districts of the United States](#)

"Adverse health effects, such as learning disabilities, altered immune responses, headaches, etc. from wireless radio frequency fields do exist and are well documented in the scientific literature. Safer technology, such as using hard-wiring, must be seriously considered in schools for the safety of those susceptible individuals who may be affected by this phenomenon. "

[Wireless Radiofrequency Radiation in Schools](#)

[American Academy of Environmental Medicine Recommendations Regarding Electromagnetic and Radiofrequency Exposure](#)

[Letter to the FCC regarding Radiofrequency Exposure Limits.](#)

## **International Society of Doctors for the Environment**

ISDE has made the following recommendations: Avoid Wi-Fi in home or work if possible, particularly in schools or hospitals and Use wired technology whenever possible.

- “Because of the potentially increased risks for the foetus, infants and young children due to their thinner more permeable skulls and developing systems, particularly the immune and neurological systems, based on the precautionary principle and on the mounting evidence for harm at the sub-cellular level, we recommend that EMR exposure should be kept to a minimum.”
- [Read the Statement Here.](#)

### **Irish Doctors Environmental Association**

The Irish Doctors Environmental Association wrote a statement in 2013 concerning health concerns with Wi-Fi in school:

“We urge you to use wired technologies for your own safety and that of your pupils and staff.” [Read the 2013 Letter](#)

### **Bioinitiative Working Group**

[Bioinitiative 2012 Report](#): **A report by [29 independent scientists and health experts](#) from around the world\* about possible risks from wireless technologies and electromagnetic fields.**

“The science, public health, public policy and global response to the growing health issue of chronic exposure to electromagnetic fields and radiofrequency radiation in the daily life of billions of people around the world. Covers brain tumor risks from cell phones, damage to DNA and genes, effects on memory, learning, behavior, attention; sleep disruption and cancer and neurological diseases like Alzheimer’s disease. Effects on sperm and miscarriage (fertility and reproduction), effects of wireless on the brain development of the fetus and infant, and effects of wireless classrooms on children and adolescents is addressed. Mechanisms for biological action and public health responses in other countries are discussed. Therapeutic use of very low intensity EMF and RFR are addressed.”

[Henry Lai’s Research Summaries](#): These abstracts (data-based to be searchable) cover the RFR scientific literature from both RFR and ELF on research published between 1990-2012.

[The Bioinitiative RF Color Charts](#) summarize many studies that report biological effects and adverse health effects relevant for cell towers, WI-FI, 'smart' wireless utility meters, wireless laptops, baby monitors, cell phones and cordless phones. The reader can compare the level of EMF used in specific research studies relative to the health effect.

[Bioinitiative Letter to Education Super Highway CEOs](#) the Co-Editors of the Bioinitiative Report Cindy Sage and David Carpenter sent a letter on behalf of the Bioinitiative Working Group to the CEO’s on the health risks of wireless infrastructure in US schools stating:

*“WiFi in schools, in contrast to wired internet connections, will increase risk of neurologic impairment and long-term risk of cancer in students. Corporations cannot avoid responsibility simply by asserting compliance with existing legal, but outdated and inadequate FCC public safety limits. Today, corporations that deal with educational technology should be looking forward and helping school administrators and municipal*

leaders to access safe, wired solutions.” [Read the Letter to Education Super Highway CEOs,](#)

### **Austrian Medical Association**

[Guidelines of the Austrian Medical Association for the diagnosis and treatment of EMF related health problems and illnesses \(EMF syndrome\):](#) The Austrian Medical Association, on March 3, 2012, released their guide for diagnosing and treating people with EMF-related health problems.

"Wi-Fi environments will lead to high microwave exposure for students and teachers which might increase the burden of oxidative stress. Oxidative stress might slow down the energy production especially in brain cells and may lead e.g. to concentration difficulties and memory problems in certain individuals. The Austrian Medical Association recommends Wi-Fi free school environments."

Dr Gerd Oberfeld, MD, Public Health Department, Salzburg, Austria, on behalf of the Austrian Medical Association stated, "Schools should provide the best possible learning environments. In this context low noise levels, good air quality and low radiofrequency / microwave radiation are crucial. Wi-Fi environments will lead to high microwave exposure for students and teachers which might increase the burden of oxidative stress. Oxidative stress might slow down the energy production especially in brain cells and may lead e.g. to concentration difficulties and memory problems in certain individuals. The Austrian Medical Association recommends Wi-Fi free school environments".

### **Pittsburgh Cancer Institute**

Dr. Ronald B. Herberman, Director of the University of Pittsburgh Cancer Institute, issued a [Memo to PCI Staff: Important Precautionary Advice Regarding Cell Phone Use](#)

"Do not allow children to use a cell phone, except for emergencies. The developing organs of a fetus or child are the most likely to be sensitive to any possible effects of exposure to electromagnetic fields".

- [Prominent Cancer Doctor Warns About Cellphones](#): New York Times article
- [Statement Of Ronald B. Herberman, MD Director University of Pittsburgh Cancer Institute and UPMC Cancer Centers](#) to the Domestic Policy Subcommittee Oversight and Government Reform Committee Thursday, September 25, 2008 2154 Rayburn HOB 11:00 a.m. "Tumors and Cell Phone use: What the Science Says"

### **The Cancer Association of South Africa (CANSA)**

"In order to prove that the use of cell phones can cause cancer, many thousands of cell phone users would need to be studied over many years. Such studies are now in progress in many countries and it is expected that definitive results will be forthcoming in the near future. However, just because there is no definite evidence at this stage, does not mean that there is no potential danger."

Recommendations to reduce Exposure: [CANSA has issued a Fact Sheet and Position Statement on Exposure to Radiofrequency Electromagnetic Fields](#)

“CANSA proposes that exposure to cell phone radiation be kept to a minimum by:  
Limiting the number and duration of calls    Texting rather than making calls    Switching the sides of the head when a call is long – one should, however, avoid long conversations  
Making use of hands-free kits or speaker phone mode to keep the phone a distance from the head. Instructing children and teenagers to limit calls to emergencies only as they are more vulnerable to electro-magnetic radiation because of the thickness of their skulls and their brains are still developing    Not sleeping with one’s cell phone close to one’s bed or under one’s pillow    Women not to keep their cell phones in their brassiere    Men not to carry their cell phones in the pockets of their pants (close to their testicles).”

### **The Canadian Medical Association**

2011 Resolution on Cell Phone Radiation

*“The Canadian Medical Association will educate and advise the profession and the public on methods of cellphone operation that will minimize radio frequency penetration to the brain.”*

[Read the 2011 General Council of the Canadian Medical Association Proceedings \(page 54\)](#)

Canadian Medical Association Journal reports Health Canada's wireless limits are "A Disaster to Public Health" [Read the article here.](#)

### **Canadian Doctors**

[2014 Letter by 55 Canadian Doctors](#)

The Doctors wrote Health Canada calling for more protective limits stating, *“There is considerable evidence and research from various scientific experts that exposure to microwave radiation from wireless devices; Wi-Fi, smart meters and cell towers can have an adverse impact on human physiological function”*.- [Canadian Doctors Declaration to Health Canada, International Group in Support of Safer Standards for Canadians](#)  
[53 Doctors sign a Scientific Declaration on Health Canada EMF Limits July 9,2014](#)

### **The Russian National Committee on Non-Ionizing Radiation Protection**

[ELECTROMAGNETIC FIELDS FROM MOBILE PHONES: HEALTH EFFECT ON CHILDREN AND TEENAGERS \(2011\)](#) warns about electromagnetic radiation impacts on children and recommended WiFi not be used in schools.

- **Official Recommendations:** Those under the age of 18 should not use a mobile phone at all, recommends low- emission phones; and requires the following: on-device labelling notifying users that it is a source of RF-EMF, user guide information advising that “it is a source of harmful RF-EMF exposure” and the inclusion of courses in schools regarding mobile phones use and RF-EMF exposure issues. “Thus, for the first time in the human history, children using mobile telecommunications along with the adult population are included into the health risk group due to the RF EMF exposure.”
  - “In children, the amount of so-called stem cells is larger than in adults and the

stem cells were shown to be the most sensitive to RF EMF exposure.”

- “It is reasonable to set limits on mobile telecommunications use by children and adolescents, including ban on all types of advertisement of mobile telecommunications for children.”

[Decision of Russian National Committee on Non-Ionizing Radiation Protection](#) 2008, "Children and Mobile Phones: The Health of the Following Generations is in Danger”

### **The Cyprus National Committee on Environment and Child Health**

This Health Committee was created by the Cyprus government to advise on children’s environmental health issues and is comprised of pediatricians. They have issued strong recommendations to reduce exposure to children.

- [Protecting children from radiation emitted by Wi-Fi, mobile phones and wireless](#) by Dr. Stella Kanna Michailidou of the National Committee Chairman "Environment and Children's Health"
- [See the Commission's EMF brochure](#) on reducing the risks to children from exposure to the Non Ionizing Radiation (mobile phones, Wi-Fi, tablets, etc.).
- The Cyprus National Committee on Environment and Child Health created [a short PSA for citizens](#) about children and wireless radiation and how to reduce Wi-Fi exposure. <https://www.youtube.com/watch?v=996vzcCYcNE>

### **British Medical Doctors**

In 2014 a group of **British Medical Doctors** issued [Health and safety of Wi-Fi and mobile phones](#):

*“We wish to highlight our concern over the safety of exposure to microwave radiation from wireless technology, particularly for vulnerable groups like children, pregnant women, the elderly and those with compromised health”.*

### **U. S. President’s Cancer Panel, 2009**

The 2009 U.S. President’s Cancer Panel pointed to cell phones and other wireless technologies as potential causes of cancer. In its recommendations, the panel stated:

“Several steps can be taken to reduce personal exposure to RF fields from cell phones. Landlines or text messaging should be used whenever possible. If a mobile phone must be used, a headset is preferable to holding the phone to the ear. Children should be prohibited from using mobile phones except in emergencies. Active phones should not be kept on belts or in pockets. Phones should not be kept in close proximity during sleep.

Reduction of exposure to other sources of RF can be accomplished by keeping AM, FM, television, and mobile phone towers far from homes, schools, and businesses. Wireless networks should not be used in schools; wired connections should be used instead. There should be resistance to the general trend toward making everything wireless without consideration of negative consequences.”

[DR. MARTHA LINET: CELLULAR \(MOBILE\) TELEPHONE USE AND CANCER RISK](#)

[DR. DAVID CARPENTER: ELECTROMAGNETIC FIELDS AND CANCER: THE COST OF DOING NOTHING Page 15](#)

“Since latency for brain cancer from environmental exposures is thought to be 20 to 30 years, comprehensive studies looking at longer-term human exposure are needed. Participants urged that a precautionary approach be taken with respect to the use of cell phones by children, who are more susceptible than adults to radiation risks.”

- [Summary of of the President's Cancer Panel 2009 January 27 Phoenix, AZ](#)

### **Israel Dental Association**

Israeli Dental Association issued a recommendation to decrease exposure after their research showed links to salivary gland tumors.

“One in every five rare malignant tumors of the cheek occurs in someone under age 20 Young people should limit direct exposure of the head to microwave radiation from cell phones.” [News Article:Israeli Study Sees Link Between Oral Cancer, Cell Phones Israel Dental Association: Number of cases of parotid salivary cancer rose dramatically in past five years.](#)

### **The Seletun Scientific Statement**

In November, 2009, a scientific panel met in Seletun, Norway, for three days of intensive discussion on existing scientific evidence and public health implications of the unprecedented global exposures to artificial electromagnetic fields (EMF). EMF exposures (static to 300 GHz) result from the use of electric power and from wireless telecommunications technologies for voice and data transmission, energy, security, military and radar use in weather and transportation. The Scientific Panel recognizes that the body of evidence on EMF requires a new approach to protection of public health; the growth and development of the fetus, and of children; and argues for strong preventative actions. New, biologically-based public exposure standards are urgently needed to protect public health worldwide.

The report and Consensus Statement, published in the journal Reviews on Environmental Health (<http://www.ncbi.nlm.nih.gov/pubmed/21268443>),

[Seletun Consensus Statement](#)

### **Potenza Picena Resolution 2011**

On April 20th , 2013 the International Congress of Potenza Picena entitled “[Radar, radiofrequency and health risk](#)” concluded that stricter safety standards for EMF needs to be adopted by governments and public health agencies because the existing ones are obsolete and they are not based on recent literature about biological effects.” [Potenza Picena Resolution 2011](#)

### **Porto Alegre Resolution, Brazil**

Dozens of Doctors, (primarily from Brazil) have issued recommendations

“We are deeply concerned that current uses of non-ionizing radiation for mobile phones,

wireless computers and other technologies place at risk the health of children and teens, pregnant women, 2 seniors and others who are most vulnerable due to age or disability, including a health condition known as electromagnetic hypersensitivity. We strongly recommend these precautionary practices: 1. Children under the age of 16 should not use mobile phones and cordless phones, except for emergency calls;” Read more at [Porto Alegre Resolution](#)

Even as far back as 1997, dozens of Boston Doctors and Health experts signed onto a petition with concerns about Sprint's Wireless Rollout.

### [1997 Boston Physicians' and Scientists' Petition To Avert Public Exposures to Microwaves](#)

“We the undersigned physicians and scientists call upon public health officials to intervene to halt the initiation of communication transmissions employing ground level, horizontally transmitting, pulsed microwaves in Boston.”

## **MORE RECOMMENDATIONS TO KNOW**

### **Consumer Reports**

**May 2016 Consumer Reports Recommendations in article:** [Does Cell Phone Use Cause Brain Cancer? What the New Study Means For You: Groundbreaking study reveals the strongest link yet between cell phone radiation and cancer. Important advice for all consumers.](#)

- Try to keep the cell phone away from your head and body. Keeping it an arm's distance away significantly reduces exposure to the low-level radiation it emits. This is particularly important when the cellular signal is weak—when your phone has only one bar, for example—because phones may increase their power then to compensate.
- Text or video call when possible, because this allows you to hold the phone farther from your body.
- When speaking, use the speakerphone on your device or a [hands-free headset](#).
- Don't stow your phone in your pants or shirt pocket. Instead, carry it in a bag or use a belt clip.

### **May 2016 Consumer Reports Recommendations to Government and Industry**

“The substantial questions and concerns raised by this and previous research regarding cell phones and cancer requires swift and decisive action by the government and industry.

Specifically, Consumer Reports believes that:

- The National Institutes of Health should commission another animal study using current cell phone technology to determine if it poses the same risks as found in this new study.
- The Federal Communications Commission should update its requirements for testing the effect of cell phone radiation on human heads. The agency's current test is based on the devices' possible effect on large adults, though research suggests that children's thinner

skulls mean they may absorb more radiation. The FCC should develop new tests that take into account the potential increased vulnerability of children.

- The Food and Drug Administration and the FCC should determine whether the maximum specific absorption rate of 1.6 W/kg over a gram of tissue is an adequate maximum limit of radiation from cell phones.
- The Centers for Disease Control and Prevention should repost it's advice on the potential hazard of cell phone radiation and cautionary advice that was taken down in August 2014.
- Cell phone manufacturers should prominently display advice on steps that cell phone users can take to reduce exposure to cell phone radiation."

**September 2015 Consumer Reports Recommendations in article [Does Cell-Phone Radiation Cause Cancer?: As the debate over cell-phone radiation heats up, consumers deserve answers to whether there's a cancer connection](#)**

"We feel that the research does raise enough questions that taking some common-sense precautions when using your cell phone can make sense."

**New Jersey Education Association (NJEA)**

The September 2016 NJEA Review recommends staff and students "*Minimize health risks from electronic devices*" and issues these steps to reduce radiation exposure:

- *Keep devices away from the body and bedroom.*
- *Carry phones in briefcases, etc., not on the body.*
- *Put devices on desks, not laps.*
- *Hard wire all devices that connect to the internet.*
- *Hard wire all fixed devices such as printers, projectors and boards.*
- *Use hard-wired phones instead of cell or cordless phones.*
- *Text rather than call.*
- *Keep conversations short or talk in person.*
- *Put devices in airplane mode, which suspends EMF transmission by the device, thereby disabling Bluetooth, GPS, phone calls, and WiFi.*
- *Use speaker phone or ear buds instead of holding the phone next your head.*
- *Take off Bluetooth devices when not using them."*
- [Read the article on the NJEA Review here. Download a PDF of the article here.](#)

**The Israeli Psoriasis Association**

2016: The Israeli Psoriasis Association started selling retro headsets to reduce exposure from cell phones with the logo of the association on the headsets.



[See the link at the Israeli Psoriasis Association.](#)

## **National Center for Health Research**

[2015: Children and cell phones: is phone radiation risky for kids?](#) Article explains what we know, what we do not know and what we can do.

“By the time we find out, many people will have been harmed if cell phones are found to be dangerous. Here are some precautionary tips on how to protect your children from the health issues that could be connected to cell phone radiation.<sup>9</sup>

1. Turn airplane mode on when giving a child a technology device or when a cell phone is near a pregnant abdomen, to prevent exposure to radiation.
2. Turn off wireless networks and devices to decrease your family’s radiation exposure whenever you aren’t actively using them. As an easy first step, turn your Wi-Fi router off at bedtime.
3. Decrease use of phones or wifi where wireless coverage is difficult, in order to avoid an increase in radiation exposure.”

## **Over 17 Government Health Agencies**

Health agencies of countries worldwide have issued recommendations to reduce exposure to cell phones and wireless devices because of the lack of safety data. Please see a full list of the recommendations of health agencies at

<http://ehtrust.org/policy/international-policy-actions-on-wireless/>

# **Letters by Medical Doctors to Schools on Wireless Installations in Schools**

## **Letters to Petaluma Public Schools California, 2016**

(Note: These letters are important as they were written after the NTP study release and include an analysis of how the research impacts an understanding of the risk to children).

- [Letter from Dr. Carpenter to Petaluma Public Schools 8/3/2016](#)
- [Letter from Dr. Anthony Miller to Petaluma Public Schools 8/4/2016](#)
- [Letter from Dr. Martha Herbert to Petaluma Public Schools 9/2016](#)
- [Letter from Dr. Lennart Hardell to Petaluma Public Schools 8/4/2016](#)

## **Letters to Montgomery County Public Schools Maryland, 2015**

- [Lennart Hardell, MD, PhD, and Michael Carlberg, MSc, Department of Oncology, Orebro University Hospital, Sweden to Montgomery County Schools](#) 11/30/2015
- [Dr. Olle Johansson, Karolinska Institute to Montgomery County Schools](#) 12/8/2015
- [Dr. Martha Herbert, Harvard Pediatric Neurologist to Montgomery County Schools](#) 12/12/2015

- [Anthony B. Miller, MD FACE, Professor Emeritus Dalla Lana School of Public Health, University of Toronto, World Health Organization Advisor to Montgomery County Schools](#)
- [Dr. David O. Carpenter, M.D. University of Albany to Montgomery County Schools](#)
- [Dr. Martin L. Pall, Professor Emeritus, Biochemistry and Basic Medical Sciences, Washington State University to Montgomery County Schools](#)
- [Devra Davis, PhD MPH, President and Founder Environmental Health Trust to Montgomery County Schools](#)
- [Mikko Ahonen, PhD, Finland, Institute of Environmental Health and Safety, Mrs. Lena Hedendahl, MD Practitioner, Luleå, Sweden, Mr. Tarmo Koppel, MSc., PhD to Montgomery County Schools December 13, 2015](#)
- [Cindy Sage, MA, Sage Associates, Co-Editor, BioInitiative 2007 and 2012 Reports and Prof. Trevor Marshall, PhD. Director, Autoimmunity Research Foundation, Senior Member IEEE, Founding chair \(retired\) IEEE EMBS \(Buenaventura Chapter\) Fellow, European Association for Predictive, Preventive and Personalised Medicine \(Brussels\) International Expert Council, Community of Practice: Preventative Medicine \(Moscow\) to Montgomery County Schools](#)
- [Dr. Ronald Powell, retired U.S. Government scientist \(Ph.D., Applied Physics, Harvard University\) to Montgomery County Schools](#)
- [Cris Rowan, BScBi, BScOT, SIPT, to Montgomery County Schools](#)
- [Lloyd Morgan, Engineer, Scientific Advisor, Environmental Health Trust to Montgomery County](#)

**Q: Why do federal regulations allow cell phones to be sold to children if Doctors are so concerned?**

A: As history shows, federal protections are usually implemented **decades after** research shows an environmental exposure is harmful. In the United States, for example, the American Academy of Pediatrics recommends reducing exposure to cell phones *and at the same time*, the federal government's FCC - lead by a former Chief of the Wireless Industry- is rolling out more and more wireless infrastructure. Not a single US federal health agency has done a systematic research review on the issue and -as far as we know- there are currently no plans to do so. Therefore, it is important for people to be made aware of these issues and take precautions *now*- in their homes, work, school and community.

Dec 8 (4 days ago)

----- Forwarded message -----

From: **Nadia Azumi** <[nadia@absolutejapan.com](mailto:nadia@absolutejapan.com)>

Date: Sat, Sep 10, 2016 at 4:48 PM

Subject: No cell towers in school grounds

To: [ematsui@jhmi.edu](mailto:ematsui@jhmi.edu), [rachel.hess-](mailto:rachel.hess-)

[mutinda@maryland.gov](mailto:mutinda@maryland.gov), [emily@marylandpirg.org](mailto:emily@marylandpirg.org), [guy.guzzone@senate.state.md.us](mailto:guy.guzzone@senate.state.md.us), [amezu@msde.state.md.us](mailto:amezu@msde.state.md.us), [allison@mdehn.org](mailto:allison@mdehn.org), [Angela.Angel@house.state.md.us](mailto:Angela.Angel@house.state.md.us), [benoythomas@gmail.com](mailto:benoythomas@gmail.com), [brandi.stocksdales@maryland.gov](mailto:brandi.stocksdales@maryland.gov), [\[Alvarado@dhcd.state.md.us\]\(mailto:Alvarado@dhcd.state.md.us\), \[christina.church@maryland.gov\]\(mailto:christina.church@maryland.gov\), \[dbishai@jhsph.edu\]\(mailto:dbishai@jhsph.edu\), \[dianna.abney@maryland.gov\]\(mailto:dianna.abney@maryland.gov\), \[gdiette@jhmi.edu\]\(mailto:gdiette@jhmi.edu\), \[lornegarr@msn.com\]\(mailto:lornegarr@msn.com\), \[bgitterman@aol.com\]\(mailto:bgitterman@aol.com\), \[jicarella@msn.com\]\(mailto:jicarella@msn.com\), \[julianlevy@comcast.net\]\(mailto:julianlevy@comcast.net\), \[megan.latshaw@aphl.org\]\(mailto:megan.latshaw@aphl.org\), \[cliff.mitchell@maryland.gov\]\(mailto:cliff.mitchell@maryland.gov\), \[nancy.servatius@maryland.gov\]\(mailto:nancy.servatius@maryland.gov\), \[nobot@cehn.org\]\(mailto:nobot@cehn.org\), \[rob.hofstetter@maryland.gov\]\(mailto:rob.hofstetter@maryland.gov\)](mailto:Varney-</a></p></div><div data-bbox=)

Cc: [theodorams@aol.com](mailto:theodorams@aol.com)

Dear Maryland Children's Environmental Health and Protection Advisory Council Members,

Schools should be safe environments for children. Currently schools across the state are placing cell towers on school grounds unaware of the many health and safety risks they pose. Cell towers emit radio-frequency radiation and children will be exposed long term to this radiation when cell towers are installed on school grounds. In addition, the tower installation includes diesel tanks, lead acid batteries and thus is considered a HAZMAT area.

Please make a strong recommendation to the State Department of Education that schools PROHIBIT cell towers on school grounds.

Please make a strong recommendation to the General Assembly that schools PROHIBIT cell towers on school grounds.

Please make a strong recommendation to the General Assembly that the Department of Health be allocated funds to do research on electromagnetic radiation and children's health.

Although health issues have not been established ( which I am certain they have) this is very detrimental to the health of growing children. I have been an advocate against cell towers for over 10 years, and strongly suggest that you REALLY look into the side effects of radiation. Tobacco was not bad for you, now tobacco kills you. Birth control were good for women now it is not. Children are the future of this country. Remember that, and we need a strong country in our future.

[See 25 Reasons Cell Towers Have No Business On or Near School Property by The Maryland Coalition To Halt Cell Towers at Schools](http://www.safeschoolspg.org/joint-statement-of-the-maryland-coalition-to-halt-cell-towers-at-schools.html) for a detailed list of health and safety concerns. <http://www.safeschoolspg.org/joint-statement-of-the-maryland-coalition-to-halt-cell-towers-at-schools.html>

Thank you so much,  
Nadia Azumi

# Minimize health risks from electronic devices

By Adrienne Markowitz and Eileen Senn

Desktops, laptops, tablets, eBook readers, printers, projectors, smart boards, smart TVs, cellphones, cordless phones and wireless networks (WiFi) have become ubiquitous in schools. At their best, they are powerful tools for education. At their worst, they threaten the physical and mental health of teachers, paraeducators, secretaries, librarians and other school staff members and students who spend numerous hours using the devices.

Physical health risks from electronic devices include pain and tingling from repetitive strain injuries to the hands and wrists; pain in the neck, shoulders and back; dry, burning, itchy eyes, blurred vision and headaches; altered sleep patterns and next-day fatigue from exposure to blue screen light; distracted driving; and various health problems from exposure to radiation.

Mental health risks arise from stress due to raised expectations for multitasking, productivity and proficiency with devices; dealing with malfunctioning devices; student and colleague distraction from and addiction to devices; and intrusion of devices into nonwork time.

## WiFi devices emit radiation

Radio frequency (RF) electromagnetic frequency (EMF) radiation is sent and/or received by the antennae of phones, routers and other wireless devices. RF radiation is capable of causing cancer, reproductive, neurological and ocular effects. The amount of radiation exposure received depends on the amount of time exposed and distance from the source. Radiation levels fall off exponentially with distance from antennae. If you double the distance, the radiation is four times less. If you triple the distance, it is nine times less, and so on. Children and developing fetuses are particularly at risk because their bodies are still growing. People with implanted medical devices are at risk for device interference.

## Hazards and solutions

The most straightforward ways to minimize health risks are to use electronic devices in moderation and to maximize your distance from them. There are also specific solutions to specific hazards listed below.

Local associations should work with their UniServ field representative to negotiate solutions that are in the control of district administrators such as providing training and ergonomic equipment and hard-wiring devices. Individuals should take steps within their control, such as:

### For repetitive strain injuries

- Use voice control/speech recognition.
- Use ergonomic alternatives to traditional mice and keyboards.
- Use as many fingers as possible when typing and both thumbs when texting.

### For neck, shoulder and back pain

- Ensure an ergonomic workstation.
- When using a hand-held device, support it and the forearms.
- Avoid bending the head down or jutting it forward.
- Take frequent, short breaks from the device.
- Ensure good posture and change positions frequently.
- Stand and do stretching exercises.

### For eye pain, blurred vision and headaches

- Use sufficient, but not excessive, lighting.
- Use assistive technology built into Apple, Android and Windows devices.
- Enlarge and darken the cursor and pointer.
- Enlarge the font; magnify the text.
- Use text-to-speech instead of reading.
- Use special computer glasses.
- Relax the eyes on a minibreak.

### For altered sleep patterns and next-day fatigue

- Stop using devices at least one hour before bedtime.

### For distracted driving

- Use hands-free devices, preferably speakerphones.
- Pull over and park.
- Let someone else drive.

### For radiation exposure

- Keep devices away from the body and bedroom.
- Carry phones in briefcases, etc., not on the body.
- Put devices on desks, not laps.
- Hard wire all devices that connect to the internet.
- Hard wire all fixed devices such as printers, projectors and boards.
- Use hard-wired phones instead of cell or cordless phones.
- Text rather than call.
- Keep conversations short or talk in person.
- Put devices in airplane mode, which suspends EMF transmission by the device, thereby disabling Bluetooth, GPS, phone calls, and WiFi.
- Use speaker phone or ear buds instead of holding the phone next your head.
- Take off Bluetooth devices when not using them.

### For stress

- Training in device use, assistive technology.
- Easy access to user manuals.
- Easily available technical support. 📞

*Adrienne Markowitz holds a Master of Science in Industrial Hygiene from Hunter College, City University of New York. Eileen Senn holds a Master of Science in Occupational Health from Temple University in Philadelphia. They are consultants with the New Jersey Work Environment Council, which is a frequent partner with NJEA on school health and safety concerns.*



# For more information

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**“Job stress: Is it killing you?”** *NJEA Review*, May 2012. [bit.ly/jobstress8](http://bit.ly/jobstress8)
- 

**“As schools lift bans on cell phones, educators weigh pros and cons,”** Kinjo Kiema, *NEA Today*, Feb. 23, 2015. [bit.ly/2b6eOr8](http://bit.ly/2b6eOr8)
- 

**Be kind to your eyes,** *NJEA Review*, September 2012. [bit.ly/2bdZnAp](http://bit.ly/2bdZnAp)
- 

**Computer workstations eTool,** Occupational Safety and Health Administration (OSHA). [bit.ly/2aJUeRw](http://bit.ly/2aJUeRw)
- 

**“Stretching Exercises at Your Desk, 12 Simple Tips,”** WebMD. [wb.md/2beOvUk](http://wb.md/2beOvUk)
- 

**“Cell phone facts and tips,”** Grassroots Environmental Education. [bit.ly/2bqpFQP](http://bit.ly/2bqpFQP)
- 

**“Radiofrequency and microwave radiation,”** Occupational Safety and Health Administration (OSHA). [bit.ly/2aR1TIY](http://bit.ly/2aR1TIY)
- 

**“Report of Partial Findings from the National Toxicology Program (NTP) Carcinogenesis Studies of Cell Phone Radiofrequency Radiation in Hsd: Sprague Dawley SD Rats (Whole Body Exposure).”** [bit.ly/2bqq8Cc](http://bit.ly/2bqq8Cc)
- 

**“Low EMF Best Practices,”** Collaborative for High Performance Schools (CHPS), 2014. [bit.ly/2bs51Rx](http://bit.ly/2bs51Rx)
- 

**Microsoft Accessibility Center:** [www.microsoft.com/enable](http://www.microsoft.com/enable)
- 

**Apple Accessibility Center:** [www.apple.com/accessibility](http://www.apple.com/accessibility)
- 

**Google/Android Accessibility Center:** [www.google.com/accessibility/products-features.html](http://www.google.com/accessibility/products-features.html)

## Cell phones and cancer

The National Toxicology Program (NTP) is conducting the largest set of laboratory rodent studies to date on cellphone RF radiation. The studies cost \$25 million and are designed to mimic human exposure. They are based on the cellphone frequencies and modulations currently in use in the United States. The NTP studies are designed to look at effects in all parts of the body.

On May 27, 2016, NTP released a report with partial results of the studies. They found increased occurrence of rare brain tumors called gliomas and increases in nerve tumors called schwannoma of the heart in male rats. The released results are partial because more rat studies and all of the mouse studies will be forthcoming by 2017. The cells that became cancerous in the rats were the same types of cells as those that have been reported to develop into tumors in human cellphone users.

The EMF produced by cellphones was classified as possibly carcinogenic to humans by the World Health Organization in 2011. They found that long-term use of a cell phone might lead to two different types of tumors, gliomas and acoustic neuroma, a tumor of the auditory nerve.

## Wireless in Schools

### Exposes Children to Radiofrequency Microwave Radiation



## U.S. National Toxicology Program Radiofrequency Carcinogenicity Research Study

On May 27<sup>th</sup>, 2016, the U.S. National Toxicology Program (NTP), of the U.S. National Institutes of Health, released a [report](#) with partial results of their large study on the carcinogenicity of radiofrequency radiation (RFR, also known as microwave radiation) in male and female rats and mice.

The world's largest, most well-designed study of its type, at a cost of \$25 million, **found increased occurrence of rare brain tumors in male rats and increases in rare heart tumors in both male and female rats exposed to RFR.** The results also show increased DNA damage in exposed rats and mice. The released results are “partial” because more rat results and all of the mouse study results will be forthcoming, by 2017.

### Quick Links

[National Toxicology Program \(New\) Cell Phones Webpage with Study Overview](#)

[NIEHS New Factsheet on the NTP Study Results 2016](#)

[U.S. Food and Drug Administration 1999 Report on the Nomination of the NTP To Study](#)

[Radiofrequency](#) (Explains basis for the study)

NTP [Video Presentation on the Results of Toxicology and Carcinogenicity of Radiofrequency Radiation Studies at the National Institute of Environmental Health Sciences, June 2016.](#)

[Report of Partial findings from the National Toxicology Program](#)

[Carcinogenesis Studies of Cell Phone Radiofrequency Radiation in Hsd: Sprague Dawley® SD rats \(Whole Body Exposure\)](#)

A video player interface showing a presentation slide titled "Summary". The slide lists key findings from the study. The video player includes a progress bar at 30:22 / 50:02 and standard playback controls. The speaker in the video is a man in a white shirt and tie, standing at a podium with the NIH logo.

- Body weights at birth and throughout lactation in rat pups exposed *in utero* tended to be lower than controls
- In general, survival was greater in all groups of GSM or CDMA RFR-exposed rats compared to controls
- Increased incidence of schwannoma was observed in the hearts of male rats at 6 W/kg
  - Significant SAR-dependent positive trend (GSM and CDMA)
  - Significant pair-wise increase at 6 W/kg (CDMA)
- There was a significant SAR-dependent trend for increased gliomas in the brain of rats exposed to CDMA-modulated RFR
- No exposure-related effects were observed in the brains or hearts of female rats

[Powerpoint Slides of NIEHS Study by NIEHS for BIOEM Conference](#)

[Powerpoint slides of NIEHS Presentation June 15, 2015 \(some are different than the BIOEM slides\)](#)

[NIEHS Online Documents on the NTP Study](#)

[Spin Versus Fact : The NTP Study by Dr. Moskowitz Download the Factsheet](#)

## SCIENTIFIC RESPONSE

[American Cancer Society Press Release: ACS Responds to New Study Linking Cell Phone Radiation to Cancer](#)

[American Academy of Pediatrics Responds to National Toxicology Program study](#)

[Barcelona Institute for Global Health, GROWING EVIDENCE FOR THE LINK BETWEEN MOBILE PHONES AND CANCER](#)

[Dr. Eitan Kerem, Chair of Pediatrics at Hadassah Hebrew University Hospital Interview with NIEHS Toxicologist Dr. Ron Melnick, lead design of the NTP](#)

# Study Design and Results

## ***How were the animals exposed?***



Animals were exposed daily during gestation and for two years after their birth to two commonly used types of RFR—Global System for Mobile (GSM) and Code Division Multiple Access (CDMA). For the rats studies, in each type of RFR there were three exposure groups: 1.5 W/kg, 3W/kg, and 6 W/kg.

The rodents were housed in specially designed underground chambers for uniform RFR exposure.

RFR exposures were 10-minutes on, 10-minutes off for 18 hours a day, resulting in a total exposure of 9 hours daily.

Exposure intensity was set to low *nonthermal or non-heating levels*. Heating from microwaves is the only adverse effect currently recognized by US regulators, who rely on standards set almost two decades ago. In order to test if biological effects occur at non-thermal levels, the NTP study set exposures at low levels determined *not* to heat the body.

## ***What cancers and tumors were found?***

Increased incidence of gliomas (a rare, aggressive and highly malignant brain cancer) as well as schwannomas (a rare tumor of the nerve sheath) of the heart were found in both sexes, but reached

statistical significance only in males. Overall, a higher number of brain abnormalities and tumors were observed in exposed male rats in comparison to exposed female rats. In humans, gliomas are also more common in men than in women.

In addition to the gliomas, there were significantly more rare, pre-cancerous changes in the glial cells of the brain in both sexes, while not a single unexposed control animal developed these abnormal brain cells. Male rats exposed to all levels of CDMA developed exceptionally high numbers of damaged, pre-cancerous brain cells (glial hyperplasia). Both male and female rats, exposed to all levels of microwave radiation, developed increased incidence of rare malignant tumors of Schwann cells (nerve sheaths) of the heart. Females exposed to all levels of CDMA also developed precancerous hyperplastic Schwann cells, while none of the unexposed controls developed this rare abnormality.

It should be noted that this partial report focused only on these brain and heart tumors, and that additional results from the rats study will be released by 2017.

### ***How strong are these results?***

“Game-changer” is increasingly being used to describe these results. For decades people believed that microwave radiation at low (non-heating) levels is safe and cannot cause harm. The NTP results clearly show that this assumption is false. Microwave radiation can cause harmful effects even at low non-heating levels.



Although the results show “low” increases in tumors, these tumors are quite lethal. Moreover, even a small increase can have a large impact. As the NTP report stated, *"Given the extremely large number of people who use wireless communication devices, even a very small increase in the incidence of disease resulting from exposure to the RFR*

*generated by those devices could have broad implications for public health."*

Significantly more gliomas were seen in males exposed to CDMA (95% confidence level). Positive trends for a greater number of tumors at higher doses were observed for both gliomas and schwannomas of the heart in males. Both the trends and the replication make these very strong results.

### ***Why is this study considered a “landmark” study?***

These results are very significant for three reasons:



**1. In case-controlled studies, humans develop the same types of tumors from cell phone exposures.**

Epidemiological studies in humans show increased risks for gliomas and schwannomas after long-term use of cell phones – these are the same types of tumors that were found in the exposed rats.

**2. The results show adverse biological effects at non-thermal levels meaning that current international regulations (based on avoiding heating) do not adequately protect public health.**

The NTP study was designed to test if the basis for government safety standards is accurate. Current safety standards are based on the premise that only RFR levels that cause heating are harmful. The study was carefully designed to ensure that the body temperature of the exposed rats did not increase significantly. *Yet an effect was shown at non-thermal levels.* The NTP study provides well-documented, scientific evidence that current international regulations are based on a faulty assumption.

**3. The results add significant weight to the scientific evidence that radio frequency radiation is carcinogenic.**

In 2011, the International Agency for Research on Cancer of the World Health Organization (IARC/WHO) classified radio frequency radiation as a Class 2B “possible carcinogen.” One of the reasons for the classification “possible” was because human epidemiological studies showed increased brain tumors after long term exposures, however, *more evidence* was needed from animal studies showing carcinogenicity and a mechanism of action. The recent NTP results provide new, well-designed research evidence in animal models that links RFR to cancer. As the NTP stated, “These findings appear to support the International Agency for Research on Cancer (IARC) conclusions regarding the possible carcinogenic potential of RFR.”

**Is it true that the NTP study found DNA damage in the exposed animals?**



Yes - [the NTP study found](#) statistically significant evidence of DNA damage. The preliminary data with comet assay showed a statistically significant trend in RF-induced DNA damage in both rat and mice brain tissues. These findings were shared by the National

Toxicology Program during the [BIOEM 2016 Annual Meeting](#).

Associate Director of NTP John Bucher described some of the DNA findings in a Science Magazine interview stating that, “In a small side experiment of the NTP study, DNA from the tissues of 80 mice and rats that had spent 90 days in the reverberation rooms were examined for breaks in the DNA strands. There was more DNA damage in some of the rodents that received the highest radiation levels.”

Genotoxicity findings will be published in the forthcoming paper from the NTP rodent study entitled “Evaluation of the genotoxicity of cell phone radiofrequency radiation in male and female rats and mice following subchronic exposure” (as noted on [page 3 of the released NTP Report](#)).

### **Is this study well designed?**

This \$ 25 Million Study is, in fact, the world’s largest and most comprehensive rodent study of radiofrequency electromagnetic fields. The design of this study was presented at an annual meeting of the Bioelectromagnetics Society prior to the start of these studies.



According to Ron Melnick PhD, *“the overwhelming opinion expressed by the meeting participants was that this would be the largest and most comprehensive study in animals exposed to cell phone radiation, and that the results from this study would trump all other animal carcinogenicity studies of this agent.”*

Seven thousand rodents were used for the entire study, which used a three-phased study design: (1) Pilot studies to establish field strengths that did not excessively raise body temperatures; (2) Subchronic toxicology studies in which the rodents were exposed to various low-level field strengths for up to two months; and (3) Chronic toxicology and carcinogenicity studies in which the rodents were exposed prenatally and for the majority of their lifetime (up to 24 months). The chronic exposure study employed seven groups of 90 rats: a sham control group that was not exposed to the radiation, and three groups for each of two common types of cell phone signal.

### ***Why was this study initiated?***

The US Food and Drug Administration (FDA) nominated this study because, “There is currently insufficient scientific basis for concluding either that wireless communication technologies are safe or that they pose a risk to millions of users. A significant research effort, including well-planned animal experiments, is needed to provide the basis to assess the risk to human health of wireless communications devices.” [Read the FDA Nomination here.](#)



The National Toxicology Program Testified to [US Congress](#) that, “The FDA nomination was based on the following concerns:

- There is widespread human exposure;
  - Current exposure guidelines are based on protection from acute injury from thermal effects;
  - Little is known about the potential for health effects of long-term exposure; and
- Sufficient data from human studies to definitively answer these questions may not be available for many years.”

The recommendation for the NTP study was made in 1999 with a contract signed in 2005. It is years behind schedule as results were due to be published in 2014. [See the slide presentation that the NTP gave in 2013 here](#) describing the experiments initial results. [See slides from 2009 NTP presentation describing the experiment setup.](#)

### ***What was the objective of the study?***



According to Ron Melnick who lead the study design, the researchers wanted to test the hypothesis that *cell phone radiation could not cause adverse health effects at levels that did not cause heating*. The study was designed to provide data to characterize dose-response for any detected toxic and/or carcinogenic effects of cell phone radiofrequency radiation (RFR) in Sprague-Dawley rats and B6C3F1 mice exposed unconstrained in reverberation chambers.

At the time the study was initiated, slightly more more than 100 million Americans used wireless communication devices, yet guidelines for cell phone radiation were (and still are) are based largely on protection from acute injury from thermal effects. The researchers were aware of several ongoing animal studies, but felt they might not provide an adequate challenge to the null hypothesis, so the NTP set out to design the world’s largest animal study on radiofrequency radiation to date.

## Some Clarifications in Response to Concerns Raised In the Media

***Does the fact that increased numbers of tumors were statistically significant in the male rats, but not in the female rats, mean the findings of carcinogenicity can be dismissed?***



No. In *previous* NTP toxicology studies male rats were *more than ten times more likely* to develop malignant gliomas (brain tumors) than females. For malignant schwannoma of the heart, males were *more than twice as likely* to develop this type of cancer than the females. (These statistics called “historical control incidence” are documented in [the NTP report](#) at the bottom of the tables starting at page 9.)

[Microwave News](#) quoted Ron Melnick’s comments on the sex differences:

“It is not surprising that the exposed males had more tumors than the females given what we have seen in the historical controls. But we can go one step further, the fact that we saw any of these tumors in the exposed females but none in the concurrent controls adds support to the conclusion that cell phone radiation leads to cancer among rats.”

These gender-specific results are not uncommon in animal carcinogenicity research studies. As the [American Cancer Society explains in their statement about the NTP results](#), “It’s important to note that these sorts of gender differences often appear in carcinogenic studies, so the fact they show up here should not detract from the importance of the findings.”

[Analyses of NTP bioassays](#) show that “male rats are more sensitive to chemical carcinogens compared to female rats.” The fact that male rats are more likely to show carcinogenesis in NTP studies is well documented in “[Gender differences in chemical carcinogenesis in National Toxicology Program 2-year bioassays](#)”.

It is also important to note that in human studies, gender differences in cancer incidence and mortality is a regular finding.

Notably, in the NTP study, increased incidence of rare malignant tumors of Schwann cells (nerve sheaths) in the heart was found in both male *and* female rats, as were precancerous hyperplastic Schwann cells. The findings in the female rats were not statistically significant, but these tumors are known to occur more rarely in females.

The NTP findings cannot be dismissed because of the gender differences.

### ***Were the results peer reviewed?***

The findings have undergone extensive reviews. The biological tissue analyses were reviewed by multiple pathologists and statisticians who were unaware of the test agent being evaluated, and looked solely at the obtained slides. The report has addressed several expert reviews with responses that are appended to the online document.

The National Toxicology Program states in the abstract, “The findings in this report were reviewed by expert peer reviewers selected by the NTP and National Institutes of Health (NIH). These reviews and responses to comments are included as appendices to this report, and revisions to the current document have incorporated and addressed these comments.”

Results have not yet been published in a journal but were released early by the NTP because of their importance for public health.

### ***Is the statistical power strong?***



Typically, in this type of testing the NTP uses 50 animals per group. For this study they used 90 animals per group, as such, so it may be considered a large study relative to other similar animal studies. The expected background rate of the two tumors that have been found (glioma and Schwannoma of the heart) is also extremely low.

The chances of finding a true effect--or power of a study--depend on two principal things: (1) the size of the sample studied and (1) the size of the expected occurrence of the endpoints under study. With smaller numbers of animals, the chances of finding an effect—called the statistical power—would have been lower. Studies that are underpowered do not have enough data to present a full and clear picture. Had more animals been studied, there might have been further positive associations, possibly resulting in statistical significance in the female rats as well. The NTP finding of positive results in *multiple* tumor types means that these study results are even more important.

As Associate Director of the U.S. National Toxicology Program John Bucher stated in the [May 27, 2016 NTP Press conference](#), “The power to detect these tumors is probably in the range of between 10% and 20%, which also actually makes it more interesting that we have found statistically significant findings.”

Contrary to some claims about this study, false positives are not a significant concern. The reason that clinical trials (such as those Dr. Lauer conducts) use large numbers of people is to *increase* their chances of finding a true effect. The smaller the sample, the greater the chance of NOT finding an effect *when one is actually there*--also called a false negative.

***Control group animals did not develop either schwannomas in the heart or gliomas. The control group animals also did not live as long as those that were exposed. Does this call into question the validity of the study?***



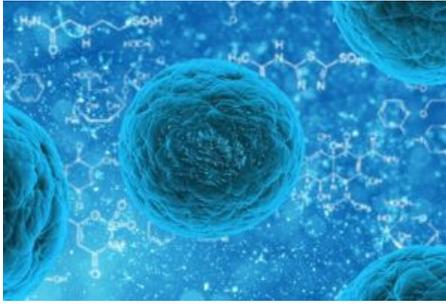
NTP scientists carefully considered this question. Control group lifespans were within historical ranges, and a statistical procedure was used so as not to over-estimate risks. In fact, it is not surprising to see that the stresses of RFR exposure might contribute to increased lifetime while also contributing to serious health damage. For example, calorie-restricted animals live longer on average. It is important to note that other statistically significant effects from exposure were seen early on, as the pups exposed *in utero* had lower body weights at birth and remained at a lower weight throughout their lifetimes.

The mortality rates are not as important a fact as it seems when the data is analyzed. First, there was no statistical difference in survival between control male rats and those exposed to CDMA at 6 W/kg (the group with the highest rate of gliomas and heart schwannomas); at week 94, survival of rats in these two groups were the same. Second, no glial cell hyperplasias (potential precancerous lesions) or heart schwannomas were observed in any control rat, even though glial cell hyperplasia was detected in a CDMA-exposed rat *as early at week 58* and heart schwannomas were detected as early as week 70 in exposed rats. If the control rats were going to develop tumors, these precancerous lesions and tumors *would have already been present*. Yet not a single control had any evidence of an effect.

It is notable that [a US Air Force study from the 80's](#) which *also found increased cancer* also showed chronic RF exposure increased lifespan in rodents. The median survival time was 688 days for exposed animals and 663 days for the sham-exposed.

***In this study, the exposed group developed tumors at rates comparable to historic rates of tumors in rats in other such studies. How is this finding considered statistically significant?***

Most importantly, in every study, *the preferred control group is the present one*, as every detail of feed, housing, etc. is truly identical. If all groups of rats are treated the same in the same experiment and only the exposed group has a statistically significant effect, then an effect has been shown.



A crude analysis comparing all controls—historic and present—with all exposed animals in the present study still shows a consistently increased probability

of developing cancer.

This chart shows the percentage of exposed rats that developed tumors as compared with the percentage of the same tumor in all current and historical control rats. *In every case there were more tumors in the exposed group than in the control group.*

Probability of cancer compared with all controls, in rats in NTP wireless radiation study

	<b>Ratio of % exposed cases / % cases in all controls including historic</b>
<b>Glioma</b>	
Male	1.19
Female	3.50*
<b>Schwannoma</b>	
Male	3.08
Female	2.19

\*gliomas are extremely rare in these female rats; there were more gliomas in males, both in unexposed and exposed animals, so the ratio is lower.

***The rats were exposed for nine hours per day for two years, over the whole body, with some at levels higher than cell phones. How is this study relevant to people?***



The study is relevant to humans because it tests the scientific basis for current cellular communication

safety regulations, which are intended to protect humans from adverse health effects.

In case-control studies that compare persons with brain cancer to matched controls without the disease, increased gliomas have been seen with less than 1,000 hours of cell phone exposure. Animal studies typically last two years, or the lifetime of the rodent. The animals are specially bred in an attempt to induce tumors in an animal with a short lifetime. The overall exposure of the rats is set to approximate that of humans.

Government safety regulations for microwave radiation are based on the assumption that *“as it does not heat you, it will not hurt you.”* To test the “no-heating” cut-off for harm, animals were exposed up to almost the maximum dose they could tolerate with no increase in body temperature. The animals in this experiment never had an increase in body temperature over one degree Celsius. This study shows that adverse biological effects occur at non-thermal (non-heating) levels.

Dr. Moskowitz calculated the overall risk for the male rats in the group exposed to the lowest intensity of cell phone radiation (i.e., 1.5 watts/kilogram or W/kg). He found 12 of 180 (or 1 in 15) male rats in the exposed group developed cancer or a precancerous lesion. He concluded that, “This latter finding has policy implications as the FCC’s current cell phone regulations allow cell phones to emit up to 1.6 W/kg at the head or near the body (partial body SAR).” [Read his review here.](#)

### ***Why was keeping the rats from overheating so important?***

Exposure to high levels of RFR energy, particularly at microwave frequencies, can rapidly heat biological tissue. This is known as a *thermal effect*. Thermal effects can cause harm by disrupting biological processes, and damaging tissue. Government safety regulations require mobile phones and wireless devices to operate at power levels well below the threshold for known thermal effects.

The study was carefully designed to ensure that the exposed rats did not have an increase in temperature beyond one degree, so the tumor development reflects a “non-thermal” mechanism of action. If adverse non-thermal effects are confirmed, then cell phone and wireless device emission regulations will need to be re-evaluated *because they would not be protecting humans from non-thermal effects*. This is precisely why this NTP study is so significant.

### ***Why were effects for CDMA-modulated RFR exposures different from GSM?***

Code Division Multiple Access (CDMA) and Global System for Mobile (GSM) are two *different* communication technologies. CDMA is the primary type of technology used for cell phones in the

United States with providers including Verizon, Sprint, and US Cellular. GSM is the primary type of technology used for cell phones in the rest of the world. In the United States, T-Mobile and AT&T use GSM. Europe adopted GSM technology in the 1980s, and users will not find access to CDMA networks in any European countries.

It is unclear why the more modern modulation (CDMA) proved to be more harmful, and there is no way to determine this from the NTP study. However, it makes sense that the body, at a cellular level, may have a different reaction to different types of exposures and waveforms, *even if the power level is the same.*

Swedish cancer researchers have reported differences in gliomas associated with different modulations, with the more recent technologies appearing to have more a more dramatic biological effect. Modulations are evolving to transmit more data faster at a given frequency, and this results in higher peak to average power ratios. In the lab, it is notable that [experiments using real-life devices are much more likely to find significant effects.](#)

This is an important finding which will hopefully will spur researchers to explore in future studies how different radio frequency radiation technology impacts the body. Until recently, regulators considered the power density of the radiation (linked to heating) important for human health and the issue of modulation was assumed to be less significant. *However, the reality is that cellular communication signals are very complex and all signal characteristics, such as modulation, waveform, and power density, must be considered.*

This is a topic of great concern as we prepare to move to newer technologies, driverless cars, and more and more wireless in schools with young children.

***The study is not applicable to modern cell phones and wireless devices. Cell phones are now using even newer technology that uses even lower power.***



In fact, the newer technology may have more adverse effects. These newer devices involve technology with greater variations in pulsed signaling the information content of signals that are being used. The pulse of the signals may well prove to be more important biologically than their power. The biological effects of the NTP study that produced an increase in cancer occurred *without heat.*

In addition, the NTP animals were exposed solely to *one frequency* throughout their lifetimes. This scenario does not even compare to the real life exposures *we* are exposed to. People are now exposed to *multiple exposures* from multiple devices in our everyday environment. Each device itself often has multiple antennas. The combined effect of such microwave radiation exposures is a matter of serious concern in light of these findings of increased cancer in the NTP animals which were exposed to just *one frequency* at non-thermal levels.

***Cell Phones have been around for decades and if they caused cancer brain, then cancer rates would be rising. Instead research shows brain cancer rates to be steady for the last few decades. These results must then be wrong.***



Brain tumours are now the leading cancer in American adolescents, and according to the American Brain Tumor Association's largest, most comprehensive analysis of these age groups to date, *the incidence of the most aggressive gliomas (a category of brain tumors) are rising in young adults within the US.* This study shows increased yearly incidence of the following brain tumors: anaplastic astrocytoma, tumors of the meninges, tumors of the sellar

region and unclassified tumors. Glioblastomas, the type of brain cancer found to be linked to cell phone radiation in the NTP study and in human studies, are increasing in those age 15-39 in the United States.

These increases are *not* evident in population based research studies when the incidence of *all* brain cancers “overall” are considered. As Microwave News points out in a detailed analysis of this rise of glioblastomas, “The higher incidence of glioblastomas is being masked by the lower rates of the other types of brain cancer.”

International registries have *also* indicated an increase. Zada et al, 2012 shows an increase in brain tumors in three major cancer registries in the United States. An Australian study showed an overall significant increase in primary malignant brain tumors from 2000 to 2008, particularly since 2004 (Dobes 2011).

Brain cancers are slow growing and can take decades to develop after toxic exposure. For example, studies of smokers found no increase in risk just ten years after most have

begun to smoke. While cell phones have been around for decades, the majority of cellphone users have only become heavy users recently, so it is not likely that a large *overall* increase in incidence rates will have appeared yet. Research shows increased prevalence in the most aggressive malignant forms of brain cancer in younger people; however, since brain tumors are predominantly a disease of aging, and there are not increases in all *other* tumor types, the level of brain tumors “overall” is not rising.

More importantly, population based studies are not the best way to assess the cell phone cancer link. Instead, research looking at high-risk groups using case-control designs are more suited to showing cancer risk from cell phones. All independent research using a case control design that looked at long term (ten years plus) users have showed increases in brain cancer.

Read Dr. Davis, Dr. Miller and Lloyd Morgan’s response in [Oxford University Press: Why there can be no increase in all brain cancers tied with cell phone use](#) where they state:

*“The link between the carcinogenic effects of tobacco and cancer did not come about from studying population trends, but by special study of high-risk groups using case-control designs of selected cases and comparing their histories with those of persons who were otherwise similar but did not smoke, and cohort studies of groups with identified smoking histories followed for up to 40 years, as in the American Cancer Society and British Doctors studies. The fact that population-based trends in Australia do not yet show an increase in brain cancer does not mean it will not be detectable in the future—perhaps soon.”*

While glioblastoma is a very rare cancer, it is an often fatal one.

## Putting the National Toxicology Program Study in Context

**Have any other animal studies shown a link to cancer?**



Yes. With the results of the NTP, there are now *three* important animal studies within the past six years showing increased development of cancers after RF-EMF exposure. [A German study](#) published in 2015 replicated 2010 [research](#) which showed carcinogen-induced tumor rates were

significantly higher in the lung and liver of animals exposed to RF -EMF along with a known carcinogen.

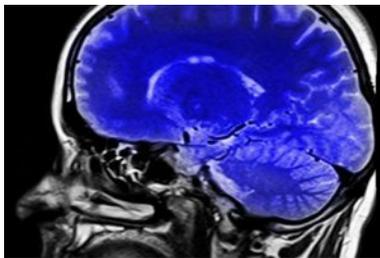
Furthermore, there are many examples of research over the last few decades which have indicated that radiofrequency radiation is carcinogenic and can damage DNA.

A 5 year, \$5 Million [U.S. Air Force study conducted in the early 1980's](#) and later published in Bioelectromagnetics (Chou et al., 1992) found that significantly higher numbers of male rats exposed to low-intensity microwave radiation developed cancer in comparison to those not exposed. The Chou study exposed experimental animals to 2450 MHz, which is similar to the frequencies used for WiFi, whereas the NTP study exposed rodents to 900 MHz and 1800 MHz microwave radiation. However in the Air Force Study, the rats' average exposure was about 4-10 times *lower* than in the NTP study. [Read more about this study in Dr. Moskowitz analysis.](#) It is notable that [in this study the researchers state](#), “Only male rats were used to minimize statistical variation, i.e., to avoid the hormonal variations characteristic of female rats. Use of female rats would have required a substantial increase in the number of animals.”

In the 1990's, Henry Lai and V.J. Singh demonstrated that low levels of microwave radiation (2.45GHz) well below that of cell phone radiation levels could increase the frequency of single-strand DNA breaks in the brain cells of live rats. The in-vitro studies of the \$15 Million dollar [REFLEX project lead by Franz Adlkofer](#) also indicated a genotoxic effect of RF-EMFs at levels below proposed radiation safety levels. In an June 2016 interview, [Professor Adlkofer commented](#) that the NTP and Reflex study complement each other, and “intensify in their significance.”

In the late 90's, the \$25 Million Wireless Technology Research (WTR) project (funded by the Wireless Industry) researchers found genetic damage inside cells exposed to RF radiation in two separate studies, an increased risk of a non-malignant tumor called acoustic neuroma, and an increased risk of neuroepithelial cancer (both rare brain tumors). The WTR epidemiologist George Carlo, later wrote the book [Cell Phones, Invisible Hazards in the Wireless Age](#) documenting the suppression of these research results by the Wireless Industry. The research studies listed above are just a few examples of the past research demonstrating the link between radiofrequency and radiation cancer.

**How could radiofrequency radiation “cause “cancer?**



[A 2016 review paper](#) reported that in 93 of 100 studies RFR produced a cellular stress response which can lead to DNA damage and cancer. In 2001, Catholic University physics professor Theodore A. Litovitz briefed US Congressional members on how chronic exposure to non-thermal levels of electromagnetic radiation can diminish DNA repair and the body's immune response. [His conclusion](#), "because stress proteins are involved in the progression of a number of diseases, *heavy daily cell-phone usage* could lead to great incidence of disorders such as Alzheimer's and cancer" has been reiterated by two leading EMF/RF researchers, Frank Barnes and Ben Greenebaum in a [2016 article published in IEEE Power Electronics Magazine](#). Barnes and Greenebaum stated, "We present the possible theoretical mechanisms and experimental data that show long-term exposures to relatively weak static, low-frequency, and RF magnetic fields can change radical concentrations. As a consequence, a long-term exposure to fields below the guideline levels may affect biological systems and modify cell growth rates, while an organism's built-in mechanisms may compensate for these changes."

Notably, in 2002, Leszczynski and colleagues published the results of an experiment using a human cell line and *just like in the NTP rat study*, the researchers ensured that the exposures were non thermal. They found that after merely one hour of exposure to a 900 MHz GSM signal at an average SAR of 2 W/kg , a specific type of cellular stress response was activated. They hypothesized that this effect links the radiation to cancer because "These events, when occurring repeatedly over a long period of time, might become a health hazard because of the possible accumulation of brain tissue damage. This suggests that the presently allowed radiation emission levels for the mobile phones, although low, might be sufficient to induce biological effects."

### **Why was this study released *before* it was published in a journal?**

According to page 4 of [the NTP Report](#), these findings were released after extensive reviews because:

The screenshot shows the National Toxicology Program website. The header includes the logo and text: "National Toxicology Program U.S. Department of Health and Human Services". Below the header are navigation tabs: "Home", "Testing Information", "Study Results & Research Projects". The main content area is titled "Cell Phones" and contains the following text: "The National Toxicology Program has been potential health hazards from cell phone r findings on May 27, 2016. Here are some key points about the cell p". A bullet point is partially visible: "• The nomination for NTP to studv cell r".

"Given the extremely large number of people who use wireless communication devices, even a very small increase in the incidence of disease resulting from exposure to RFR resulting from those devices could have broad implications for public health."

“Lastly, the tumors in the brain and heart observed at low incidence in male rats exposed to GSM- 2 and CDMA-modulated cell phone RFR in this study are of a type similar to tumors observed in some epidemiology studies of cell phone use. These findings appear to support the International Agency for Research on Cancer (IARC) conclusions regarding the possible carcinogenic potential of RFR.”

The NTP has now created [a new webpage on cell phones](#) and posted a link to the FDA’s recommendations on how to reduce cell phone radiation exposure.

### ***How are humans exposed to radiofrequency radiation?***



The International Agency for Research on Cancer (IARC) of the World Health Organization classified the range of radio frequency from 30 kHz to 300 GHz as a “Possible Human Carcinogen.” The classification is for radio frequency *from any source*, be it a cell phone, laptop, Wi-Fi, baby monitor, cell tower, tablet or electric utility meter.

Dr. Robert Bann, the World Health Organization International Agency for Research on Cancer Secretary stated in a 2011 [lecture](#) and in his writing [found here](#).

*“It should be noted that the working group in the overall evaluation decided to make a generic evaluation of radio frequency fields and did not want to limit it to mobile telephone use and all other exposures .. that was based on the diversity of the exposures in the animal cancer studies where different types of radiation with different frequencies across the radio frequency part of the emf spectrum were noted and **the radiation from the environmental sources.(i.e Wi-Fi, Cell Towers etc) and from the mobile telephones is basically and physically speaking the same type of agent .”***

Considering we now use cell phones all day and even sleep with them at night, cell phones likely expose humans to more radio frequency than any other single device. Indoor exposures are primarily from wireless computer networks, home cordless phones and the myriad of wireless devices we purchase and bring into our home. In addition, homes, offices and buildings now have various built-in wireless equipment and apparatus such as thermostats, security networks, sound systems, appliances and utility meters called “Smartmeters”.

Outdoor exposures are primarily from base stations (cell towers) and building-mounted cellular antennas *in addition to* the cell phone you may carry in your pocket as you walk down the street.

## The Bottom Line



Wireless radiation from phones, tablets, routers, baby monitors, and a growing number of applications has never been tested for safety, because it was assumed to have no effect except heating. That assumption is no longer valid. While details relating to the increased cancer will continue to be evaluated, this study clearly shows that wireless radiation produces adverse biological effects in animals. The weight of evidence has

significantly *increased* now that the the NTP study findings are placed in the context of the epidemiological, animal and in vitro studies done to date.

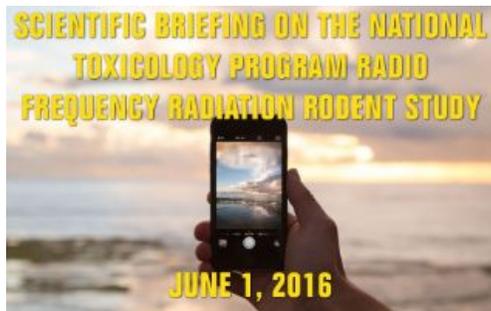
Rates of cancers specifically associated with cell phones are increasing, especially the most aggressive forms. In February 2016, the [CBTRUS \(Central Brain Tumor Registry of the US\)](#) reported that brain tumors are now the leading type of cancer in adolescents, surpassing leukemia and lymphoma.

It is imperative that there be experimental testing, *now*, of newer technologies *before* they enter the marketplace. Data on wireless exposures must be collected in a systematic way to understand real life exposures, and to enable correlation with health. Without such testing and monitoring, we are engaging in a massive human experiment with no controls and without the public's knowledge or consent.

Based on this new information, regulatory and health agencies should make strong recommendations for consumers to take precautionary measures, to choose non-wireless devices whenever possible, and to avoid close contact with their cell phones and Wi-Fi devices. Since children and pregnant women are more vulnerable to radiation exposures, health authorities must place additional importance on educating families and communities about how to reduce children's exposures. Schools, offices and homes can be equipped with non-wireless internet connections to significantly reduce indoor exposures. Technology companies must design and provide safer communication devices so that the public can reduce exposure.

Most importantly, international regulations on cell phones and radiofrequency radiation exposures need to be immediately updated. The NTP study provides strong evidence that the current limits- based on thermal effects only- *do not adequately protect us*. New regulations must protect against these non-thermal biological effects.

**The Israeli Institute Of Advanced Studies At Hebrew University Press briefing, June 1st, 2016 with Ronald L. Melnick, PhD, the senior toxicologist who designed the National Toxicology Program (NTP) study. [Click here to watch youtube video.](#)**



“We tested the hypothesis that cell phone radiation could not cause health effects. We feel that this hypothesis has now been disproved because these results clearly show cell phone radiation has adverse cell effects. These same cells that became cancerous in rats are the same cells that are reported to turn into tumors in epidemiology studies,” remarked Dr. Melnick.

Referring to the widely circulated reviewer critique that “the study had low statistical power and that might lead to a false positive,” Melnick responded, “I’m not sure if that was a misstatement by the reviewer because low statistical power means that there is a high probability of accepting the null effect hypothesis even when a true effect may exist.”

Regarding the finding of increased, rare, pre-cancerous lesions in the brain and heart, Melnick added, “If this study had continued for a longer period of time, it is likely that some of those hyperplasias found in the exposed rats would have progressed into a tumor. It was unfortunate that the study only lasted two years.”



[Watch a Wall Street Journal Interview on the NTP Cell Phone Cancer Research Study here](#)  
[Read the NPR News Story Here.](#)

[Listen to the NPR News Story Here.](#)

[Read Scientific American Article Here.](#)

[Read Consumer Reports Article Here.](#)

[Watch a WTOP radio interview with Dr. Melnick here.](#)

## **NATIONAL TOXICOLOGY PROGRAM (NTP) INFORMATION**

*Report of Partial findings from the National Toxicology Program Carcinogenesis Studies of Cell Phone Radiofrequency Radiation in Hsd: Sprague Dawley® SD rats (Whole Body Exposure)*

NTP Press Conference Audio is online to listen to here.

NTP Press Release: Media Telebriefing: NTP Cell Phone Radiofrequency Radiation Study: Partial Release of Findings

New NTP Webpage on Cell Phones

## **NEWS MEDIA COVERAGE**

**Wall Street Journal:** [Debate Renews Over Health Risks from Cell Phone Use](#)

**Wall Street Street Journal:** Cell Phone Study Fans Cancer Worries

**Consumer Reports:** Does Cell Phone Use Cause Brain Cancer? What the New Study Means For You

**Science Magazine:** Questions abound after study links tumors to cellphone radiation

**Mother Jones:** Game-Changing” Study Links Cellphone Radiation to Cancer

**PBS:** How Might Cell Phone Signals Cause Cancer May 30, 2016

**Scientific American:** How Might Cell Phones Cause Cancer in Rats

**Scientific American:** Major Cell Phone Radiation Study Reignites Cancer Questions: Exposure to radiofrequency radiation linked to tumor formation in rats

**Science Magazine:** Questions abound after study links tumors to cellphone radiation

## **ADDITIONAL RESOURCES ON THE NTP STUDY RESULTS**

Joel Moskowitz, PhD. Summary and preliminary analysis EMR Safety; May 27, 2016

- [National Toxicology Program Finds Cell Phone Radiation Causes Cancer](#)
- [Spin Versus Fact on the NTP Study by Dr. Moskowitz Download the Factsheet](#)
- [STORYLINE vs. REST-OF-THE-STORY: Brain cancer incidence, cellphone use, and trends data](#)

[Environmental Health Trust: Everything You Wanted to Know About the National Toxicology Program Rodent Study on Cell Phone Radiation](#)

[Microwave News Cell Phone Radiation Boosts Cancer Rates in Animals](#)

[Dr. Gautam Khurana, NeuroSurgeon, Comments: Breaking News – Cell Phones and Brain Tumors – Leaked Insight from the U.S. National Toxicology Program?](#)

[Interview with Prof. Adlkofer the NTP study of the US government:](#) Translate the page.

[American Cancer Society Press Release: ACS Responds to New Study Linking Cell Phone Radiation to Cancer](#)

Dec 8 (4 days ago)

----- Forwarded message -----

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Date: Thu, Sep 8, 2016 at 2:07 PM

Subject: Fw: very important- from Theodora- will take two seconds

To: "[cliff.mitchell@maryland.gov](mailto:cliff.mitchell@maryland.gov)" <[cliff.mitchell@maryland.gov](mailto:cliff.mitchell@maryland.gov)>, "[rachel.hess-mutinda@maryland.gov](mailto:rachel.hess-mutinda@maryland.gov)" <[rachel.hess-mutinda@maryland.gov](mailto:rachel.hess-mutinda@maryland.gov)>, "[veronika.carella@mdcehc.org](mailto:veronika.carella@mdcehc.org)" <[veronika.carella@mdcehc.org](mailto:veronika.carella@mdcehc.org)>, "[mlatshaw@jhu.edu](mailto:mlatshaw@jhu.edu)" <[mlatshaw@jhu.edu](mailto:mlatshaw@jhu.edu)>, "[amezu@msde.state.md.us](mailto:amezu@msde.state.md.us)" <[amezu@msde.state.md.us](mailto:amezu@msde.state.md.us)>, "[allison@mdehn.org](mailto:allison@mdehn.org)" <[allison@mdehn.org](mailto:allison@mdehn.org)>, "[benoythomas@gmail.com](mailto:benoythomas@gmail.com)" <[benoythomas@gmail.com](mailto:benoythomas@gmail.com)>, "[Varney-Alvarado@dhcd.state.md.us](mailto:Varney-Alvarado@dhcd.state.md.us)" <[Varney-Alvarado@dhcd.state.md.us](mailto:Varney-Alvarado@dhcd.state.md.us)>, "[christina.church@maryland.gov](mailto:christina.church@maryland.gov)" <[christina.church@maryland.gov](mailto:christina.church@maryland.gov)>, "[dbishai@jhsph.edu](mailto:dbishai@jhsph.edu)" <[dbishai@jhsph.edu](mailto:dbishai@jhsph.edu)>, "[dianna.abney@maryland.gov](mailto:dianna.abney@maryland.gov)" <[dianna.abney@maryland.gov](mailto:dianna.abney@maryland.gov)>, "[gdiette@jhmi.edu](mailto:gdiette@jhmi.edu)" <[gdiette@jhmi.edu](mailto:gdiette@jhmi.edu)>, "[ematsui@jhmi.edu](mailto:ematsui@jhmi.edu)" <[ematsui@jhmi.edu](mailto:ematsui@jhmi.edu)>, "[lornegarr@msn.com](mailto:lornegarr@msn.com)" <[lornegarr@msn.com](mailto:lornegarr@msn.com)>, "[bgitterman@aol.com](mailto:bgitterman@aol.com)" <[bgitterman@aol.com](mailto:bgitterman@aol.com)>, "[bgitterm@cnmc.org](mailto:bgitterm@cnmc.org)" <[bgitterm@cnmc.org](mailto:bgitterm@cnmc.org)>, "[jpowell@maryland.gov](mailto:jpowell@maryland.gov)" <[jpowell@maryland.gov](mailto:jpowell@maryland.gov)>, "[jlcarella@msn.com](mailto:jlcarella@msn.com)" <[jlcarella@msn.com](mailto:jlcarella@msn.com)>, "[julianlevy@comcast.net](mailto:julianlevy@comcast.net)" <[julianlevy@comcast.net](mailto:julianlevy@comcast.net)>, "[megan.latshaw@aphl.org](mailto:megan.latshaw@aphl.org)" <[megan.latshaw@aphl.org](mailto:megan.latshaw@aphl.org)>, "[nancy.servatius@maryland.gov](mailto:nancy.servatius@maryland.gov)" <[nancy.servatius@maryland.gov](mailto:nancy.servatius@maryland.gov)>, "[nobot@cehn.org](mailto:nobot@cehn.org)" <[nobot@cehn.org](mailto:nobot@cehn.org)>, "[rob.hofstetter@maryland.gov](mailto:rob.hofstetter@maryland.gov)" <[rob.hofstetter@maryland.gov](mailto:rob.hofstetter@maryland.gov)>, "[rebeccaruggles@gmail.com](mailto:rebeccaruggles@gmail.com)" <[rebeccaruggles@gmail.com](mailto:rebeccaruggles@gmail.com)>, "[Angela.Angel@house.state.md.us](mailto:Angela.Angel@house.state.md.us)" <[Angela.Angel@house.state.md.us](mailto:Angela.Angel@house.state.md.us)>, "[elizabeth.young@maryland.gov](mailto:elizabeth.young@maryland.gov)" <[elizabeth.young@maryland.gov](mailto:elizabeth.young@maryland.gov)>, "[lisa.nissley@maryland.gov](mailto:lisa.nissley@maryland.gov)" <[lisa.nissley@maryland.gov](mailto:lisa.nissley@maryland.gov)>, "[ruth.namuyinga@maryland.gov](mailto:ruth.namuyinga@maryland.gov)" <[ruth.namuyinga@maryland.gov](mailto:ruth.namuyinga@maryland.gov)>, "[crowea@mda.state.md.us](mailto:crowea@mda.state.md.us)" <[crowea@mda.state.md.us](mailto:crowea@mda.state.md.us)>, "[steering.committee@mdcehc.org](mailto:steering.committee@mdcehc.org)" <[steering.committee@mdcehc.org](mailto:steering.committee@mdcehc.org)>, "[anja@ecoipso.com](mailto:anja@ecoipso.com)" <[anja@ecoipso.com](mailto:anja@ecoipso.com)>

Dear Maryland Children's Environmental Health and Protection Advisory Council Members,

I'm a scientist by degree and a mother of 3 school aged children. I have reviewed a lot of the science that shows that radiofrequency radiation that is emitted from all wireless transmitters including WiFi, all wireless devices that connect to WiFi (iPads, Chromebooks etc.) and cell phones **can** cause cancer, DNA damage, neurological disorders, reproductive harm and so much more.

Recently The National Toxicology Program, in a \$25 million U.S. Government funded study, showed radiofrequency radiation causes cancer and DNA breaks in the brain. This study just confirmed what has been known for many years by independent, non-industry-funded scientists in this field. Please find attached hundreds of scientific studies showing that radiofrequency (from any wireless transmitter/device) can cause serious and irreparable harm.

Please do what is right for all kids and know that you have the support of hundreds of scientists that have done research in this field:

Please make strong recommendations to reduce and eliminate as much as possible radiofrequency radiation in schools by

1. Installing non-wireless technology for internet connection.
2. Ensuring all cell phones and other wireless devices are turned OFF in classrooms.
3. Teaching students about radiofrequency radiation and how they can reduce RF from cell phones and technology by changing how they use the technology so they are safer at home.

Dear Members of the Children's Environmental Health and Protection Advisory Council:

Please issue the report "Wifi Radiation in Schools in Maryland" which urges no mandates but gently suggests some important guidelines. .

Please do not delay anymore. This report is only the beginning of letting the public and educators know about potential health risks to children.

Many parents don't complain because they don't know that there are **any** potential harmful effects of nonionizing radiation and chronic exposure through wifi routers, chrome books, and computers.

"Surely" they think, "if it was unsafe, **"they"** wouldn't allow it." Well, as we all know from our work in public policy, the "they" is "us." And with regard to this report, the "they" is the voting members of the CEHPAC.

It is up to this Council to caution schools and parents about the known harmful effects of non ionizing radiation exposure from wifi routers and tablets and laptops and smart boards. There is solid science to back the precautionary principle.

Based on the data, other countries and cities have eliminated or limited children's exposure to wifi. Individual schools in the U.S. have also completely eliminated wifi in schools.

**None of the schools which have eliminated wifi have limited the Internet.** They have simply wired up the laptops and computers. **It is important not to conflate these issues.** Reducing exposure to wifi is not the same as reducing time on the Internet.

It is now time for the Maryland CEHPAC at the very least *begin* a public conversation with parents and educators.. Please approve and issue the report "Wifi Radiation in Schools in Maryland."

As Dr. Martha Hebert, assistant professor for Neurology at Harvard Medical School, has stated in the attached letter:

**"Radiofrequency electromagnetic radiation from wifi and cell towers can exert a disorganizing effect on the ability to learn and remember, and can also be destabilizing to immune and metabolic function. This will make it harder for some children to learn, particularly those who are already having learning or medical problems in the first place. And since half of the children in this country have some kind of chronic illness, this means that a lot of people are more vulnerable than you might expect to these issues. Powerful industrial entities have a vested interest in leading the public to believe that EMF/RFR, which we cannot see, taste or touch, is harmless, but this is not true. Please do the right and precautionary thing for our children."**

Thank you.

Susannah Goodman, Chevy Chase, MD  
mother, lifetime consumer advocate



# Medical Associations, medical doctors and leading scientists call for safe technologies in schools

## Introduction

More<sup>1</sup> Medical Associations, medical doctors and scientists, many of whom work on the biological effects of wireless technologies, have expressed their concerns about the safety of wireless devices for schools. They are asking for wired information and communication technologies to be used in order to safeguard<sup>2</sup> children and young people, protect and promote healthy development and maximise learning and achievement.

These experts do not agree with the health protection agencies which currently support or allow the use of microwave, radiofrequency-emitting technologies by children and young people in schools.

Other authorities have also called for the protection of children from wireless technologies.

- Council of Europe: Mobile phone use by pupils in schools to be strictly regulated and wired internet connections to be preferred (Resolution 1815, 2011<sup>3</sup>).
- World Health Organization's International Agency for Research on Cancer (IARC) classified radiofrequency radiation as a possible human carcinogen, class 2B (2011)<sup>4</sup>.
- UK Trades Union Congress (TUC): Caution should be taken to prevent exposure to Class 2B carcinogens in the workplace<sup>5</sup>.
- European Environment Agency: All reasonable measures to be taken to reduce exposures to electromagnetic fields, especially radiofrequencies from mobile phones and particularly the exposures to children and young adults. Current exposure limits to be reconsidered<sup>6</sup>.
- International Commission for Electromagnetic Safety (ICEMS): Strongly advise limited use of cell phones, and other similar devices, by young children and teenagers<sup>7</sup>.
- Russian National Committee on Non-Ionizing Radiation Protection have recommended the use of wired networks in schools and educational institutions, rather than wireless broadband systems, including Wi-Fi<sup>8</sup>. *"It is our professional obligation not to damage the children's health by inactivity"*<sup>9</sup>.
- German Government and Israeli Parliament recommended wired computer networks for schools or workplaces<sup>10,11</sup>.
- Several countries have advised children and young people to limit their use of mobile/smart/cell phones<sup>1</sup>.

This document serves to inform schools, Governing Bodies, Academy Trusts, School Boards, Education Authorities, teachers and parents of the professional, medical and scientific concerns about children using wireless technologies in schools. The information can be used to implement safe school policies, practices and guidance in order to safeguard the health and development of children and young people and to aid cognitive abilities, learning and achievement.

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Grateful appreciation is given to all those who have offered comments for this document and helped in its preparation.

Available electronically at: <http://www.wifiinschools.org.uk/resources/safeschools2012.pdf>

June 2012. To contribute to a future edition, please contact:

E-mail: [contact@wifiinschools.org.uk](mailto:contact@wifiinschools.org.uk), Address: BM Wifiinschools.org.uk, London, WC1N 3XX.

Wifiinschools.org.uk offers free information about the safety of wireless technologies. It does not sell any products and has no monetary or other conflicts of interest on this issue. © Copyright 2012 All Rights Reserved

## Medical Associations

**Dr Gerd Oberfeld, MD, Public Health Department, Salzburg, Austria, on behalf of the Austrian Medical Association.**

*Schools should provide the best possible learning environments. In this context low noise levels, good air quality and low radiofrequency / microwave radiation are crucial. Wi-Fi environments will lead to high microwave exposure for students and teachers which might increase the burden of oxidative stress. Oxidative stress might slow down the energy production especially in brain cells and may lead e.g. to concentration difficulties and memory problems in certain individuals. The Austrian Medical Association recommends Wi-Fi free school environments.*

### **The American Academy of Environmental Medicine**

**The Board of Officers and Directors: Dr Alvis L. Barrier, MD, FAAOA; Dr Amy Dean, DO; Dr Charles L. Crist, MD; Dr James W. Willoughby, II, DO; Dr Robin Bernhoft, MD; Dr Gary R. Oberg, MD, FAAEM; Dr Craig Bass, MD; Dr Stephen Genius, MD, FRCS, DABOG, FAAEM, DABEM; Dr Martha Grout, MD, MD(H); Dr W. Alan Ingram, MD; Dr Janette Hope, MD; Dr Derek Lang, DO; Dr Glen A. Toth, MD; Dr Ty Vincent, MD.**

*The Board of the American Academy of Environmental Medicine approved the following statement on Wi-Fi in schools on 9<sup>th</sup> June 2012:*

*Adverse health effects, such as learning disabilities, altered immune responses, headaches, etc. from wireless radio frequency fields do exist and are well documented in the scientific literature. Safer technology, such as using hard-wiring, must be seriously considered in schools for the safety of those susceptible individuals who may be affected by this phenomenon.*

January 2012:

*The Board of the American Academy of Environmental Medicine opposes the installation of wireless “smart meters” in homes and schools based on a scientific assessment of the current medical literature (references available on request). Chronic exposure to wireless radiofrequency radiation is a preventable environmental hazard that is sufficiently well documented to warrant immediate preventative public health action.*

*The Board of the American Academy of Environmental Medicine also wishes to note that the US NIEHS National Toxicology Program in 1999 cited radiofrequency (RF) radiation as a potential carcinogen. Existing safety limits for pulsed RF were termed “not protective of public health” by the Radiofrequency Interagency Working Group (a federal interagency working group including the FDA, FCC, OSHA, the EPA and others) (From AAEM Letter, January 2012, <http://wifiinschools.org.uk/resources/AAEM.pdf>).*

The AAEM asks for:

- *Use of safer technology, including for “Smart Meters”, such as hard-wiring, fiber optics or other non-harmful methods of data transmission.*
- *Independent studies to further understand the health effects of electromagnetic and radiofrequency exposures.*
- *Understanding and control of this electrical environmental bombardment for the protection of society.*

(For full list, see: <http://aaemonline.org/pressadvisoryemf.pdf>; AAEM Position Statement: [http://aaemonline.org/emf\\_rf\\_position.html](http://aaemonline.org/emf_rf_position.html)). References from the AAEM statements below can be found in: <http://aaemonline.org/pressadvisoryemf.pdf>.

The AAEM Position Statement on electromagnetic fields includes:

*Multiple studies correlate radiofrequency exposure with diseases such as cancer, neurological disease, reproductive disorders, immune dysfunction, and electromagnetic hypersensitivity.*

*Arguments are made with respect to radiofrequency exposure from Wi-Fi, cell towers and smart meters that due to the distance, exposure to these wavelengths are negligible (2). However, many in vitro, in vivo and epidemiological studies demonstrate that significant harmful biological effects occur from non-thermal radiofrequency exposure and satisfy Hill’s criteria of causality (3). Genetic damage, reproductive defects, cancer, neurological degeneration and nervous system dysfunction, immune system dysfunction, cognitive effects, protein and peptide damage, kidney damage and developmental effects have all been reported in the peer-reviewed scientific literature.*

*The fact that radiofrequency exposure causes neurological damage has been documented repeatedly. Increased blood-brain barrier permeability and oxidative damage, which are associated with brain cancer and neurodegenerative diseases, have been found (4,7,15-17). Nittby et al. demonstrated a statistically significant dose-response effect between non-thermal radiofrequency exposure and occurrence of albumin across the blood-brain barrier (15). Changes associated with degenerative neurological diseases such as Alzheimer’s, Parkinson’s and Amyotrophic Lateral Sclerosis (ALS) have been reported (4,10). Other neurological and cognitive disorders such as headaches, dizziness, tremors, decreased memory and attention, autonomic nervous system dysfunction, decreased reaction times, sleep disturbances and visual disruptions have been reported to be statistically significant in multiple epidemiological studies with radiofrequency exposure occurring non-locally (18-21).*

*In an era when all society relies on the benefits of electronics, we must find ideas and technologies that do not disturb bodily function. It is clear that the human body uses electricity from the chemical bond to the nerve impulse and obviously this orderly sequence can be disturbed by an individual-specific electromagnetic frequency environment.*

## **International Society of Doctors for the Environment (ISDE)**

### **Irish Doctors Environmental Association (IDEA)**

*Both the International Society of Doctors for the Environment [ISDE] and the Irish Doctors Environmental Association [IDEA] have stated, the former by an ad hoc majority opinion of the Directing Board and the latter by unanimous decision of the Executive Committee, that there is sufficient scientific evidence to warrant more stringent controls on the level and distribution of electromagnetic radiation [EMR].*

*ISDE and IDEA recommendations (full list in Appendix 1):*

- *Avoid Wi-Fi in home or work if possible, particularly in schools or hospitals.*
- *Use wired technology whenever possible.*
- *Measure the radiation levels at sites which are occupied for prolonged periods, particularly by infants or young children.*
- *Base stations should not be located on or near [500m] schools or hospitals.*

*The Interphone Study organised by the International Agency for Research on Cancer [IARC] – a \$20 million study in many countries over 5 years, presented partial results in 2011 of their analysis of 6,600 cancer cases in relation to cell phone use. The results were equivocal but IARC has since designated EMR as “possibly carcinogenic to humans” [Group 2B].*

*Attention deficit hyperactivity disorder [ADHD] is known to be increasing in prevalence by 3% per year in the USA for which there is no generally accepted explanation. There is evidence from an epidemiological study [Divan, H. et al *Epidemiology* 19 523-529] from 2008 indicating an association between maternal cell phone use and the prevalence of behavioural problems in children. This was supported by an experimental study in mice from Yale University which demonstrated neurobehavioural defects which persisted into adulthood and was shown to be due to dose-dependent altered neurodevelopmental programming [Aldad T. S. et al Mar 2012 [www.nature.com/scientificreports](http://www.nature.com/scientificreports)].*

*Because of the potentially increased risks for the foetus, infants and young children due to their thinner more permeable skulls and developing systems, particularly the immune and neurological systems, based on the precautionary principal and on the mounting evidence for harm at the sub-cellular level, we recommend that EMR exposure should be kept to a minimum. The basic theory is that the younger they are the more likely they are to be damaged for the above reasons and also they will be exposed for a longer period over their lifetime on average.*

*The Parliamentary Assembly of the Council of Europe Resolution 1815 in 2011 made numerous specific recommendations relating to EMR, the basic message being to maintain radiation levels ‘as low as reasonably achievable’ [ALARA].*

**Dr P. Michael, April 2012**

**Interdisciplinary Society for Environmental Medicine (Interdisziplinäre Gesellschaft für Umweltmedizin e. V.), Germany.**

In the Freiburger Appeal in 2002, medical doctors in Germany requested:

- *Ban on mobile telephone use and digital cordless (DECT) telephones in preschools and schools.*
- *Ban on mobile telephone use by small children and restrictions on use by adolescents.*
- *Education of the public, especially of mobile telephone users, regarding the health risks of electromagnetic fields.*
- (Appeal in full: [www.planningsanity.co.uk/reports/md341.doc](http://www.planningsanity.co.uk/reports/md341.doc)).

**Swiss Doctors for Environmental Protection (Ärztinnen und Ärzte für Umweltschutz (AefU)).**

The Swiss Doctors for Environmental Protection have not specifically mentioned schools, but have called for caution with respect to wireless technologies:

*The International Agency for Research on Cancer (IARC) considers the waves emitted by wireless communication “possibly carcinogenic”. According to the IARC, the risk of cancer for this type of radiation is thus similar to that of the insecticide DDT, rightly banned. Doctors for the Environment is concerned that the limit values expected to protect the Swiss population, notably vulnerable groups such as children and pregnant women, constitute insufficient protection. In a communication sent to the Federal Assembly, Doctors for the Environment thus requests strict application of the principle of precaution and – in view of the risk of cancer – lower limit values.*

*Children’s rooms, housing, trams or offices are experiencing a growing exposure to radiation from diverse sources: baby monitors, mobile telephony, Wi-Fi, etc., yet more and more studies warn against the serious health consequences of electromagnetic pollution for human beings and animals.*

Dr Peter Kälin, President, states “From the medical point of view, it is urgent to apply the precautionary principle for mobile telephony, Wi-Fi, power lines, etc.”  
[http://www.aefu.ch/typo3/fileadmin/user\\_upload/aefu-data/b\\_documents/Aktuell/M\\_120322\\_NIS.pdf](http://www.aefu.ch/typo3/fileadmin/user_upload/aefu-data/b_documents/Aktuell/M_120322_NIS.pdf)

## Scientists and Medical Doctors

**Dr Igor Belyaev Dr.Sc., Head Research Scientist, Cancer Research Institute, Slovak Academy of Science, Slovak Republic; Associate Professor in Toxicological Genetics, Faculty of Natural Science, Stockholm University, Sweden.**

*To my opinion, which is based on 25-year research of non-thermal effects of microwaves, usage of Wi-Fi and cell/mobile/smart phones in the classroom should be either forbidden or reduced as much as possible. I believe that the majority of scientists with long lasting experience in this scientific field are of the same opinion. Several national authorities have already advised limiting usage of mobile communication by children. Please, see recent news from Israel by the link below <http://www.haaretz.com/business/knesset-backs-bill-requiring-cell-phones-to-bear-health-hazard-warning-1.415677>, recommendation of the RNCNIRP in the file attached (Appendix 2) and my recent review (Belyaev 2010)<sup>12</sup>.*

**Professor Dr. Nesrin Seyhan, Medical Faculty and Chair of Biophysics Department, Gazi University, Turkey; WHO EMF International Advisory Committee; Panel Member NATO RTA Human Factors and Medicine.**

*Dr. Seyhan, founder of the Gazi Non-Ionizing Protection Center (GNRK), always opposes radiofrequency sources near schools. She believes that potential adverse health effects from the children's use of Wi-Fi and cell/mobile/smart phone would be greater than with respect to adults. She also recommends that children younger than 16-years-old should not have their own mobile phone. Please find her last publication attached<sup>13</sup>.*

**Professor Lukas H. Margaritis, PhD, Professor Emeritus of Cell Biology and Radiobiology, Dept of Cell Biology and Biophysics, University of Athens, Greece.**

*Having done experiments on cellular model systems we have found an effect from electromagnetic radiation of ordinary Wi-Fi. I have strongly suggested for years now that they should be used only if absolutely necessary in the home and not at all in schools. There is no reason for having Wi-Fi in schools since there is an alternative - wired connections which are safer and faster.*

**Dr Stelios A. Zinelis, BA, MD, Hellenic Cancer Society, Cefallonia, Greece**

*We should not subject and force electromagnetic radiation on school children. Technology can be applied by a wired connection. Effects of the electromagnetic radiation have been well documented and should not be ignored. The past has taught as many lessons, for example asbestos.*

**Dr Samuel Milham MD, MPH, Epidemiology and Public Health, Formerly Washington State Department of Health, USA.**

*Wireless technologies have no place in schools. I strongly recommend that where they exist, they be replaced by fiber-optic cable and hard wiring.*

<http://www.wifiinschools.org.uk/resources/safeschools2012.pdf>

**Professor Dr. Oleg Grigoriev, PhD, Director of the Russian Centre for Electromagnetic Safety and Vice-Chairman of the RCNIRP.**

**Professor Yury Grigoriev, Dr. of Medical Science, Chairman of the Russian National Committee on Non-Ionizing Radiation Protection (RCNIRP); member of International Advising Committee on WHO EMF Project.**

*Our Committee and I are personally against the use of Wi-Fi systems in schools. Professor Yury Grigoriev (chairman of the RCNIRP) has the same opinion. The reason is that it forms a very complex form of electromagnetic field, but in this case the probability of biological effect is higher than when the same total dose is created by one source of unmodulated electromagnetic field. This pattern is for non-thermal electromagnetic fields. There are very good studies that have shown that prolonged exposure to low-intensity radio waves in children disturbed cognitive function, and we trust this research.*

RCNIRP recommendation about Wi-Fi in schools and educational institutions, June 2012:  
<http://international-emf-alliance.org/images/pdf/RussCNIRP%20WiFi%2019-06-12.pdf>.

**Professor Dr. Alvaro Augusto A. de Salles, PhD, Electrical Engineering Department, Federal University of Rio Grande do Sul, Porto Alegre, Brazil.**

*I believe that responsible governments should act firmly to avoid the use of mobile/smart phones and Wi-Fi in schools.*

*The main reasons are due to the scientific evidence already available in the international literature (e.g., Bioinitiative report, Pathophysiology 2009, Interphone report, Hardell's group papers, etc) showing health risks even at low level exposure to the non-ionizing radiation (NIR), the 2011 IARC/WHO possible carcinogenic (2 B) classification of the NIR and because due to different reasons, the children are more susceptible to this radiation.*

*Then the "Precautionary Principle" should effectively be used in this subject and instead of wireless connection, other fixed connections such as twisted pairs, coaxial cables, optical fiber, etc should be available for each student, avoiding therefore exposure during several hours to the NIR.*

*If serious and responsible decisions are not taken in due time, the price in terms of future generations public health can be very high.*

**Dr Kevin O'Neill, FRCS (SN), Consultant Neurosurgeon, Charing Cross Hospital, London, UK.**

Letter to the British Medical Journal<sup>14</sup>:

*You reported (BMJ 2011;342:d3428) on the Council of Europe's recommendation that children be protected from the electro-magnetic radiation emitted by wireless equipment in schools. Since then, the International Agency for Research into Cancer (IARC) has classified such radiation as a possible carcinogen.*

*The evidence for children's particular vulnerability is accumulating. Most recently a study by the University of Orebro, published in the International Journal of Oncology (Int J Oncol. 2011 May;38(5):1465-74) found almost a fivefold increase of astrocytoma among subjects who started mobile phone use before the age of 20.*

*Since the Council of Europe has little influence over national health policy and the IARC classification will take time to translate into practical advice, we as medical practitioners and professional bodies have a role in ensuring timely action is taken to protect children. Previous public health threats (tobacco, asbestos, x-rays) indicate that the evidence of risk often increases as research progresses. Given a latency lag of up to 20 years for many tumours, we are in danger of repeating these public health disasters.*

**Dr David Carpenter, MD, Director Institute for Health and the Environment, University at Albany and Professor Environmental Health Sciences, School of Public Health, USA.**

*Chronic, such as all-day, school exposure, is more likely than short and intermittent exposure, such as cell phone use, to produce harmful health effects, and is likely to do so at lower exposure levels. Persons stationed close to school computers with WI-FI and especially those very near to any WI-FI infrastructure will receive considerably higher exposure than do others.*

*Exposure to high-frequency radiofrequency (RF) and microwave (MW) radiation and also the extreme low frequency (ELF) EM fields that accompany WI-FI exposure have been linked to a variety of adverse health outcomes. Some of the many adverse effects reported to be associated with and/or caused by ELF fields and/or RF/MW radiation include neurologic, endocrine, immune, cardiac, reproductive and other effects, including cancers. Human studies of comparable RF/MW radiation parameters show changes in brain function including memory loss, retarded learning, performance impairment in children, headaches and neurodegenerative conditions, melatonin suppression and sleep disorders, fatigue, hormonal imbalances, immune dysregulation such as allergic and inflammatory responses, cardiac and blood pressure problems, genotoxic effects like miscarriage, cancers such as childhood leukemia, childhood and adult brain tumors, and more.*

*Children are more vulnerable to RF/MW radiation because of the susceptibility of their developing nervous systems. RF/MW penetration is greater relative to head size in children, who have a greater absorption of RF/MW energy in the tissues of the head at WI-FI frequencies. Children are largely unable to remove themselves from exposures to harmful substances in their environments. Their exposure is involuntary. There is a major legal difference between an exposure that an individual chooses to accept and one that is forced upon a person, especially a dependent, who can do nothing about it. WI-FI must be banned from school deployment. <http://www.magdahavas.com/wordpress/wp-content/uploads/2012/01/Amended-Declaration-of-Dr-David-Carpenter.pdf>*

Letter about Wi-Fi in schools: <http://wifiinschools.org.uk/resources/Carpenter+letter+Feb2011.pdf>.

**Dr Martin Blank, Ph.D., Associate Professor of Physiology and Cellular Biophysics, College of Physicians and Surgeons, Columbia University, New York, USA.**

*Just because we allow microwaves, doesn't mean that Wi-Fi at the same frequency should be allowed into all classrooms.*

*There is now sufficient scientific data about the biological effects of electromagnetic fields (EMF), and in particular about radiofrequency (RF) radiation, to argue for adoption of precautionary measures. We can state unequivocally that EMF can cause single and double strand DNA breakage at exposure levels that are considered safe under the FCC guidelines in the USA.*

*EMF have been shown to cause other potentially harmful biological effects, such as leakage of the blood brain barrier that can lead to damage of neurons in the brain, increased micronuclei (DNA fragments) in human blood lymphocytes, all at EMF exposures well below the limits in the current FCC guidelines. Probably the most convincing evidence of potential harm comes from living cells themselves when they start to manufacture stress proteins upon exposure to EMF. The stress response occurs with a number of potentially harmful environmental factors, such as elevated temperature, changes in pH, toxic metals, etc. This means that when stress protein synthesis is stimulated by radiofrequency or power frequency EMF, the body is telling us in its own language that RF exposure is potentially harmful.*

*It is obvious that the safety standards must be revised downward to take into account the non-thermal as well as thermal biological responses that occur at much lower intensities. Since we cannot rely on the current standards, it is best to act according to the precautionary principle. The precautionary approach appears to be the most reasonable for those who must protect the health and welfare of the public and especially its most vulnerable members, children of school-age. (Letter, Appendix 3).*

**Dr Olle Johansson, Associate Professor, Karolinska Institute, Stockholm, and Professor, The Royal Institute of Technology, Stockholm, Sweden.**

*Wireless communication is now being implemented in our daily life in a very fast way. At the same time, it is becoming more and more obvious that the exposure to the electromagnetic fields used by these systems not only may induce acute thermal effects to living organisms, but also non-thermal effects, the latter often after longer exposures. This has been demonstrated in a very large number of studies and includes cellular DNA-damage, disruptions and alterations of cellular functions like increases in intracellular stimulatory pathways and calcium handling, disruption of tissue structures like the blood-brain barrier, impact on vessel and immune functions, association to cancer, and loss of fertility.*

*Wireless systems, such as Wi-Fi routers and cell/mobile/smart phones, cannot be regarded as safe in schools, but must be deemed highly hazardous and unsafe for the children as well as for the staff.*

**Dr Magda Havas, PhD, Associate Professor, Environmental and Resource Studies, Trent University, Ontario, Canada.**

*I am a scientist researching the adverse health outcomes of electromagnetic radiation exposure, including from sources such as WI-FI networks and cell towers. I conducted a study that showed immediate and dramatic changes in both heart rate and heart rate variability associated with microwave exposure to a frequency of 2.4 GHz at levels well below (0.5 percent) federal guidelines. The reactions include heart irregularities, a rapid heart rate, up-regulation of the sympathetic nervous system, and down-regulation of the parasympathetic nervous system.*

*It is important that children be exposed to the important education, life experiences, and social structures that public education offers, but they must not be risking their health to do so! Children must not be exposed to a constant background of pulsed microwave radiation from WI-FI (or other sources) while at school.*

*The Internet is an important learning device that should not be taken away. I simply urge that its access be made available through wires rather than Wi-Fi.*

<http://www.magdahavas.com/wordpress/wp-content/uploads/2012/01/Declaration-of-Dr.-Magda-Havas.pdf>

**Dr Erica Mallery-Blythe, BM, Emergency Room Registrar, Medical Advisor ES-UK**

*Radiofrequency radiation was classified last year (2011) as a class 2B carcinogen by the International Agency for Research on Cancer (IARC)/World Health Organization (WHO). This means that Global Health Authorities are concerned that this kind of radiation (used by many kinds of household wireless devices) may cause cancer. There are several convincing mechanisms via which cellular disruption is taking place and all bodily systems are potentially vulnerable. All persons should, in my opinion, take precaution to reduce their exposure to unnatural radiation, including that from non-ionizing, non-thermal sources such as cell phones, Wi-Fi routers, cordless landlines and many others. This advice is particularly important for parents and Education Authorities when creating home and school environments because children are more vulnerable to this kind of radiation.*

*Science has repeatedly and clearly demonstrated adverse effects of artificial electromagnetic fields on biological systems. It is far too late for timely intervention, but failure to act now with conviction and protect our children could lead to a national health disaster.*

**Professor Dr. Christos Georgiou, PhD, Professor of Biochemistry, University of Patras, Greece**

*Every child has the non-negotiable, obvious right to a healthy and safe school environment.*

*Governments and school boards can no longer trust the wireless communication industry's monotonous slogan that Wi-Fi and cell phones are safe. In May 2011, the World Health Organization (WHO) classified microwave radiation, emitted by such wireless devices, as a possible carcinogen. WHO could no longer ignore the scientific and social pressure from*

<http://www.wifiinschools.org.uk/resources/safeschools2012.pdf>

*numerous studies, which have shown that Wi-Fi/cell phone radiation penetrates the body, affects cell membranes, makes cells lose their ability to function properly over time, and disturbs the body's normal metabolism causing numerous abnormalities and diseases.*

*Children are especially vulnerable to microwave radiation because their nervous system and especially the brain are still developing. Moreover, their skulls are thinner and smaller than those of the adults, so the radiation penetrates their brains more freely and deeply.*

*Microwave radiation displays in children life threatening short and long term effects: the short term effects are experienced as headaches, dizziness, nausea, vertigo, fatigue, visual and auditory distortion (voices change volume, ringing ears), abnormal heart rates (racing heart rate or tachycardia, erratic heart rates), memory loss, attention deficit (trouble concentrating while in class), skin rash, hyperactivity, anxiety, autism, depression, night sweats, insomnia (microwaves affect melatonin levels), learning impairment, behavioural changes etc; the long term effects are expressed as stress, a weakened immune system, seizures, epilepsy, high blood pressure, brain damage, diabetes, fibromyalgia, infertility, birth defects, DNA damage, leukemia, cancer, etc.*

**Dr Isaac Jamieson, PhD, DIC RIBA DipAAS BSc (Hons) MInstP, Architect, Consultant and Environmental Scientist, UK.**

*Proactively addressing 'electromagnetic pollution' issues may significantly aid well-being and achievement in individual schools. It appears sensible for 'Health Promoting Schools', and other schools interested in the well-being of their staff and pupils to consider such matters. (Full Report in Appendix 4).*

**Professor Dr. Franz Adlkofer, MD, Chairman of Pandora - Foundation for Independent Research.**

*While the use of mobile phones is the result of people's free choice, their exposure to W-LAN and other wireless applications is mostly compulsory. Especially concerned are children in schools where this technology has been given preference to wired computers. Since our knowledge on possible adverse effects of radiofrequency electromagnetic fields is still rather poor, it is obvious that at present the biggest biophysical experiment of mankind is under way – with an uncertain outcome. In May 2011, the uncertainty has been strengthened by the International Agency for Research on Cancer (IARC) that classified radiofrequency electromagnetic fields as 'possibly carcinogenic to humans'. This decision was mainly based on the results of epidemiological studies that observed after long-term (>10 years) and intensive use of mobile phones an increased risk for brain tumours exactly at the side of the head at which the mobile phone was used. The results from animal experiments, although of minor significance, supported the decision. Yet, results from basic research that showed changes in structure and functions of genes in isolated human and animal cells as well as in living animals after exposure, and that would have given additional weight to the epidemiological*

*observations, were not taken into account. Had they been included in the evaluation, the classification would not have been 'possibly carcinogenic' but rather 'probably carcinogenic'.*

*The general public is confronted with two different views, one represented by politics and industry and one by the growing number of independent researchers. Ordinary people have either no idea of the probably adverse effects of radiofrequency radiation or have full confidence in the exposure limits that according to their governments reliably protect from any risk to the health. They do not know that the exposure limits are based on pseudo-science thought to create the necessary legal frame for a telecommunication industry that wants to make use of the new technology without being hampered by medical considerations.*

*For a medical doctor like me, the conclusion from the present state of knowledge must be that a precautionary approach is overdue and must not be delayed anymore. (Full Statement in Appendix 5).*

**Dr Vini G. Khurana, MBBS, BSc (Med), PhD, FRACS, Associate Professor of Neurosurgery, Australian National University Medical School; Currently Visiting Attending Neurosurgeon, Royal Melbourne Hospital.**

*The concerns raised regarding the unnecessary and prolonged exposure of children to near-field radiofrequency electromagnetic radiation (RF-EMR) from mobile phones, wireless laptops (on their laps), and nearby Wi-Fi transmitters in schools are shared by many.*

*A precautionary approach is realistically achieved without compromising convenience and safety. See for example: [http://www.brain-surgery.us/brain\\_spine\\_health.html](http://www.brain-surgery.us/brain_spine_health.html)*

*There are good grounds for adopting such an approach in children, particularly in the context of the WHO's recent classification of RF-EMR as "possibly carcinogenic to humans", and the fact that children may be more susceptible to any adverse health effects of RF-EMR owing to their thinner scalp and skull, increased brain water content, lower brain volume, and rapidly developing neural connections.*

**Dr Annie Sasco, MD, PhD, Director, Epidemiology for Cancer Prevention, INSERM (Institut national de la santé et de la recherche médicale) Research Unit, School of Public Health, Victor-Segalen Bordeaux 2 Université, France. Formerly International Agency for Research on Cancer (IARC) Unit Chief of Epidemiology for Cancer Prevention.**

*If we want to wait for final proof, at least in terms of cancer, it may still take 20 years and the issue will become that we will not have unexposed population to act as control. We may never have the absolute final proof. But we have enough data to go ahead with a precautionary principle to avoid exposures (radiofrequencies) which are unnecessary if our goal is to reduce somewhat the burden of cancer in the years to come and other chronic diseases.*

**Dr Alfonso Balmori, PhD, Biologist, Researcher on effects of electromagnetic fields on wildlife, Valladolid, Spain.**

*The ongoing invasion of radiation caused by Wi-Fi transmitters and other radiofrequency sources represents a denial of scientific evidence and extreme myopia. It is absurd when cable can be used with much greater speeds than schools choose to do so by air. Moreover health must take priority over access to information. Wi-Fi systems are being senselessly installed, even for young children. Society is performing an extremely dangerous and suicidal experiment with them. In it are included not only the children of those who are convinced that electromagnetic radiation is harmful but also the children of the promoters of such systems, both politicians and those who work in the communications industry and also the scientists who deny the evidence. The problems of depression, attention deficit and insomnia in children are increasing worldwide at an alarming rate.*

**Dr Mae-Wan Ho, PhD, FRSA, Director of the Institute of Science in Society, London, UK.**

*It is very important for schools and other public places frequented by children to be free of Wi-Fi. The evidence on 'non-thermal' biological effects of very weak electromagnetic fields is now indisputable and children are many times more at risk than adults.*

**Dr Norbert Hankin, PhD, Environmental Scientist, Office of Radiation and Indoor Air, Environmental Protection Agency, USA.**

*The growing use of wireless communications by children and by schools will result in prolonged (possibly several hours per day), long-term exposure (12 or more years of exposure in classrooms connected to computer networks by wireless telecommunications) of developing children to low-intensity pulse modulated radiofrequency radiation.*

*Recent studies involving short-term exposures have demonstrated that subtle effects on brain functions can be produced by low-intensity pulse modulated radiofrequency radiation. Some research involving rodents has shown adverse effects on short-term and long-term memory. The concern is that if such effects may occur in young children, then even slight impairment of learning ability over years of education may negatively affect the quality of life that could be achieved by these individuals, when adults<sup>15</sup>.*

**The individuals listed below signed the Porto Alegre Resolution in 2010, which stated:**

*We strongly recommend these precautionary practices:*

- 1. Children under the age of 16 should not use mobile phones and cordless phones, except for emergency calls;*
- 2. The licensing and/or use of Wi-Fi, WIMAX, or any other forms of wireless communications technology, indoors or outdoors, shall preferably not include siting or signal transmission in ... schools ... or any other buildings where people spend considerable time.*

**Franz Adlkofer, Prof. Dr. Med., Verum Foundation, Germany.**  
**Carl Blackman, PhD., CFB, USA.**  
**Martin Blank, PhD. Prof. Columbia Univ., USA.**  
**Devra L. Davis, PhD , MPA , Founder, Environmental Health Trust, USA.**  
**Om P. Gandhi, Sc.D. , Univ. of Utah, USA.**  
**Michael Kundi, PhD. , Medical Univ. of Vienna, Austria.**  
**Henry Lai, PhD., Univ. of Washington, USA.**  
**Leif Salford, MD, PhD., Lund Univ., Sweden.**  
**Carlos E. C. Abrahão, M.D. , Campinas, SP, Brazil.**  
**Adilza C. Dode, M. Sc., MRE, MG, Brazil.**  
**Claudio R. Fernández, M. Sc., IFSUL, Pelotas, RS, Brazil.**  
**Robson Spinelli Gomes, Dr., MP/RJ, Brazil.**  
**Sergio Koifman, M.D., ENSP/Fiocruz, RJ, Brazil.**  
**Renato R. Lieber, Dr., UNESP, Guaratinguetá, SP, Brazil.**  
**Alvaro A. de Salles, Ph.D., UFRGS, RS, Brazil.**  
**Solange R. Schaffer, M.Sc., Fundacentro, SP, Brazil.**  
**Helio A. da Silva, Dr., UFJF, MG, Brazil.**  
**Francisco de A. Tejo, Dr. , UFCG, Pb, Brazil.**  
**Geila R. Vieira, M.D., CGVS/SMS, P. Alegre, RS, Brazil.**  
**Rodrigo Jaimes Abril, Vice Dean, Electrical Engineer, National University of Colombia, Bogota, Col.**  
**Betânia Bussinger, M.D., Biological Effects of Non Ionizing Radiation, UFF, RJ, Brazil.**  
**Simona Carrubba, PhD, Louisiana State Univ. Health Science Center, Shreveport, La, USA.**  
**Claudio Gómez-Perretta, MD, PhD. Centro Investigación, Hospital Universitario La Fe, Valencia. Spain.**  
**Christos Georgiou, PhD., ICEMS, Prof. Biochemistry, University of Patras, Greece.**  
**Karl Braun-von Gladiß. Dr. med., Arzt für Allgemeinmedizin, Deutsch Evern, Germany.**  
**Yury Grigoriev, Professor, Dr. of Medical Science, Chairman of Russian National Committee on Non-Ionizing Radiation Protection, Moscow (Russian Federation).**  
**Magda Havas, PhD. Prof. Environmental Science, Trent University, Peterborough, Ontario, Canada.**  
**Olle Johansson, Assoc. Prof., The Experimental. Dermatology Unit, Department of Neuroscience, Karolinska Institute; and Professor, The Royal Institute of Technology, Stockholm, Sweden.**  
**Lukas H. Margaritis, Professor of Cell Biology and Radiobiology, Athens University, Greece.**  
**L. Lloyd Morgan, Electronics Engineer (retired), USA.**  
**Wilhelm Mosgoeller, MD, Prof. Medical University of Vienna, Austria.**  
**Jerry L. Phillips, PhD. Prof. Dir. Science Learning Ctr. Univ. Colorado, Colorado Springs, USA.**  
**Nesrin Seyhan, PhD., ICEMS, Prof. Medical Faculty of Gazi University, Chair, Biophysics Dept. Turkey Rep/WHO EMF IAC, Panel member, NATO RTO, HFM, Turkey.**  
**David Servan-Schreiber, MD, PhD. Clinical Professor, Psychiatry, Univ. Pittsburgh USA.**  
**Stanislaw Smigielski, MD, ICEMS, Military Institute of Hygiene & Epidemiology, Poland.**  
**Stelios A Zinelis MD, ICEMS, Hellenic Cancer Society, Cefallonia, Greece.**  
**Jose Maria Tiburcio Barroso, engineer, Niteroi, RJ, Brazil.**  
**Elza Antonia Pereira Cunha Boiteux, Prof. Dra., Faculdade de Direito, Universidade de São Paulo, BR.**

**Sergio A. Pereira De Borja, Prof. Direito Constitucional, PUC/RS e da Instituições de Direito, UFRGS.**

**Elaine S. A. Cabral, M. Sc., Education, Environmental Law; member, Human Rights Commission - of Attorney Association-OAB, J. de Fora, MG, Brazil.**

**Bill Curry, PhD. Physics, ret. Argonne National Labs, Board Member, EMR Network, USA.**

**Adamantia F. Fragopoulou, B.Sc., M.Sc., Ph.D. Candidate, EMF Bioeffects, Athens Univ. Greece.**

**Cristiano M. Gallep, Prof. Dr., DTT, Unicamp, Brazil.**

**Carol C. Georges, PhD. Psychologist, Italy.**

**Andrew Goldsworthy BSc PhD, Lecturer in Biology (retired) Imperial College, London, UK.**

**Laura Elza L. F. Gomes. M.Sc., Prof. da Escola de Arquitetura e Urbanismo da UFF – Universidade - Federal Fluminense.**

**Sue Grey, LLB(Hons), BSc (Microbiology and Biochemistry), RSHDipPHI, New Zealand.**

**João Henrique C. Kanan, PhD, UFRGS, RS, Brazil.**

**Luiz Roberto Santos Moraes, Professor Titular em Saneamento, Universidade Federal da - Bahia, Brazil.**

**Daniel Oberhausen, Prof. Physics (retired), Association PRIARTÉM, France.**

**Fanny Helena Martins Salles, psychologist, public official, Prof. University of Bage, RS, Brazil.**

**Sarah J. Starkey, PhD. Neuroscientist, UK.**

**Alex W. Thomas, Ph.D, CIHR University-Industry, Chair, Bioelectromagnetics, Lawson Health Research - Institute, University of Western Ontario.**

**Casper Wickman, PhD, Chalmers University of Technology, Sweden.**

Porto Alegre Resolution in full, with all signatures:

[http://www.icems.eu/docs/resolutions/Porto\\_Alegre\\_Resolution.pdf](http://www.icems.eu/docs/resolutions/Porto_Alegre_Resolution.pdf)

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Protecting children and learners from maltreatment; preventing impairment of children’s and learners’ health or development; ensuring that children and learners are growing up in circumstances consistent with the provision of safe and effective care; undertaking that role so as to enable those children and learners to have optimum life chances and to enter adulthood successfully.
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Papers finding biological or health effects of Wi-Fi signals or Wi-Fi-enabled technologies can be found here: <http://wifiinschools.org.uk/22.html>

## Appendix 1

### **Statement on Electromagnetic [radio frequency] Radiation [EMR] and Health Risks.**

#### **International Society of Doctors for the Environment [ISDE] and the Irish Doctors Environmental Association [IDEA].**

Both the International Society of Doctors for the Environment [ISDE] and the Irish Doctors Environmental Association [IDEA] have stated, the former by an ad hoc majority opinion of the Directing Board and the latter by unanimous decision of the Executive Committee, that there is sufficient scientific evidence to warrant more stringent controls on the level and distribution of EMR.

The Interphone Study organised by the International Agency for Research on Cancer [IARC] – a \$20 million study in many countries over 5 years, presented partial results in 2011 of their analysis of 6,600 cancer cases in relation to cellphone use. The results were equivocal but IARC has since designated EMR as “possibly carcinogenic to humans” [Group 2B].

ADHD is known to be increasing in prevalence by 3% per year in the USA for which there is no generally accepted explanation. There is evidence from an epidemiological study [Divan, H et al *Epidemiology* 19 523-529] from 2008 indicating an association between maternal cell phone use and the prevalence of behavioural problems in children. This was supported by an experimental study in mice from Yale University which demonstrated neurobehavioural defects which persisted into adulthood and was shown to be due to dose-dependent altered neurodevelopmental programming [Tamir S Aldad et al Mar 2012 [www.nature.com/scientificreports](http://www.nature.com/scientificreports)]

Because of the potentially increased risks for the foetus, infants and young children due to their thinner more permeable skulls and developing systems, particularly the immune and neurological systems, based on the precautionary principal and on the mounting evidence for harm at the sub-cellular level, we recommend that EMR exposure should be kept to a minimum. The basic theory is that the younger they are the more likely they are to be damaged for the above reasons and also they will be exposed for a longer period over their lifetime on average.

The Parliamentary Assembly of the Council of Europe Resolution 1815 in 2011 made numerous specific recommendations relating to EMR, the basic message being to maintain radiation levels ‘as low as reasonably achievable’ [ALARA].

#### **Recommendations**

##### **Personal:**

Avoid totally or minimise to essential usage below the age of 14 years

Use 'hands free' at all ages.

Minimise duration of calls.

Avoid having the phone on standby on your person, particularly adjacent to the gonads [testicles and ovaries] or heart.

Avoid using in a motor car or enclosed space.

Avoid use in pregnancy.

Use phone with the lowest Specific Absorption Ratio [SAR].

**General:**

Avoid living or working within 100m of a base station.

Avoid Wi-Fi in home or work if possible, particularly in schools or hospitals.

If Wi-Fi is present only switch it on when in use.

Measure the radiation levels at sites which are occupied for prolonged periods, particularly by infants or young children.

Base stations should not be located on or near [500m] schools or hospitals.

Use wired technology whenever possible.

Dr P. Michael May 2012

## Appendix 2

### **Children and mobile phones: The Health of the Following Generations is in Danger.**

**Russian National Committee on Non-Ionizing Radiation Protection.**

April 2008

(Page iv)

## CHILDREN AND MOBILE PHONES: THE HEALTH OF THE FOLLOWING GENERATIONS IS IN DANGER

Moscow, Russia

14 April 2008

For the first time in history, we face a situation when most children and teenagers in the world are continuously exposed to the potentially adverse influence of the electromagnetic fields (EMF) from mobile phones.

Electromagnetic field is an important biotropic factor, affecting not just a human health in general, but also the processes of the higher nervous activity, including behavior and thinking. Radiation directly affects human brain when people use mobile phones.

Despite the recommendations, listed in the Sanitary Rules of the Ministry of Health, which insist that persons under 18 years should not use mobile phones (SanPiN 2.1.8/2.2.4.1190-03 point 6.9), children and teenagers became the target group for the marketing the mobile communications.

The current safety standards for exposure to microwaves from the mobile phones have been developed for the adults and don't consider the characteristic features of the children's organism. The WHO considers the protection of the children's health from possible negative influence of the EMF of the mobile phones as a highest priority task. This problem has also been confirmed by the Scientific Committee of the European Commission, by national authorities of the European and Asian countries, by participants of the International scientific conferences on biological effects of the EMF.

### **Potential risk for the children's health is very high:**

- the absorption of the electromagnetic energy in a child's head is considerably higher than that in the head of an adult (children's brain has higher conductivity, smaller size, thin skull bones, smaller distance from the antenna etc.);
- children's organism has more sensitivity to the EMF, than the adult's;
- children's brain has higher sensitivity to the accumulation of the adverse effects under conditions of chronic exposure to the EMF;
- EMF affects the formation of the process of the higher nervous activity;
- today's children will spend essentially longer time using mobile phones, than today's adults will.

According to the opinion of the Russian National Committee on Non-Ionizing Radiation Protection, the following **health hazards** are likely to be faced by the children mobile phone users in the **nearest** future: disruption of memory, decline of attention, diminishing learning and cognitive abilities, increased irritability, sleep problems, increase in sensitivity to the stress, increased epileptic readiness.

**Expected (possible) remote health risks:** brain tumors, tumors of acoustical and vestibular nerves (in the age of 25-30 years), Alzheimer's disease, "got dementia", depressive syndrome, and the other types of degeneration of the nervous structures of the brain (in the age of 50 to 60).

The members of the Russian National Committee on Non-Ionizing Radiation Protection emphasize ultimate urgency to defend children's health from the influence of the EMF of the mobile communication systems. We appeal to the government authorities, to the entire society to pay closest attention to this coming threat and to take adequate measures in order to prevent negative consequences to the future generation's health.

The children using mobile communication are not able to realize that they subject their brain to the EMF radiation and their health – to the risk. We believe that this risk is not much lower than the risk to the children's health from tobacco or alcohol. It is our professional obligation not to let damage the children's health by inactivity.

On behalf of members of Russian National Committee on Non-Ionizing Radiation Protection

Chairman, professor



## Appendix 3

### **Columbia University, College of Physicians and Surgeons**

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May 22, 2009

Ms. Julie Korenstein

Board Member

Los Angeles Unified School District

Board of Education

333 South Beaudry Avenue, 24th Floor

Los Angeles, CA 90017

Re: Health effects of cell tower radiation

Dear Ms. Korenstein,

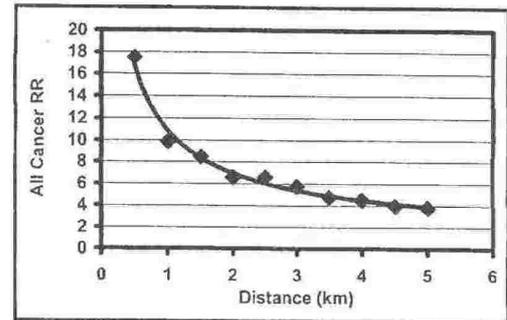
As an active researcher on biological effects of electromagnetic fields (EMF) for over twenty five years at Columbia University, as well as one of the organizers of the 2007 online Bioinitiative Report on the subject, I am writing in support of a limit on the construction of cell towers in the vicinity of schools.

There is now sufficient scientific data about the biological effects of EMF, and in particular about radiofrequency (RF) radiation, to argue for adoption of precautionary measures. We can state unequivocally that EMF can cause single and double strand DNA breakage at exposure levels that are considered safe under the FCC guidelines in the USA. As I shall illustrate below, there are also epidemiology studies that show an increased risk of cancers associated with exposure to RF. Since we know that an accumulation of changes or mutations in DNA is associated with cancer, there is good reason to believe that the elevated rates of cancers among persons living near RF towers are probably linked to DNA damage caused by EMF. Because of the nature of EMF exposure and the length of time it takes for most cancers to develop, one cannot expect 'conclusive proof' such as the link between helicobacter pylori and gastric ulcer. (That link was recently demonstrated by the Australian doctor who proved a link conclusively by swallowing the bacteria and getting the disease.) However, there is enough evidence of a plausible mechanism to link EMF exposure to increased risk of cancer, and therefore of a need to limit exposure, especially of children.

EMF have been shown to cause other potentially harmful biological effects, such as leakage of the blood brain barrier that can lead to damage of neurons in the brain, increased micronuclei (DNA fragments) in human blood lymphocytes, all at EMF exposures well below the limits in the current FCC guidelines. Probably the most convincing evidence of potential harm comes

<http://www.wifiinschools.org.uk/resources/safeschools2012.pdf>

from living cells themselves when they start to manufacture stress proteins upon exposure to EMF. The stress response occurs with a number of potentially harmful environmental factors, such as elevated temperature, changes in pH, toxic metals, etc. This means that ***when stress protein synthesis is stimulated by radiofrequency or power frequency EMF, the body is telling us in its own language that RF exposure is potentially harmful.***



There have been several attempts to measure the health risks associated with exposure to RF, and I can best summarize the findings with a graph from the study by Dr. Neil Cherry of all childhood cancers around the Sutro Tower in San Francisco between the years 1937 and 1988. Similar studies with similar results were done around broadcasting antennas in Sydney, Australia and Rome, Italy, and there are now studies of effects of cellphones on brain cancer. The Sutro tower contains antennas for broadcasting FM (54.7 kW), TV (616 kW) and UHF (18.3 MW) signals over a fairly wide area, and while the fields are not uniform, and also vary during the day, the fields were measured and average values estimated, so that one could associate the cancer risk with the degree of EMF exposure.

The data in the figure are the risk ratios (RR) for a total of 123 cases of childhood cancer from a population of 50,686 children, and include a 51 cases of leukaemia, 35 cases of brain cancer and 37 cases of lymphatic cancer. It is clear from the results that the risk ratio for all childhood cancers is elevated in the area studied, and while the risk falls off with radial distance from the antennas, as expected, it is still above a risk ratio of 5 even at a distance of 3km where the field was  $1\mu\text{W}/\text{cm}^2$ . This figure is what we can expect from prolonged RF exposure. In the Bioinitiative Report, we recommended  $0.1\mu\text{W}/\text{cm}^2$  as a desirable precautionary level based on this and related studies, including recent studies of brain cancer and cellphone exposure.

As I mentioned above, many potentially harmful effects, such as the stress response and DNA strand breaks, occur at nonthermal levels (field strengths that do not cause a temperature increase) and are therefore considered safe. It is obvious that the safety standards must be revised downward to take into account the nonthermal as well as thermal biological responses that occur at much lower intensities. Since we cannot rely on the current standards, it is best to act according to the precautionary principle, the approach advocated by the European Union and the scientists involved in the Bioinitiative report. In light of the current evidence, the precautionary approach appears to be the most reasonable for those who must protect the health and welfare of the public and especially its most vulnerable members, children of school-age.

Sincerely yours,

Martin Blank, Ph.D.

Associate Professor of Physiology and Cellular Biophysics.

<http://www.wifiinschools.org.uk/resources/safeschools2012.pdf>

## Appendix 4

### Comments on use of Wi-Fi & smart/mobile phones in schools

#### A Need for Caution?

The recent classification of RF/microwave radiation as a Class 2B carcinogen by the International Agency for Research on Cancer (IARC) (WHO/IARC 2011), the Council of Europe's recommendation that electromagnetic emissions should be "as low as reasonably achievable" (PACE 2011) and calls - such as that of the Seletun Resolution (Fragopoulou et al. 2010) - to reduce electromagnetic fields (EMF) exposures, indicate it may be wise to reassess current UK policies as related to the use of Wi-Fi and smart/mobile phone use in schools, particularly as low field alternatives are available. UK unions state "Caution should be used to prevent exposure to substances in Group 2B," and that "the aim should be to remove all exposure to any known or suspected carcinogen in the workplace" (TUC 2008).

#### Influence of field regimes on clumping of red blood cells

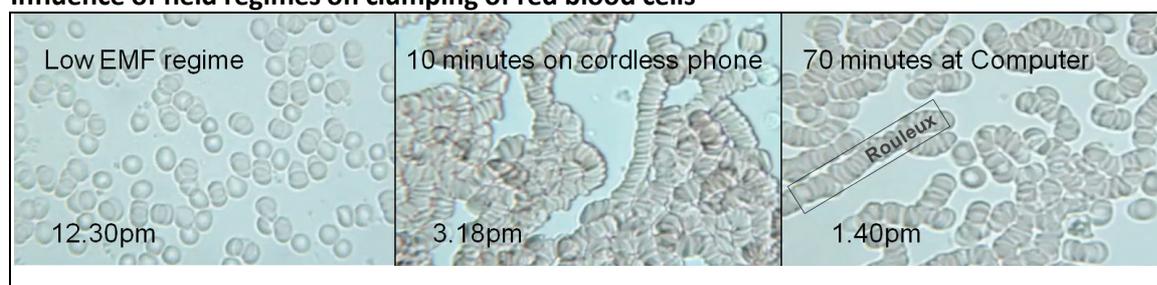
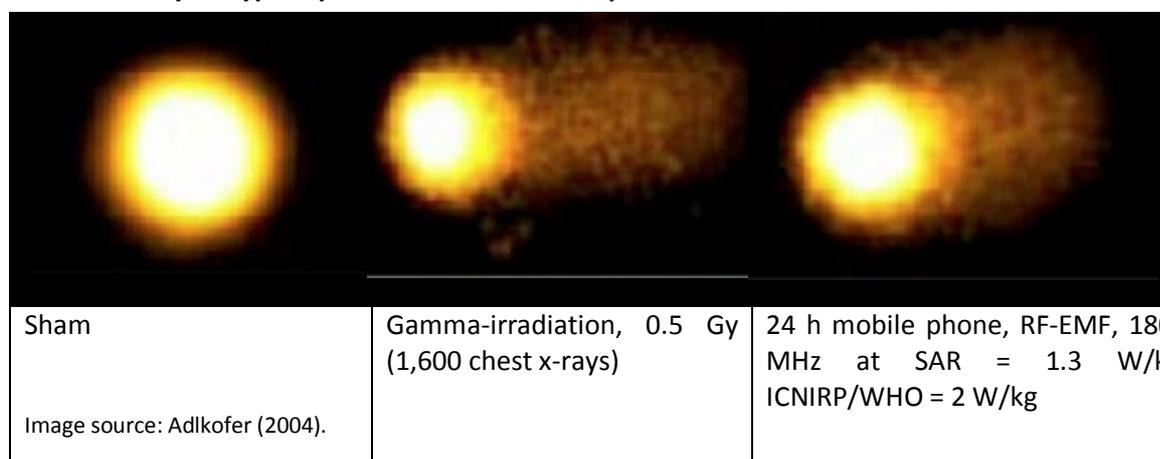


Image source: Havas (2010).

"Wireless communication is now being implemented in our daily life in a very fast way. At the same time, it is becoming more and more obvious that the exposure to electromagnetic fields not only may induce acute thermal effects to living organisms, but also non-thermal effects, the latter often after longer exposures. This has been demonstrated in a very large number of studies and includes cellular DNA-damage, disruptions and alterations of cellular functions like increases in intracellular stimulatory pathways and calcium handling, disruption of tissue structures like the blood-brain barrier, impact on vessel and immune functions, and loss of fertility," Johansson (2011).

#### Comet Assay - a typical picture after RF-EMF-exposition of HL60 leukaemia cells



The photos above show the effects of different types of radiation on gene expression of human HL60 cells. The damage from radiation from the mobile phone [at levels below current ICNIRP/WHO standards [and which the UK's Health Protection Agency (HPA 2012) currently adheres to], are similar to those resulting from the high dosage of gamma radiation (Adlkofer 2004).

It is noted by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) that "... children, the elderly, and some chronically ill people might have a lower tolerance for one or more forms of [non-ionising radiation] exposure than the rest of the population." (ICNIRP 2002).

### Some Within Industry Also Suggest Caution

When wishing to consider whether the use of Wi-Fi and smart/mobile phones in schools (and exposing school occupants to such radiation) is appropriate, it is perhaps worth also considering what is being said within some sectors of the telecommunications industry:

"I want to be very clear. Industry has not said once - once - that ... [RF / microwave radiation is] safe. The federal government and various interagency working groups have said it is safe." K. Dane Snowden, Vice President, External & State Affairs, CTIA-The Wireless Association®\* (Safeschool 2010).

\* CTIA - The Wireless Association®, is the International Association for the Wireless Telecommunications Industry. It is "Dedicated to Expanding the Wireless Frontier".

*"The influence of electrosmog [created by inappropriately design technology – present author's comment] on the human body is a known problem. ... The risk of damage to health through electrosmog has also become better understood as a result of more recent and improved studies. When for example, human blood cells are irradiated with electromagnetic fields, clear damage to hereditary material has been demonstrated and there have been indications of an increased cancer risk. ..."* Swisscom AG - major Swiss telecommunications provider (Swisscom AG 2003).

**Warnings** - Mobile phone manuals too now carry warnings: As an example, one states that studies *"have suggested that low levels of RF could accelerate the development of cancer in laboratory animals. In one study, mice genetically altered to be predisposed to developing one type of cancer developed more than **twice as many cancers** [emphasis by current author] when they were exposed to RF energy compared to controls,"* (Motorola 2011).

Another mobile phone manual gives the following guidance: ***"When using iPhone near your body for voice calls or wireless data transmission over a cellular network, keep iPhone at least 15 mm (5/8 inch away from the body),*** [emphasis by current author] *and only use carrying cases, belt clips, or holders that do not have metal parts and that maintain at least 15 mm (5/8 inch) separation."* (Apple 2010). The text for that warning was originally in grey in 6 font, making it particularly difficult for many people to read:

"When using iPhone near your body for voice calls or wireless data transmission over a cellular network, keep iPhone at least 15 mm (5/8 inch away from the body), and only use carrying cases, belt clips, or holders that do not have metal parts and that maintain at least 15 mm (5/8 inch) separation."

## **Studies on Learning Ability & RF/Microwave Exposure**

### **The hippocampus**

The brain's hippocampus plays a vital role in consolidating information from short-term memory to the long-term memory and in matters related to spatial navigation in both children and adults. Some RF/microwave regimes have been indicated as damaging it and also compromising its development. Animal tests by Salford et al. (2003) reported exposure to 915 MHz RF/microwave regimes from mobile phones for 2 hours produced highly significant ( $p < 0.002$ ) evidence of neuronal damage in the hippocampus and other parts of the brain.

### **Memory function**

Nittby et al. (2008) also investigated the possible effects of exposure to 900 MHz radiation on animals' cognitive functioning; 32 out of 56 rats (the rest being either sham exposed or controls) were exposed for 2 hours every week for 55 weeks to RF/microwave mobile phone radiation. After this protracted exposure, they were compared to sham exposed controls. The RF/microwave exposed animals exhibited impaired memory for objects and temporal order of presentation compared to the sham exposed controls ( $p = 0.02$ ). Their results indicated significantly reduced memory functions occurred after 900 MHz RF/microwave exposures ( $p = 0.02$ ).

Research by Fragopoulou et al. (2009) demonstrated that exposing test-animals for approximately 2 hours per day to 900 MHz RF/microwave radiation from a mobile for four days caused cognitive deficits in spatial learning and memory. In that study, the exposed animals were shown to be less proficient in transferring learned information to the following day, and exhibited deficits in consolidation and/or retrieval of learned information.

Narayanan et al. (2009), undertaking tests on 10-12 week old male rats, found exposing them to the 900/1800 MHz RF/microwave radiation of 50 missed calls a day from a mobile phone daily for 4 weeks induced behavioural changes, though the exact cause of these was undetermined. The animals exposed to RF/microwave radiation took longer to undertake tasks, had poorer spatial navigation and exhibited poorer memory function than those unexposed.

### **2.4 GHz exposures**

Research undertaken by Wang & Lai & (2000) indicated that exposure to some 2.45 GHz RF/microwave regimes may affect memory. In that work, the long-term memory and navigational skills of rats appeared negatively influenced by one hour of exposure to 2.45 GHz radiation (pulse width 2ms, 500 pulses/s, average power density of  $2,000 \mu\text{W}/\text{cm}^2$ ) as compared to the unexposed control group. Whilst some studies by others failed to replicate this work (MMF 2005), the need for caution with regard to introducing exposures RF/microwave regimes is indicated.

A later study by Li et al. (2008), found exposing rats to a 2.45 GHz pulsed RF/microwave field at an average power density of 1,000  $\mu\text{W}/\text{cm}^2$  for 3 hours daily for up to 30 days resulted in significant deficits in spatial learning and memory performance in the exposed animals.

As a precautionary measure to improve health, wellbeing and learning ability in schools, it may prove prudent to introduce low field regimes wherever possible.

As noted by the U.S. President's Cancer Panel in its 2008-2009 report, "*... just as there are many opportunities for harmful environmental exposures, ample opportunities also exist to intervene in, ameliorate, and prevent environmental health hazards. Governments, industry, the academic and medical communities, and individuals all have untapped power to protect the health of current and future generations ... and reduce the national burden of cancer.*" (US DHSS 2010).

One of these international initiatives is the creation of Health Promoting Schools. This is an initiative that the UK can greatly contribute to.

## **Health Promoting Schools (HPS)**

### **Schools, Wellbeing & Achievement**

It is recognised by the UK Secretary of State for Education, the Right Honourable Michael Gove MP, that "*... the five outcomes for Every Child Matters... are: being healthy, staying safe, enjoying and achieving, making a positive contribution and securing economic well-being. As a statement of five things that we'd like for children - ... They are unimpeachable ...*" (Gove & Bell 2010).

This foresight is also shared by the UK's Directgov, "*Everyone in the education system must do what is sensible to keep pupils safe and healthy. This includes making the school environment as safe as possible. ...*" Directgov (2011). It therefore appears prudent, where possible, for the UK to minimise electromagnetic pollution in kindergartens, schools and colleges, and use wired alternatives to standard RF/microwave emitting technologies and other low cost/no cost mitigative measures where feasible.

The creation of environments that actively encourage wellbeing may also help contribute deliverables to Prime Minister David Cameron's groundbreaking National Well-being Debate initiative with parameters that might be easily assessed.

The presence or absence of environmental pollutants, such as electromagnetic pollution, may significantly impact on the learning and wellbeing of some individuals and reductions often be achieved at low or no cost. "*Healthy students learn better. The core business of a school is maximising learning outcomes. Effective Health Promoting Schools (HPS) make a major contribution to schools achieving their educational and social goals.*" IUHPE (2010).

The essential elements required in HPS, as based on the WHO's Ottawa Charter for Health Promotion (WHO 1986), include having 'Healthy school policies' that are clearly defined in documents or accepted best practices which promote health and well-being; and that the school's physical environment (buildings, grounds and equipment) help promote health.

Another of the essential elements required in HPS is that potential environmental contaminants detrimental to health are addressed (IUHPE 2009).

The reduction of such potential stressors as electromagnetic pollution could be brought in through appropriate low cost/no cost 'best practice' legislation to help protect children. As noted by the UK Secretary of State for Education, when talking about child protection, "*It is critically important that we make some big changes early on and then allow change to be driven from within the system rather than from Whitehall.*" (Gove & Bell 2010). Might introducing suitable legislation on electromagnetic hygiene initiatives to create Health Promoting Schools that encourage health, well-being and improved performance for current and future generations be one of the initiatives he champions?

The Parliamentary Assembly of the Council of Europe (PACE) recommends that the member states of the Council of Europe take "*all reasonable measures*" to reduce the exposure of children and young people to manmade electromagnetic fields to those that are 'As Low As Reasonably Achievable' (ALARA) and that preference should be given to adopting wired as opposed to wireless connections to reduce potential exposures (PACE 2011). The question is can the UK take the initiative and lead the way on this issue, or will another country?

*"Systematic assessment of the health impact of a rapidly changing environment – particularly in areas of technology, work, energy production and urbanization - is essential."*  
WHO (1986).

*"Pupil's education, health and wellbeing should be at the centre of any initiatives to introduce new technologies into schools. The technologies need to be adding value and need to be safe."*  
WFIS (2011). It is proposed by the present author that introducing appropriate electromagnetic hygiene measures and legislation for schools could significantly benefit the UK and lead the way to improved scholastic performance, the development of new generations of 'bio-friendly' technology and increased National Well-being.

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Dr Isaac Jamieson is an independent scientist, architect and built environment consultant. He is presently a scientific advisor on stakeholder groups in the EU and UK involved in policy decisions for the creation of healthy environments at national and international level.

**Main source document for present article: Smart Meters - Smarter Practices: Solving emerging problems, A review**

[http://www.radiationresearch.org/index.php?option=com\\_content&view=article&id=173](http://www.radiationresearch.org/index.php?option=com_content&view=article&id=173)

## Appendix 5

### **Governmental Protection Against Radiation is in Conflict With Science**

#### **Professor Dr. Franz Adlkofer, MD.**

There is no technology that made its way as quickly and as extensively into people's daily life like wireless communication. In only 30 years, the number of mobile phone users has world-wide increased from zero to about five billion. While the use of mobile phones is the result of people's free choice, their exposure to W-LAN and other wireless applications is mostly compulsory. Especially concerned are children in schools where this technology has been given preference to wired computers. Since our knowledge on possible adverse effects of radiofrequency electromagnetic fields is still rather poor, it is obvious that at present the biggest biophysical experiment of mankind is under way – with an uncertain outcome.

In May 2011, the uncertainty has been strengthened by the International Agency for Research on Cancer (IARC) that classified radiofrequency electromagnetic fields as 'possibly carcinogenic to humans'. This decision was mainly based on the results of epidemiological studies that observed after long-term (>10 years) and intensive use of mobile phones an increased risk for brain tumours exactly at the side of the head at which the mobile phone was used. The results from animal experiments, although of minor significance, supported the decision. Yet, results from basic research that showed changes in structure and functions of genes in isolated human and animal cells as well as in living animals after exposure and that would have given additional weight to the epidemiological observations were not taken into account. Had they been included in the evaluation, the classification would not have been 'possibly carcinogenic' but rather 'probably carcinogenic'.

The biggest dilemma is caused by the fact that the general public is confronted with two different views, one represented by politics and industry and one by the growing number of independent researchers. Ordinary people have either no idea of the probably adverse effects of radiofrequency radiation or have full confidence in the exposure limits that according to their governments reliably protect from any risk to the health. They do not know that the exposure limits are based on pseudo-science thought to create the necessary legal frame for a telecommunication industry that wants to make use of the new technology without being hampered by medical considerations. For this purpose, the exposure limits were based on physical deliberations solely accepting the existence of biological effects through temperature increase. The occurrence of biological effects far below the exposure limits, meanwhile demonstrated in numerous studies, was totally neglected. The human brain contains hundred billions of living cells, which operate and communicate with each other on the basis of electrochemical mechanisms. That these mechanisms can be deranged quite easily by electromagnetic fields has been shown many times by now. However, it is well known that

findings in conflict with industrial policies require decades of research and discussion until they are finally accepted.

For a medical doctor like me, the conclusion from the present state of knowledge must be that a precautionary approach is overdue and must not be delayed anymore.

As the organizer and coordinator of the EU funded REFLEX study carried out between 2000 and 2004 by 12 research groups from seven European countries, I had to realize that radiofrequency radiation far below the exposure limits owes - opposite to our expectations – a genotoxic potential, thus, contradicting the reliability of the current exposure limits. Our results are in line with those reported in many other scientific papers that in the meantime add up to more than 100. Up to now, all these findings are not considered in the radiation protection policy of most countries all over the world. Based on my experience gathered in more than 20 years of research in the area of electromagnetic fields, I came to the conclusion that institutional corruption is responsible (1) for the still miserable state of knowledge on biological effects of electromagnetic fields, and (2) for the blindness of most governments in regard of the growing set of data that cry out for the acceptance of the precautionary principle. The poor state of knowledge is due to selective funding of research by government and industry and the willingness of hired scientists to adjust their findings to the needs of the awarding authorities, while the governmental blindness is the result of lobbyism in the antechambers of political power ([http://www.pandora-foundation.eu/downloads/harvard\\_23-03-2012\\_en.pdf](http://www.pandora-foundation.eu/downloads/harvard_23-03-2012_en.pdf)). To those who are mostly affected by such an irresponsible attitude belong certainly our children. This is due to a higher susceptibility of juvenile tissue to radiofrequency radiation and – probably more important – to their high life expectancy that gives any tumour enough time to grow.

It remains to be seen how long the truth about the effects of radiofrequency radiation on the health of people can be suppressed by denying the facts. History teaches that early warnings are far too often followed by late insights for which a great number of people may have to pay with disease and premature death.

Good afternoon,  
my name is Stefania Clerici. I am the chair of Health and Safety Committee of the Montgomery County Council of the PTAs.

I am pleased you are addressing the issue of the WiFi in schools and I am planning to attend your next week meeting. We ask that, unless the science is clear about the radiations being harmless, school administrators apply the precautionary principle.

Parents concerned with the potential damages caused by radiations cannot do anything to protect their students. We ask you either to reassure them there you can state that no risk exists, or to avoid an unnecessary exposure.

We plead the conclusion of your work not to be "more research is needed", as children are spending years in schools while further studies are being conducted. We need a clear decision as soon as possible.

Respectfully,

Stefania Clerici  
MCCPTA Health and Safety Committee

From: <[theodorams@aol.com](mailto:theodorams@aol.com)>

Date: Thu, Dec 1, 2016 at 2:24 PM

Subject: Re: CEHPAC Meeting and Report Public Comment Information

To: [rachel.hess-](mailto:rachel.hess-mutinda@maryland.gov)

[mutinda@maryland.gov](mailto:mutinda@maryland.gov), [cliff.mitchell@maryland.gov](mailto:cliff.mitchell@maryland.gov), [veronika.carella@mdcehc.org](mailto:veronika.carella@mdcehc.org)

Thank you Ms. Hess-Mutinda and Dr. Cliff Mitchell,

I am writing out of concern about the fact that presentations to the Council are placed in a prominent place in the Draft report. I do not think either of these Reports by interns should be in the report in a prominent place **as neither of these people are experts and the report was filled with misleading conclusions and inaccuracies.**

This is scientifically unacceptable. Can you please tell me the process to proceed on my concerns.

Having 3 minutes in public comment to speak to the multitude of reasons why these reports are misleading and inaccurate is problematic.

If the Council wants to put forth best available science then they cannot put in those reports. They are not peer reviewed. At best they could go into the documents submitted by the public- if so, they should be followed by any critiques of these presentations so that the public can see the concerns raised.

Please let me know the process.

Thank you ,

Theodora Scarato

Comments on the Maryland Children's Environmental Health and Protection  
Advisory Council Wi-Fi Report

***The Council needs a presentation by an expert in the field of electromagnetic radiation and health to be fully informed on the health issues.***

*The Draft Wi-Fi Report reads: [The first two questions were addressed as part of an MPH Capstone project by Linda Li, a University of Maryland student in the Maryland Institute for Applied Environmental Health \(see Appendix\). Since her report, the National Institutes of Health released an interim report indicating a correlation between high exposure to cell phone radiation and low incidences of tumors in the brains and hearts of male rats, but not in female rats](#)<sup>1</sup> .*

Linda Li does not have expertise in the area of radio frequency radiation and health and her report does not fully address the issue. While I applaud the work she has compiled it is missing critical information on children and electromagnetic radiation. The most important omission is the fact that children are exposed to various radiofrequency signals in a classroom all at the same time. To simply look at just Wi-Fi frequencies misses the total exposure. In addition one cannot just look at Wi-Fi research to understand the links to health. The World Health

Organization International Agency for the Research on Cancer specifically refers to Wi-Fi in its classification and WHO/IARC scientists state that Wi-Fi is "the same agent" as other RF.

The Council needs to be informed of the following information.

*Li's Report states that "The SAR is a value that corresponds to the rate at which RF energy is absorbed by body tissue. This limit, set in 1996, is 1.6 watts per kilogram (W/kg), averaged over one gram of tissue (Federal Communication Commission, 1997)."*

This is incomplete. In fact, the FCC SAR limit is 1.6 W/kg *for the head*. It is in fact- 4 W/kg for *other body parts* including the ear and extremities (ear was labeled in 2013 as a pinna). This is very important because the NTP Study used SAR RF exposures at 0, 1.5, 3, and 6 W/kg GSM or CDMA RFR.

*Li's report states: "The report on exposures and health effects from Linda Li shows that the research is still inconclusive."*

This is not accurate. The WHO/IARC has classified RF as a Class 2 B possible Carcinogen and the classification includes wireless radiation as stated repeatedly by WHO IARC scientists. **This information is missing from the report.** The World Health Organization/IARC specifically and repeatedly has stated the carcinogenic classification is for radiofrequency radiation from any source, including WiFi. Note this documentation:

- The Lancet WHO/IARC published statement: Wireless radiofrequency radiation is classified as a "Possible Human Carcinogen" by the International Agency for Research on Cancer (IARC) of the World Health Organization(WHO) [Read The Lancet's published statement by the IARC from 2011 on cancer risk of wireless radiation.](#)
- WHO/IARC Press Release: The Class 2B classification includes wireless radiation from any transmitting source such as "cell phones, baby monitors, tablets, cell towers, radar, other wifi, etc". It applies to RF-EMF in the range of 30 KHz to 300 GHz emitted from any device. These statements are detailed in [The Lancet article](#) and in the related WHO IARC [press release in 2011](#). All wireless emissions from electronic devices are RF-EMF (wireless radiation). It does not matter what type of device is the source.
- [The 2013 WHO/IARC Monograph: Non-Ionizing Radiation, Part 2: Radiofrequency Electromagnetic Fields](#), which states, "Human exposure to RF radiation can occur from many different sources and under a wide variety of circumstances, including the use of personal devices (mobile phones, cordless phones, Wi-Fi, Bluetooth, amateur radios, etc.), occupational sources (high-frequency dielectric and induction heaters, broadcast antennas, high-power pulsed radars, and medical applications), and environmental sources (mobile-phone base stations, broadcast antennae). These multiple sources contribute to an individual's total exposure, with contributions varying by different characteristics, e.g. place of residence."

According to the NIEHS here is the summary of the recent NTP Study:

- Body weights at birth and throughout lactation in rat pups exposed in utero tended to be lower than controls

- In general, survival was greater in all groups of GSM or CDMA RFR-exposed rats compared to controls
- Increased incidence of schwannoma was observed in the hearts of male rats at 6 W/kg – Significant SAR-dependent positive trend (GSM and CDMA) – Significant pair-wise increase at 6 W/kg (CDMA)
- There was a significant SAR-dependent trend for increased gliomas in the brain of rats exposed to CDMA-modulated RFR
- No exposure-related effects were observed in the brains or hearts of female rats
- The hyperplastic lesions and glial cell neoplasms of the heart and brain observed in male rats are considered likely the result of whole-body exposures to GSM- or CDMA-modulated RFR. – There is higher confidence in the association between RFR exposure and the neoplastic lesions in the heart than in the brain.

In addition DNA damage was found in the brains of exposed animals.

“The NTP results provide “strong evidence for the genotoxicity of cell phone radiation,” [Ron Melnick told Microwave News](#). Melnick led the team that designed the NTP study; he is now retired. This “should put to rest the old argument that RF radiation cannot cause DNA damage.”



## Comet assay summary for rats and mice

		MALE					FEMALE				
RATS	CDMA	Frontal Cortex	Cerebellum	Hippocamp	Liver	Blood	Frontal Cortex	Cerebellum	Hippocamp	Liver	Blood
	GSM	Frontal Cortex	Cerebellum	Hippocamp	Liver	Blood	Frontal Cortex	Cerebellum	Hippocamp	Liver	Blood
MICE	CDMA	Frontal Cortex	Cerebellum	Hippocamp	Liver	Blood	Frontal Cortex	Cerebellum	Hippocamp	Liver	Blood
	GSM	Frontal Cortex	Cerebellum	Hippocamp	Liver	Blood	Frontal Cortex	Cerebellum	Hippocamp	Liver	Blood

**Yellow** Statistically significant trend and pairwise SAR-dependent increase

**Blue** Statistically significant trend or a pairwise increase

**Green** Not significantly different, but increased in 2 or more treatment groups

This is pulled from the slides presented to the NIEHS on June 15. [See the video presentation by lead NTP RF Study researcher here.](#)

Here is the link to the slides from this lecture.

[http://ntp.niehs.nih.gov/ntp/about\\_ntp/bsc/2016/june/presentations/cellphone\\_508.pdf](http://ntp.niehs.nih.gov/ntp/about_ntp/bsc/2016/june/presentations/cellphone_508.pdf)

**Li's Report fails to note the funding source of the studies.** Funding and sponsorship are shown to influence research outcomes.

**Li's Report also does not explore these other issues**

1. Childrens unique vulnerability to RF due to their developing brains and bodies.
2. Childrens unique physiology whereby they absorb the radiation more deeply into their bodies.
3. Children's cumulative exposure in school includes *all the sources of RF energy in the classroom* which includes cell phones, fitbit, apple watches, virtual reality, cell towers on school grounds and all other wireless devices in use.

Due to time constraints I am unable to do a full response to Linda Li's Report but ask that the Council take the time to watch these two videos to understand the health issues for children posed by wireless radiation.



# UPPER STURT PRIMARY SCHOOL POLICIES

## WiFi and Wireless Devices

### Purpose

Upper Sturt Primary School is committed to providing a safe and healthy learning environment for our children. Unprecedented long term exposure to wireless computer networks (WiFi) and wireless communication devices in school may present a potential health and safety risk or hazard for children and staff.

WiFi and wireless communication devices such as mobile phones and tablets use microwave radiofrequency. The World Health Organisation's International Agency for Research on Cancer (IARC) classified microwave radiofrequency electromagnetic fields as Group 2B '**possibly carcinogenic to humans**' (May 2011).

The Australian Radiation Protection and Nuclear Safety Agency's (ARPANSA) Fact Sheet 14 *How to reduce exposure from mobile phones and other wireless devices* recommends **reducing unnecessary exposure** to radiofrequency emissions from mobile and cordless phones, other wireless devices and wireless computer networks (WiFi).

As a precautionary approach, Upper Sturt Primary School uses wired computers to safely access the internet. Wired smart boards and telephones have also been installed for educational and administrative purposes.

### ***The Precautionary Principle***

*"When an activity raises threats of harm to the environment or human health, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically."*

[http://www.sehn.org/Volume\\_3-1.html](http://www.sehn.org/Volume_3-1.html)

**Operations:** To reduce exposure to unnecessary microwave radiofrequency emissions.

### **Roles and Responsibilities:**

<b>Leaders</b>	<b>Teachers &amp; SSO</b>	<b>Students</b>	<b>Parents</b>
<ul style="list-style-type: none"> <li>inform staff, parents and students of WiFi and Wireless Devices Policy</li> <li>provide access to wired computers and telephones (no cordless DECT phones)</li> <li>ensure new buildings (if internet access required) include a fully wired ethernet infrastructure</li> <li>use powerline ethernet adaptors which use existing electrical wiring to extend a network</li> <li>recommend mobile phones be switched to flight/airplane mode when not in use and ipods and tablets be used in flight/airplane mode</li> <li>restrict use of microwave oven around children</li> </ul>	<ul style="list-style-type: none"> <li>limit use of mobile phone on school grounds and use landline where possible</li> <li>turn off mobile phone or switch to flight/airplane mode when not in use</li> <li>keep connected phone away from children</li> <li>wireless devices (tablets/ipods) used for teaching must be in flight/airplane mode</li> <li>avoid use of microwave oven when children are present</li> </ul>	<ul style="list-style-type: none"> <li>turn off mobile phone or switch to flight/airplane mode when not in use</li> <li>wireless devices (tablets/ipods) used for learning purposes must be in flight/airplane mode.</li> </ul>	<ul style="list-style-type: none"> <li>limit use of mobile phone and wireless devices on school grounds</li> <li>turn off mobile phone or switch to flight/airplane mode if spending extended time at school with children eg hearing children read</li> </ul>





COLLABORATIVE FOR  
HIGH PERFORMANCE  
SCHOOLS.



2014 US-CHPS

# Criteria

New Construction  
and Renovation

# Low-EMF Best Practices

## Intent

*Minimize exposure to extremely low frequency (ELF) magnetic fields.*

### EQ 15.1 – Low-EMF Wiring

### EQ 15.2 – Low-EMF Best Practices

Numerous organizations recommend minimizing exposure to extremely-low frequency (ELF) electric and magnetic fields (EMF).

The US National Electrical Code (NEC) has been published since 1897 to promote safe electrical installations and to prevent fire hazards and electric shock. Wiring errors not only violate electrical code rules but may also cause unnecessary ELF magnetic field exposures. Wiring errors may occur in new construction or modernization projects, and inspections conducted by local code enforcement authorities may not detect the great majority of these problems.

In 2000, the expert panel of the [California EMF Project](#) (scientists of the California Department of Health Services on behalf of the

California Public Utilities Commission) concluded based on the then-available scientific evidence that “EMFs can cause some degree of increased risk of childhood leukemia, adult brain cancer, Lou Gehrig’s Disease, and miscarriage.”

In 2002, the International Agency for Research on Cancer classified **extremely low frequency magnetic fields** (ELF MF) as possibly carcinogenic ([monograph volume 80](#)).

In 2006, the [IEQ Indoor Environmental Quality Project](#) committee of the **US National Institute of Building Sciences** recommended to keep [magnetic field exposure levels](#) in occupied areas below 2.5 mG (250 nT), and preferably below 1 mG (100 nT).

In 2009, the **Austrian Sustainability Building Council** with support by the Federal Ministry of Transportation, Innovation and Technology released its latest version of the [Total Quality Building Assessment](#) tool. This green building rating system includes a criterion for low ELF magnetic field exposure levels: less than 1 mG (100 nT) “excellent”, 1-2 mG (100-200 nT) “very good” (summary of threshold levels in [English](#)).

In addition, many education technology tools such as desktop computers, laptops, tablets, and other electronic devices are sources of electromagnetic fields. When used within close range of the human body, a student’s exposure to electromagnetic fields such as ELF magnetic and electric as well as radio-frequency electromagnetic fields may increase considerably. ELF magnetic fields were classified as possibly carcinogenic by the World Health Organization (WHO) International Agency for Research on Cancer (IARC) in 2002, and radio-frequency (RF) electromagnetic fields (including mobile phones) were classified as possibly carcinogenic by the WHO/IARC in 2011. In order to reduce the potential for adverse effects due to these exposures, it is important in school environments with children to apply the precautionary principle “as low as reasonably achievable (ALARA)” by providing low-EMF classrooms, specifying low-EMF IT equipment and wired Internet access network technology, and establishing low-EMF user practices.

EQ 15.1 – Low-EMF Wiring		Credit	
		2 points	
Applicability	Verification		
All projects.	Design Review	Construction Review	Performance Review



## Requirement

2 points	EQ 15.1	<p><i>No net current magnetic fields – Correct school wiring</i></p> <p>The wiring in all school rooms shall be compliant with the currently adopted US National Electrical Code (NEC) in the local jurisdiction, and applicable state electrical code.</p> <p>All school rooms shall be free of the following common wiring errors:</p> <ol style="list-style-type: none"> <li>Improperly wired subpanels (neutral-to-ground bond);</li> <li>Incorrect three-way switch wiring;</li> <li>Incorrect wiring of switched outlet circuits;</li> <li>Neutrals from separate branch circuits that are connected anywhere beyond the panel of origin for the circuits;</li> <li>Neutral-ground shorts (intentional or inadvertent) anywhere in the system.</li> </ol> <p>The correctness of the wiring shall be checked in each room and the ELF magnetic field exposure measured levels (tRMS) comply with 1 mG (100 nT) in new construction and 2 mG (200 nT) in existing school modernizations, see the Austrian Sustainability Building Council (2009) – Total Quality Building Assessment Rating System as shown in Table 13 below.</p>
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EQ 15.2 – Low-EMF Best Practices		Credit	
		1 - 2 points	
Applicability	Verification		
All projects.	Design Review	Construction Review	Performance Review

## Requirement

1 point	EQ 15.2.1	<p><i>Low EMF Best Practices for Computers</i></p> <p>The District or equivalent governing body for a private school shall pass a resolution requiring:</p> <ul style="list-style-type: none"> <li>Desktop computers, laptops, notebooks, and tablets be operated on a desk; operation of these devices on an occupant's lap or body is prohibited; computer workstation equipment must be greater than 2 feet from occupants.</li> <li>Desktop computers, laptops, notebooks, and tablets be TCO-certified or laboratory tested to meet TCO Criteria "Mandate A.4.2" for EMF emissions.</li> <li>Laptops or notebooks have an Ethernet port and a physical switch to conveniently disable all wireless radios at once and an adaptor with a 3-pin plug.</li> <li>Only tablets that support a USB Ethernet adaptor for a wired network connection; operate tablets only in battery mode and not when plugged in.</li> </ul>
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<b>OR</b> 1 point	EQ 15.2.2	<p><i>Wired local area network (LAN) to reduce radio-frequency (RF) EMF</i></p> <ul style="list-style-type: none"> <li>Install a wired local area network (LAN) for Internet access throughout the school. Provide wired network connections for desktop computers, laptops, notebooks, and tablets. All wireless transmitters shall be disabled on all Wi-Fi-enabled devices. Provide wired input devices for computer workstations.</li> </ul>
<b>OR</b> 1 point	EQ 15.2.3	<p><i>Wired Phones to reduce RF EMF in classroom</i></p> <ul style="list-style-type: none"> <li>Install easily accessible hard-wired phones for teacher and student use and prohibit installation and use of standard DECT cordless phones and cordless phones operating at 2.4 GHz and 5.8 GHz unless they have been laboratory tested to demonstrate that the cordless phone base station and handsets (whether placed in the charging station or not) do not emit RF EMF emissions in standby mode.</li> <li>Prohibit the use of cell phones and other personal electronic devices in instructional areas / classrooms. Additionally, they shall be required to be powered off or be in airplane mode (sleep mode is not sufficient) except during fire-life-safety drills and incidents.</li> </ul>

## Implementation

### EQ 15.1

ELF levels shall be measured using a professional 3-axis gaussmeter. The international standard unit for ELF magnetic fields is microtesla ( $\mu\text{T}$ ) or nanotesla (nT). A nanotesla is 1/1000th of a microtesla. 1 mG is equivalent to 100 nT.

#### *Special Consideration*

The World Health Organization International Agency for Research on Cancer has classified ELF magnetic fields and radio-frequency (RF) electromagnetic fields as possibly carcinogenic based on scientific evidence surrounding incidence of childhood leukemia and brain cancer. Schools districts and design teams should:

1. Prohibit cell phone towers and base stations on school buildings or school property. (See siting)
2. Prohibit above ground transformers within 50ft from outdoor play, exercise and recreation areas. (See siting)
3. Run conduits for the future possibility of fiber optic connections.
4. Position electrical supply rooms and building power supply adjacent to low occupancy areas, among other strategies.

If using a wireless local area network (WLAN) for Internet access, choose the minimum number of access points and adjust the power output of the access points to the lowest maximum level required to meet the needs. Access points shall be placed a minimum distance of 16-32 feet (5-10 m) from where students and staff spend the majority of their time. The access points and Wi-Fi transmitters in the computer devices shall be turned off when not in use. Clearly label access points with warning signs.

Provide a Wireless-free Zone where cell phones, cordless phones, and Wi-Fi-enabled electronic devices shall not be used. Post clear signage at the door to instruct users on how to disable the wireless transmitters on their personal electronic devices (power off or airplane mode) before entering this space.



### *EMF Measurement Information*

ELF EMF measurements are made with a professional 3-axis gaussmeter (broadband, minimum sensitivity: 0.2 mG (20 nT)). The ELF magnetic field exposure level at a given student seating area or workstation shall be as low as possible or less than 1 mG (100 nT) (tRMS – true root mean square). See Table 13. Measurements shall be taken on the floor in the foot area and across a vertical plane at half way between floor and edge of desk, at the edge of desk, and at 6 feet (180 cm). Retest ELF magnetic field exposure levels if the placement of workstations is changed or changes are made to the electrical installation.

RF EMF measurements are made with a professional RF meter or spectrum analyzer (minimum sensitivity: 0.02 V/m or -50 dBm; minimum frequency range 10 MHz – 3 GHz (preferably higher)). The radio-frequency electromagnetic field exposure level at a given student seating area or workstation shall be as low as possible or less than 0.2 V/m or 100  $\mu\text{W}/\text{m}^2$  (peak). Measurements shall be taken on the floor in the foot area and across a vertical plane halfway between the floor and the edge of the desk, at the edge of the desk, and at 6 feet (180 cm). Retest RF electromagnetic field exposure levels if IT equipment, electronic devices, or networks with wireless connectivity are installed or added.



**Table 13: ELF EMF Exposure Guidelines and Reference Levels**

EMF Emission Standard or Guideline	Performance Measure	Reference Level Band I ELF 5 Hz-2 kHz Magnetic field
CA EMF Project Survey of 89 schools- 5,403 school rooms	20% of measured areas had average magnetic fields	>1 mG (100 nT)
EMF Working Group of the Austrian Medical Association – Exposure greater than 4 hours per day	Within normal limits	≤0.2 mG (20nT)
	Slightly above normal limits	0.2-1 mG (20-100 nT)
	Above normal limits	1-4 mG
	Far above normal limits	≥4 mG
Austrian Sustainability Building Council (2009) – Total Quality Building Assessment Rating System	Excellent	≤1 mG (100 nT)
	Very good	1-2 mG
	Good	2-4 mG
	Satisfactory	≥4 mG
IEQ Project Committee Recommendation of the U.S. National Institute of Building Sciences (2006)	Preferably	<1 mG (100 nT)
	All occupied areas	<2.5 mG (250 nT)
TCO Criteria “Mandate A.4.2”: – International sustainability standard for IT equipment (since 1992)	At 12-20” distance from equipment	≤2 mG (200 nT)
Federal Safety Guideline of Russia for Computer Workstations, including schools (2003)	At 20” distance from equipment	≤2.5 mG (250 nT)
International Agency for the Research on Cancer/WHO (2002)	Possibly carcinogenic Group 2B	>3-4 mG (300-400 nT) Increased childhood leukemia risk

Austrian Sustainability Building Council (2009) – Total Quality Building Assessment Rating System

15.2.1

No net current magnetic fields – Correct school wiring

The Project Team shall provide a letter stating the following:

1. Wiring in all school rooms is compliant with the currently adopted US National Electrical Code (NEC) in the local jurisdiction, and applicable state electrical code.
2. All school rooms are free of the following common wiring errors:



- a. Improperly wired subpanels (neutral-to-ground bond);
- b. Incorrect three-way switch wiring;
- c. Incorrect wiring of switched outlet circuits;
- d. Neutrals from separate branch circuits that are connected anywhere beyond the panel of origin for the circuits;
- e. Neutral-ground shorts (intentional or inadvertent) anywhere in the system.

The correctness of the wiring has been checked in each room and the ELF magnetic field exposure measured levels (tRMS) comply with 1 mG (100 nT) in new construction and 2 mG (200 nT) in existing school modernizations; see the Austrian Sustainability Building Council (2009) – Total Quality Building Assessment Rating System as shown in Table 13 above.

### 15.2.2

Submit wiring diagrams indicating LAN wiring to all rooms with computers.

### 15.2.3

Submit wiring diagrams indicating phone wiring to all rooms with telephones. Also submit a district resolution indicating compliance with other required measures.

*Note:* This may be in conflict with emergency communications in classrooms unless there are landline phones, or with the use of portable handheld devices required for standardized testing.

## Documentation Requirements

### *Design Review*

EQ 15.1 Reference specifications requiring compliance with the necessary codes including testing of rooms for compliance.

EQ 15.2.1 The Project Team shall provide a letter stating the following:

1. Wiring in all school rooms is compliant with the currently adopted US National Electrical Code (NEC) in the local jurisdiction, and applicable state electrical code.
2. All school rooms are free of common wiring errors.

EQ 15.2.2 Submit wiring diagrams indicating LAN wiring to all rooms with computers.

EQ 15.2.3 - Submit wiring diagrams indicating phone wiring to all rooms with telephones. Also submit a district resolution indicating compliance with other required measures.

### *Construction Review*

EQ 15.1 Measurement Report from a third party or testing lab documenting compliance of each classroom.

EQ 15.2.1: Provide a report from a third party or testing lab documenting that the correctness of the wiring has been checked in each room and the ELF magnetic field exposure measured levels (tRMS) comply with 1 mG (100 nT) in new construction and 2 mG (200 nT) in existing school modernizations.

## Resources

- National Electrical Code NFPA 70: [www.nfpa.org/aboutthecodes/AboutTheCodes.asp?DocNum=70](http://www.nfpa.org/aboutthecodes/AboutTheCodes.asp?DocNum=70)



- Suggested Protocol for School Electricians for Correcting Wiring Errors Causing Net Current Magnetic Fields [www.ehib.org/emf/WiringProtocol.pdf](http://www.ehib.org/emf/WiringProtocol.pdf)
  - Tracing EMFs in Building Wiring and Grounding. (book),Karl Riley (2005): [www.magneticsciences.com/TracingEMFsBook.html](http://www.magneticsciences.com/TracingEMFsBook.html)
  - Tracing Magnetic Fields in Building Wiring. (DVD) [www.magneticsciences.com/TracingEMFsVideo.html](http://www.magneticsciences.com/TracingEMFsVideo.html)
  - California EMF Project- School Related Documents, [www.ehib.org/emf/general.html#school](http://www.ehib.org/emf/general.html#school) School Design Guidelines <http://www.ehib.org/emf/cklist.html>
  - ELECTRIC AND MAGNETIC FIELD EXPOSURE ASSESSMENT OF POWERLINE AND NON-POWERLINE SOURCES FOR CALIFORNIA PUBLIC SCHOOL ENVIRONMENTS, Luciano E. Zaffanelia, H. Christopher Hooper, Prepared for the Public Health Institute, California Department of Health Services EMF Program, , January 31,2000, [www.ehib.org/emf/school\\_exp\\_ass\\_exec.pdf](http://www.ehib.org/emf/school_exp_ass_exec.pdf)
  - EU Directive 90/270/EEC (1990 May 29) on the minimum safety and health requirements for work with display screen equipment: [eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31990L0270:EN:HTML](http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31990L0270:EN:HTML)
  - Ministry of Health of the Russian Federation. 2003 Jun 30. [Sanitary and epidemiological norms on hygienic requirements for personal computers and work organization]. Norm No.: SanPiN 2.2.2./2.4.1340-03. (in Russian)
  - Katharina Gustavs (2008): Options to Minimize Non-Ionizing Electromagnetic Radiation Exposures (EMF/RF/Static Fields) in Office Environments: [buildingbiology.ca/wd/wp-content/uploads/2012/09/2008\\_Low\\_EMR\\_Office\\_Environment.pdf](http://buildingbiology.ca/wd/wp-content/uploads/2012/09/2008_Low_EMR_Office_Environment.pdf)
  - TCO standards for IT equipment: [www.tcodevelopment.com](http://www.tcodevelopment.com)
  - Product search data base: [http://79.136.114.89/pls/nvp/!tco\\_search](http://79.136.114.89/pls/nvp/!tco_search)
  - Displays: [tcodevelopment.com/manufacture-resources/product-categories-2/displays/](http://tcodevelopment.com/manufacture-resources/product-categories-2/displays/)
  - Notebooks: [tcodevelopment.com/manufacture-resources/product-categories-2/notebooks/](http://tcodevelopment.com/manufacture-resources/product-categories-2/notebooks/)
  - Desktops: [www.ultrasone.com/index.php/en/company/technology/ule-technology.html](http://www.ultrasone.com/index.php/en/company/technology/ule-technology.html)
  - All-in-on PCs: [tcodevelopment.com/manufacture-resources/product-categories-2/all-in-one-pcs/](http://tcodevelopment.com/manufacture-resources/product-categories-2/all-in-one-pcs/)
  - Projectors: [tcodevelopment.com/manufacture-resources/product-categories-2/projectors/](http://tcodevelopment.com/manufacture-resources/product-categories-2/projectors/)
  - Headsets: [tcodevelopment.com/manufacture-resources/product-categories-2/headsets/](http://tcodevelopment.com/manufacture-resources/product-categories-2/headsets/)
  - Desktops: [www.ultrasone.com/index.php/en/company/technology/ule-technology.html](http://www.ultrasone.com/index.php/en/company/technology/ule-technology.html)
  - All-in-on PCs: [tcodevelopment.com/manufacture-resources/product-categories-2/all-in-one-pcs/](http://tcodevelopment.com/manufacture-resources/product-categories-2/all-in-one-pcs/)
  - Projectors: [tcodevelopment.com/manufacture-resources/product-categories-2/projectors/](http://tcodevelopment.com/manufacture-resources/product-categories-2/projectors/)
  - Headsets: [tcodevelopment.com/manufacture-resources/product-categories-2/headsets/](http://tcodevelopment.com/manufacture-resources/product-categories-2/headsets/)
  - Austrian Sustainability Building Council with support by the Federal Ministry of Transportation, Innovation and Technology: Total Quality Building Assessment tool [www.oegnb.net/de/zertifikat.htm?typ=wb](http://www.oegnb.net/de/zertifikat.htm?typ=wb)
- Threshold levels for ELF-modulated RF radiation: <10  $\mu\text{W}/\text{m}^2$  excellent / 10-100  $\mu\text{W}/\text{m}^2$  very good / 100-1000  $\mu\text{W}/\text{m}^2$  good / 1000-3000  $\mu\text{W}/\text{m}^2$  satisfactory
- EMF Working Group of the Austrian Medical Association (2012): EMF Guideline of the Austrian Medical Association for the diagnosis and treatment of EMF-related health problems and illnesses. [freiburger-appell-2012.info/media/EMF%20Guideline%20OAK-AG%20%202012%2003%2003.pdf](http://freiburger-appell-2012.info/media/EMF%20Guideline%20OAK-AG%20%202012%2003%2003.pdf) Benchmarks apply to regular exposure of more than four hours per day: <1  $\mu\text{W}/\text{m}^2$  within normal limits / 1-10  $\mu\text{W}/\text{m}^2$  slightly above normal limits / 10-1000  $\mu\text{W}/\text{m}^2$  far above normal limits / >1000  $\mu\text{W}/\text{m}^2$  very far above normal limits





## 10 MEDICAL RULES FOR A SAFER USE OF MOBILE PHONES!

The radiation from mobile phones or smartphones is most likely not as safe as cell phone providers claim it to be. Therefore, the Ärztekammer Wien (Vienna Medical Association) has decided to do the responsible thing and inform the Austrian public about possible adverse effects from a medical perspective.

- **In general, keep calls short and as few as possible.** Use a landline or write an SMS. Children and teenagers under the age of 16 should carry mobile phones for emergencies only!
- **“Distance is your friend.”** Keep the phone away from your body and head during dialing and maintain at least the minimum distance recommended in the user guide. Take advantage of the built-in speakerphone or use a headset!
- **Do not keep the phone directly on your body when using a headset or the built-in speakerphone.** Pregnant women should be especially cautious. In men, mobile phones are a risk to their fertility when carried in the pant pocket. Persons with electronic implants (pacemaker, insulin pump, etc.) must pay particular attention to distance. If no other option is available, use the outer coat pocket, a backpack or a purse/handbag to carry the phone!
- **Do not use in vehicles (car, bus, train).** Without an external antenna, the radiation inside the vehicle is higher. In addition, the user is distracted and becomes a nuisance to others on public transport! No texting while driving – ever! The distraction causes you to become a danger to yourself and a danger to other road users!
- **Make phone calls at home and at work via a hardwired network.** Internet access via a hardwired connection such as LAN (e.g. via ADSL, VDSL, fiber optics) does not emit radiation: it is fast and secure. Constantly radiating DECT cordless phones, Wi-Fi access points, data sticks and LTE modems should be avoided!
- **Work offline more often or put your phone in airplane mode.** For functions such as listening to music, camera, alarm clock, calculator or offline games, you do not always need an Internet connection!
- **Fewer apps means less radiation.** Minimize the number of apps and disable the most unnecessary background services on your smartphone. Disabling “mobile services”/“data network mode” turns the smartphone into a conventional mobile phone. You can still be reached, but you avoid a lot of unnecessary radiation from background data traffic!
- **Avoid making calls in places with poor reception (basement, elevator and the like).** In such instances, a mobile phone increases its transmission power. When there is poor reception, use a headset or the speakerphone instead!
- **Buy mobile phones with a very low SAR value and an external antenna connector, if possible!**



**NOTE!  
MOBILE PHONES HAVE NO  
PLACE IN WAITING ROOMS.  
THEY EMIT RADIATION AND  
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## 10 MEDICAL RULES FOR A SAFER USE OF MOBILE PHONES

The radiation from mobile phones or smartphones is most likely not as safe as cell phone providers claim it to be.

Therefore, the Ärztekammer Wien (Vienna Medical Association) has decided to do the responsible thing and inform the Austrian public about possible adverse effects from a medical perspective.

- **In general, keep calls short and as few as possible.** Use a landline or write an SMS. Children and teenagers under the age of 16 should carry mobile phones for emergencies only!
- **“Distance is your friend.”** Keep the phone away from your body and head during dialing and maintain at least the minimum distance recommended in the user guide. Take advantage of the built-in speakerphone or use a headset!
- **Do not keep the phone directly on your body when using a headset or the built-in speakerphone.** Pregnant women should be especially cautious. In men, mobile phones are a risk to their fertility when carried in the pant pocket. Persons with electronic implants (pacemaker, insulin pump, etc.) must pay particular attention to distance. If no other option is available, use the outer coat pocket, a backpack or a purse/handbag to carry the phone!
- **Do not use in vehicles (car, bus, train).** Without an external antenna, the radiation inside the vehicle is higher. In addition, the user is distracted and becomes a nuisance to others on public transport! No texting while driving – ever! The distraction causes you to become a danger to yourself and a danger to other road users!
- **Make phone calls at home and at work via a hardwired network.** Internet access via a hardwired connection such as LAN (e.g. via ADSL, VDSL, fiber optics) does not emit radiation: it is fast and secure. Constantly radiating DECT cordless phones, Wi-Fi access points, data sticks and LTE modems should be avoided!
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# Studies that show **WiFi** and Devices Health Effects

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### Effects On Brain and Neurons

**Lai, H, Carino, MA, Singh, NP, Naltrexone blocks RFR-induced DNA double strand breaks in rat brain cells. *Wireless Networks* 3:471-476, 1997.**

Previous research in our laboratory has shown that various effects of radiofrequency electromagnetic radiation (RFR) exposure on the nervous system are mediated by endogenous opioids in the brain. We have also found that acute exposure to RFR induced DNA strand breaks in brain cells of the rat. The present experiment was carried out to investigate whether endogenous opioids are also involved in RFR-induced DNA strand breaks. Rats were treated with the opioid antagonist naltrexone (1 mg/kg, IP) immediately before and after exposure to **2450-MHz pulsed** (2 ms pulses, 500 pps) RFR at a power density of 2 mW/cm<sup>2</sup> (average whole body specific absorption rate of 1.2 W/kg) for 2 hours. DNA double strand breaks were assayed in brain cells at 4 hours after exposure using a microgel electrophoresis assay. Results showed that the RFR exposure significantly increased DNA double strand breaks in brain cells of the rat, and the effect was partially blocked by treatment with naltrexone. Thus, these data indicate that endogenous opioids play a mediating role in RFR-induced DNA strand breaks in brain cells of the rat.

**Kesari KK, Behari J, Kumar S. Mutagenic response of 2.45 GHz radiation exposure on rat brain. *Int J Radiat Biol.* 86(4):334-343, 2010.**

Purpose: To investigate the effect of **2.45 GHz microwave radiation** on rat brain of male wistar strain. Material and methods: Male rats of wistar strain (35 days old with 130 +/- 10 g body weight) were selected for this study. Animals were divided into two groups: Sham exposed and experimental. Animals were exposed for 2 h a day for 35 days to 2.45 GHz frequency at 0.34 mW/cm<sup>2</sup> power density. The whole body specific absorption rate (SAR) was estimated to be 0.11 W/Kg. Exposure took place in a ventilated Plexiglas cage and kept in anechoic chamber in a far field configuration from the horn antenna. After the completion of exposure period, rats were sacrificed and the whole brain tissue was dissected and used for study of double strand DNA (Deoxyribonucleic acid) breaks by micro gel electrophoresis and the statistical analysis was carried out using comet assay (IV-2 version software). Thereafter, antioxidant enzymes and histone kinase estimation was also performed. Results: A significant increase was observed in comet head ( $P < 0.002$ ), tail length ( $P < 0.0002$ ) and in tail movement ( $P < 0.0001$ ) in exposed brain cells. An analysis of antioxidant enzymes glutathione peroxidase ( $P < 0.005$ ), and superoxide dismutase ( $P < 0.006$ ) showed a decrease while an increase in catalase ( $P < 0.006$ ) was observed. A significant decrease ( $P < 0.023$ ) in histone kinase was also recorded in the exposed group as compared to the control (sham-exposed) ones. One-way analysis of variance (ANOVA) method was adopted for statistical analysis. Conclusion: The study concludes that the chronic exposure to these radiations may cause significant damage to brain, which may be an indication of possible tumour promotion (Behari and Paulraj 2007).

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**Lai, H, Singh, NP, Melatonin and a spin-trap compound block radiofrequency electromagnetic radiation-induced DNA strand breaks in rat brain cells. Bioelectromagnetics 18(6):446-454, 1997.**

Effects of in vivo microwave exposure on DNA strand breaks, a form of DNA damage, were investigated in rat brain cells. In previous research, we have found that acute (2 hours) exposure to pulsed (2 microseconds pulses, 500 pps) **2450-MHz radiofrequency electromagnetic radiation (RFR)** (power density 2 mW/cm<sup>2</sup>, average whole body specific absorption rate 1.2 W/kg) caused an increase in DNA single- and double-strand breaks in brain cells of the rat when assayed 4 hours post exposure using a microgel electrophoresis assay. In the present study, we found that treatment of rats immediately before and after RFR exposure with either melatonin (1 mg/kg/injection, SC) or the spin-trap compound N-tert-butyl-alpha-phenylnitron (PBN) (100 mg/kg/injection, i.p.) blocks this effects of RFR. Since both melatonin and PBN are efficient free radical scavengers it is hypothesized that free radicals are involved in RFR-induced DNA damage in the brain cells of rats. Since cumulated DNA strand breaks in brain cells can lead to neurodegenerative diseases and cancer and an excess of free radicals in cells has been suggested to be the cause of various human diseases, data from this study could have important implications for the health effects of RFR exposure.

**Lai H, Singh NP, Interaction of Microwaves and a Temporally Incoherent Magnetic Field on Single and Double DNA Strand Breaks in Rat Brain Cells. Electromag Biol Med 24:23-29, 2005.**

The effect of a temporally incoherent magnetic field ('noise') on microwave-induced DNA single and double strand breaks in rat brain cells was investigated. Four treatment groups of rats were studied: microwave-exposure (continuous-wave **2450-MHz microwaves**, power density 1 mW/cm<sup>2</sup>, average whole body specific absorption rate of 0.6 W/kg), 'noise'-exposure (45 mG), 'microwave + noise'-exposure, and sham-exposure. Animals were exposed to these conditions for 2 hrs. DNA single and double strand breaks in brain cells of these animals were assayed 4 hrs later using a microgel electrophoresis assay. Results show that brain cells of microwave-exposed rats had significantly higher levels of DNA single and double strand breaks when compared with sham-exposed animals. Exposure to 'noise' alone did not significantly affect the levels (i.e., they were similar to those of the sham-exposed rats). However, simultaneous 'noise' exposure blocked microwave-induced increases in DNA strand breaks. These data indicate that simultaneous exposure to a temporally incoherent magnetic field could block microwave-induced DNA damage in brain cells of the rat.

**Papageorgiou CC, Hountala CD, Maganioti AE, Kyprianou MA, Rabavilas AD, Papadimitriou GN, Capsalis CN. Effects of wi-fi signals on the p300 component of event-related potentials during an auditory hayling task. J Integr Neurosci. 10(2):189-202, 2011.**

The P300 component of event-related potentials (ERPs) is believed to index attention and working memory (WM) operation of the brain. The present study focused on the possible gender-related **effects of Wi-Fi** (Wireless Fidelity) electromagnetic fields (EMF)

## Studies that show WiFi and Devices Health Effects

on these processes. Fifteen male and fifteen female subjects, matched for age and education level, were investigated while performing a modified version of the Hayling Sentence Completion test adjusted to induce WM. ERPs were recorded at 30 scalp electrodes, both without and with the exposure to a Wi-Fi signal. P300 amplitude values at 18 electrodes were found to be significantly lower in the response inhibition condition than in the response initiation and baseline conditions. Independent of the above effect, within the response inhibition condition there was also a significant gender X radiation interaction effect manifested at 15 leads by decreased P300 amplitudes of males in comparison to female subjects only at the presence of EMF. In conclusion, the present findings suggest that Wi-Fi exposure may exert gender-related alterations on neural activity associated with the amount of attentional resources engaged during a linguistic test adjusted to induce WM.

**Ghazizadeh V, Nazıroğlu M. Electromagnetic radiation (Wi-Fi) and epilepsy induce calcium entry and apoptosis through activation of TRPV1 channel in hippocampus and dorsal root ganglion of rats. *Metab Brain Dis.* 29(3):787-799, 2014.**

Incidence rates of epilepsy and use of Wi-Fi worldwide have been increasing. TRPV1 is a  $\text{Ca}^{2+}$  permeable and non-selective channel, gated by noxious heat, oxidative stress and capsaicin (CAP). The hyperthermia and oxidant effects of Wi-Fi may induce apoptosis and  $\text{Ca}^{2+}$  entry through activation of TRPV1 channel in epilepsy. Therefore, we tested the effects of Wi-Fi (2.45 GHz) exposure on  $\text{Ca}^{2+}$  influx, oxidative stress and apoptosis through TRPV1 channel in the murine dorsal root ganglion (DRG) and hippocampus of pentylentetrazol (PTZ)-induced epileptic rats. Rats in the present study were divided into two groups as controls and PTZ. The PTZ groups were divided into two subgroups namely PTZ + Wi-Fi and PTZ + Wi-Fi + capsazepine (CPZ). The hippocampal and DRG neurons were freshly isolated from the rats. The DRG and hippocampus in PTZ + Wi-Fi and PTZ + Wi-Fi + CPZ groups were exposed to Wi-Fi for 1 hour before CAP stimulation. The cytosolic free  $\text{Ca}^{2+}$ , reactive oxygen species production, apoptosis, mitochondrial membrane depolarization, caspase-3 and -9 values in hippocampus were higher in the PTZ group than in the control although cell viability values decreased. The Wi-Fi exposure induced additional effects on the cytosolic  $\text{Ca}^{2+}$  increase. However, pretreatment of the neurons with CPZ, results in a protection against epilepsy-induced  $\text{Ca}^{2+}$  influx, apoptosis and oxidative damages. In results of whole cell patch-clamp experiments, treatment of DRG with  $\text{Ca}^{2+}$  channel antagonists [thapsigargin, verapamil + diltiazem, 2-APB, MK-801] indicated that Wi-Fi exposure induced  $\text{Ca}^{2+}$  influx via the TRPV1 channels. In conclusion, epilepsy and Wi-Fi in our experimental model is involved in  $\text{Ca}^{2+}$  influx and oxidative stress-induced hippocampal and DRG death through activation of TRPV1 channels, and negative modulation of this channel activity by CPZ pretreatment may account for the neuroprotective activity against oxidative stress.

**Deshmukh PS, Megha K, Banerjee BD, Ahmed RS, Chandna S, Abegaonkar MP, Tripathi AK. Detection of Low Level Microwave Radiation Induced Deoxyribonucleic Acid Damage Vis-à-vis Genotoxicity in Brain of Fischer Rats. *Toxicol Int.* 20(1):19-24, 2013.**

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**BACKGROUND:** Non-ionizing radiofrequency radiation has been increasingly used in industry, commerce, medicine and especially in mobile phone technology and has become a matter of serious concern in present time. **OBJECTIVE:** The present study was designed to investigate the possible deoxyribonucleic acid (DNA) damaging effects of low-level microwave radiation in brain of Fischer rats. **MATERIALS AND METHODS:** Experiments were performed on male Fischer rats exposed to microwave radiation for 30 days at three different frequencies: 900, 1800 and **2450 MHz**. Animals were divided into 4 groups: Group I (Sham exposed): Animals not exposed to microwave radiation but kept under same conditions as that of other groups, Group II: Animals exposed to microwave radiation at frequency 900 MHz at specific absorption rate (SAR)  $5.953 \times 10^{-4}$  W/kg, Group III: Animals exposed to 1800 MHz at SAR  $5.835 \times 10^{-4}$  W/kg and Group IV: Animals exposed to 2450 MHz at SAR  $6.672 \times 10^{-4}$  W/kg. At the end of the exposure period animals were sacrificed immediately and DNA damage in brain tissue was assessed using alkaline comet assay. **RESULTS:** In the present study, we demonstrated DNA damaging effects of low level microwave radiation in brain. **CONCLUSION:** We concluded that low SAR microwave radiation exposure at these frequencies may induce DNA strand breaks in brain tissue.

**Lai H, Carino MA, Horita A, Guy AW, Intraseptal microinjection of beta-funaltrexamine blocked a microwave-induced decrease of hippocampal cholinergic activity in the rat. Pharmacol Biochem Behav 53(3):613-616, 1994.**

Acute (45 min) exposure to pulsed (2 microseconds pulse width, 500 pulses per second) **2450-MHz microwaves** at a power density of 1 mW/cm<sup>2</sup> (whole body specific absorption rate 0.6 W/kg) microwaves caused a decrease in cholinergic activity in the hippocampus of the rat as measured by the sodium-dependent high-affinity choline uptake. Microinjection of beta-funaltrexamine (1 microgram) into the septum before microwave exposure blocked this effect. These data indicate that mu-opioid receptors in the septum mediate a microwave-induced decrease in cholinergic activity in the hippocampus and support our hypothesis that microwaves at a whole body SAR of 0.6 W/kg can activate endogenous opioids in the brain.

**Lai H, Carino MA, Horita A, Guy AW, Single vs. repeated microwave exposure: effects on benzodiazepine receptors in the brain of the rat. Bioelectromagnetics 13(1):57-66, 1992.**

We studied the effects of single (45 min) and repeated (ten daily 45-min sessions) microwave exposures (**2450-MHz**, 1 mW/cm<sup>2</sup>, average whole-body SAR of 0.6 W/kg, pulsed at 500 pps with pulse width of 2 microseconds) on the concentration and affinity of benzodiazepine receptors in the cerebral cortex, hippocampus, and cerebellum of the rat. We used a receptor-binding assay with 3H-flunitrazepam as ligand. Immediately after a single exposure, an increase in the concentration of receptor was observed in the cerebral cortex, but no significant effect was observed in the hippocampus or cerebellum. No significant change in binding affinity of the receptors was observed in any of the brain-regions studied. In rats subjected to repeated exposures, no significant change in receptor concentration was found in the cerebral cortex immediately after the last exposure, which may indicate an adaptation to repeated exposures. Our data also

## Studies that show **WiFi** and Devices Health Effects

show that handling and exposure procedures in our experiments did not significantly affect benzodiazepine receptors in the brain. Because benzodiazepine receptors in the brain are responsive to anxiety and stress, our data support the hypothesis that low-intensity microwave irradiation can be a source of stress.

**Lai H, Carino MA, Horita A, Guy AW, Opioid receptor subtypes that mediate a microwave-induced decrease in central cholinergic activity in the rat. *Bioelectromagnetics* 13(3):237-246, 1992.**

We performed experiments to investigate subtypes of opioid receptors in the brain involved in the effect of acute (45 min) pulsed microwave exposure (**2,450-MHz**, 2-microseconds pulses, 500 pps, average power density 1 mW/cm<sup>2</sup>, peak-power density, 1 W/cm<sup>2</sup>, average whole body SAR 0.6 W/kg) on cholinergic activity in the rat brain. Rats were pretreated by microinjection of specific antagonists of mu, delta, and kappa opioid-receptors into the lateral cerebroventricle before exposure to microwaves. The data showed that all three subtypes of opioid receptors are involved in the microwave-induced decrease in cholinergic activity in the hippocampus. However, the microwave-induced decrease in cholinergic activity in the frontal cortex was not significantly affected by any of the drug treatments, confirming our previous conclusion that the effect of microwaves on the frontal cortex is not mediated by endogenous opioids.

**Yang XS, He GL, Hao YT, Xiao Y, Chen CH, Zhang GB, Yu ZP. Exposure to 2.45 GHz electromagnetic fields elicits an HSP-related stress response in rat hippocampus. *Brain Res Bull.* 88(4):371-378, 2012.**

The issue of possible neurobiological effects of the electromagnetic field (EMF) exposure is highly controversial. To determine whether electromagnetic field exposure could act as an environmental stimulus capable of producing stress responses, we employed the hippocampus, a sensitive target of electromagnetic radiation, to assess the changes in its stress-related gene and protein expression after EMF exposure. Adult male Sprague-Dawley rats with body restrained were exposed to a **2.45 GHz EMF** at a specific absorption rate (SAR) of 6 W/kg or sham conditions. cDNA microarray was performed to examine the changes of gene expression involved in the biological effects of electromagnetic radiation. Of 2048 candidate genes, 23 upregulated and 18 downregulated genes were identified. Of these differential expression genes, two heat shock proteins (HSP), HSP27 and HSP70, are notable because expression levels of both proteins are increased in the rat hippocampus. Result from immunocytochemistry revealed that EMF caused intensive staining for HSP27 and HSP70 in the hippocampus, especially in the pyramidal neurons of cornu ammonis 3 (CA3) and granular cells of dentate gyrus (DG). The gene and protein expression profiles of HSP27 and HSP70 were further confirmed by reverse transcription polymerase chain reaction (RT-PCR) and Western blot. Our data provide direct evidence that exposure to electromagnetic fields elicits a stress response in the rat hippocampus.

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**Lai H, Carino MA, Wen YF, Horita A, Guy AW, Naltrexone pretreatment blocks microwave-induced changes in central cholinergic receptors. *Bioelectromagnetics* 12(1):27-33, 1991.**

Repeated exposure of rats to pulsed, circularly polarized microwaves (2,450-MHz, 2-microseconds pulses at 500 pps, power density 1 mW/cm<sup>2</sup>, at an averaged, whole-body SAR of 0.6 W/kg) induced biphasic changes in the concentration of muscarinic cholinergic receptors in the central nervous system. An increase in receptor concentration occurred in the hippocampus of rats subjected to ten 45-min sessions of microwave exposure, whereas a decrease in concentration was observed in the frontal cortex and hippocampus of rats exposed to ten 20-min sessions. These findings, which confirm earlier work in the authors' laboratory, were extended to include pretreatment of rats with the narcotic antagonist naltrexone (1 mg/kg, IP) before each session of exposure. The drug treatment blocked the microwave-induced changes in cholinergic receptors in the brain. These data further support the authors' hypothesis that endogenous opioids play a role in the effects of microwaves on central cholinergic systems.

**Lai H, Horita A, Guy AW, Microwave irradiation affects radial-arm maze performance in the rat. *Bioelectromagnetics* 15(2):95-104, 1994.**

After 45 min of exposure to pulsed 2450 MHz microwaves (2 microseconds pulses, 500 pps, 1 mW/cm<sup>2</sup>, average whole body SAR 0.6 W/kg), rats showed retarded learning while performing in the radial-arm maze to obtain food rewards, indicating a deficit in spatial "working memory" function. This behavioral deficit was reversed by pretreatment before exposure with the cholinergic agonist physostigmine or the opiate antagonist naltrexone, whereas pretreatment with the peripheral opiate antagonist naloxone methiodide showed no reversal of effect. These data indicate that both cholinergic and endogenous opioid neurotransmitter systems in the brain are involved in the microwave-induced spatial memory deficit.

**Lai H. Interaction of microwaves and a temporally incoherent magnetic field on spatial learning in the rat. *Physiol Behav.* 82(5):785-789, 2004.**

The effect of a temporally incoherent magnetic field ('noise') on microwave-induced spatial learning deficit in the rat was investigated. Rats were trained in six sessions to locate a submerged platform in a circular water maze. Four treatment groups of rats were studied: microwave-exposure (2450-MHz continuous-wave microwaves, power density 2 mW/cm<sup>2</sup>, average whole-body specific absorption rate 1.2 W/kg), 'noise' exposure (60 mG), 'microwave+noise' exposure, and sham exposure. Animals were exposed to these conditions for 1 h immediately before each training session. One hour after the last training session, animals were tested in a 2-min probe trial in the maze during which the platform was removed. The time spent during the 2 min in the quadrant of the maze in which the platform had been located was scored. Results show that microwave-exposed rats had significant deficit in learning to locate the submerged platform when compared with the performance of the sham-exposed animals. Exposure to 'noise' alone did not significantly affect the performance of the animals (i.e., it was similar to that of the sham-exposed rats). However, simultaneous exposure to 'noise'

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significantly attenuated the microwave-induced spatial learning deficit (i.e. 'microwave+noise'-exposed rats learned significantly better than the microwave-exposed rats). During the probe trial, microwave-exposed animals spent significantly less time in the quadrant where the platform was located. However, response of the 'microwave+noise'-exposed animals was similar to that of the sham-exposed animals during the probe trial. Thus, simultaneous exposure to a temporally incoherent magnetic field blocks microwave-induced spatial learning and memory deficits in the rat.

### **Kesari KK, Kumar S, Behari J. Pathophysiology of microwave radiation: effect on rat brain. *Appl Biochem Biotechnol.* 166(2):379-388, 2012.**

The study aims to investigate the effect of **2.45 GHz microwave radiation** on Wistar rats. Rats of 35 days old with  $130 \pm 10$  g body weight were selected for this study. Animals were divided into two groups: sham exposed and experimental (six animals each). Animals were exposed for 2 h a day for 45 days at 2.45 GHz frequency (power density, 0.21 mW/cm<sup>2</sup>). The whole body specific absorption rate was estimated to be 0.14 W/kg. Exposure took place in a ventilated plexiglas cage and kept in an anechoic chamber under a horn antenna. After completion of the exposure period, rats were killed, and pineal gland and whole brain tissues were isolated for the estimation of melatonin, creatine kinase, caspase 3, and calcium ion concentration. Experiments were performed in a blind manner and repeated. A significant decrease ( $P < 0.05$ ) was recorded in the level of pineal melatonin of exposed group as compared with sham exposed. A significant increase ( $P < 0.05$ ) in creatine kinase, caspase 3, and calcium ion concentration was observed in whole brain of exposed group of animals as compared to sham exposed. One-way analysis of variance method was adopted for statistical analysis. The study concludes that a reduction in melatonin or an increase in caspase-3, creatine kinase, and calcium ion may cause significant damage in brain due to chronic exposure of these radiations. These biomarkers clearly indicate possible health implications of such exposures.

### **Hao Y, Yang X, Chen C, Yuan-Wang, Wang X, Li M, Yu Z. STAT3 signalling pathway is involved in the activation of microglia induced by 2.45 GHz electromagnetic fields. *Int J Radiat Biol.* 86(1):27-36, 2010.**

**PURPOSE:** Microglia activation plays a pivotal role in the initiation and progression of central nervous system (CNS) insult. The aim of the present work was to investigate the activation of microglia and involvement of signal transducer and activator of transcription 3 (STAT3) in microglia activation after 2.45 GHz electromagnetic fields (EMF) exposure. **MATERIALS AND METHODS:** In this study, murine N9 microglial cells were exposed to **2.45 GHz EMF**, the protein expressions of STAT3, Janus Tyrosine kinase 1 and 2 (JAK1 and JAK2), phosphor-(Try705)STAT3 and DNA binding activity of STAT3 were examined by Western blot analysis and electrophoresis mobility shift assay (EMSA). Levels of the nitric oxide (NO) derivative nitrite were determined in the culture medium by the Griess reaction. The mRNA expression of tumour necrosis factor alpha (TNF-alpha) and inducible nitric oxide synthase (iNOS) were detected by reverse transcription and polymerase chain reaction (RT-PCR). **RESULTS:** A significant increase of STAT3 DNA-

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binding ability was noted after exposure. Consistent with this, EMF rapidly induced phosphorylation of STAT3 and activated JAK1 and JAK2. In addition, EMF exposure increased transcription levels of the inflammation-associated genes, iNOS and TNF-alpha, which are reported to contain STAT-binding elements in their promoter region. P6, a JAK inhibitor, reduced induction of iNOS and TNF-alpha, nuclear factor binding activity, and activation of STAT3 in EMF-stimulated microglia. CONCLUSION: These results provide evidence that EMF exposure can initiate the activation of microglia cells and STAT3 signalling involves in EMF-induced microglial activation.

**Zhang Y, She F, Li L, Chen C, Xu S, Luo X, Li M, He M, Yu Z. p25/CDK5 is partially involved in neuronal injury induced by radiofrequency electromagnetic field exposure. Int J Radiat Biol. 2013 Jul 29. [Epub ahead of print]**

Purpose: Several studies suggest that radiofrequency electromagnetic field (RF-EMF) exposure can induce neuronal injury. The aim of the present work was to investigate whether the cyclin-dependent kinase 5 (CDK5) pathway is involved in neuronal injury induced by RF-EMF exposure. Materials and methods: Newborn Sprague-Dawley rats' primary cultured cortical neurons were exposed to pulsed 2.45 GHz RF-EMF for 10 min. The cellular viability was assessed using the 3-(4,5-Dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide assay. The apoptosis was assessed by Hoechst 33342 and terminal deoxynucleotidyl transferase (TdT)-mediated dUTP nick-end labeling co-staining. The protein expressions of CDK5, p35, p25, and phosphorylated tau at Ser<sup>404</sup> were examined by Western blot analysis. The CDK5 activity was detected using a histone-H1 kinase assay. Results: The cellular viability of neurons was significantly decreased ( $p < 0.01$ , Partial Eta Squared [ $\eta_p^2$ ]: 0.554), and the percentage of apoptotic nuclei ( $p < 0.01$ ,  $\eta_p^2 = 0.689$ ), activity of CDK5 ( $p < 0.05$ ,  $\eta_p^2 = 0.589$ ), ratio of p25 and p35 ( $p < 0.05$ ,  $\eta_p^2 = 0.670$ ), levels of tau phosphorylation at Ser<sup>404</sup> ( $p < 0.01$ ,  $\eta_p^2 = 0.896$ ) were significantly increased after RF-EMF exposure. No significant change was detected in CDK5 expression after RF-EMF exposure. Pretreatment with Roscovitine (a CDK5 inhibitor) significantly blocked the RF-EMF-induced decrease of cellular viability ( $p < 0.05$ ,  $\eta_p^2 = 0.398$ ) and tau hyperphosphorylation at Ser<sup>404</sup> ( $p < 0.01$ ,  $\eta_p^2 = 0.917$ ), but did not significantly block the RF-EMF-induced apoptosis ( $p > 0.05$ ,  $\eta_p^2 = 0.130$ ). Conclusions: These results suggest that abnormal activity of p25/CDK5 is partially involved in primary cultured cortical neuron injury induced by RF-EMF exposure.

**Eser O, Songur A, Aktas C, Karavelioglu E, Caglar V, Aylak F, Ozguner F, Kanter M. The effect of electromagnetic radiation on the rat brain: an experimental study. Turk Neurosurg. 23(6):707-715, 2013.**

AIM: The aim of this study is to determine the structural changes of electromagnetic waves in the frontal cortex, brain stem and cerebellum. MATERIAL and METHODS: 24 Wistar Albino adult male rats were randomly divided into four groups: group I consisted of control rats, and groups II-IV comprised electromagnetically irradiated (EMR) with 900, 1800 and **2450 MHz**. The heads of the rats were exposed to 900, 1800 and 2450 MHz microwaves irradiation for 1h per day for 2 months. RESULTS: While the histopathological changes in the frontal cortex and brain stem were normal in the control group, there were severe degenerative changes,

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shrunk cytoplasm and extensively dark pyknotic nuclei in the EMR groups. Biochemical analysis demonstrated that the Total Antioxidative Capacity level was significantly decreased in the EMR groups and also Total Oxidative Capacity and Oxidative Stress Index levels were significantly increased in the frontal cortex, brain stem and cerebellum. IL-1 $\beta$  level was significantly increased in the EMR groups in the brain stem. CONCLUSION: EMR causes to structural changes in the frontal cortex, brain stem and cerebellum and impair the oxidative stress and inflammatory cytokine system. This deterioration can cause to disease including loss of these areas function and cancer development.

### **Wang, BM, Lai, H, Acute exposure to pulsed 2450-MHz microwaves affects water maze learning in the rat. *Bioelectromagnetics* 21:52-56, 2000.**

Rats were trained in six sessions to locate a submerged platform in a circular water maze. They were exposed to pulsed **2450-MHz** microwaves (pulse width 2 ms, 500 pulses/s, power density 2 mW/cm<sup>2</sup>, average whole body specific absorption rate 1.2 W/kg) for 1 hr in a circular waveguide system immediately before each training session. One hour after the last training session, they were tested in a probe trial during which the platform was removed and the time spent in the quadrant of the maze in which the platform had been located during the 1-min trial was scored. Three groups of animals: microwave-exposed, sham-exposed, and cage control were studied. Data show that microwave-exposed rats were slower than sham-exposed and cage control rats in learning to locate the platform. However, there was no significant difference in swim speed among the three groups of animals, indicating that the difference in learning was not due to a change in motor functions or motivation. During the probe trial, microwave-exposed animals spent significantly less time in the quadrant that had contained the platform, and their swim patterns were different from those of the sham-exposed and cage control animals. The latter observation indicates that microwave-exposed rats used a different strategy in learning the location of the platform. These results show that acute exposure to pulsed microwaves caused a deficit in spatial "reference" memory in the rat.

### **Neubauer C, Phelan AM, Kues H, Lange DG, Microwave irradiation of rats at 2.45 GHz activates pinocytotic-like uptake of tracer by capillary endothelial cells of cerebral cortex. *Bioelectromagnetics* 11(4):261-268, 1990.**

Far-field exposures of male albino rats to 2.45-GHz microwaves (10-microseconds pulses, 100 pps) at a low average power density (10 mW/cm<sup>2</sup>; SAR approximately 2 W/kg) and short durations (30-120 min) resulted in increased uptakes of tracer through the blood-brain barrier (BBB). The uptake of systemically administered rhodamine-ferritin complex by capillary endothelial cells (CECs) of the cerebral cortex was dependent on power density and on duration of exposure. At 5 mW/cm<sup>2</sup>, for example, a 15-min exposure had no effect. Near-complete blockade of uptake resulted when rats were treated before exposure to microwaves with a single dose of colchicine, which inhibits microtubular function. A pinocytotic-like mechanism is presumed responsible for the microwave-induced increase in BBB permeability.

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**Nazıroğlu M, Çelik Ö, Özgül C, Çiğ B, Doğan S, Bal R, Gümrall N, Rodríguez AB, Pariente JA. Melatonin modulates wireless (2.45 GHz)-induced oxidative injury through TRPM2 and voltage gated Ca(2+) channels in brain and dorsal root ganglion in rat. *Physiol Behav.* 105(3):683-692, 2012.**

We aimed to investigate the protective effects of melatonin and **2.45 GHz electromagnetic radiation (EMR)** on brain and dorsal root ganglion (DRG) neuron antioxidant redox system, Ca(2+) influx, cell viability and electroencephalography (EEG) records in the rat. Thirty two rats were equally divided into four different groups namely group A1: Cage control, group A2: Sham control, group B: 2.45 GHz EMR, group C: 2.45 GHz EMR+melatonin. Groups B and C were exposed to 2.45 GHz EMR during 60 min/day for 30 days. End of the experiments, EEG records and the brain cortex and DRG samples were taken. Lipid peroxidation (LP), cell viability and cytosolic Ca(2+) values in DRG neurons were higher in group B than in groups A1 and A2 although their concentrations were increased by melatonin, 2-aminoethyldiphenyl borinate (2-APB), diltiazem and verapamil supplementation. Spike numbers of EEG records in group C were lower than in group B. Brain cortex vitamin E concentration was higher in group C than in group B. In conclusion, Melatonin supplementation in DRG neurons and brain seems to have protective effects on the 2.45 GHz-induced increase Ca(2+) influx, EEG records and cell viability of the hormone through TRPM2 and voltage gated Ca(2+) channels.

**Testylier G, Tonduli L, Malabiau R, Debouzy JC. Effects of exposure to low level radiofrequency fields on acetylcholine release in hippocampus of freely moving rats. *Bioelectromagnetics* 23:249-255, 2002.**

Some central cholinergic effects have been reported in animals after acute exposure to radiofrequency electromagnetic field at low intensity. We studied acetylcholine (ACh) release in the brain of freely moving rats exposed for 1 h during the day to a **2.45 GHz** continuous wave radiofrequency field (RF) (2 or 4 mW/cm<sup>2</sup>) or exposed for 1 or 14 h during the night to a 800 MHz field modulated at 32 Hz (AM 200 mW/cm<sup>2</sup>). Measurements were performed by microdialysis using a membrane implanted through the upper CA1 region of the hippocampus. After irradiation with the 2.45 GHz RF, rats exposed at 2 mW/cm<sup>2</sup> did not show a significant modification of ACh release, whereas those exposed at 4 mW/cm<sup>2</sup> showed a significant 40% decrease in mean ACh release from hippocampus. This decrease was maximal at 5 h post exposure. Exposure to the 800 MHz RF for 1 h did not cause any significant effect, but exposure for 14 hrs induced a significant 43% decrease in ACh release during the period 11 p.m.-4 a.m. compared to control rats. In the control group we observed an increase of ACh release at the beginning of the night, which was linked to the waking period of rats. This normal increase was disturbed in rats exposed overnight to the 800 MHz RF. This work indicates that neurochemical modification of the hippocampal cholinergic system can be observed during and after an exposure to low intensity RF.

**Lu Y, Xu S, He M, Chen C, Zhang L, Liu C, Chu F, Yu Z, Zhou Z, Zhong M. Glucose administration attenuates spatial memory deficits induced by chronic low-power-density microwave exposure. *Physiol Behav.* 106(5):631-637, 2012.**

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Extensive evidence indicates that glucose administration attenuates memory deficits in rodents and humans, and cognitive impairment has been associated with reduced glucose metabolism and uptake in certain brain regions including the hippocampus. In the present study, we investigated whether glucose treatment attenuated memory deficits caused by chronic low-power-density microwave (MW) exposure, and the effect of MW exposure on hippocampal glucose uptake. **We exposed Wistar rats to 2.45 GHz pulsed MW irradiation** at a power density of 1 mW/cm<sup>2</sup> for 3 h/day, for up to 30 days. MW exposure induced spatial learning and memory impairments in rats. Hippocampal glucose uptake was also reduced by MW exposure in the absence or presence of insulin, but the levels of blood glucose and insulin were not affected. However, these spatial memory deficits were reversed by systemic glucose treatment. Our results indicate that glucose administration attenuates the spatial memory deficits induced by chronic low-power-density MW exposure, and reduced hippocampal glucose uptake may be associated with cognitive impairment caused by MW exposure.

### **Paulraj R, Behari J. Single strand DNA breaks in rat brain cells exposed to microwave radiation. *Mutat Res.* 596:76-80, 2006.**

This investigation concerns with the effect of low intensity microwave (2.45 and 16.5GHz, SAR 1.0 and 2.01W/kg, respectively) radiation on developing rat brain. Wistar rats (35 days old, male, six rats in each group) were selected for this study. These animals were exposed for 35 days at the above mentioned frequencies separately in two different exposure systems. After the exposure period, the rats were sacrificed and the whole brain tissue was dissected and used for study of single strand DNA breaks by micro gel electrophoresis (comet assay). Single strand DNA breaks were measured as tail length of comet. Fifty cells from each slide and two slides per animal were observed. One-way ANOVA method was adopted for statistical analysis. This study shows that the chronic exposure to these radiations cause statistically significant ( $p < 0.001$ ) increase in DNA single strand breaks in brain cells of rat.

### **Paulraj R, Behari J. Protein Kinase C Activity in developing rat brain cells exposed to 2.45 GHz radiation. *Electromag Biol Med* 25(1) 61-70, 2006.**

There is growing concern by the public regarding the potential human health hazard due to exposure to microwave frequencies. **2.45 GHz radiation** widespread use in industry, research, and medicine, and leakage into the environment is possible. In order to quantitate this, experiments were performed on developing rat brain. Male Wistar 35-day-old rats ( $n = 6$ ) were used for this study. Animals were exposed to 2.45 GHz radiation for 2 h/day for a period of 35 days at a power density of 0.344 mW/cm<sup>2</sup> (SAR 0.11 W/kg). The control group was sham irradiated. After 35 days these rats were sacrificed and whole brain tissue was isolated for protein kinase C (PKC) assay. For morphological study the forebrain was isolated from the whole brain and PKC activity was measured using P<sup>32</sup> labeled ATP. Our study reveals a statistically significant ( $p < 0.05$ ) decrease in PKC activity in hippocampus as compared to the remaining portion of the whole brain and the control group. A similar experiment conducted on hippocampus and the whole brain gave a similar result. Electron microscopic study shows an increase in the glial cell population in

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the exposed group as compared to the control group. This present study is indicative of a significant change after exposure to the above-mentioned field intensity. This suggests that chronic exposures may affect brain growth and development.

**Kubinyi G, Thuroczy G, Bakos J, Boloni E, Sinay H, Szabo LD, Effect of continuous-wave and amplitude-modulated 2.45 GHz microwave radiation on the liver and brain aminoacyl-transfer RNA synthetases of in utero exposed mice. *Bioelectromagnetics* 17(6):497-503, 1996.**

Investigations have been carried out concerning the effects of **microwave (MW)** exposure on the aminoacyl-transfer ribonucleic acid (tRNA) synthetase of the progeny of females that were exposed during their entire period of gestation (19 days). The changes caused by **continuous-wave (CW)** and amplitude-modulated (AM) MW radiation have been compared. CFLP mice were exposed to MW radiation for 100 min each day in an anechoic room. The MW frequency was **2.45 GHz**, and the amplitude modulation had a 50 Hz rectangular waveform (on/off ratio, 50/50%). The average power density exposure was 3 mW/cm<sup>2</sup>, and the whole body specific absorption rate (SAR) was 4.23 +/- 0.63 W/kg. The weight and mortality of the progeny were followed until postnatal day 24. Aminoacyl-tRNA synthetase enzymes and tRNA from the brains and livers of the offspring (461 exposed, 487 control) were isolated. The aminoacyl-tRNA synthetase activities were determined. The postnatal increase of body weight and organ weight was not influenced by the prenatal MW radiation. The activity of enzyme isolated from the brain showed a significant decrease after CW MW exposure, but the changes were not significant after 50 Hz AM MW exposure. The activity of the enzyme isolated from liver increased under CW and 50 Hz modulated MW.

**Jorge-Mora T, Folgueiras MA, Leiro-Vidal JM, Jorge-Barreiro FJ, Ares-Pena FJ, López-Martin E. Exposure to 2.45 GHz Microwave Radiation Provokes Cerebral Changes in Induction of Hsp-90  $\alpha/\beta$  Heat Shock Protein in Rat. *Prog Electromagn Res*, 100:351-379, 2010.**

Physical agents such as non-ionizing continuous-wave **2.45 GHz radiation** may cause damage that alters cellular homeostasis and may trigger activation of the genes that encode heat shock proteins (HSP). We used Enzyme-Linked ImmunoSorbent Assay (ELISA) and immunohistochemistry to analyze the changes in levels of HSP-90 and its distribution in the brain of Sprague-Dawley rats, ninety minutes and twenty-four hours after acute (30min) continuous exposure to 2.45 GHz radiation in a the Gigahertz Transverse Electromagnetic (GTEM cell). In addition, we studied further indicators of neuronal insult: dark neurons, chromatin condensation and nucleus fragmentation, which were observed under optical conventional or fluorescence microscopy after DAPI staining. The cellular distribution of protein HSP-90 in the brain increased with each corresponding SAR ( $0.034 \pm 3.10^{-3}$ ,  $0.069 \pm 5.10^{-3}$ ,  $0.27 \pm 21.10^{-3}$  W/kg), in hypothalamic nuclei, limbic cortex and somatosensorial cortex after exposure to the radiation. At twenty-four hours post-irradiation, levels of HSP-90 protein remained high in all hypothalamic nuclei for all SARs, and in the parietal cortex, except the limbic system, HSP-90 levels were lower than in non-irradiated rats, almost half the levels in rats

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exposed to the highest power radiation. Non-apoptotic cellular nuclei and a some dark neurons were found ninety minutes and twenty-four hours after maximal SAR exposure. The results suggest that acute exposure to electromagnetic fields triggered an imbalance in anatomical HSP- 90 levels but the anti-apoptotic mechanism is probably sufficient to compensate the non-ionizing stimulus. Further studies are required to determine the regional effects of chronic electromagnetic pollution on heat shock proteins and their involvement in neurological processes and neuronal damage.

**Gürler HS, Bilgici B, Akar AK, Tomak L, Bedir A. Increased DNA oxidation (8-OHdG) and protein oxidation (AOPP) by Low level electromagnetic field (2.45 GHz) in rat brain and protective effect of garlic. Int J Radiat Biol. 2014 May 21:1-15. [Epub ahead of print]**

Purpose: To investigate the oxidative damage and protective effect of garlic on rats exposed to low level of electromagnetic fields (EMF) at **2.45 GHz Microwave** radiation (MWR). Methods: Thirty six Wistar rats were divided into three groups. Group I was the control group and not exposed to EMF. Group II and III were exposed to low level EMF ( $3.68 \pm 0.36$  V/m) at 2.45 GHz MWR for 1 hour/day for 30 consecutive days. Daily 500 mg/kg garlic was given to Group III during the study period. At the end of the study, thiobarbituric acid reactive substances (TBARS), advanced oxidation protein products (AOPP) and 8-hydroxydeoxyguanosine (8-OHdG) levels were investigated in brain tissue and blood samples. Results: Exposure to low level of EMF increased 8-OHdG level in both plasma and brain tissue whereas it increased AOPP level only in plasma. Garlic prevented the increase of 8-OHdG level in brain tissue and plasma AOPP levels. Conclusions: It may be concluded that low level EMF at 2.45 GHz MWR increases the DNA damage in both brain tissues and plasma of the rats whereas it increases protein oxidation only in plasma. It may also be argued that the use of garlic decreases these effects.

**Fukui Y, Hoshino K, Inouye M, Kameyama Y, Effects of hyperthermia induced by microwave irradiation on brain development in mice. J Radiat Res (Tokyo) 33(1):1-10, 1992.**

Pregnant mice were exposed to **2.45 GHz of microwave** radiation for 15 or 20 min on day 13 of gestation. The highest maternal core temperature during the exposure did not exceed 42.5 degrees C. Pregnant females also were immersed in hot water at 42 degrees C for 15 min to compare thermal effects on brain development. Animals were killed 9 hours after treatment, and the pyknotic cells in the ventricular zone of telencephalon were counted. The respective incidences of these cells in the groups exposed to microwaves for 15 and 20 min were 1.83% and 3.06%. Microwave radiation for 20 min had an effect that was comparable to that of immersion in 42 degrees C hot water for 15 min. In addition, some animals were examined on day 18 of gestation, and some of their offspring were examined at 6 weeks of age in an examination of long-term effects. Brain weight for the group exposed to microwaves for 20 min was significantly lower than for the control group, and the numerical density of the neurons in the cerebrum was higher. We concluded that microwave radiation at the dose tested mainly has a thermal effect.

**Nazıroğlu M, Çelik Ö, Özgül C, Çiğ B, Doğan S, Bal R, Gümral N, Rodríguez AB, Pariente JA. Melatonin modulates wireless (2.45 GHz)-induced oxidative injury through TRPM2**

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**and voltage gated Ca(2+) channels in brain and dorsal root ganglion in rat. *Physiol Behav.* 105(3):683-692, 2012.**

We aimed to investigate the protective effects of melatonin and 2.45 GHz electromagnetic radiation (EMR) on brain and dorsal root ganglion (DRG) neuron antioxidant redox system, Ca(2+) influx, cell viability and electroencephalography (EEG) records in the rat. Thirty two rats were equally divided into four different groups namely group A1: Cage control, group A2: Sham control, group B: 2.45 GHz EMR, group C: 2.45 GHz EMR+melatonin. Groups B and C were exposed to 2.45 GHz EMR during 60 min/day for 30 days. End of the experiments, EEG records and the brain cortex and DRG samples were taken. Lipid peroxidation (LP), cell viability and cytosolic Ca(2+) values in DRG neurons were higher in group B than in groups A1 and A2 although their concentrations were increased by melatonin, 2-aminoethyl-diphenyl borinate (2-APB), diltiazem and verapamil supplementation. Spike numbers of EEG records in group C were lower than in group B. Brain cortex vitamin E concentration was higher in group C than in group B. In conclusion, Melatonin supplementation in DRG neurons and brain seems to have protective effects on the 2.45 GHz-induced increase Ca(2+) influx, EEG records and cell viability of the hormone through TRPM2 and voltage gated Ca(2+) channels.

**Field AS, Ginsburg K, Lin JC The effect of pulsed microwaves on passive electrical properties and interspike intervals of snail neurons. *Bioelectromagnetics* 14(6):503-520, 1993.**

The effects of pulsed microwaves (2.45 GHz, 10 microseconds, 100 pps, SAR: 81.5 kW/kg peak, 81.5 W/kg average) on membrane input resistance and action potential (AP) interval statistics were studied in spontaneously active ganglion neurons of land snails (*Helix aspersa*), at strictly constant temperature (20.8 +/- .07 degrees C worst case). Statistical comparison with sham-irradiated neurons revealed a significant increase in the mean input resistance of neurons exposed to pulsed microwaves (P < or = .05). Pulsed microwaves had no visible effect on mean AP firing rate; this observation was confirmed by analysis of interspike intervals (ISIs). Using an integrator model for spontaneously active neurons, we found the net input current to be more variable in neurons exposed to pulsed microwaves. The mean input current was not affected. The standard deviation of ISIs and the autocorrelation of the input current were marginally affected, but these changes were not consistent across neurons. Although the observed effects were less obvious than those reported in other studies, they represent evidence of a direct interaction between neurons and pulsed microwaves, in the absence of macroscopic temperature changes. The data do not suggest a single, specific mechanism for such interaction.

**Ding G, Xie X, Zhang L et al. Changes of nitric oxide synthase in hippocampus and cerebellum of the rat following exposure to electromagnetic pulse. *Chin J Phys Med* 20:81-83, 1998.**

Objective: In order to explore the role of nitric oxide in the obstruction of learning and memory of the rat caused by exposing to electromagnetic pulses (EMP), the distribution of nitric oxide synthase (NOS) expression was studied in hippocampus and cerebellum of

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the rat following exposure to EMP. Methods: SP immunohistochemical staining was employed to detect the distribution of NOS expression. Results: The number of NOS positive neurons and the intensity of positive staining in hippocampus were decreased at 1.5 and 24 h after exposure to EMP. At 48 h, the number of NOS positive neurons reversed to control level but the intensity of positive staining was still low. the expression of NOS in cerebellum had no obvious changes. Conclusion: Decrease of NOS expression in hippocampus relates to the obstruction of learning and memory of the rat after exposure to EMP.

### **Lange DG, Sedmak J, Japanese encephalitis virus (JEV): potentiation of lethality in mice by microwave radiation. Bioelectromagnetics 12(6):335-348, 1991.**

The expression of Japanese Encephalitis Virus (JEV) lethality in mice requires entry of the virus into the central nervous system. This entry is presumably through the capillary endothelial cells (CEC), because entry between CECs is inhibited by bands of circumferential tight-junctions. A viremic stage occurs during the first 4 to 5 days after JEV administration in mice, and both microwave **radiation (2.45-GHz, continuous wave, 10-min exposure)** and hypercarbia were employed to increase CEC permeability to JEV. Exposure to microwaves at power densities of 10-50 mW/cm<sup>2</sup> resulted in a dose-dependent increase in JEV-induced lethality. Mice did not become tolerant or sensitized to microwave potentiation of JEV-induced mortality because 4 daily exposures at 10 or 50 mW/cm<sup>2</sup> (SARS, approximately 24-98 W/kg) did not alter the lethality pattern to subsequent microwave radiation of JEV-exposed animals. Similarly, hypercarbia (5, 10, and 20% CO<sub>2</sub>) was observed to produce a dose-dependent increase in JEV-induced lethality. Both microwave radiation and hypercarbia are thought to promote pinocytosis in CNS capillary endothelial cells. This may be one mechanism by which they enhance JEV-induced lethality in adult Swiss-Cox mice.

### **Inaba R, Shishido K, Okada A, Moroji T. Effects of whole body microwave exposure on the rat brain contents of biogenic amines. Eur J Appl Physiol Occup Physiol. 65(2):124-128, 1992.**

The effects of whole body microwave exposure on the central nervous system (CNS) of the rat were investigated. Rats weighing from 250 to 320 g were exposed for 1 h to whole body **microwave with a frequency of 2450 MHz** at power densities of 5 and 10 mW.cm<sup>-2</sup> at an ambient temperature of 21-23 degrees C. The rectal temperatures of the rats were measured just before and after microwave exposure and mono-amines and their metabolites in various discrete brain regions were determined after microwave exposure. Microwave exposure at power densities of 5 and 10 mW.cm<sup>-2</sup> increased the mean rectal temperature by 2.3 degrees C and 3.4 degrees C, respectively. The noradrenaline content in the hypothalamus was significantly reduced after microwave exposure at a power density of 10 mW.cm<sup>-2</sup>. There were no differences in the dopamine (DA) content of any region of the brain between microwave exposed rats and control rats. The dihydroxyphenyl acetic acid (DOPAC) content, the main metabolite of DA, was significantly increased in the pons plus medulla oblongata only at a power density of 10 mW.cm<sup>-2</sup>. The DA turnover rates, the DOPAC:DA ratio, in the striatum and cerebral

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cortex were significantly increased only at a power density of 10 mW.cm<sup>-2</sup>. The serotonin (5-hydroxytryptamine, 5-HT) content in all regions of the brain of microwave exposed rats was not different from that of the control rats. The 5-hydroxyindoleacetic acid (5-HIAA) content in the cerebral cortex of microwave exposed rats was significantly increased at power densities of 5 and 10 mW.cm<sup>-2</sup>.

**Naziroğlu M, Gümral N. Modulator effects of L-carnitine and selenium on wireless devices (2.45 GHz)-induced oxidative stress and electroencephalography records in brain of rat. *Int J Radiat Biol.* 85(8):680-689, 2009.**

**PURPOSE:** Electromagnetic radiation (EMR) from wireless devices may affect biological systems by increasing free radicals. The present study was designed to determine the effects of **2.45 GHz EMR** on the brain antioxidant redox system and electroencephalography (EEG) records in rat. The possible protective effects of selenium and L-carnitine were also tested and compared to untreated controls. **MATERIALS AND METHODS:** Thirty rats were equally divided into five different groups, namely Group A(1): Cage control, Group A(2): Sham control, group B: 2.45 GHz EMR, group C: 2.45 GHz EMR + selenium, group D: 2.45 GHz EMR + L-carnitine. Groups B, C and D were exposed to 2.45 GHz EMR during 60 min/day for 28 days. End of the experiments, EEG records and the brain cortex samples were taken. **RESULTS:** The cortex brain vitamin A ( $p < 0.05$ ), vitamin C ( $p < 0.01$ ) and vitamin E ( $p < 0.05$ ) concentrations values were lower in group B than in group A1 and A2 although their concentrations were increased by selenium and L-carnitine supplementation. Lipid peroxidation, levels were lower in group C ( $p < 0.05$ ) and D ( $p < 0.01$ ) than in group B where as reduced glutathione levels were higher in group C ( $p < 0.05$ ) than in group A1, A2 and B. However, B-carotene levels did not change in the five groups. **CONCLUSIONS:** L-carnitine and selenium seem to have protective effects on the 2.45 GHz-induced decrease of the vitamins by supporting antioxidant redox system. L-carnitine on the vitamin concentrations seems to more protective affect than in selenium.

**De Roos AJ, Teschke K, Savitz DA, Poole C, Grufferman S, Pollock BH, Olshan AF. Parental occupational exposures to electromagnetic fields and radiation and the incidence of neuroblastoma in offspring. *Epidemiology* 12(5):508-517, 2001.**

We examined parental occupational exposures to electromagnetic fields and radiation and the incidence of neuroblastoma in offspring. Cases were 538 children diagnosed with neuroblastoma between 1992 and 1994 in the United States or Canada. Age-matched controls were selected by random-digit dialing. Occupational exposures to electrical equipment and radiation sources were classified by an industrial hygienist, and average exposures to extremely low frequency magnetic fields were estimated using a job exposure matrix. Maternal exposure to a broad grouping of sources that produce radiofrequency radiation was associated with an increased incidence of neuroblastoma (odds ratio = 2.8; 95% confidence interval = 0.9-8.7). Paternal exposure to battery-powered forklifts was positively associated with neuroblastoma (odds ratio = 1.6; 95% confidence interval = 0.8-3.2), as were some types of equipment that emit radiofrequency radiation (odds ratios congruent with 2.0); however, the broad groupings

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of sources that produce ELF fields, radiofrequency radiation, or ionizing radiation were not associated with neuroblastoma. Paternal average extremely low frequency magnetic field exposure >0.4 microTesla was weakly associated with neuroblastoma (odds ratio = 1.6; 95% confidence interval = 0.9-2.8), whereas maternal exposure was not. Overall, there was scant supportive evidence of strong associations between parental exposures in electromagnetic spectrum and neuroblastoma in offspring.

## Effects on Eyes

**Liu X, Shen H, Shi Y, Chen J, Chen Y, Ji A. The microarray study on the stress gene transcription profile in human retina pigment epithelial cells exposed to microwave radiation. Zhonghua Yu Fang Yi Xue Za Zhi 36(5):291-294, 2002.**

**OBJECTIVE:** To study the difference in stress and apoptosis related genes transcription between hTERT-RPE1 cells exposed to simulated microwave radiation and the cells with heat water bath, and the effects of microwave on gene transcription in cultured human retina pigment epithelial cells. **METHODS:** cDNA microarray technique was used to detect the mRNA isolated from hTERT-RPE1 cells exposed to **2 450 MHz** simulated microwave radiation and with heat water bath, respectively. **RESULTS:** Among the 97 related aim genes, there were seven genes up-regulating its transcription, i.e., M31166 (2.52fold), L24123 (2.66fold), AF039704 (2.22fold), U67156 (2.07fold), AF040958 (2.13fold), NM-001423 (2.63fold) and NM-005346 (3.68fold). But, no notably down-regulating gene in transcription was detected. **CONCLUSIONS:** Microwave could induce up-regulating in multiple stress and apoptosis related genes transcription in cultured human retina pigment epithelial cells, hTERT-RPE1 cells. Microwave radiation has unique effect itself in addition to its heat effect.

**Akar A, Karayığit MO, Bolat D, Gültiken ME, Yarım M, Castellani G. Effects of low level electromagnetic field exposure at 2.45 GHz on rat cornea. Int J Radiat Biol. 2012 Dec 3. [Epub ahead of print]**

**Abstract Purpose:** To investigate the effects of low level Electromagnetic Field (low level-EMF) exposure, as frequently encountered in daily life, on the yesmal rat cornea using histological and stereological method. **Methods:** Twenty-two adult male Wistar rats were randomly divided into two groups: study group (n=11) and control group (n=11). Rats in the study group were exposed to **2.45 GHz Microwave (MW) radiation** (11.96±0.89V/m), 0.25 W/kg specific absorption rate (SAR) for 2 hours each day for 21 days. The corneal thickness and the anterior epithelium corneal thickness were measured using two different methods. **Results:** Using the histological method, the mean corneal thicknesses in the control and study group were 278.9±54.5 µm, and 272.4±85.6 µm, respectively. There was no statistically significant difference between the groups (p>0.05). The anterior corneal epithelium thickness was 28.1±4.9 µm in the control group and 31.7±5.5 µm in the study group. There were statistically differences between the groups with regard to the thickness of anterior epithelium (p<0.05). In the measurement made by the stereological method, the percentage of the cornea occupied by anterior corneal

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epithelium was 15.94% in the control group and 17.9% in the study group. Despite the fact that there was a relation between increased anterior epithelial area (AEA) and radiation exposure, no statistically significant relationship in area fraction of each compartment was found between the control and study groups. Conclusions: Results of this preliminary study show that exposure to MW radiation might cause alterations in the rat cornea.

**Tök L, Nazıroğlu M, Doğan S, Kahya MC, Tök O. Effects of melatonin on Wi-Fi-induced oxidative stress in lens of rats. Indian J Ophthalmol. 62(1):12-15, 2014. doi: 10.4103/0301-4738.126166.**

Introduction: Melatonin has been considered a potent antioxidant that detoxifies a variety of reactive oxygen species in many pathophysiological states of eye. The present study was designed to determine the effects of Wi-Fi exposure on the lens oxidant, antioxidant redox systems, as well as the possible protective effects of melatonin on the lens injury induced by electromagnetic radiation (EMR). Materials and Methods: Thirty-two rats were used in the current study and they were randomly divided into four equal groups as follows: First and second groups were cage-control and sham-control rats. Rats in third group were exposed to **Wi-Fi (2.45 GHz)** for duration of 60 min/day for 30 days. As in the third group, the fourth group was treated with melatonin. The one-hour exposure to irradiation in second, third and fourth took place at noon each day. Results: Lipid peroxidation levels in the lens were slightly higher in third (Wi-Fi) group than in cage and sham control groups although their concentrations were significantly ( $P < 0.05$ ) decreased by melatonin supplementation. Glutathione peroxidase (GSH-Px) activity was significantly ( $P < 0.05$ ) lower in Wi-Fi group than in cage and sham control groups although GSH-Px ( $P < 0.01$ ) and reduced glutathione ( $P < 0.05$ ) values were significantly higher in Wi-Fi + melatonin group than in Wi-Fi group. Conclusions: There are poor oxidative toxic effects of one hour of Wi-Fi exposure on the lens in the animals. However, melatonin supplementation in the lens seems to have protective effects on the oxidant system by modulation of GSH-Px activity.

**Pologea-Moraru R, Kovacs E, Iliescu KR, Calota V, Sajin G. The effects of low level microwaves on the fluidity of photoreceptor cell membrane. Bioelectrochemistry 56(1-2):223-225, 2002.**

Due to the extensive use of electromagnetic fields in everyday life, more information is required for the detection of mechanisms of interaction and the possible side effects of electromagnetic radiation on the structure and function of the organism. In this paper, we study the effects of low-power microwaves (2.45 GHz) on the membrane fluidity of rod photoreceptor cells. The retina is expected to be very sensitive to microwave irradiation due to the polar character of the photoreceptor cells [Biochim. Biophys. Acta 1273 (1995) 217] as well as to its high water content [Stud. Biophys. 81 (1981) 39].

**Yang R, Chen J, Deng Z, Liu X, [Effect of vitamin E on morphological variation of retinal ganglion cells after microwave radiation]. Wei Sheng Yan Jiu 30(1):31-33, 2001. [Article in Chinese]**

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To determine the morphological variation in the primary cultured pig retinal ganglion cells induced by microwave and the protection of VE can supply some experiment foundation for study of effect of microwave and its protection. Retinal ganglion cells of pig were cultured in vitro and added VE of different concentration, Each group was taken after 30 mW/cm<sup>2</sup> microwave intensity radiated for 1 h in shielded room by **2450 MHz** continuous wave physiotherapy machine. Immediately after radiation, the morphological variation of cells was observed by optics microscope and transmission electronic microscope. The result showed that a portion of cells congregated, with their axon disappeared after radiation. Mitochondria and endoplasmic reticulum are detected swelling by transmission electronic microscope. The results showed that A poposis cells can be observed. Cells of VE added groups had not obvious changes with optics microscope, but could be found that mitochondria swelling lightly and integrate mitochondria cristae by transmission electronic microscope. The results showed that microwave induced the morphological damage in primary cultured retinal ganglion cells, VE could reduced the damage of retina ganglion cells by microwave in some extent.

**Behrens T, Lynge E, Cree I, Sabroe S, Lutz JM, Afonso N, Eriksson M, Guénel P, Merletti F, Morales-Suarez-Varela M, Stengrevics A, Févotte J, Llopis-González A, Gorini G, Sharkova G, Hardell L, Ahrens W. Occupational exposure to electromagnetic fields and sex-differential risk of uveal melanoma. *Occup Environ Med.*67(11):751-759, 2010**

Objectives The association between occupational exposure to electromagnetic fields (EMF) and the risk of uveal melanoma was investigated in a case-control study in nine European countries. Methods Incident cases of uveal melanoma and population as well as hospital controls were included and frequency matched by country, 5-year birth cohort and sex. Subjects were asked whether they had worked close to high-voltage electrical transmission installations, computer screens and various electrical machines, or in complex electrical environments. Measurements of two Scandinavian job-exposure matrices were applied to estimate lifelong cumulative EMF exposure. Unconditional logistic regression analyses, stratified by sex and eye colour were calculated, adjusting for several potential confounders. Results 293 patients with uveal melanoma and 3198 control subjects were interviewed. Women exposed to electrical transmission installations showed elevated risks (OR 5.81, 95% CI 1.72 to 19.66). Positive associations with exposure to control rooms were seen among men and women, but most risk increases were restricted to subjects with dark iris colour. Application of published EMF measurements revealed stronger risk increases among women compared to men. Again, elevated risks were restricted to subjects with dark eye colour. Conclusion Although based on a low prevalence of exposure to potential occupational sources of EMF, our data indicate that exposed dark-eyed women may be at particular risk for uveal melanoma.

**Yao K, Wang KJ, Sun ZH, Tan J, Xu W, Zhu LJ, Lu de Q. Low power microwave radiation inhibits the proliferation of rabbit lens epithelial cells by upregulating P27Kip1 expression. *Mol Vis.* 10:138-143, 2004.**

PURPOSE: The goal of this study was to examine the effects of low power microwave

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radiation (<10 mW/cm<sup>2</sup>) on the proliferation of cultured rabbit lens epithelial cells (RLEC). METHODS: Cultured RLEC were exposed to continuous microwave radiation at a frequency of **2,450 MHz** and power densities of 0.10, 0.25, 0.50, 1.00, and 2.00 mW/cm<sup>2</sup> for 8 h. Cell morphologic changes were observed under a phase-contrast microscope. Cell viability was measured using the MTT assay and cell cycle analysis was measured using flow cytometry. After exposure to 2.00 mW/cm<sup>2</sup> microwave radiation for 4, 6, and 8 h, the expression of cell cycle-regulatory proteins, P21WAF1 and P27Kip1, was examined using western blot analysis. Finally, the levels of P21WAF1 and P27Kip1 mRNA were analyzed by reverse transcription-polymerase chain reaction (RT-PCR). RESULTS: After 8 h of radiation treatment, cells treated with 0.50, 1.00, and 2.00 mW/cm<sup>2</sup> microwave radiation exhibited decreased cell viability, increased cell condensation and an inhibition of DNA synthesis. RLEC showed significant G0/G1 arrest. No obvious changes could be detected in the 0.10 and 0.25 mW/cm<sup>2</sup> microwave treatment groups. Protein expression of P27Kip1 was markedly increased after microwave radiation. However, the mRNA levels were unchanged. On the other hand, there were no detectable differences in P21WAF1 protein expression and mRNA levels between microwave treatment and control groups. CONCLUSIONS: This study suggests that low power microwave radiation higher than 0.50 mW/cm<sup>2</sup> can inhibit lens epithelial cell proliferation, and increase the expression of P27Kip1. These effects may account for the decline of lens epithelial proliferation after exposure to microwave radiation.

### **Kues HA, Monahan JC, D'Anna SA, McLeod DS, Luty GA, Koslov S, Increased sensitivity of the non-human primate eye to microwave radiation following ophthalmic drug pretreatment. *Bioelectromagnetics* 13(5):379-393, 1992.**

Previous studies in our laboratory have established that pulsed microwaves at 2.45 GHz and 10 mW/cm<sup>2</sup> are associated with production of corneal endothelial lesions and with disruption of the blood-aqueous barrier in the non-human primate eye. In the study reported here we examined ocular damage in monkeys (*M. mulatta* and *M. fascicularis*) following topical treatment with one of two ophthalmic drugs (timolol maleate and pilocarpine) that preceded exposure to pulsed microwaves. Anesthetized monkeys were sham exposed or exposed to pulsed, 2.45 GHz microwaves (10 microseconds, 100 pps) at average power densities of 0.2, 1, 5, 10, or 15 mW/cm<sup>2</sup> 4 h a day for 3 consecutive days (respective SARs were 0.052, 0.26, 1.3, 2.6, and 3.9 W/kg). Immediately before microwave exposure, one or both eyes were treated topically with one drop of 0.5% timolol maleate or of 2% pilocarpine. Following administration of a drug, we observed a significant reduction in the power-density threshold (from 10 to 1 mW/cm<sup>2</sup>) for induction of corneal endothelial lesions and for increased vascular permeability of the iris. Diagnostic procedures (in vivo specular microscopy and fluorescein iris angiography) were performed following each exposure protocol. In addition, increased vascular permeability was confirmed with horseradish peroxidase tracer techniques. Although we did not measure intraocular temperatures in experimental animals, the results suggest that a mechanism other than significant heating of the eye is involved. Our data indicate that pulsed microwaves at an average SAR of 0.26 W/kg, if administered after pretreatment with ophthalmic drugs, can produce significant ocular effects in the

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anesthetized primate.

**Kojima M, Hata I, Wake K, Watanabe S, Yamanaka Y, Kamimura Y, Taki M, Sasaki K. Influence of anesthesia on ocular effects and temperature in rabbit eyes exposed to microwaves. *Bioelectromagnetics* 25(3):228-233, 2004.**

To investigate the effect of systemic anesthesia on ocular effects and temperature in rabbit eyes exposed to microwaves, one eye each of 43 male pigmented rabbits (Dutch, 1.8-2.2 kg) was **exposed at 2.45 GHz** for 60-20 min (300 mW/cm<sup>2</sup>; 108 W/kg), either under anesthesia (ketamine hydrochloride (5 mg/kg) + xylazine (0.23 mg/kg)) or without anesthesia. Changes in the anterior segment were evaluated by image analysis utilizing a Scheimpflug camera, specular microscopy, and a laser flare cell meter. Temperatures within the eye were measured during microwave exposure by a Fluoroptic thermometer. The exposed eyes showed miosis, conjunctival congestion, corneal edema, and an increase in the light scattering of the anterior shallow cortex in the pupillary area of the lens. The group under systemic anesthesia showed much stronger symptoms than those treated without anesthesia. All of the anterior ocular changes disappeared within a week. The highest temperature during exposure was in the vitreous, followed by the anterior chamber, and the retrobulbar cavity of the orbit. The ocular temperatures of the rabbits under systemic anesthesia were 2-9 degrees C higher than those without anesthesia. Body temperature showed an increase of 1 degrees C during the exposure. Acute high intensity microwave exposure temporarily induced anterior segments inflammation and lens changes. The more pronounced ocular effects in the anesthetized rabbits were associated with the significantly higher ocular temperatures in the anesthetized animals. The influence of systemic anesthesia on ocular changes should be considered.

**Yu Y, Yao K. Non-thermal cellular effects of lowpower microwave radiation on the lens and lens epithelial cells. *J Int Med Res.* 38(3):729-736, 2010.**

Because of the increased use of modern radiofrequency devices, public concern about the possible health effects of exposure to microwave radiation has arisen in many countries. It is well established that high-power microwave radiation can induce cataracts via its thermal effects. It remains unclear whether low-power microwave radiation, especially at levels below the current exposure limits, is cataractogenic. This review summarizes studies on the biological effects of low-power microwave radiation on lens and lens epithelial cells (LECs). It has been reported that exposure affects lens transparency, alters cell proliferation and apoptosis, inhibits gap junctional intercellular communication, and induces genetic instability and stress responses in LECs. These results raise the question of whether the ambient microwave environment can induce non-thermal effects in the lens and whether such effects have potential health consequences. Further in vivo studies on the effects on the lens of exposure to low-power microwave radiation are needed.

**Balci M, Namuslu M, Devrim E, Durak I. Effects of computer monitor-emitted radiation on oxidant/antioxidant balance in cornea and lens from rats. *Mol Vis.* 15:2521-2525, 2009.**

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**PURPOSE:** This study aims to investigate the possible effects of computer monitor-emitted radiation on the oxidant/antioxidant balance in corneal and lens tissues and to observe any protective effects of vitamin C (vit C). **METHODS:** Four groups (PC monitor, PC monitor plus vitamin C, vitamin C, and control) each consisting of ten Wistar rats were studied. The study lasted for three weeks. Vitamin C was administered in oral doses of 250 mg/kg/day. The computer and computer plus vitamin C groups were exposed to computer monitors while the other groups were not. Malondialdehyde (MDA) levels and superoxide dismutase (SOD), glutathione peroxidase (GSH-Px), and catalase (CAT) activities were measured in corneal and lens tissues of the rats. **RESULTS:** In corneal tissue, MDA levels and CAT activity were found to increase in the computer group compared with the control group. In the computer plus vitamin C group, MDA level, SOD, and GSH-Px activities were higher and CAT activity lower than those in the computer and control groups. Regarding lens tissue, in the computer group, MDA levels and GSH-Px activity were found to increase, as compared to the control and computer plus vitamin C groups, and SOD activity was higher than that of the control group. In the computer plus vitamin C group, SOD activity was found to be higher and CAT activity to be lower than those in the control group. **CONCLUSION:** The results of this study suggest that computer-monitor radiation leads to oxidative stress in the corneal and lens tissues, and that vitamin C may prevent oxidative effects in the lens.

**Lu L, Xu H, Wang X, Guo G. Increased nitric oxide synthase activity is essential for electromagnetic-pulse-induced blood-retinal barrier breakdown in vivo. Brain Res. 1264:104-10, 2009.**

**PURPOSE:** To examine whether electromagnetic pulses (EMPs) affected the permeability of the blood-retinal barrier (BRB), gene expression of occludin and activity of nitric oxide synthase (NOS). **METHODS:** Sprague-Dawley (SD) rats were used and randomized into EMP and control groups. Retinas were removed immediately, and 2 h or 24 h after EMP radiation. BRB permeability was analyzed by transmission electron microscopy and Evans Blue staining. Retinal NOS activity and concentrations of nitrite and nitrate were measured. Occludin mRNA and protein levels were detected by RT-PCR and Western blotting. **RESULTS:** Exposure of SD rats to EMP resulted in increased BRB permeability, with the greatest decrease in occludin at 24 h. Moreover, this permeability defect was also correlated with significant increases in the formation of NO and induction of NOS activity in SD rats. Furthermore, we found that treatment with NOS inhibitor N-nitro-L-arginine methyl ester (L-NAME) blocked BRB breakdown and prevented the increase in NO formation and induction of NOS activity, as well as the decrease in occluding expression. **CONCLUSION:** Taken together, these results support the view that NOS-dependent NO production is an important factor that contributes to EMP-induced BRB dysfunction, and suggests that NOS induction may play an important role in BRB breakdown.

**Wang KJ, Yao K, Lu DQ. [Effects of different dose microwave radiation on protein components of cultured rabbit lens] Zhonghua Lao Dong Wei Sheng Zhi Ye Bing Za Zhi. 25(4):208-210, 2007. [Article in Chinese]**

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**OBJECTIVE:** To study the effects of different dose microwave radiation on protein components of cultured rabbit lens, and analyze the mechanisms of lens injury caused by microwave radiation. **METHODS:** Cultured rabbit lens were exposed to microwave radiation with frequency of **2450 MHz** and power density of 0.25, 0.50, 1.00, 2.00, 5.00 mW/cm(2) for 8 hours in vitro. The transparency of lens was observed. Changes of protein concentration were detected after different lens protein components were extracted, including water-soluble protein (WSP), urea soluble protein (USP), alkali soluble protein (ASP) and sonicated protein (SP). The influence of microwave radiation on WSP was analyzed using SDS-PAGE electrophoresis and coomassie-blue staining. **RESULTS:** Transparency of lens decreased after radiation. There was obvious opacification of lens cortex after 5.00 mW/cm(2) microwave radiation for 8 hours. After 1.00, 2.00 and 5.00 mW/cm(2) radiation, the percentage of WSP decreased while USP increased obviously. There was no change of ASP. The percentage of SP decreased when the power of microwave was 5.00 mW/cm(2). The low molecular weight protein of WSP decreased while high molecular weight protein increased after microwave radiation. **CONCLUSION:** Microwave radiation higher than 1.00 mW/cm(2) can affect the proportion of WSP and USP in cultured rabbit lens, and cause changes of lens transparency and refractive power, which leads to lens opacity.

## Effect on Fertility and Reproduction

**Atasoy HI, Gunal MY, Atasoy P, Elgun S, Bugdayci G. Immunohistopathologic demonstration of deleterious effects on growing rat testes of radiofrequency waves emitted from conventional Wi-Fi devices. J Pediatr Urol. 9(2):223-229, 2013.**

**OBJECTIVE:** To investigate effects on rat testes of radiofrequency radiation emitted from indoor Wi-Fi Internet access devices using 802.11.g wireless standards. **METHODS:** Ten Wistar albino male rats were divided into experimental and control groups, with five rats per group. Standard wireless gateways communicating at 2.437 GHz were used as radiofrequency wave sources. The experimental group was exposed to radiofrequency energy for 24 h a day for 20 weeks. The rats were sacrificed at the end of the study. Intracardiac blood was sampled for serum 8-hydroxy-2'-deoxyguanosine levels. Testes were removed and examined histologically and immunohistochemically. Testis tissues were analyzed for malondialdehyde levels and prooxidant-antioxidant enzyme activities. **RESULTS:** We observed significant increases in serum 8-hydroxy-2'-deoxyguanosine levels and 8-hydroxyguanosine staining in the testes of the experimental group indicating DNA damage due to exposure ( $p < 0.05$ ). We also found decreased levels of catalase and glutathione peroxidase activity in the experimental group, which may have been due to radiofrequency effects on enzyme activity ( $p < 0.05$ ). **CONCLUSIONS:** These findings raise questions about the safety of radiofrequency exposure from Wi-Fi Internet access devices for growing organisms of reproductive age, with a potential effect on both fertility and the integrity of germ cells.

## Studies that show WiFi and Devices Health Effects

**Dasdag S, Taş M, Akdag MZ, Yegin K. Effect of long-term exposure of 2.4 GHz radiofrequency radiation emitted from Wi-Fi equipment on testes functions. *Electromagn Biol Med.* 2014 Jan 24. [Epub ahead of print]**

The aim of this study was to investigate long-term effects of radiofrequency radiation (RFR) emitted from a Wireless Fidelity (Wi-Fi) system on testes. The study was carried out on 16 Wistar Albino adult male rats by dividing them into two groups such as sham (n: 8) and exposure (n: 8). Rats in the exposure group were exposed to 2.4 GHz RFR radiation for 24 h/d during 12 months (1 year). The same procedure was applied to the rats in the sham control group except the Wi-Fi system was turned off. Immediately after the last exposure, rats were sacrificed and reproductive organs were removed. Motility (%), concentration ( $\times 10^6/\text{mL}$ ), tail defects (%), head defects (%) and total morphologic defects (%) of sperms and weight of testes (g), left epididymis (g), prostate (g), seminal vesicles (g) were determined. Seminiferous tubules diameter ( $\mu\text{m}$ ) and tunica albuginea thickness ( $\mu\text{m}$ ) were also measured. However, the results were evaluated by using Johnsen's score. Head defects increased in the exposure group ( $p < 0.05$ ) while weight of the epididymis and seminal vesicles, seminiferous tubules diameter and tunica albuginea thickness were decreased in the exposure group ( $p < 0.01$ ,  $p < 0.001$ ,  $p < 0.0001$ ). However, other alterations of other parameters were not found significant ( $p > 0.05$ ). In conclusion, we observed that long-term exposure of 2.4 GHz RF emitted from Wi-Fi (2420  $\mu\text{W}/\text{kg}$ , 1 g average) affects some of the reproductive parameters of male rats. We suggest Wi-Fi users to avoid long-term exposure of RF emissions from Wi-Fi equipment.

**Avendaño C, Mata A, Sanchez Sarmiento CA, Doncel GF. Use of laptop computers connected to internet through Wi-Fi decreases human sperm motility and increases sperm DNA fragmentation. *Fertil Steril.* 97(1):39-45, 2012.**

**OBJECTIVE:** To evaluate the effects of laptop computers connected to local area networks wirelessly (Wi-Fi) on human spermatozoa. **DESIGN:** Prospective in vitro study. **SETTING:** Center for reproductive medicine. **PATIENT(S):** Semen samples from 29 healthy donors. **INTERVENTION(S):** Motile sperm were selected by swim up. Each sperm suspension was divided into two aliquots. One sperm aliquot (experimental) from each patient was exposed to an internet-connected laptop by Wi-Fi for 4 hours, whereas the second aliquot (unexposed) was used as control, incubated under identical conditions without being exposed to the laptop. **MAIN OUTCOME MEASURE(S):** Evaluation of sperm motility, viability, and DNA fragmentation. **RESULT(S):** Donor sperm samples, mostly normozoospermic, exposed ex vivo during 4 hours to a wireless internet-connected laptop showed a significant decrease in progressive sperm motility and an increase in sperm DNA fragmentation. Levels of dead sperm showed no significant differences between the two groups. **CONCLUSION(S):** To our knowledge, this is the first study to evaluate the direct impact of laptop use on human spermatozoa. Ex vivo exposure of human spermatozoa to a wireless internet-connected laptop decreased motility and induced DNA fragmentation by a nonthermal effect. We speculate that keeping a laptop connected wirelessly to the internet on the lap near the testes may result in decreased male fertility. Further in vitro and in vivo studies are needed to prove this contention.

## Studies that show WiFi and Devices Health Effects

**Nazıroğlu M, Yüksel M, Köse SA, Özkaya MO. Recent reports of Wi-Fi and mobile phone-induced radiation on oxidative stress and reproductive signaling pathways in females and males. J Membr Biol. 246(12):869-875, 2013.**

Environmental exposure to electromagnetic radiation (EMR) has been increasing with the increasing demand for communication devices. The aim of the study was to discuss the mechanisms and risk factors of EMR changes on reproductive functions and membrane oxidative biology in females and males. It was reported that even chronic exposure to EMR did not increase the risk of reproductive functions such as increased levels of neoantigens abort. However, the results of some studies indicate that EMR induced endometriosis and inflammation and decreased the number of follicles in the ovarium or uterus of rats. In studies with male rats, exposure caused degeneration in the seminiferous tubules, reduction in the number of Leydig cells and testosterone production as well as increases in luteinizing hormone levels and apoptotic cells. In some cases of male and female infertility, increased levels of oxidative stress and lipid peroxidation and decreased values of antioxidants such as melatonin, vitamin E and glutathione peroxidase were reported in animals exposed to EMR. In conclusion, the results of current studies indicate that oxidative stress from exposure to Wi-Fi and mobile phone-induced EMR is a significant mechanism affecting female and male reproductive systems. However, there is no evidence to this date to support an increased risk of female and male infertility related to EMR exposure.

**Saygin M, Caliskan S, Karahan N, Koyu A, Gumral N, Uguz A. Testicular apoptosis and histopathological changes induced by a 2.45 GHz electromagnetic field. Toxicol Ind Health. 27(5):455-463, 2011.**

There is a growing public concern about the potential human health hazard caused by exposure to electromagnetic radiation (EMR). The objective of this study is to investigate the effects of **2450 mhz** electromagnetic field on apoptosis and histopathological changes on rat testis tissue. Twelve-week-old male Wistar Albino rats were used in this study. Eighteen rats equally divided into three different groups which were named group I, II and III. Cage control (group I), sham control (group II) and 2.45 GHz EMR (group III) groups were formed. Group III were exposed to 2.45 GHz EMR, at 3.21 W/kg specific absorption rate for 60 minutes/ day for 28 days. There was no difference among the groups for the diameter of the seminiferous tubules, pyknotic, karyoleptic and karyotic cells. However, the number of Leydig cells of testis tissue of the rats in group III was significantly reduced comparing with the group I ( $p < 0.05$ ). Estimation of spermatogenesis using the Johnsen testicular biopsy score revealed that the difference between groups is statistically significant. The level of TNF- $\alpha$ , Caspase-3 and Bcl-2 were compared, and no significant difference was found between the groups. When Bax apoptosis genes and Caspase-8 apoptosis enzyme were compared, there were significant differences between the groups ( $p < 0.05$ ). Electromagnetic field affects spermatogenesis and causes to apoptosis due to the heat and other stress-related events in testis tissue.

**Wang H, Peng R, Zhou H, Wang S, Gao Y, Wang L, Yong Z, Zuo H, Zhao L, Dong J, Xu X, Su Z. Impairment of long-term potentiation induction is essential for the disruption of**

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### **spatial memory after microwave exposure. Int J Radiat Biol. 2013 Jul 24. [Epub ahead of print]**

Purpose: To assess the impact of microwave exposure on learning and memory and to explore the underlying mechanisms. Materials and methods: 100 Wistar rats were exposed to a 2.856 GHz pulsed microwave field at average power densities of 0 mW/cm<sup>2</sup>, 5 mW/cm<sup>2</sup>, 10 mW/cm<sup>2</sup> and 50 mW/cm<sup>2</sup> for 6 min. The spatial memory was assessed by the Morris Water Maze (MWM) task. An in vivo study was conducted soon after microwave exposure to evaluate the changes of population spike (PS) amplitudes of long-term potentiation (LTP) in the medial perforant path (MPP)-dentate gyrus (DG) pathway. The structure of the hippocampus was observed by the light microscopy and the transmission electron microscopy (TEM) at 7 d after microwave exposure. Results: Our results showed that the rats exposed in 10 mW/cm<sup>2</sup> and 50 mW/cm<sup>2</sup> microwave displayed significant deficits in spatial learning and memory at 6 h, 1 d and 3 d after exposure. Decreased PS amplitudes were also found after 10 mW/cm<sup>2</sup> and 50 mW/cm<sup>2</sup> microwave exposure. In addition, varying degrees of degeneration of hippocampal neurons, decreased synaptic vesicles and blurred synaptic clefts were observed in the rats exposed in 10 mW/cm<sup>2</sup> and 50 mW/cm<sup>2</sup> microwave. Compared with the sham group, the rats exposed in 5 mW/cm<sup>2</sup> microwave showed no difference in the above experiments. Conclusions: This study suggested that impairment of LTP induction and the damages of hippocampal structure, especially changes of synapses, might contribute to cognitive impairment after microwave exposure.

### **Oksay T, Naziroğlu M, Doğan S, Güzel A, Gümral N, Koşar PA. Protective effects of melatonin against oxidative injury in rat testis induced by wireless (2.45 GHz) devices. Andrologia. 2012 Nov 12. doi: 10.1111/and.12044. [Epub ahead of print]**

Wireless devices have become part of everyday life and mostly located near reproductive organs while they are in use. The present study was designed to determine the possible protective effects of melatonin on oxidative stress-dependent testis injury induced by **2.45-GHz electromagnetic radiation (EMR)**. Thirty-two rats were equally divided into four different groups, namely cage control (A1), sham control (A2), 2.45-GHz EMR (B) and 2.45-GHz EMR+melatonin (C). Group B and C were exposed to 2.45-GHz EMR during 60 min day<sup>-1</sup> for 30 days. Lipid peroxidation levels were higher in Group B than in Group A1 and A2. Melatonin treatment prevented the increase in the lipid peroxidation induced by EMR. Also reduced glutathione (GSH) and glutathione peroxidase (GSH-Px) levels in Group D were higher than that of exposure group. Vitamin A and E concentrations decreased in exposure group, and melatonin prevented the decrease in vitamin E levels. In conclusion, wireless (2.45 GHz) EMR caused oxidative damage in testis by increasing the levels of lipid peroxidation and decreasing in vitamin A and E levels. Melatonin supplementation prevented oxidative damage induced by EMR and also supported the antioxidant redox system in the testis.

### **Mortazavi S, Parsanezhad M, Kazempour M, Ghahramani P, Mortazavi A, Davari M. Male reproductive health under threat: Short term exposure to radiofrequency radiations emitted by common mobile jammers. J Hum Reprod Sci. 2013 Apr;6(2):124-**

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### 8. doi: 10.4103/0974-1208.117178.

**BACKGROUND:** Modern life prompted man to increasingly generate, transmit and use electricity that leads to exposure to different levels of electromagnetic fields (EMFs). Substantial evidence indicates that exposure to common sources of EMF such as mobile phones, laptops or wireless internet-connected laptops decreases human semen quality. In some countries, mobile jammers are occasionally used in offices, shrines, conference rooms and cinemas to block the signal. **AIMS:** To the best of our knowledge, this is the first study to investigate the effect of short term exposure of human sperm samples to radiofrequency (RF) radiations emitted by common mobile jammers. **SUBJECTS AND METHODS:** Fresh semen samples were collected by masturbation from 30 healthy donors who had referred to Infertility Treatment Center at the Mother and Child Hospital with their wives. Female problem was diagnosed as the reason for infertility in these couples. **STATISTICAL ANALYSIS:** T-test and analysis of variance were used to show statistical significance. **RESULTS:** The motility of sperm samples exposed to jammer RF radiation for 2 or 4 h were significantly lower than those of sham-exposed samples. These findings lead us to the conclusion that mobile jammers may significantly decrease sperm motility and the couples' chances of conception. **CONCLUSION:** Based on these results, it can be suggested that in countries that have not banned mobile jammer use, legislations should be urgently passed to restrict the use of these signal blocking devices in public or private places.

### **Meena R, Kumari K, Kumar J, Rajamani P, Verma HN, Kesari KK. Therapeutic approaches of melatonin in microwave radiations-induced oxidative stress-mediated toxicity on male fertility pattern of Wistar rats. Electromagn Biol Med. 2013 May 15. [Epub ahead of print]**

Abstract Microwave (MW) radiation produced by wireless telecommunications and a number of electrical devices used in household or in healthcare institutions may adversely affects the reproductive pattern. Present study aimed to investigate the protective effects of melatonin (is well known antioxidant that protects DNA, lipids and proteins from free radical damage) against oxidative stress-mediated testicular impairment due to long-term exposure of MWs. For this, 70-day-old male Wistar rats were divided into four groups (n = 6/group): Sham exposed, Melatonin (Mel) treated (2 mg/kg), **2.45 GHz MWs** exposed and MWs + Mel treated. Exposure took place in Plexiglas cages for 2 h a day for 45 days where, power density (0.21 mW/cm<sup>2</sup>) and specific absorption rate (SAR 0.14 W/Kg) were estimated. After the completion of exposure period, rats were sacrificed and various stress related parameters, that is LDH-X (lactate dehydrogenase isoenzyme) activity, xanthine oxidase (XO), ROS (reactive oxygen species), protein carbonyl content, DNA damage and MDA (malondialdehyde) were performed. Result shows that melatonin prevent oxidative damage biochemically by significant increase (p < 0.001) in the levels of testicular LDH-X, decreased (p < 0.001) levels of MDA and ROS in testis (p < 0.01). Meanwhile, it reversed the effects of MWs on XO, protein carbonyl content, sperm count, testosterone level and DNA fragmentation in testicular cells. These results concluded that the melatonin has strong antioxidative potential against MW induced oxidative stress mediated DNA damage in testicular cells.

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### Effects on Pregnancy

**Col-Araz N. Evaluation of factors affecting birth weight and preterm birth in southern Turkey. J Pak Med Assoc. 2013 Apr;63(4):459-62.**

**OBJECTIVE:** To identify factors affecting birth weight and pre-term birth, and to find associations with electromagnetic devices such as television, computer and mobile phones. **METHODS:** The study was conducted in Turkey at Gazintep University, Faculty of Medicine's Outpatient Clinic at the Paediatric Ward. It comprised 500 patients who presented at the clinic from May to December 2009. All participants were administered a questionnaire regarding their pregnancy history. SPSS 13 was used for statistical analysis. **RESULTS:** In the study, 90 (19%) patients had pre-term birth, and 64 (12.9%) had low birth weight rate Birth weight was positively correlated with maternal age and baseline maternal weight ( $r = 0.115$ ,  $p < 0.010$ ;  $r = 0.168$ ,  $p < 0.000$ , respectively). Pre-term birth and birth weight less than 2500g were more common in mothers with a history of disease during pregnancy ( $p < 0.046$  and  $p < 0.008$ , respectively). The habit of watching television and using mobile phones and computer by mothers did not demonstrate any relationship with birth weight. Mothers who used mobile phones or computers during pregnancy had more deliveries before 37 weeks ( $p < 0.018$ ,  $p < 0.034$ ; respectively). Similarly, pregnancy duration was shorter in mothers who used either mobile phone or computers during pregnancy ( $p < 0.005$ ,  $p < 0.048$ , respectively). **CONCLUSION:** Mobile phones and computers may have an effect on pre-term birth.

**Cabot E, Christ A, Bühlmann B, Zefferer M, Chavannes N, Bakker JF, van Rhoon GC, Kuster N. Quantification Of RF-exposure of the Fetus Using Anatomical CAD-Models in Three Different Gestational Stages. Health Phys. 107(5):369-381, 2014.**

This study analyzes the exposure of pregnant women and their fetuses in three different gestational stages to electromagnetic radiation in the radio frequency range in the near- and the far-field using numerical modeling. For far-field exposure, the power density at which the basic restriction for the whole body SAR is reached is calculated for both the mother and the fetus at whole body resonance and at frequencies between 450 MHz and **2,450 MHz**. The near-field exposure is assessed at 450 MHz, 900 MHz, and 2,450 MHz using half wavelength dipoles as generic sources located at different locations around the abdomen of the mother. For the investigated cases, the exposure of the mother is always below or on the order of magnitude of the basic restriction for exposure at the reference level. When applying the reference levels for the general public, the fetus is sufficiently shielded by the mother. However, the basic restrictions for general public exposure can be exceeded in the fetus when the mother is exposed at reference levels for occupational conditions. For plane wave exposure at occupational levels, the whole body SAR in the fetus can exceed the basic restrictions for the general population by at least 1.8 dB, and in the near-field of professional devices, the 10 g SAR can be non-compliant with the product standard for the general public by > 3.5 dB.

**Bellieni CV, Pinto I, Bogi A, Zoppetti N, Andreuccetti D, Buonocore G. Exposure to electromagnetic fields from laptop use of "laptop" computers. Arch Environ Occup**

## Studies that show WiFi and Devices Health Effects

### **Health. 67(1):31-36, 2012.**

Portable computers are often used at tight contact with the body and therefore are called "laptop." The authors measured electromagnetic fields (EMFs) laptop computers produce and estimated the induced currents in the body, to assess the safety of laptop computers. The authors evaluated 5 commonly used laptop of different brands. They measured EMF exposure produced and, using validated computerized models, the authors exploited the data of one of the laptop computers (LTCs) to estimate the magnetic flux exposure of the user and of the fetus in the womb, when the laptop is used at close contact with the woman's womb. In the LTCs analyzed, EMF values (range 1.8-6  $\mu$ T) are within International Commission on Non-Ionizing Radiation (NIR) Protection (ICNIRP) guidelines, but are considerably higher than the values recommended by 2 recent guidelines for computer monitors magnetic field emissions, MPR II (Swedish Board for Technical Accreditation) and TCO (Swedish Confederation of Professional Employees), and those considered risky for tumor development. When close to the body, the laptop induces currents that are within 34.2% to 49.8% ICNIRP recommendations, but not negligible, to the adult's body and to the fetus (in pregnant women). On the contrary, the power supply induces strong intracorporal electric current densities in the fetus and in the adult subject, which are respectively 182-263% and 71-483% higher than ICNIRP 98 basic restriction recommended to prevent adverse health effects. Laptop is paradoxically an improper site for the use of a LTC, which consequently should be renamed to not induce customers towards an improper use.

**Çelik Ö, Kahya MC, Nazıroğlu M. Oxidative stress of brain and liver is increased by Wi-Fi (2.45GHz) exposure of rats during pregnancy and the development of newborns. J Chem Neuroanat. 2015 Oct 28. pii: S0891-0618(15)00074-5. doi: 10.1016/j.jchemneu.2015.10.005. [Epub ahead of print]**

An excessive production of reactive oxygen substances (ROS) and reduced antioxidant defence systems resulting from electromagnetic radiation (EMR) exposure may lead to oxidative brain and liver damage and degradation of membranes during pregnancy and development of rat pups. We aimed to investigate the effects of **Wi-Fi-induced EMR** on the brain and liver antioxidant redox systems in the rat during pregnancy and development. Sixteen pregnant rats and their 48 newborns were equally divided into control and EMR groups. The EMR groups were exposed to 2.45GHz EMR (1hour/day for 5 days/week) from pregnancy to 3 weeks of age. Brain cortex and liver samples were taken from the newborns between the first and third weeks. In the EMR groups, lipid peroxidation levels in the brain and liver were increased following EMR exposure; however, the glutathione peroxidase (GSH-Px) activity, and vitamin A, vitamin E and -carotene concentrations were decreased in the brain and liver. Glutathione (GSH) and vitamin C concentrations in the brain were also lower in the EMR groups than in the controls; however, their concentrations did not change in the liver. In conclusion, Wi-Fi-induced oxidative stress in the brain and liver of developing rats was the result of reduced GSH-Px, GSH and antioxidant vitamin concentrations. Moreover, the brain seemed to be more sensitive to oxidative injury compared to the liver in the development of newborns.

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**Yoshida Y, Seto T, Ohsu W, Hayashi S, Okazawa T, Nagase H, Yoshida M, Nakamura H, [Endocrine mechanism of placental circulatory disturbances induced by microwave in pregnant rats]. *Nippon Sanka Fujinka Gakkai Zasshi* 47(2):101-108, 1995. [Article in Japanese]**

Effects of microwaves on fetus and female genital organs remain to be elucidated. To demonstrate the placental circulatory disturbances induced by microwaves and to clarify the endocrine pathogenesis, placental blood flow and five endocrine indicators, i.e., corticosterone (CS), estradiol (E2), progesterone (P), prostaglandin E2 (PGE2) and prostaglandin F2 alpha (PGF2 alpha) were measured in rats exposed to whole-body microwaves with an intensity of 10 mW/cm<sup>2</sup> at a frequency of **2,450 MHz**. The placental blood flow at 45-90 min after exposure was significantly decreased in the rats exposed to the microwaves. Placental blood flow at 15 and 30 min was increased by pretreatment with intraperitoneal administration of angiotensin II (All). In contrast, no significant change in placental blood flow was recognized in the All pretreated rats exposed to the microwaves. An increase in CS and a decrease in E2 were induced by the microwave exposure independent of pretreatment with All. P was increased by microwave exposure in the rats without pretreatment with All. PGE2 was not changed by the microwave exposure in the case of either nonpretreatment or pretreatment with All. PGF2 alpha was increased by the microwave exposure in the rats without pretreatment with All. The present results indicate that excessive exposure to whole-body microwave disorders pregnancy in terms of placental circulatory dysfunction. The data suggest the involvement of endocrine mechanisms in the decrease in placental blood flow which is induced via a detrimental effect of microwaves on PGF2 alpha and on pituitary functions such as general emotional stress.

**Cobb BL, Jauchem JR, Mason PA, Dooley MP, Miller SA, Ziriak JM, Murphy MR, Neural and behavioral teratological evaluation of rats exposed to ultra-wideband electromagnetic fields. *Bioelectromagnetics* 21(7):524-537, 2000.**

Several investigators have reported teratologic effects of electromagnetic field exposure. The majority of these studies have been performed at levels of exposure that could produce substantial heating of the animals. New and unique sources of ultra-wideband (UWB) electromagnetic fields are currently being developed and tested that are capable of generating nonthermalizing, high-peak-power, microwave(MW) pulses with nanosecond (ns) pulse widths, picosecond (ps) rise times, and an UWB of frequencies. Our study was performed to determine if teratological changes occur in rat pups as a result of (i) daily UWB exposures during gestation days 3-18, or (ii) as a result of both prenatal and postnatal (10 days) exposures. Dams were exposed either to (i) UWB irradiation from a Kentech system that emitted a 55 kV/m-peak E field, 300 ps rise time, and a 1.8 ns pulse width, average whole-body specific absorption rate 45 mW/kg; (ii) sham irradiation; or (iii) a positive control, lead (Pb) acetate solution (2000 mug/ml) continuously available in the drinking water. Offspring were examined for ontogeny (litter size, sex-ratios, weights, coat appearance, tooth-eruption, eye-opening, air-righting, and ultrasonic stress vocalizations). Male pups were tested on various

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performance measures (locomotor, water-maze learning, and fertilization capabilities). The pups postnatally exposed were examined for hippocampal morphology and operant behavior. Behavioral, functional, and morphological effects of UWB exposure were unremarkable with these exceptions: (i) The UWB-exposed pups emitted significantly more stress vocalizations than the sham-exposed pups; (ii) the medial-to-lateral length of the hippocampus was significantly longer in the UWB-exposed pups than in the sham-exposed animals; (iii) male offspring exposed in utero to UWB mated significantly less frequently than sham-exposed males, but when they did mate there was no difference in fertilization and offspring numbers from the sham group. There does not appear to be a unifying physiological or behavioral relationship among the significant differences observed, and our findings could be due to the expected spurious results derived when a large number of statistical comparisons are made. Significant effects found between our positive-controls and other groups on numerous measures indicates that the techniques used were sensitive enough to detect teratological effects.

## Cancer

**Richter E, Berman T, Ben-Michael E, Laster R, Westin JB, Cancer in Radar Technicians Exposed to Radiofrequency/Microwave Radiation: Sentinel Episodes. Int J Occup Environ Health 6(3):187-193, 2000.**

Controversy exists concerning the health risks from exposures to radiofrequency/microwave irradiation (RF/MW). The authors report exposure-effect relationships in sentinel patients and their co-workers, who were technicians with high levels of exposure to RF/MW radiation. Information about exposures of patients with sentinel tumors was obtained from interviews, medical records, and technical sources. One patient was a member of a cohort of 25 workers with six tumors. The authors estimated relative risks for cancer in this group and latency periods for a larger group of self-reported individuals. Index patients with melanoma of the eye, testicular cancer, nasopharyngioma, non-Hodgkin's lymphoma, and breast cancer were in the 20-37-year age group. Information about work conditions suggested prolonged exposures to high levels of RF/MW radiation that produced risks for the entire body. Clusters involved many different types of tumors. Latency periods were extremely brief in index patients and a larger self-reported group. The findings suggest that young persons exposed to high levels of RF/MW radiation for long periods in settings where preventive measures were lax were at increased risk for cancer. Very short latency periods suggest high risks from high-level exposures. Calculations derived from a linear model of dose-response suggest the need to prevent exposures in the range of 10-100  $\mu\text{w}/\text{cm}^2$ .

**Paulraj R, Behari J. The effect of low level continuous 2.45 GHz waves on enzymes of developing rat brain. Electromag Biol Med 21:221-231, 2002.**

The present work describes the effect of low level continuous microwaves (2.45 GHz) on developing rat brain. Some 35-day-old Wistar rats were used for this study. The animals were exposed 2 hr/day for 35 days at a power density of  $0.34 \text{ mW}/\text{cm}^2$  [specific

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absorption rate (SAR), 0.1 W/kg] in a specially made anechoic chamber. After the exposure, the rats were sacrificed and the brain tissue was dissected out and used for various biochemical assays. A significant increase in calcium ion efflux and ornithine decarboxylase (ODC) activity was observed in the exposed group as compared to the control. Correspondingly, a significant decrease in the calcium-dependent protein kinase activity was observed. These results indicate that this type of radiation affects the membrane bound enzymes, which are associated with cell proliferation and differentiation, thereby pointing out its possible role as a tumor promoter.

**Lourencini da Silva R , Albano F, Lopes dos Santos LR , Tavares AD, Felzenszwalb I, The effect of electromagnetic field exposure on the formation of DNA lesions. Redox Rep 5(5):299-301, 2000.**

In an attempt to determine whether electromagnetic field (EMF) exposure might lead to DNA damage, we exposed SnCl<sub>2</sub>-treated pBR322 plasmids to EMF and analysed the resulting conformational changes using agarose gel electrophoresis. An EMF-dependent potentiation of DNA scission (i.e. the appearance of relaxed plasmids) was observed. In confirmation of this, plasmids pre-exposed to EMF also were less capable of transforming *Escherichia coli*. The results indicate that EMF, in the presence of a transition metal, is capable of causing DNA damage. These observations support the idea that EMF, probably through secondary generation of reactive oxygen species, can be clastogenic and provide a possible explanation for the observed correlation between EMF exposure and the frequency of certain types of cancers in humans.

**Singh N, Rudra N, Bansal P, Mathur R, Behari J, Nayar U, Poly ADP ribosylation as a possible mechanism of microwave--biointeraction. Indian J Physiol Pharmacol 38(3):181-184, 1994.**

Electromagnetic fields (EMFs) affect the metabolism of the body including the nervous, endocrine, cardiovascular, hematological as well as the reproductive system. EMFs are environmental pollutants, thus posing a health hazard which can cause steric changes in the molecule located at the cell surface. Microwaves are known to cause chromosomal aberrations and act as tumor promoters. The process involves a stream of signals from cell membrane to nucleus and other organelles. The present investigations aim to understand the mechanism of biological effects of **microwaves (2.45 GHz)**. The effect was studied on poly ADP-ribosylation, which is a post translational modification of chromatin protein catalysed by the enzyme poly ADPR polymerase using NAD<sup>+</sup> as the substrate. Poly ADP-ribosylation has been shown to be involved in several aspects of chromatin structure and function. Twenty-three days old rats weighing 42-48 gms were exposed at a microwave dose level of 1.0 mW/cm<sup>2</sup>. After exposure for sixty days the animals were sacrificed and an estimation of poly ADPR polymerase activity was undertaken in different organs of these animals. There was an increase of 20% in its activity in liver, 35% in testis, whereas brain showed a 53% decrease in diencephalon and 20% decrease in the cortex in the exposed animals as compared to their respective controls. There was no change in enzyme activity in spleen and kidney. This was accompanied by concomitant changes in NAD<sup>+</sup> levels. The above results may be cited as important events in carcinogenesis and tumor promotion related to microwave exposure

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and the signal transduction mechanism involved. The goal is to shed light on complex ecogenetic interactions leading to cancer modulation of gene expression by epigenetic mechanism.

**Balcer-Kubiczek EK, Harrison GH. Neoplastic transformation of C3H/10T1/2 cells following exposure to 120-Hz modulated 2.45-GHz microwaves and phorbol ester tumor promoter. Radiat Res 126(1):65-72, 1991.**

Some recent epidemiological studies have shown a positive association between cancer incidence and exposure to electromagnetic (EM) fields. Evidence from in vitro studies indicates that this effect could be due to synergistic interaction between EM fields and tumor promoters. However, no dose-response data related directly to carcinogenesis have been published. In this study, actively growing cultures of C3H/10T1/2 cells were exposed for 24 h to **2.45-GHz microwaves pulse-modulated** at 120 Hz. Conditions of EM-field exposure were designed to simulate low-field exposures (specific absorption rate 0.1, 1, or 4.4 W/kg; the corresponding peak amplitudes were electric field 18, 56, or 120 V/m, magnetic field 0.09, 0.27, or 0.56  $\mu$ T, respectively). In separate experiments, a 24-h EM-field exposure at 4.4 W/kg was preceded or followed by X irradiation at 0.5, 1, or 1.5 Gy. Cells were assayed for cell survival and neoplastic transformation with or without post-treatment administration of 0.1 micrograms/ml of 12-O-tetradecanoylphorbol-13-acetate (TPA) for the duration of the assay. The EM fields alone had no effect on cell survival or induction of neoplastic transformation. However, enhancement of transformation due to EM fields plus TPA was highly significant and ranged up to a level equivalent to that produced by 1.5 Gy of X rays. The frequency of neoplastic transformation was dependent on the level of EM exposure and was additive with doses of X rays given as a cocarcinogen.

**Zhu W, Zhang W, Li Y, Xu J, Luo J, Jiang Y, Lu X, Lü S. [Inhibitory effect of microwave radiation on proliferation of human pancreatic cancer JF305 cells and its mechanism]. Wei Sheng Yan Jiu. 42(6):1008-1011, 2013.**

**[Article in Chinese]**

**OBJECTIVE:** To investigate on the proliferation effect of different intensities **2450 MHz microwave radiation on human pancreatic cancer JF305 cells** and its possible mechanism. **METHODS:** JF305 cells were radiated by intensity of 2.5, 5.0, 10.0, 15.0 and 20.0 mW/cm<sup>2</sup> microwave for 20 min. The proliferation capacity of JF305 was measured by MTT assays, Annexin V-FITC and PI staining was used for detecting cell apoptosis. The activity of Caspase-3 was examined. The expressions of Caspase-3 and HSP 70 protein after the cell treatment with microwave were detected by Western blotting. **RESULTS:** After microwave radiation, the proliferation inhibition rates of JF305 cells were significantly higher compared with control group. Annexin V-FITC and PI staining result showed that microwave radiation could induce cell apoptosis. Caspase-3 increased after radiated by microwave, compared with control group (P < 0.05). Results of Western blotting showed that the expression of Caspase-3 and HSP 70 protein increased significantly in different dosage radiation group. **CONCLUSION:** Microwave radiation can

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inhibit the proliferation of JF305 cells, the possible mechanism may be related with inducing cell apoptosis by changing of stress level.

**Johnson EH, Chima SC, Muirhead DE, A cerebral primitive neuroectodermal tumor in a squirrel monkey (*Saimiri sciureus*). *J Med Primatol* 28(2):91-96, 1999.**

An adult squirrel monkey with a history of long-term exposure to microwave radiation was found at necropsy to have a malignant tumor of the right cerebral cortex. Gross examination revealed a mass with expanding borders in the right frontoparietal cortex with compression of the adjacent lateral ventricle. Microscopy revealed a tumor composed of sheets of moderate-sized cells, resembling an oligodendroglioma, with clear cytoplasm and central nuclei interrupted by delicate vasculature. Malignant features were present in the form of marked nuclear pleomorphism, frequent mitotic figures, and focal necrosis. A neuronal cell origin for this tumor was supported by immunohistochemical analysis, which revealed immunopositivity for neurofilament proteins and neuron-specific enolase. Staining for vimentin and glial fibrillary acid protein was negative, except in reactive astrocytes at the tumor margins and adjacent to intra-tumoral blood vessels. Antibody activity against Ki-67 antigen, a marker of rapidly proliferating tumor cells, and p53 oncoprotein was strongly positive, indicative of the aggressive and malignant nature of this tumor. The tumor was diagnosed as a cerebral primitive neuroectodermal tumor.

## Effects on Children

**Sangun O, Dundar B, Darici H, Comlekci S, Doguc DK, Celik S. The effects of long-term exposure to a 2450 MHz electromagnetic field on growth and pubertal development in female Wistar rats. *Electromagn Biol Med.* 2014 Jan 24. [Epub ahead of print]**

The aim of this study was to investigate the effects of a **2450 MHz electromagnetic field (EMF) (wireless internet frequency)** on the growth and development of female Wistar rats. The study was conducted on three groups of rats. The prenatal and postnatal groups were exposed to EMF 1 h/day beginning from intrauterine and postnatal periods, respectively. The third group was the sham-exposed group. Growth, nutrition and vaginal opening (VO) were regularly monitored. Serum and tissue specimens were collected at puberty. Histological examinations, total antioxidant status (TAS), total oxidant status (TOS) and oxidative stress index (OSI) measurements in ovary and brain tissues and also immunohistochemical staining of the hypothalamus were performed besides the determination of serum FSH, LH, E2 and IGF-1 values. Birth masses of the groups were similar ( $p > 0.05$ ). Mass gain per day was significantly lower and the puberty was significantly later in the prenatal group. Brain and ovary TOS and OSI values in the prenatal group were significantly increased ( $p < 0.05$ ) compared to the control group. Serum LH levels of the prenatal and postnatal groups were increased, although serum FSH, and E2 values did not differ among the groups ( $p > 0.05$ ). Histological examinations of the specimens revealed no statistically significant difference between the groups

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( $p > 0.05$ ). Exposure to 2450 MHz EMF, particularly in the prenatal period, resulted in postnatal growth restriction and delayed puberty in female Wistar rats. Increased TOS and OSI values in the brain and ovary tissues can be interpreted as a sign of chronic stress induced by EMF. This is the first longitudinal study which investigates the effects of EMF induced by wireless internet on pubertal development beside growth.

## Hormones

**Sinha RK. Chronic non-thermal exposure of modulated 2450 MHz microwave radiation alters thyroid hormones and behavior of male rats. *Int J Radiat Biol.* 84(6):505-513, 2008.**

**Purpose:** The purpose of this investigation was to analyze the effects of leakage microwave (**2450 MHz**) irradiation on thyroid hormones and behavior of male rats.  
**Materials and methods:** Experiments were carried out on two groups of male rats (exposure and control, respectively). Radio-immuno assay (RIA) methods were used for estimation of 3,5,3'-triiodothyronine (T(3)), thyroxine (T(4)) and thyrotrophin or thyroid stimulating hormone (TSH). The assessments of behavioral changes were performed in Open-Field (OF) and Elevated Plus-Maze (EPM) apparatuses. **Results:** Following chronic microwave exposure, rats were found hyperactive and aggressive on the 16th and 21st days. Behavioral changes in OF were analyzed and found to be significantly changed from controls ( $p < 0.05$ ) for immobilization, rearing and ambulation behavior. In EPM, rats showed increased activity with decreased time spent in the open arm and more time spent in the center on the 11th ( $p < 0.05$ ), 16th ( $p < 0.05$ ) and 21st day ( $p < 0.01$ ) after irradiation. Changes in behavioral parameters are also correlated with the trend of changes, compared to control animals, in hormonal blood levels of T3 (decreased on the 16th day,  $p < 0.05$  and 21st day,  $p < 0.01$ ) and T4 (increased on the 21st day,  $p < 0.05$ ). **Conclusion:** Low energy microwave irradiation may be harmful as it is sufficient to alter the levels of thyroid hormones as well as the emotional reactivity of the irradiated compared to control animals.

**Koveshnikova IV, Antipenko EN, [The participation of thyroid hormones in modifying the mutagenic effect of microwaves]. *Radiobiologiya* 31(1):147-149, 1991. [Article in Russian]**  
The mutagenic effect of microwaves (2,450 or 2,750 MHz, 500 microW/cm<sup>2</sup>, 30 days, 7 h a day) increases with both low and high thyroid hormone content in rats. This indicates that normal functioning of the thyroid gland is an important condition for the stabilization of chromosome integrity under the effect of nonionizing radiation of microwaves.

**Eskander EF, Estefan SF, Abd-Rabou AA. How does long term exposure to base stations and mobile phones affect human hormone profiles? *Clin Biochem.* 45(1-2):157-161, 2012**

**OBJECTIVES:** This study is concerned with assessing the role of exposure to radio frequency radiation (RFR) emitted either from mobiles or base stations and its relations

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with human's hormone profiles. **DESIGN AND METHODS:** All volunteers' samples were collected for hormonal analysis. **RESULTS:** This study showed significant decrease in volunteers' ACTH, cortisol, thyroid hormones, prolactin for young females, and testosterone levels. **CONCLUSION:** The present study revealed that high RFR effects on pituitary-adrenal axis.

## DNA Damage

**Sarkar S, Ali S, Behari J, Effect of low power microwave on the mouse genome: a direct DNA analysis. Mutat Res 320(1-2):141-147, 1994.**

The potential mutagenic effect of low power microwave at the DNA sequence level in the mouse genome was evaluated by direct DNA analysis. Animals were exposed to microwave at a power density of 1 mW/cm<sup>2</sup> for 2 h/day at a frequency of **2.45 GHz** over a period of 120, 150 and 200 days. HinfI digested DNA samples from testis and brain of control and exposed animals were hybridized with a synthetic oligo probe (OAT 36) comprising nine repeats of 5'-GACA-3'. As compared to control animals, band patterns in exposed animals were found to be distinctly altered in the range of 7-8 kb which was also substantiated by densitometric analysis. Though the mechanism of this rearrangement is not yet clear, the results obtained at the present dose are of significance. This dose, which has been set as the safe limit for general public exposure by the Non-Ionizing Radiation Committee of the International Radiation Protection Association, may imply a need for (re)evaluation of the mutagenic potential of microwaves at the prescribed safe limit for the personnel and people who are being exposed.

**Lee S, Johnson D, Dunbar K, Dong H, Ge X, Kim YC, Wing C, Jayathilaka N, Emmanuel N, Zhou CQ, Gerber HL, Tseng CC, Wang SM. 2.45GHz radiofrequency fields alter gene expression in cultured human cells. FEBS Lett. 579(21):4829-4836, 2005.**

The biological effect of radiofrequency (RF) fields remains controversial. We address this issue by examining whether RF fields can cause changes in gene expression. We used the pulsed RF fields at a frequency of **2.45GHz** that is commonly used in telecommunication to expose cultured human HL-60 cells. We used the serial analysis of gene expression (SAGE) method to measure the RF effect on gene expression at the genome level. We observed that 221 genes altered their expression after a 2-h exposure. The number of affected genes increased to 759 after a 6-h exposure. Functional classification of the affected genes reveals that apoptosis-related genes were among the upregulated ones and the cell cycle genes among the downregulated ones. We observed no significant increase in the expression of heat shock genes. These results indicate that the RF fields at 2.45GHz can alter gene expression in cultured human cells through non-thermal mechanism.

**Lai H, Singh NP, Single- and double-strand DNA breaks in rat brain cells after acute exposure to radiofrequency electromagnetic radiation. Int J Radiat Biol 69(4):513-521, 1996.**

We investigated the effects of acute (2-h) exposure to pulsed (2-micros pulse width, 500

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pulses s(-1)) and continuous wave **2450-MHz radiofrequency** electromagnetic radiation on DNA strand breaks in brain cells of rat. The spatial averaged power density of the radiation was 2mW/cm<sup>2</sup>, which produced a whole-body average-specific absorption rate of 1.2W/kg. Single- and double-strand DNA breaks in individual brain cells were measured at 4h post-exposure using a microgel electrophoresis assay. An increase in both types of DNA strand breaks was observed after exposure to either the pulsed or continuous-wave radiation, No significant difference was observed between the effects of the two forms of radiation. We speculate that these effects could result from a direct effect of radiofrequency electromagnetic energy on DNA molecules and/or impairment of DNA-damage repair mechanisms in brain cells. Our data further support the results of earlier in vitro and in vivo studies showing effects of radiofrequency electromagnetic radiation on DNA.

### **Lai H, Singh NP, Acute low-intensity microwave exposure increases DNA single-strand breaks in rat brain cells. Bioelectromagnetics 16(3):207-210, 1995.**

Levels of DNA single-strand break were assayed in brain cells from rats acutely exposed to low-intensity **2450 MHz microwaves** using an alkaline microgel electrophoresis method. Immediately after 2 h of exposure to pulsed (2 microseconds width, 500 pulses/s) microwaves, no significant effect was observed, whereas a dose rate-dependent [0.6 and 1.2 W/kg whole body specific absorption rate (SAR)] increase in DNA single-strand breaks was found in brain cells of rats at 4 h postexposure. Furthermore, in rats exposed for 2 h to continuous-wave 2450 MHz microwaves (SAR 1.2 W/kg), increases in brain cell DNA single-strand breaks were observed immediately as well as at 4 h postexposure.

### **Hatice Ş. Gürler, Birşen Bilgici, Ayşegül K. Akar, Leman Tomak & Abdülkerim Bedir. Increased DNA oxidation (8-OHdG) and protein oxidation (AOPP) by low level electromagnetic field (2.45 GHz) in rat brain and protective effect of garlic. International Journal of Radiation Biology. Posted online on August 4, 2014.**

*Purpose:* To investigate the oxidative damage and protective effect of garlic on rats exposed to low level of electromagnetic fields (EMF) at 2.45 GHz Microwave radiation (MWR). *Methods:* Thirty-six Wistar rats were divided into three groups. Group I was the control group and not exposed to EMF. Group II and III were exposed to low level EMF ( $3.68 \pm 0.36$  V/m) at **2.45 GHz MWR** for 1 hour/day for 30 consecutive days. Daily 500 mg/kg garlic was given to Group III during the study period. At the end of the study, thiobarbituric acid reactive substances (TBARS), advanced oxidation protein products (AOPP) and 8-hydroxydeoxyguanosine (8-OHdG) levels were investigated in brain tissue and blood samples. *Results:* Exposure to low level of EMF increased 8-OHdG level in both plasma and brain tissue whereas it increased AOPP level only in plasma. Garlic prevented the increase of 8-OHdG level in brain tissue and plasma AOPP levels. *Conclusions:* It may be concluded that low level EMF at 2.45 GHz MWR increases the DNA damage in both brain tissues and plasma of the rats whereas it increases protein oxidation only in plasma. It may also be argued that the use of garlic decreases these effects.

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**Maes A, Verschaeve L, Arroyo A, De Wagter C, Vercruyssen L, In vitro cytogenetic effects of 2450 MHz waves on human peripheral blood lymphocytes. *Bioelectromagnetics* 14(6):495-501, 1993.**

Cytogenetic analyses were performed on human peripheral blood lymphocytes exposed to **2450 MHz microwaves** during 30 and 120 min at a constant temperature of 36.1 degrees C (body temperature). The temperature was kept constant by means of a temperature probe put in the blood sample which gives feedback to a microcomputer that controls the microwave supply. We found a marked increase in the frequency of chromosome aberrations (including dicentric chromosomes and acentric fragments) and micronuclei. On the other hand the microwave exposure did not influence the cell kinetics nor the sister chromatid exchange (SCE) frequency.

**Lakshmi NK, Tiwari R, BhargavaSC, Ahuja YR Investigations on DNA damage and frequency of micronuclei in occupational exposure to electromagnetic fields (EMFs) emitted from video display terminals (VDTs). *Gen Mol Biol* 33(1): 154-158, 2010.**

The potential effect of electromagnetic fields (EMFs) emitted from video display terminals (VDTs) to elicit biological response is a major concern for the public. The software professionals are subjected to cumulative EMFs in their occupational environments. This study was undertaken to evaluate DNA damage and incidences of micronuclei in such professionals. To the best of our knowledge, the present study is the first attempt to carry out cytogenetic investigations on assessing bioeffects in personal computer users. The study subjects (n = 138) included software professionals using VDTs for more than 2 years with age, gender, socioeconomic status matched controls (n = 151). DNA damage and frequency of micronuclei were evaluated using alkaline comet assay and cytochalasin blocked micronucleus assay respectively. Overall DNA damage and incidence of micronuclei showed no significant differences between the exposed and control subjects. With exposure characteristics, such as total duration (years) and frequency of use (minutes/day) sub-groups were assessed for such parameters. Although cumulative frequency of use showed no significant changes in the DNA integrity of the classified sub-groups, the long-term users (> 10 years) showed higher induction of DNA damage and increased frequency of micronuclei and micro nucleated cells.

**Fucic A, Garaj-Vrhovac V, Skara M, Dimitrovic B, X-rays, microwaves and vinyl chloride monomer: their clastogenic and aneugenic activity, using the micronucleus assay on human lymphocytes. *Mutat Res* 282(4):265-271, 1992.**

Chromosome aberration assays, sister-chromatid exchange techniques and micronucleus assays are commonly used methods for biomonitoring genetic material damaged by chemical or physical agents. On the other hand, their aneugenic activity, which can lead to hypoploidy and may also be associated with carcinogenesis, has not been thoroughly investigated. In our study we chose the micronucleus assay with a new mathematical approach to separate clastogenic from aneugenic activity of three well-known mutagens (vinyl chloride monomer, X-rays and microwaves) on the genome of human somatic cells. The comparison of frequencies of size distribution of micronuclei in the lymphocytes of humans exposed to each of these three mutagens showed that X-rays and microwaves

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were preferentially clastogens while vinyl chloride monomer showed aneugenic activity as well. Microwaves possess some mutagenic characteristics typical of chemical mutagens.

### Effects on the Heart

**Türker Y, Nazıroğlu M, Gümral N, Celik O, Saygın M, Cömlekçi S, Flores-Arce M. Selenium and L-carnitine reduce oxidative stress in the heart of rat induced by 2.45-GHz radiation from wireless devices. Biol Trace Elem Res. 143(3):1640-1650, 2011.**

The aim of this study was to investigate the possible protective role of selenium and L-carnitine on oxidative stress induced by **2.45-GHz** radiation in heart of rat. For this purpose, 30 male Wistar Albino rats were equally divided into five groups namely controls, sham controls, radiation-exposed rats, radiation-exposed rats treated with intraperitoneal injections of sodium selenite at a dose of 1.5 mg/kg/day, and radiation-exposed rats treated with intraperitoneal injections of L-carnitine at a dose of 1.5 mg/kg/day. Except for the controls and sham controls, the animals were exposed to 2.45-GHz radiation during 60 min/day for 28 days. The lipid peroxidation (LP) levels were higher in the radiation-exposed groups than in the control and sham control groups. The lipid peroxidation level in the irradiated animals treated with selenium and L-carnitine was lower than in those that were only exposed to 2.45-GHz radiation. The concentrations of vitamins A, C, and E were lower in the irradiated-only group relative to control and sham control groups, but their concentrations were increased in the groups treated with selenium- and L-carnitine. The activity of glutathione peroxidase was higher in the selenium-treated group than in the animals that were irradiated but received no treatment. The erythrocyte-reduced glutathione and  $\beta$ -carotene concentrations did not change in any of the groups. In conclusion, 2.45-GHz electromagnetic radiation caused oxidative stress in the heart of rats. There is an apparent protective effect of selenium and L-carnitine by inhibition of free radical formation and support of the antioxidant redox system.

**Seaman RL, DeHaan RL, Inter-beat intervals of cardiac-cell aggregates during exposure to 2.45 GHz CW, pulsed, and square-wave-modulated microwaves. Bioelectromagnetics 14(1):41-55, 1993.**

Inter-beat intervals of aggregated cardiac cells from chicken embryos were studied during 190 s exposures to **2.45 GHz microwaves** in an open-ended coaxial device. Averaged specific-absorption rates (SARs) and modulation conditions were 1.2-86.9 W/kg continuous-wave (CW), 1.2-12.2 W/kg pulse modulation (PW, duty cycle approximately 11%), and 12.0-43.5 W/kg square-wave modulation (duty cycle = 50%). The inter-beat interval decreased during microwave exposures at 42.0 W/kg and higher when CW or square-wave modulation was used, which is consistent with established effects of elevated temperatures. However, increases in the inter-beat interval during CW exposures at 1.2-12.2 W/kg, and decreases in the inter-beat interval after PW exposures at 8.4-12.2 W/kg, are not consistent with simple thermal effects. Analysis of variance

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indicated that SAR, modulation, and the modulation-SAR interaction were all significant factors in altering the inter-beat interval. The latter two factors indicated that the cardiac cells were affected by athermal as well as thermal effects of microwave exposure.

### Inflammation

**Trosic I. Multinucleated giant cell appearance after whole body microwave irradiation of rats. Int J Hyg Environ Health. 204(2-3):133-138, 2001.**

Multinucleated giant cells are common for some chronic inflammatory processes in the lung. These cells are formed by fusion of macrophages, but how the process relates to the kinetics of alveolar macrophage generation is not clear. This study investigated the influence of **2450 MHz microwave irradiation** on alveolar macrophage kinetics and formation of multinucleated giant cells after whole body irradiation of rats. The range of electromagnetic radiation was selected as 2450 MHz microwaves at a power density of 5-15 mW/cm<sup>2</sup>. A group of experimental animals was divided in four subgroups that received 2, 8, 13 and 22 irradiation treatments of two hours each. The animals were killed on experimental days 1, 8, 16, and 30. Free lung cell population was obtained by bronchoalveolar lavage. Cell response to the selected irradiation level was followed quantitatively, qualitatively and morphologically using standard laboratory methods. Total cell number retrieved by lavage slightly decreased in treated animals showing time- and dose-dependence. Cell viability did not significantly change in the irradiated animal group (G2) as compared with the control group (G1). Multinucleated cells significantly increased ( $p < 0.01$ ) in treated animals. The elevation of the number of nuclei per cell was time- and dose-dependent. Macrophages with two nucleoli were more common in animals treated twice or eight times. Polynucleation, that is three and more nucleoli in a single cell, was frequently observed after 13 or 22 treatments. Binucleation and multinucleation of alveolar macrophages were sensitive time- and dose-dependent morphological indicators of pulmonary stress.

### Effects on Blood

**Cleary SF, Liu LM, Merchant RE, In vitro lymphocyte proliferation induced by radio-frequency electromagnetic radiation under isothermal conditions. Bioelectromagnetics 11(1):47-56, 1990.**

Whole human blood was exposed or sham-exposed in vitro for 2 h to 27 or **2,450 MHz radio-frequency electromagnetic (RF) radiation** under isothermal conditions (i.e., 37 +/- 0.2 degrees C). Immediately after exposure, mononuclear cells were separated from blood by Ficoll density-gradient centrifugation and cultured for 3 days at 37 degrees C with or without mitogenic stimulation by phytohemagglutinin (PHA). Lymphocyte proliferation was assayed at the end of the culture period by 6 h of pulse labeling with 3H-thymidine (3H-TdR). Exposure to radiation at either frequency at specific absorption rates (SARs) below 50 W/kg resulted in a dose-dependent, statistically significant

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increase of 3H-TdR uptake in PHA-activated or unstimulated lymphocytes. Exposure at 50 W/kg or higher suppressed 3H-TdR uptake relative to that of sham-exposed cells. There were no detectable effects of RF radiation on lymphocyte morphology or viability. Notwithstanding the characteristic temperature dependence of lymphocyte activation in vitro, the isothermal exposure conditions of this study warrant the conclusion that the biphasic, dose-dependent effects of the radiation on lymphocyte proliferation were not dependent on heating.

**Czerska EM, Elson EC, Davis CC, Swicord ML, Czerski P, Effects of continuous and pulsed 2450-MHz radiation on spontaneous lymphoblastoid transformation of human lymphocytes in vitro. *Bioelectromagnetics* 13(4):247-259, 1992.**

Normal human lymphocytes were isolated from the peripheral blood of healthy donors. One-ml samples containing (10<sup>6</sup>) cells in chromosome medium 1A were exposed for 5 days to conventional heating or to **continuous wave (CW)** or **pulsed wave (PW) 2450-MHz radiation** at non-heating (37 degrees C) and various heating levels (temperature increases of 0.5, 1.0, 1.5, and 2 degrees C). The pulsed exposures involved 1-microsecond pulses at pulse repetition frequencies from 100 to 1,000 pulses per second at the same average SAR levels as the CW exposures. Actual average SARs ranged to 12.3 W/kg. Following termination of the incubation period, spontaneous lymphoblastoid transformation was determined with an image analysis system. The results were compared among each of the experimental conditions and with sham-exposed cultures. At non-heating levels, CW exposure did not affect transformation. At heating levels both conventional and CW heating enhanced transformation to the same extent and correlate with the increases in incubation temperature. PW exposure enhanced transformation at non-heating levels. This finding is significant (P less than .002). At heating levels PW exposure enhanced transformation to a greater extent than did conventional or CW heating. This finding is significant at the .02 level. We conclude that PW 2450-MHz radiation acts differently on the process of lymphoblastoid transformation in vitro compared with CW 2450-MHz radiation at the same average SARs.

**Trosic I, Matausicpisl M, Radalj Z, Prlic I, Animal study on electromagnetic field biological potency. *Arh Hig Rada Toksikol* 50(1):5-11, 1999.**

This recent basic research study used an animal model protocol to assess specific biomarkers of the effect of non-ionising, non-thermal radiation (**2450 MHz microwave radiation** at 5-15 mW/cm<sup>2</sup>) on bone marrow, peripheral blood, and bronchoalveolar free cell populations. Of 40 male Wistar rats taken in the study, 20 animals of the experimental group were irradiated for 2 hours a day, 5 days a week, and subsequently killed on days 1, 8, 16, and 30 of the experiment. The remaining 20 rats served as control. All animals were previously intratracheally instilled with biologically inert microspheres to see the influence of irradiation on lung retention kinetics. The cell response to chosen electromagnetic irradiation was followed quantitatively and qualitatively using the standard laboratory methods. The results of peripheral blood cell response suggested a decreasing tendency in total leukocyte count and in relative lymphocyte count in the treated group. A slight increase was also observed in granulocyte count and in the

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absolute count of peripheral blood erythrocytes over control animals.

**Trosic I, Busljeta I, Pavicic I. Blood-forming system in rats after whole-body microwave exposure; reference to the lymphocytes. Toxicol Lett. 154(1-2):125-132, 2004.**

The influence of 2.45GHz microwave (RF/MW) irradiation on blood-forming cells after whole-body irradiation of rats was investigated. The exposures were conducted with a field power density of 5-10mW/cm(2), and whole-body average specific absorption rate (SAR) of 1-2W/kg. Four experimental subgroups were created and irradiated 2, 8, 15 or 30 days, for 2h a day, 7 days a week. Concurrent sham-exposed rats were also included in the study. The cell response was assessed by number and type of the bone marrow nuclear cells and peripheral blood white cells using standard laboratory methods. Significant decrease in lymphoblast count was obtained at 15 and 30th experimental day (P < 0.05), whereas other examined parameters did not significantly differed in comparison to the sham-exposed controls. The findings point out at stress response in blood-forming system in rats after selected microwave exposure, which could be considered rather as sign of adaptation than malfunction.

**Grigoriev YG, Grigoriev OA, Ivanov AA, Lyaginskaya AM, Merkulov AV, Shagina NB, Maltsev VN, Lévêque P, Ulanova AM, Osipov VA, Shafirkin AV. Confirmation studies of Soviet research on immunological effects of microwaves: Russian immunology results. Bioelectromagnetics. 31(8):589-602, 2010.**

This paper presents the results of a replication study performed to investigate earlier Soviet studies conducted between 1974 and 1991 that showed immunological and reproductive effects of long-term low-level exposure of rats to radiofrequency (RF) electromagnetic fields. The early studies were used, in part, for developing exposure standards for the USSR population and thus it was necessary to confirm the Russian findings. In the present study, the conditions of RF exposure were made as similar as possible to those in the earlier experiments: Wistar rats were exposed in the far field to **2450 MHz** continuous wave RF fields with an incident power density in the cages of 5 W/m<sup>2</sup> for 7 h/day, 5 days/week for a total of 30 days, resulting in a whole-body SAR of 0.16 W/kg. Effects of the exposure on immunological parameters in the brain and liver of rats were evaluated using the complement fixation test (CFT), as in the original studies, and an additional test, the more modern ELISA test. Our results, using CFT and ELISA, partly confirmed the findings of the early studies and indicated possible effects from non-thermal RF exposure on autoimmune processes. The RF exposure resulted in minor increases in formation of antibodies in brain tissue extract and the exposure did not appear to be pathological. In addition, a study was conducted to replicate a previous Soviet study on effects from the injection of blood serum from RF-exposed rats on pregnancy and foetal and offspring development of rats, using a similar animal model and protocol. Our results showed the same general trends as the earlier study, suggesting possible adverse effects of the blood serum from exposed rats on pregnancy and foetal development of intact rats, however, application of these results in developing exposure standards is limited.

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**Zotti-Martelli L, Peccatori M, Scarpato R, Migliore L, Induction of micronuclei in human lymphocytes exposed in vitro to microwave radiation. *Mutat Res* 472(1-2):51-58, 2000.**

Increasing applications of electromagnetic fields are of great concern with regard to public health. Several in vitro studies have been conducted to detect effects of microwave exposure on the genetic material leading to negative or questionable results. The micronucleus (MN) assay which is proved to be a useful tool for the detection of radiation exposure-induced cytogenetic damage was used in the present study to investigate the genotoxic effect of microwaves in human peripheral blood lymphocytes in vitro exposed in G(0) to electromagnetic fields with different frequencies (2.45 and 7.7GHz) and power density (10, 20 and 30mW/cm<sup>2</sup>) for three times (15, 30 and 60min). The results showed for both radiation frequencies an induction of micronuclei as compared to the control cultures at a power density of 30mW/cm<sup>2</sup> and after an exposure of 30 and 60min. Our study would indicate that microwaves are able to cause cytogenetic damage in human lymphocytes mainly for both high power density and long exposure time.

## Oxidative Stress

**Naziroğlu M, Ciğ B, Doğan S, Uğuz AC, Dilek S, Faouzi D. 2.45-Gz wireless devices induce oxidative stress and proliferation through cytosolic Ca<sup>2+</sup> influx in human leukemia cancer cells. *Int J Radiat Biol.* 88(6):449-456, 2012.**

PURPOSE: Electromagnetic radiation from wireless devices may affect biological systems by increasing free radicals. The present study was designed to determine the effects of 2.45 GHz radiation on the antioxidant redox system, calcium ion signaling, cell count and viability in human leukemia 60 cells. MATERIALS AND METHODS: Twelve cell cultures were equally divided into two main groups as controls (n = 6) and irradiated (n = 6) and then subdivided into four different subgroups depending on the duration of exposure, namely 1, 2, 12 and 24 hours. The samples were analyzed immediately after the experimental period. RESULTS: The extent of lipid peroxidation, cytosolic free Ca<sup>2+</sup> and cell numbers were higher in 2.45 GHz groups than in the controls. The increase of cytosolic free Ca<sup>2+</sup> concentrations was radiation time-dependent and was highest at 24-h exposure. The reduced glutathione, glutathione peroxidase, vitamin C and cell viability values did not show any changes in any of the experimental groups. 2-aminoethyl diphenylborinate inhibits Ca<sup>2+</sup> ions influx by blockage of the transient receptor potential melastatin 2. CONCLUSIONS: 2.45 GHz electromagnetic radiation appears to induce proliferative effects through oxidative stress and Ca<sup>2+</sup> influx although blocking of transient receptor potential melastatin 2 channels by 2-aminoethyl diphenylborinate seems to counteract the effects on Ca<sup>2+</sup> ions influx.

**Kim MJ, Rhee SJ. Green tea catechins protect rats from microwave-induced oxidative damage to heart tissue. *J Med Food.* 7(3):299-304, 2004.**

We investigated the effects of greentea catechin on oxidative damage in microwave-exposed rats. The microwave-exposed rats received one of three diets: catechin-free

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(MW-0C), 0.25% catechin (MW-0.25C), or 0.5% catechin (MW-0.5C). Rats were sacrificed 6 days after microwave irradiation (2.45 GHz, 15 minutes). Cytochrome P(450) levels in the MW-0C group was increased by 85% compared with normal, but was 11% and 14% lower in the MW-0.25C and MW-0.5C groups than in the MW-0C group. NADPH-cytochrome P(450) reductase activity in the MW-0C group was increased by 29%, compared with the normal group, but was significantly less in the MW-0.25C and MW-0.5C groups. Superoxide dismutase activity in the MW-0C group was decreased by 34%, compared with the normal group, but in the MW-0.25C and MW-0.5C groups was 19% and 25% higher. The activity of glutathione peroxidase in the MW-0C group was decreased by 28% but remained near normal with catechin supplements. Superoxide radical concentrations in the MW-0C group were increased by 35%, compared with the normal group. However, superoxide radicals in the MW-0.25C and MW-0.5C groups were 11% and 12% lower, respectively, compared with the MW-0C group. Microwave irradiation significantly increased levels of thiobarbituric acid-reactive substances, carbonyl values, and lipofuscin contents, but **greentea** catechin partially overcame the effects of the microwave irradiation. In conclusion, the mixed function oxidase system was activated, the formation of superoxide radical, lipid peroxide, oxidized protein, and lipofuscin was increased, and the antioxidative defense system was weakened in heart tissue of microwave-exposed rats, but the oxidative damage was significantly reduced by catechin supplementation.

### **Aweda MA, Gbenebitse S, Meidinyo RO. Effects of 2.45 GHz microwave exposures on the peroxidation status in Wistar rats. Niger Postgrad Med J. 10(4):243-246, 2003.**

One of the consequences of exposures to microwave (MW) radiations is the enhanced production of free O<sub>2</sub>, free radicals, peroxides and superoxides. The effects on the **lipid peroxidation status (LPS)** of whole body irradiation of 120 Wistar rats with **2.45 GHz MW** at a power density of 6mWcm<sup>-2</sup> have been studied using the MW generator model ER6660E from Toshiba UK Ltd. The LPS in the rats was monitored for a period of 8 weeks post irradiation using thiobarbituric acid (TRA) method. The MW exposures caused an increase in the LPS from the mean control value of 4.18 x 10<sup>-6</sup>g 1<sup>-1</sup> to a maximum of 6.50 x 10<sup>-6</sup>g 1<sup>-1</sup> within the first 24 hrs, and then gradually reduced to control value after about a week. 1mg kg<sup>-1</sup> of ascorbic acid administered before irradiation caused a decrease in the LPS from the control value to a minimum of 2.86 x 10<sup>-6</sup>g 1<sup>-1</sup> within the first week. The value then gradually rose to a maximum of 3.96 x 10<sup>-6</sup>g 1<sup>-1</sup> within the monitoring period. 1 mg kg<sup>-1</sup> of α-tocopherol also administered before irradiation also caused a decrease in the LPS from the control value to a minimum of 2.10 x 10<sup>-6</sup>g 1<sup>-1</sup> within the first week. The value then gradually rose to a maximum of 3.94 x 10<sup>-6</sup>g 1<sup>-1</sup> within the monitoring period. The results obtained from this study demonstrate that MW exposures cause significant increase in the LPS and there are protective effects of the anti-oxidants ascorbic acid and alpha-tocopherol.

### **Aynali G, Nazıroğlu M, Celik O, Doğan M, Yarıktaş M, Yasan H. Modulation of wireless (2.45 GHz)-induced oxidative toxicity in laryngotracheal mucosa of rat by melatonin. Eur Arch Otorhinolaryngol. 270(5):1695-1700, 2013.**

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It is well known that oxidative stress induces larynx cancer, although antioxidants induce modulator role on etiology of the cancer. It is well known that electromagnetic radiation (EMR) induces oxidative stress in different cell systems. The aim of this study was to investigate the possible protective role of melatonin on oxidative stress induced by **Wi-Fi (2.45 GHz)** EMR in laryngotracheal mucosa of rat. For this purpose, 32 male rats were equally categorized into four groups, namely controls, sham controls, EMR-exposed rats, EMR-exposed rats treated with melatonin at a dose of 10 mg/kg/day. Except for the controls and sham controls, the animals were exposed to 2.45 GHz radiation during 60 min/day for 28 days. The lipid peroxidation levels were significantly ( $p < 0.05$ ) higher in the radiation-exposed groups than in the control and sham control groups. The lipid peroxidation level in the irradiated animals treated with melatonin was significantly ( $p < 0.01$ ) lower than in those that were only exposed to Wi-Fi radiation. The activity of glutathione peroxidase was lower in the irradiated-only group relative to control and sham control groups but its activity was significantly ( $p < 0.05$ ) increased in the groups treated with melatonin. The reduced glutathione levels in the mucosa of rat did not change in the four groups. There is an apparent protective effect of melatonin on the Wi-Fi-induced oxidative stress in the laryngotracheal mucosa of rats by inhibition of free radical formation and support of the glutathione peroxidase antioxidant system.

**Ceyhan AM, Akkaya VB, Güleçol ŞC, Ceyhan BM, Özgüner F, Chen W. Protective effects of  $\beta$ -glucan against oxidative injury induced by 2.45-GHz electromagnetic radiation in the skin tissue of rats. Arch Dermatol Res. 304(7):521-527, 2012.**

In recent times, there is widespread use of 2.45-GHz irradiation-emitting devices in industrial, medical, military and domestic application. The aim of the present study was to investigate the effect of **2.45-GHz** electromagnetic radiation (EMR) on the oxidant and antioxidant status of skin and to examine the possible protective effects of  $\beta$ -glucans against the oxidative injury. Thirty-two male Wistar albino rats were randomly divided into four equal groups: control; sham exposed; EMR; and EMR +  $\beta$ -glucan. A 2.45-GHz EMR emitted device from the experimental exposure was applied to the EMR group and EMR +  $\beta$ -glucan group for 60 min daily, respectively, for 4 weeks.  $\beta$ -glucan was administered via gavage at a dose of 50 mg/kg/day before each exposure to radiation in the treatment group. The activities of antioxidant enzymes, superoxide dismutase (SOD), glutathione peroxidase (GSH-Px) and catalase (CAT), as well as the concentration of malondialdehyde (MDA) were measured in tissue homogenates of the skin. Exposure to 2.45-GHz EMR caused a significant increase in MDA levels and CAT activity, while the activities of SOD and GSH-Px decreased in skin tissues. Systemic  $\beta$ -glucan significantly reversed the elevation of MDA levels and the reduction of SOD activities.  $\beta$ -glucan treatment also slightly enhanced the activity of CAT and prevented the depletion of GSH-Px activity caused by EMR, but not statistically significantly. The present study demonstrated the role of oxidative mechanisms in EMR-induced skin tissue damages and that  $\beta$ -glucan could ameliorate oxidative skin injury via its antioxidant properties.

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### Wellbeing

**Kowall B, Breckenkamp J, Heyer K, Berg-Beckhoff G. German wide cross sectional survey on health impacts of electromagnetic fields in the view of general practitioners. *Int J Public Health*.55(5):507-512, 2010.**

**OBJECTIVES:** The proportion of **general practitioners (GPs)** in Germany who assume health impacts of electromagnetic fields (EMF) is assessed. Moreover, factors associated with this risk perception are examined. **METHODS:** A 7% random sample was drawn from online lists of all the GPs working in Germany. 1,867 doctors received a long version of a self-administered postal questionnaire about EMF and health (response rate 23.3%), 928 doctors received a short version (response rate 49.1%). **RESULTS:** 37.3% of responders to the short and 57.5% of responders to the long questionnaire agreed "that there are persons whose health complaints are caused by EMF when legal limit values are met". A late responder analysis for the survey with the short questionnaire led to a still lower estimate of 29% for GPs believing in health-relevant effects of EMF. **CONCLUSION:** About a third of German GPs associate EMF with health complaints and thus deviate considerably from current scientific knowledge. To avoid a strong selection bias in the surveys of the perception of EMF risks, use of short questionnaires and late responder analysis are recommended.

**Kato Y, Johansson O. Reported functional impairments of electrohypersensitive Japanese: A questionnaire survey. *Pathophysiology*.19(2) 95-100, 2012.**

An increasing number of people worldwide complain that they have become **electromagnetic hypersensitive (EHS)**. We conducted a questionnaire survey of EHS persons in Japan. The aim was to identify electromagnetic fields (EMF) and plausible EMF sources that caused their symptoms. Postal questionnaires were distributed via a self-help group, and 75 participants (95% women) responded. Reported major complaints were "fatigue/tiredness" (85%), "headache", "concentration, memory, and thinking" difficulty (81%, respectively). Seventy-two per cent used some form of complementary/alternative therapy. The most plausible trigger of EHS onset was a mobile phone base station or personal handy-phone system (37%). Sixty-five percent experienced health problems to be due to the radiation from other passengers' mobile phones in trains or buses, and 12% reported that they could not use public transportation at all. Fifty-three percent had a job before the onset, but most had lost their work and/or experienced a decrease in income. Moreover, 85.3% had to take measures to protect themselves from EMF, such as moving to low EMF areas, or buying low EMF electric appliances. EHS persons were suffering not only from their symptoms, but also from economical and social problems.

**Bergdahl J, Tillberg A, Stenman E. Odontologic survey of referred patients with symptoms allegedly caused by electricity or visual display units. *Acta Odontol Scand*. 56(5):303-307, 1998.**

Twenty-eight consecutive patients with symptoms allegedly caused by electricity or

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visual display units were odontologically investigated according to a specially designed registration form including an anamnestic interview and a clinical protocol. The most common oral and general symptoms reported were burning mouth, craniomandibular dysfunction symptoms, skin complaints, and fatigue. Oral symptoms such as craniomandibular dysfunction and general symptoms such as eye complaints and dizziness scored highest on a visual analog scale regarding mean symptom intensity. The patients reported various numbers of medical diagnoses, such as allergic rhinitis or asthma and hypothyroidism. Various dental diseases were found; the most common were temporomandibular joint and masticatory muscle dysfunctions, lesions in the oral mucosa, and periodontal diseases. Urinary-Hg (U-Hg) analysis showed a mean U-Hg concentration of 8.5 nmol Hg/L urine, and none of the patients exceeded the limit of 50 nmol Hg/L urine. The U-Hg concentration was positively correlated with the number of amalgam fillings ( $P < 0.01$ ) and craniomandibular disorders ( $P < 0.05$ ). No or low secretion of the minor mucous glands was found in 43% of the patients. One patient showed hypersensitivity to gold and cobalt. The present study showed that various odontologic factors might be involved in some of these patients' suffering. Thus, it is important that professionals from other disciplines collaborate with dentistry if these patients are to be properly investigated.

## Whole Body

**Kühn S, Jennings W, Christ A, Kuster N. Assessment of induced radio-frequency electromagnetic fields in various anatomical human body models. *Phys Med Biol.* 54(4):875-890, 2009.**

The reference levels for testing compliance of human exposure with radio-frequency (RF) safety limits have been derived from very simplified models of the human. In order to validate these findings for anatomical models, we investigated the absorption characteristics for various anatomies ranging from 6 year old child to large adult male by numerical modeling. We address the exposure to plane-waves incident from all major six sides of the humans with two orthogonal polarizations each. Worst-case scattered field exposure scenarios have been constructed in order to test the implemented procedures of current in situ compliance measurement standards (spatial averaging versus peak search). Our findings suggest that the reference levels of current electromagnetic (EM) safety guidelines for demonstrating compliance as well as some of the current measurement standards are not consistent with the basic restrictions and need to be revised.

## Bone Marrow

**Vijayalaxmi, Frei, MR, Dusch, SJ, Guel, V, Meltz, ML, Jauchem, JR, Frequency of micronuclei in the peripheral blood and bone marrow of cancer-prone mice chronically exposed to 2450 MHz radiofrequency radiation. *Radiat Res* 147(4):495-500, 1997.**

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C3H/HeJ mice, which are prone to mammary tumors, were exposed for 20 h/day, 7 days/week, over 18 months to continuous-wave **2450 MHz radiofrequency (RF)** radiation in circularly polarized wave guides at a whole-body average specific absorption rate of 1.0 W/kg. Sham-exposed mice were used as controls. The positive controls were the sentinel mice treated with mitomycin C during the last 24 h before necropsy. At the end of the 18 months, all mice were necropsied. Peripheral blood and bone marrow smears were examined for the extent of genotoxicity as indicated by the presence of micronuclei in polychromatic erythrocytes (PCEs). The results indicate that the incidence of micronuclei/1,000 PCEs was not significantly different between groups exposed to RF radiation (62 mice) and sham-exposed groups (58 mice), and the mean frequencies were 4.5 +/- 1.23 and 4.0 +/- 1.12 in peripheral blood and 6.1 +/- 1.78 and 5.7 +/- 1.60 in bone marrow, respectively. In contrast, the positive controls (7 mice) showed a significantly elevated incidence of micronuclei/1,000 PCEs in peripheral blood and bone marrow, and the mean frequencies were 50.9 +/- 6.18 and 55.2 +/- 4.65, respectively. When the animals with mammary tumors were considered separately, there were no significant differences in the incidence of micronuclei/1,000 PCEs between the group exposed to RF radiation (12 mice) and the sham-exposed group (8 mice), and the mean frequencies were 4.6 +/- 1.03 and 4.1 +/- 0.89 in peripheral blood and 6.1 +/- 1.76 and 5.5 +/- 1.51 in bone marrow, respectively. Thus there was no evidence for genotoxicity in mice prone to mammary tumors that were exposed chronically to 2450 MHz RF radiation compared with sham-exposed controls. **A correction was published in a subsequent issue of the journal, stating that there was actually a significant increase in micronucleus formation in peripheral blood and bone marrow cells after chronic exposure to the radiofrequency radiation. "Vijayalaxmi, Frei, MR, Dusch, SJ, Guel, V, Meltz, ML, Jauchem, JR, Correction of an error in calculation in the article "Frequency of micronuclei in the peripheral blood and bone marrow of cancer-prone mice chronically exposed to 2450 MHz radiofrequency radiation" (Radiat. Res. 147, 495-500, 1997). Radiat Res 149(3):308, 1998 "**

**Busljeta I, Trosic I, Milkovic-Kraus S. Erythropoietic changes in rats after 2.45 GJz nonthermal irradiation. Int J Hyg Environ Health.207(6):549-554, 2004.**

The purpose of this study was to observe the erythropoietic changes in rats subchronically exposed to radiofrequency microwave (RF/MW) irradiation at nonthermal level. Adult male Wistar rats (N=40) were exposed to **2.45 GHz** continuous RF/MW fields for 2 hours daily, 7 days a week, at 5-10 mW/cm<sup>2</sup>. Exposed animals were divided into four subgroups (n=10 animals in each subgroup) in order to be irradiated for 2, 8, 15 and 30 days. Animals were sacrificed on the final irradiation day of each treated subgroup. Unexposed rats were used as control (N=24). Six animals were included into the each control subgroup. Bone marrow smears were examined to determine absolute counts of anuclear cells and erythropoietic precursor cells. The absolute erythrocyte count, haemoglobin and haematocrit values were observed in the peripheral blood by an automatic cell counter. The bone marrow cytogenetic analysis was accomplished by micronucleus (MN) tests. In the exposed animals erythrocyte count, haemoglobin and haematocrit were increased in peripheral blood on irradiation days 8 and 15.

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Concurrently, anuclear cells and erythropoietic precursor cells were significantly decreased ( $p < 0.05$ ) in the bone marrow on day 15, but micronucleated cells' frequency was increased. In the applied experimental condition, RF/MW radiation might cause disturbance in red cell maturation and proliferation, and induce micronucleus formation in erythropoietic cells.

### **Trosic I, Busljeta I, Kasuba V, Rozgaj R. Micronucleus induction after whole-body microwave irradiation of rats. *Mutat Res* 521(1-2):73-79, 2002.**

Adult male Wistar rats were exposed for 2h a day, 7 days a week for up to 30 days to continuous **2450MHz radiofrequency microwave** (rf/MW) radiation at a power density of 5-10mW/cm<sup>2</sup>. Sham-exposed rats were used as controls. After ether anesthesia, experimental animals were euthanized on the final irradiation day for each treated group. Peripheral blood smears were examined for the extent of genotoxicity, as indicated by the presence of micronuclei in polychromatic erythrocytes (PCEs). The results for the time-course of PCEs indicated significant differences ( $P < 0.05$ ) for the 2nd, the 8th and the 15th day between control and treated subgroups of animals. Increased influx of immature erythrocytes into the peripheral circulation at the beginning of the experiment revealed that the proliferation and maturation of nucleated erythropoietic cells were affected by exposure to the 2450MHz radiofrequency radiation. Such findings are indicators of radiation effects on bone-marrow erythropoiesis and their subsequent effects in circulating red cells. The incidence of micronuclei/1000 PCEs in peripheral blood was significantly increased ( $P < 0.05$ ) in the subgroup exposed to rf/MW radiation after eight irradiation treatments of 2h each in comparison with the sham-exposed control group. It is likely that an adaptive mechanism, both in erythrocytopoiesis and genotoxicity appeared in the rat experimental model during the subchronic irradiation treatment.

### **Trosic I, Busljeta I, Modlic B. Investigation of the genotoxic effect of microwave irradiation in rat bone marrow cells: in vivo exposure. *Mutagenesis*. 19(5):361-364, 2004.**

An in vivo mammalian cytogenetic test (the erythrocyte micronucleus assay) was used to investigate the extent of genetic damage in bone marrow red cells of rats exposed to radiofrequency/microwave (RF/MW) radiation. Wistar rats ( $n = 40$ ) were exposed to a **2.45 GHz** continuous RF/MW field for 2 h daily, 7 days a week, at a power density of 5-10 mW/cm<sup>2</sup>. The whole body average specific absorption rate (SARs) was calculated to be 1.25 +/- 0.36 (SE) W/kg. Four subgroups were irradiated for 4, 16, 30 and 60 h. Sham-exposed controls ( $n = 24$ ) were included in the study. The animals of each treated subgroup were killed on the final day of irradiation. Bone marrow smears were examined to determine the extent of genotoxicity after particular treatment times. The results were statistically evaluated using non-parametric Mann-Whitney and Kruskal-Wallis tests. In comparison with the sham-exposed subgroups, the findings of polychromatic erythrocytes (PCE) revealed significant differences ( $P < 0.05$ ) for experimental days 8 and 15. The frequency of micronucleated PCEs was also significantly increased on experimental day 15 ( $P < 0.05$ ). Pair-wise comparison of data obtained after 2, 8 and 30

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irradiation treatments did not reveal statistically significant differences between sham-exposed and treated subgroups. Under the applied experimental conditions the findings revealed a transient effect on proliferation and maturation of erythropoietic cells in the rat bone marrow and the sporadic appearance of micronucleated immature bone marrow red cells.

### **Trosic I, Busljeta I. Frequency of micronucleated erythrocytes in rat bone marrow exposure to 2.45 GHz radiation. *Physica Scripta T118: 168-170, 2005.***

Wistar rats were exposed to **2.45GHz** continuous, radiofrequency microwave (RF/MW) field 2 hours daily, 7 days weekly, at power density 5–10mW/cm<sup>2</sup>. Four subgroups were created in order to be irradiated 4, 16, 30 and 60 hours. Sham exposed controls were included in the study. Animals were euthanized on the final irradiation day of each treated subgroup. Bone marrow smears were examined to determine the extent of genotoxicity after the particular treatment time. Mann-Whitney test was used for statistical evaluation of data. In comparison to the sham exposed subgroups, the findings of polychromatic erythrocytes revealed significant differences for the 8th and 15th experimental day. Bone marrow erythrocyte maturation and/or proliferation initiated by subthermogenic RF/MW irradiation showed temporary disturbance. Thereafter, the frequency of micronucleated bone marrow red cells was significantly increased after 15 irradiation treatments. Comparison of micronucleus frequency data obtained after 2, 8 and 30 irradiation treatments did not reveal statistically significant differences between sham and treated subgroups. Under the applied experimental conditions, RF/MW irradiation initiates transitory cytogenetic effect manifested with micronucleus formation in erythropoietic cells.

### **Trosic I, Busljeta I. Erythropoietic dynamic equilibrium in rats maintained after microwave irradiation. *Exp Toxicol Pathol. 57(3):247-251, 2006.***

The aim of study was to define influence of radiofrequency microwave (RF/MW) radiation on erythropoiesis in rats. The kinetics of polychromatic erythrocytes (PCEs) and micronucleated (MN) PCEs in the bone marrow (BM) and peripheral blood (PB) of rats during the intermittent subchronic experiment was followed. Rats were exposed 2h/day, 7 days/week to RF/MW of **2.45GHz** and whole-body specific absorption rate (SAR) of 1.25+/-0.36W/kg. Control animals were included in the study. Each exposed and control group was killed on the final day of irradiation. Acridine-orange stained BM and blood smears were examined by fluorescence microscope. PCEs were obtained by inspection of 2000BM and 1000PB erythrocytes/slides. BMMNs and PBMNs frequency was obtained by observation of 1000PCEs/slides. BMPCEs were increased on day 8 and 15, and PBPCes were elevated on days 2 and 8 (p<0.05). The BMMN frequency was increased on experimental day 15, and MNPCEs in the PB was increased on day 8 (p<0.05). Findings of BM and PBPCes or MNPCEs declined nearly to the control values until the end of the experiment. Such findings are considered to be indicators of radiation effects on BM erythropoiesis consequently reflected in the PB. Rehabilitated dynamic haemopoietic equilibrium in rats by the end of experiment indicates possibility of activation adaptation process in rats to the selected experimental conditions of subchronic RF/MW exposure.

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### Effects on Insulin

**Salah MB, Abdelmelek H, Abderraba M. Effects of olive leaf extract on metabolic disorders and oxidative stress induced by 2.45 GHz WIFI signals. Environ Toxicol Pharmacol. 36(3):826-834, 2013.**

We investigated the effect of olive leaves extract administration on glucose metabolism and oxidative response in liver and kidneys of rats exposed to radio frequency (RF). **The exposure of rats to RF (2.45 GHz, 1h/day during 21 consecutive days)** induced a diabetes-like status. Moreover, RF decreased the activities of glutathione peroxidase (GPx, -33.33% and -49.40%) catalase (CAT, -43.39% and -39.62%) and the superoxide dismutase (SOD, -59.29% and -68.53%) and groups thiol amount (-62.68% and -34.85%), respectively in liver and kidneys. Indeed, exposure to RF increased the malondialdehyde (MDA, 29.69% and 51.35%) concentration respectively in liver and kidneys. Olive leaves extract administration (100 mg/kg, ip) in RF-exposed rats prevented glucose metabolism disruption and restored the activities of GPx, CAT and SOD and thiol group amount in liver and kidneys. Moreover, olive leaf extract administration was able to bring down the elevated levels of MDA in liver but not in kidneys. Our investigations suggested that RF exposure induced a diabetes-like status through alteration of oxidative response. Olive leaves extract was able to correct glucose metabolism disorder by minimizing oxidative stress induced by RF in rat tissues.

### Cell Effects

**Phelan AM, Lange DG, Kues HA, Luty GA, Modification of membrane fluidity in melanin-containing cells by low-level microwave radiation. Bioelectromagnetics13(2):131-146, 1992.**

The treatment of a B16 melanoma cell line with **2.45-GHz pulsed microwaves** (10 mW/cm<sup>2</sup>, 10-microseconds pulses at 100 pps, 1-h exposure; SAR, 0.2 W/kg) resulted in changes of membrane ordering as measured by EPR (electron paramagnetic resonance) reporter techniques. The changes reflected a shift from a more fluid-like phase to a more solid (ordered) state of the cell membrane. Exposure of artificially prepared liposomes that were reconstituted with melanin produced similar results. In contrast, neither B16 melanoma cells treated with 5-Bromo-2-Deoxyuridine (3 micrograms/day x 7 days) to render them amelanotic, nor liposomes prepared without melanin, exhibited the microwave-facilitated increase of ordering. Inhibition of the ordering was achieved by the use of superoxide dismutase (SOD), which strongly implicates oxygen radicals as a cause of the membrane changes. The data indicate that a significant, specific alteration of cell-membrane ordering followed microwave exposure. This alteration was unique to melanotic membranes and was due, at least in part, to the generation of oxygen radicals.

**Misa Agustiño MJ, Leiro JM, Jorge Mora MT, Rodríguez-González JA, Jorge Barreiro FJ, Ares-Pena FJ, López-Martín E. Electromagnetic fields at 2.45 GHz trigger changes in**

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**heat shock proteins 90 and 70 without altering apoptotic activity in rat thyroid gland. Biol Open. 1(9):831-838, 2012.**

Non-ionizing radiation at 2.45 GHz may modify the expression of genes that codify heat shock proteins (HSP) in the thyroid gland. Using the enzyme-linked immunosorbent assay (ELISA) technique, we studied levels of HSP-90 and HSP-70. We also used hematoxylin eosin to look for evidence of lesions in the gland and applied the DAPI technique of fluorescence to search for evidence of chromatin condensation and nuclear fragmentation in the thyroid cells of adult female Sprague-Dawley rats. Fifty-four rats were individually exposed for 30 min to 2.45 GHz radiation in a Gigahertz transverse electromagnetic (GTEM) cell at different levels of non-thermal specific absorption rate (SAR), which was calculated using the finite difference time domain (FDTD) technique. Ninety minutes after radiation, HSP-90 and HSP-70 had decreased significantly ( $P < 0.01$ ) after applying a SAR of  $0.046 \pm 1.10$  W/Kg or  $0.104 \pm 5.10(-3)$  W/Kg. Twenty-four hours after radiation, HSP-90 had partially recovered and HSP-70 had recovered completely. There were few indications of lesions in the glandular structure and signs of apoptosis were negative in all radiated animals. The results suggest that acute sub-thermal radiation at 2.45 GHz may alter levels of cellular stress in rat thyroid gland without initially altering their anti-apoptotic capacity.

**Misa Agustiño MJ, Leiro JM, Jorge Mora MT, Rodríguez-González JA, Jorge Barreiro FJ, Ares-Pena FJ, López-Martín E. Electromagnetic fields at 2.45 GHz trigger changes in heat shock proteins 90 and 70 without altering apoptotic activity in rat thyroid gland. Biol Open. 1(9):831-838, 2012.**

The use of smartphones is expanding rapidly around the world, thus raising the concern of possible harmful effects of radiofrequency generated by smartphones. We hypothesized that Wi-Fi signals from smartphones may have harmful influence on adipose-derived stem cells (ASCs). An in vitro study was performed to assess the influence of Wi-Fi signals from smartphones. The ASCs were incubated under a smartphone connected to a **Wi-Fi network**, which was uploading files at a speed of 4.8 Mbps for 10 hours a day, for a total of 5 days. We constructed 2 kinds of control cells, one grown in 37°C and the other grown in 39°C. After 5 days of Wi-Fi exposure from the smartphone, the cells underwent cell proliferation assay, apoptosis assay, and flow cytometry analysis. Three growth factors, vascular endothelial growth factor, hepatocyte growth factor, and transforming growth factor- $\beta$ , were measured from ASC-conditioned media. Cell proliferation rate was higher in Wi-Fi-exposed cells and 39°C control cells compared with 37°C control cells. Apoptosis assay, flow cytometry analysis, and growth factor concentrations showed no remarkable differences among the 3 groups. We could not find any harmful effects of Wi-Fi electromagnetic signals from smartphones. The increased proliferation of ASCs under the smartphone, however, might be attributable to the thermal effect.

**Somosy Z, Thuroczy G, Kubasova T, Kovacs J, Szabo LD, Effects of modulated and continuous microwave irradiation on the morphology and cell surface negative charge of 3T3 fibroblasts. Scanning Microsc 5(4):1145-1155, 1991**

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Mouse embryo 3T3 cells were irradiated with **2450 MHz** continuous and low frequency (16 Hz) square modulated waves of absorbed energy ranging from 0.0024 to 2.4 mW/g. The low frequency modulated microwave irradiation yielded more morphological cell changes than did the continuous microwave fields of the same intensity. The amount of free negative charges (cationized ferritin binding) on cell surfaces decreased following irradiation by modulated waves but remained unchanged under the effect of a continuous field of the same dose. Modulated waves of 0.024 mW/g dose increased the ruffling activity of the cells, and caused ultrastructural alteration in the cytoplasm. Similar effects were experienced by continuous waves at higher (0.24 and 2.4 mW/g) doses.

### **Cleary, SF, Du, Z, Cao, G, Liu, LM, McCrady, C, Effect of isothermal radiofrequency radiation on cytolytic T lymphocytes. FASEB J 10(8):913-919. 1996.**

Previous in vitro studies provide evidence that RF electromagnetic radiation modulates proliferation of human glioma, lymphocytes, and other cell types. The mechanism of RF radiation cell proliferation modulation, as well as mechanisms for effects on other cell physiologic endpoints, are not well understood. To obtain insight regarding interaction mechanisms, we investigated effects of RF radiation exposure on interleukin 2 (IL-2) - dependent proliferation of cytolytic T lymphocytes (CTLL-2). After exposure to RF radiation in the presence or absence of IL-2 cells were cultured at various physiological concentrations of IL-2. Treatment effects on CTLL-2 proliferation were determined by tritiated thymidine incorporation immediately or 24 h after exposure. Exposure to **2450 MHz** RIF radiation at specific absorption rates (SARs) of greater than 25 W/kg (induced E-field strength 98.4 V/m) induced a consistent, statistically significant reduction in CTLL-2 proliferation, especially at low IL-2 concentrations. At lower SARs, 2450 MHz exposure increased CTLL-2 proliferation immediately after exposure but reduced 24 h postexposure proliferation. RF radiation effects depended on the mitotic state of the cells at the time of exposure. Comparison of the effects of temperature elevation and RF radiation indicated significant qualitative and quantitative differences.

### **Obukhan KI, [The effect of ultrahigh-frequency radiation on adaptation thresholds and the damages to blood system cells]. Lik Sprava (7):71-73, 1998. [Article in Ukrainian]**

Cytologic investigations designed to study bone marrow, peripheral blood, spleen, and thymus of albino rats irradiated by an electromagnetic field, 2375, **2450**, and 3000 MEGS, revealed structural and functional changes in populations of megakaryocytes, immunocompetent cells as well as of undifferentiated cells, and of other types of cells that are dependent on the intensity of irradiation and permit establishing the probability-threshold levels of exposure taking account of reactions of perception and physiologic adaptation together with compensatory and regenerative processes and the injury sustained. It is shown that changes in bone marrow cells differentiation and reproduction rather than integral shifts in the peripheral blood that acquire the utmost significance. Subjected to a particular scrutiny in the paper are blast cells, which cells' repopulation was noted to be getting increased in low-intensity exposure as were disturbances in their mitosis pattern.

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**Margaritis LH, Manta AK, Kokkaliaris CD, Schiza D, Alimisis K, Barkas G, Georgiou E, Giannakopoulou O, Kollia I, Kontogianni G, Kourouzidou A, Myari A, Roumelioti F, Skouroliakou A, Sykioti V, Varda G, Xenos K, Ziomas K. Drosophila oogenesis as a biomarker responding to EMF sources. Electromagn Biol Med. 2013 Aug 5. [Epub ahead of print]**

The model biological organisms *Drosophila melanogaster* and *Drosophila virilis* have been utilized to assess effects on apoptotic cell death of follicles during oogenesis and reproductive capacity (fecundity) decline. A total of 280 different experiments were performed using newly emerged flies exposed for short time daily for 3-7 d to various EMF sources including: GSM 900/1800 MHz mobile phone, 1880-1900 MHz DECT wireless base, DECT wireless handset, mobile phone-DECT handset combination, **2.44 GHz wireless network (Wi-Fi)**, 2.44 GHz blue tooth, 92.8 MHz FM generator, 27.15 MHz baby monitor, 900 MHz CW RF generator and microwave oven's 2.44 GHz RF and magnetic field components. Mobile phone was used as a reference exposure system for evaluating factors considered very important in dosimetry extending our published work with *D. melanogaster* to the insect *D. virilis*. Distance from the emitting source, the exposure duration and the repeatability were examined. All EMF sources used created statistically significant effects regarding fecundity and cell death-apoptosis induction, even at very low intensity levels (0.3 V/m blue tooth radiation), well below ICNIRP's guidelines, suggesting that *Drosophila oogenesis* system is suitable to be used as a biomarker for exploring potential EMF bioactivity. Also, there is no linear cumulative effect when increasing the duration of exposure or using one EMF source after the other (i.e. mobile phone and DECT handset) at the specific conditions used. The role of the average versus the peak E-field values as measured by spectrum analyzers on the final effects is discussed.

**Marjanović AM, Pavičić I, Trošić I Biological indicators in response to radiofrequency/microwave exposure. Arh Hig Rada Toksikol. 2012 Sep 25;63(3):407-416, 2012.**

Over the years, due to rapid technological progress, radiation from man-made sources exceeded that of natural origin. There is a general concern regarding a growing number of appliances that use radiofrequency/ microwave (RF/MW) radiation with particular emphasis on mobile communication systems. Since nonthermal biological effects and mechanisms of RF/MW radiation are still uncertain, laboratory studies on animal models, tissues, cells, and cell free system are of extraordinary importance in bioelectromagnetic research. We believe that such investigations play a supporting role in public risk assessment. Cellular systems with the potential for a clear response to RF/MW exposures should be used in those studies. It is known that organism is a complex electrochemical system where processes of oxidation and reduction regularly occur. One of the plausible mechanisms is connected with generation of reactive oxygen species (ROS). Depending on concentration, ROS can have both beneficial and deleterious effects. Positive effects are connected with cell signalling, defence against infectious agents, and proliferative cell ability. On the other hand, excessive production, which overloads antioxidant defence mechanism, leads to cellular damage with serious potential for disease development.

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ROS concentration increase within the cell caused by RF/MW radiation seems to be a biologically relevant hypothesis to give clear insight into the RF/MW action at non-thermal level of radiation. In order to better understand the exact mechanism of action and its consequences, further research is needed in the field. We would like to present current knowledge on possible biological mechanisms of RF/MW actions.

**Peinnequin A, Piriou A, Mathieu J, Dabouis V, Sebbah C, Malabiau R, Debouzy JC Non-thermal effects of continuous 2.45 GHz microwaves on Fas-induced apoptosis in human Jurkat T-cell line. Bioelectrochemistry 51(2):157-161, 2000.**

Non-thermal effects of microwaves (MWs) are one of the main issues studied for revising standards. The effects of MW exposure on apoptosis at non-thermal level (48 h, **2.45 GHz**, 5 mW/cm<sup>2</sup>) have been studied. Results obtained assess non-thermal MW effects on Fas, but neither on butyrate- nor on ceramide-induced apoptosis in human Jurkat T-cell line. These data show that MW interacts either with Fas pathway between receptor and caspase-3 activation or on membrane proteins (i.e. Fas receptor or neurosphingomyelinase).

**Koyama S, Narita E, Suzuki Y, Taki M, Shinohara N, Miyakoshi J. Effect of a 2.45-GHz radiofrequency electromagnetic field on neutrophil chemotaxis and phagocytosis in differentiated human HL-60 cells. J Radiat Res. 2014 Sep 5. pii: rru075. [Epub ahead of print]**

The potential public health risks of radiofrequency (RF) fields have been discussed at length, especially with the use of mobile phones spreading extensively throughout the world. In order to investigate the properties of RF fields, we examined the effect of **2.45-GHz RF** fields at the specific absorption rate (SAR) of 2 and 10 W/kg for 4 and 24 h on neutrophil chemotaxis and phagocytosis in differentiated human HL-60 cells. Neutrophil chemotaxis was not affected by RF-field exposure, and subsequent phagocytosis was not affected either compared with that under sham exposure conditions. These studies demonstrated an initial immune response in the human body exposed to 2.45-GHz RF fields at the SAR of 2 W/kg, which is the maximum value recommended by the International Commission for Non-Ionizing Radiation Protection (ICNIRP) guidelines. The results of our experiments for RF-field exposure at an SAR under 10 W/kg showed very little or no effects on either chemotaxis or phagocytosis in neutrophil-like human HL-60 cells.

**Koyama S, Isozumi Y, Suzuki Y, Taki M, Miyakoshi J. Effects of 2.45-GHz electromagnetic fields with a wide range of SARs on micronucleus formation in CHO-K1 cells. ScientificWorldJournal 4 Suppl 2:29-40, 2004.**

There has been considerable discussion about the influence of high-frequency electromagnetic fields (HFEMF) on the human body. In particular, HFEMF used for mobile phones may be of great concern for human health. In order to investigate the properties of HFEMF, we have examined the effects of **2.45-GHz EMF** on micronucleus (MN) formation in Chinese hamster ovary (CHO)-K1 cells. MN formation is induced by chromosomal breakage or inhibition of spindles during cell division and leads to cell

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damage. We also examined the influence of heat on MN formation, since HFEMF exposure causes a rise in temperature. CHO-K1 cells were exposed to HFEMF for 2 h at average specific absorption rates (SARs) of 5, 10, 20, 50, 100, and 200 W/kg, and the effects on these cells were compared with those in sham-exposed control cells. The cells were also treated with bleomycin alone as a positive control or with combined treatment of HFEMF exposure and bleomycin. Heat treatment was performed at temperatures of 37, 38, 39, 40, 41, and 42 degrees C. The MN frequency in cells exposed to HFEMF at a SAR of lower than 50 W/kg did not differ from the sham-exposed controls, while those at SARs of 100 and 200 W/kg were significantly higher when compared with the sham-exposed controls. There was no apparent combined effect of HFEMF exposure and bleomycin treatment. On heat treatment at temperatures from 38-42 degrees C, the MN frequency increased in a temperature-dependent manner. We also showed that an increase in SAR causes a rise in temperature and this may be connected to the increase in MN formation generated by exposure to HFEMF.

**Inoue S, Motoda H, Koike Y, Kawamura K, Hiragami F, Kano Y. Microwave irradiation induces neurite outgrowth in PC12m3 cells via the p38 mitogen-activated protein kinase pathway. *Neurosci Lett.* 432(1):35-39, 2008.**

The increasing use of mobile phone communication has raised concerns about possible health hazard effects of microwave irradiation. We investigated damage and differentiation caused by microwave irradiation on drug-hypersensitive PC12 cell line (PC12m3). These cells showed enhancement of neurite outgrowth to various stimulants. The frequency of neurite outgrowth induced by 2.45GHz (200W) of microwave irradiation was approximately 10-fold greater than that of non-irradiated control cells. Incubation of PC12m3 cells with SB203580, a specific inhibitor of p38 MAPK, resulted in marked inhibition of the microwave radiation-induced neurite outgrowth. Also, activation of the transcription factor CREB induced by microwave irradiation was inhibited by SB203580. Heat shock treatment at 45 degrees C had a strong toxic effect on PC12m3 cells, whereas microwave treatment had no toxic effect on PC12m3 cells. These findings indicate that p38 MAPK is responsible for the survival of PC12m3 cells and might induce neurite outgrowth via a CREB signaling pathway when subjected to microwave irradiation.

## Effects on Behavior

**Thomas S, Heinrich S, von Kries R, Radon K. Exposure to radio-frequency electromagnetic fields and behavioural problems in Bavarian children and adolescents. *Eur J Epidemiol.* 25(2):135-141, 2010.**

Only few studies have so far investigated possible health effects of radio-frequency electromagnetic fields (RF EMF) in children and adolescents, although experts discuss a potential higher vulnerability to such fields. We aimed to investigate a possible association between measured exposure to RF EMF fields and behavioural problems in children and adolescents. 1,498 children and 1,524 adolescents were randomly selected

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from the population registries of four Bavarian (South of Germany) cities. During an Interview data on participants' mental health, socio-demographic characteristics and potential confounders were collected. Mental health behaviour was assessed using the German version of the Strengths and Difficulties Questionnaire (SDQ). Using a personal dosimeter, we obtained radio-frequency EMF exposure profiles over 24 h. Exposure levels over waking hours were expressed as mean percentage of the reference level. Overall, exposure to radiofrequency electromagnetic fields was far below the reference level. Seven percent of the children and 5% of the adolescents showed an abnormal mental behaviour. In the multiple logistic regression analyses measured exposure to RF fields in the highest quartile was associated to overall behavioural problems for adolescents (OR 2.2; 95% CI 1.1-4.5) but not for children (1.3; 0.7-2.6). These results are mainly driven by one subscale, as the results showed an association between exposure and conduct problems for adolescents (3.7; 1.6-8.4) and children (2.9; 1.4-5.9). As this is one of the first studies that investigated an association between exposure to mobile telecommunication networks and mental health behaviour more studies using personal dosimetry are warranted to confirm these findings.

**Yuan K, Qin W, Wang G, Zeng F, Zhao L, Yang X, Liu P, Liu J, Sun J, von Deneen KM, Gong Q, Liu Y, Tian J. Microstructure abnormalities in adolescents with internet addiction disorder. PLoS One.6(6):e20708, 2011.**

**BACKGROUND:** Recent studies suggest that internet addiction disorder (IAD) is associated with structural abnormalities in brain gray matter. However, few studies have investigated the effects of internet addiction on the microstructural integrity of major neuronal fiber pathways, and almost no studies have assessed the microstructural changes with the duration of internet addiction. **METHODOLOGY/PRINCIPAL FINDINGS:** We investigated the morphology of the brain in adolescents with IAD (N = 18) using an optimized voxel-based morphometry (VBM) technique, and studied the white matter fractional anisotropy (FA) changes using the diffusion tensor imaging (DTI) method, linking these brain structural measures to the duration of IAD. We provided evidences demonstrating the multiple structural changes of the brain in IAD subjects. VBM results indicated the decreased gray matter volume in the bilateral dorsolateral prefrontal cortex (DLPFC), the supplementary motor area (SMA), the orbitofrontal cortex (OFC), the cerebellum and the left rostral ACC (rACC). DTI analysis revealed the enhanced FA value of the left posterior limb of the internal capsule (PLIC) and reduced FA value in the white matter within the right parahippocampal gyrus (PHG). Gray matter volumes of the DLPFC, rACC, SMA, and white matter FA changes of the PLIC were significantly correlated with the duration of internet addiction in the adolescents with IAD. **CONCLUSIONS:** Our results suggested that long-term internet addiction would result in brain structural alterations, which probably contributed to chronic dysfunction in subjects with IAD. The current study may shed further light on the potential brain effects of IAD.

**Hirata A, Kojima M, Kawai H, Yamashiro Y, Watanabe S, Sasaki H, Fujiwara O. Acute dosimetry and estimation of threshold inducing behavioral signs of thermal stress in rabbits at 2.45-GHz microwave exposure. IEEE Trans Biomed Eng. 57(5):1234-42, 2010.**

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In the current international guidelines and standards for human exposure to microwaves, the basic restriction is determined by the whole-body average specific absorption rate (SAR). The basis for the guidelines is the adverse effect such as work stoppage in animals for whole-body average SARs above a certain level. Although it is known that absorbed microwave energy causes the behavioral sign of thermal stress, the relationship of whole-body average SAR with temperature/temperature elevation has not been sufficiently investigated. In the present study, we performed experiments on rabbits exposed to 2.45-GHz microwaves. A total of 24 measurements were conducted for power densities from approximately 100 to 1,000 W/m<sup>2</sup>. Our computational code for electromagnetic-thermal dosimetry was used to set the exposure time duration and incident power density. Our experimental results suggest that a core temperature elevation of 1°C is an estimate of the threshold inducing complex behavioral signs of microwave-induced thermal stress in rabbits for different whole-body average SARs and exposure time durations. The whole-body average SAR required for microwave-induced behavioral sign in rabbits was estimated as approximately 1.3 W/kg for 2.45-GHz microwaves.

**Duan L, Shan Y, Yu X, [Observations of changes in neurobehavioral functions in workers exposed to high-frequency radiation]. Chung Hua Yu Fang I Hsueh Tsa Chih 32(2):109-111, 1998.** [Article in Chinese]

**OBJECTIVE:** To study the effects of exposure to high-frequency radiation on neurobehavioral function of the exposed workers and its measurement in evaluating occupational hazards caused by it. **METHODS:** Four neurobehavioral functions were tested for the workers exposed to high-frequency radiation with Neurobehavioral Core Tests Battery recommended by WHO. **RESULTS:** Scores for various indicators in exposed workers were significantly lower than those in controls, and correlated to the detection of neurasthenia in the exposed workers, to certain extent. **CONCLUSION:** Changes in neurobehavioral function in workers exposed to high-frequency radiation can reflect its important adverse effects.

## Immune Function

**Li CY, Liao MH, Lin CW, Tsai WS, Huang CC, Tang TK. Inhibitory Effects of Microwave Radiation on LPS-Induced NFκB Expression in THP-1 Monocytes. Chin J Physiol. 55(6):421-427, 2012.**

Microwave radiations can be encountered regularly in daily lives. When WHO announced that microwave radiations were a kind of environmental energy which interfere with the physiological functions of the human body, great concerns have been raised over the damages microwave frequencies can do to human physiology. The immunological performance and the activities of the cellular inflammatory factor NFκB have been closely related in monocyte. Due to the effect of phorbol 12-myristate 13-acetate (PMA) on THP-1 monocytes, THP-1 monocytes would differentiate into macrophages and would then react with lipopolysaccharides (LPS), and the amount of NFκB increased in the THP-

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1 monocytes. Expression of cytokine is affected when cells are exposed to a frequency of **2450 MHz** and at 900 W. Thus, in our experiments, an observation was made when THP-1 monocytes were stimulated with PMA and LPS to differentiate into macrophage, the amount of NFκB in cells increased exponentially, and the levels of NFκB expression were decreased by the exposure of microwave radiation. In conclusion, microwave radiations were found to inhibit the activity functions of THP-1 monocytes stimulated with PMA and LPS.

**Elekes, E, Thuroczy, G, Szabo, LD, Effect on the immune system of mice exposed chronically to 50 Hz amplitude-modulated 2.45 GHz microwaves. *Bioelectromagnetics* 17(3):246-248, 1996.**

The effect of continuous (CW; **2.45 GHz** carrier frequency) or amplitude-modulated (AM; 50 Hz square wave) microwave radiation on the immune response was tested. CW exposures (6 days, 3 h/day) induced elevations of the number of antibody-producing cells in the spleen of male Balb/c mice (+37%). AM microwave exposure induced elevation of the spleen index (+15%) and antibody-producing cell number (+55%) in the spleen of male mice. No changes were observed in female mice. It is concluded that both types of exposure conditions induced moderate elevation of antibody production only in male mice.

## Effects on Protein

**George DF, Bilek MM, McKenzie DR. Non-thermal effects in the microwave induced unfolding of proteins observed by chaperone binding. *Bioelectromagnetics* 29(4):324-330, 2008.**

We study the effect of microwaves at **2,450 MHz** on protein unfolding using surface plasmon resonance sensing. Our experimental method makes use of the fact that unfolding proteins tend to bind to chaperones on their unfolding pathway and this attachment is readily monitored by surface plasmon resonance. We use the protein citrate synthase (CS) for this study as it shows strong binding to the chaperone alpha crystallin when stressed by exposure to excess temperature. The results of microwave heating are compared with the effect of ambient heating and a combination of ambient and microwave heating to the same final temperature. We study the temperature distributions during the heating process. We show that microwaves cause a significantly higher degree of unfolding than conventional thermal stress for protein solutions heated to the same maximum temperature.

## Electromagnetic Hypersensitivity

**Nordin S, Neely G, Olsson D, Sandström M. Odor and Noise Intolerance in Persons with Self-Reported Electromagnetic Hypersensitivity. *Int J Environ Res Public Health*. 11(9):8794-8805, 2014.**

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Lack of confirmation of symptoms attributed to electromagnetic fields (EMF) and triggered by EMF exposure has highlighted the role of individual factors. Prior observations indicate intolerance to other types of environmental exposures among persons with electromagnetic hypersensitivity (EHS). This study assessed differences in odor and noise intolerance between persons with EHS and healthy controls by use of subscales and global measures of the Chemical Sensitivity Scale (CSS) and the Noise Sensitivity Scale (NSS). The EHS group scored significantly higher than the controls on all CSS and NSS scales. Correlation coefficients between CSS and NSS scores ranged from 0.60 to 0.65 across measures. The findings suggest an association between EHS and odor and noise intolerance, encouraging further investigation of individual factors for understanding EMF-related symptoms.

**Landgrebe M, Hauser S, Langguth B, Frick U, Hajak G, Eichhammer P. Altered cortical excitability in subjectively electrosensitive patients: results of a pilot study. J Psychosom Res. 62(3):283-288, 2007.**

**OBJECTIVE:** Hypersensitivity to electromagnetic fields is frequently claimed to be linked to a variety of unspecific somatic and/or neuropsychological complaints. Whereas provocation studies often failed to demonstrate a causal relationship between electromagnetic field exposure and symptom formation, neurophysiological examinations highlight baseline deviations in people claiming to be electrosensitive.

**METHODS:** To elucidate a potential role of dysfunctional cortical regulations in mediating hypersensitivity to electromagnetic fields, cortical excitability parameters were measured by transcranial magnetic stimulation in subjectively electrosensitive patients (n=23) and two control groups (n=49) differing in their level of unspecific health complaints.

**RESULTS:** Electrosensitive patients showed reduced intracortical facilitation as compared to both control groups, while motor thresholds and intracortical inhibition were unaffected.

**CONCLUSIONS:** This pilot study gives additional evidence that altered central nervous system function may account for symptom manifestation in subjectively electrosensitive patients as has been postulated for several chronic multisymptom illnesses sharing a similar clustering of symptoms.

**Hagström M, Auranen J, Ekman R. Electromagnetic hypersensitive Finns: Symptoms, perceived sources and treatments, a questionnaire study. Pathophysiology. 2013 Apr 1. pii: S0928-4680(13)00002-3.**

The aim was to analyze the subjective experiences of Finns who describe themselves as suffering from electromagnetic hypersensitivity (EHS), their symptoms, self-perceived sources of the health complaints and the effectiveness of medical and complementary alternative therapies. A total of 395 questionnaires were mailed to self-diagnosed EHS persons. Of the participants 345 belonged to a Finnish self-help group and 50 came from outside of the group. The return rate of the study was 52.1% (206) and 80.9% of the respondents were women. Before the onset of EHS the most common health complaints were different types of allergies (35.1%, 68). During the acute phase of EHS the most common symptoms were nervous system related: "stress" (60.3%, 117), "sleeping disorders" (59.3%, 115) and "fatigue" (57.2%, 111). The sources that were most often

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reported to have triggered EHS were: "personal computers" (50.8%, 94) and "mobile phones" (47.0%, 87). The same devices were also claimed to cause the most symptoms during the acute phase. After the acute phase of EHS had passed, the respondents still claimed to react to these same digital and wireless devices while their reactions to basic electrical appliances were reduced. According to 76% of 157 respondents the reduction or avoidance of electromagnetic fields (EMF) helped in their full or partial recovery. The best treatments for EHS were given as: "dietary change" (69.4%), "nutritional supplements" (67.8%) and "increased physical exercise" (61.6%). The official treatment recommendations of psychotherapy (2.6%) and medication (-4.2%) were not significantly helpful. According to the present results the official treatment protocols should take better account the EHS person's own experiences. The avoidance of electromagnetic radiation and fields effectively removed or lessened the symptoms in EHS persons.

**Landgrebe M, Frick U, Hauser S, Langguth B, Rosner R, Hajak G, Eichhammer P. Cognitive and neurobiological alterations in electromagnetic hypersensitive patients: results of a case-control study. *Psychol Med.* 38(12):1781-1791, 2008.**

BACKGROUND: Hypersensitivity to electromagnetic fields (EMF) is frequently claimed to be linked to a variety of non-specific somatic and neuropsychological complaints. Whereas provocation studies often failed to demonstrate a causal relationship between EMF exposure and symptom formation, recent studies point to a complex interplay of neurophysiological and cognitive alterations contributing to symptom manifestation in electromagnetic hypersensitive patients (EHS). However, these studies have examined only small sample sizes or have focused on selected aspects. Therefore this study examined in the largest sample of EHS EMF-specific cognitive correlates, discrimination ability and neurobiological parameters in order to get further insight into the pathophysiology of electromagnetic hypersensitivity. METHOD: In a case-control design 89 EHS and 107 age- and gender-matched controls were included in the study. Health status and EMF-specific cognitions were evaluated using standardized questionnaires. Perception thresholds following single transcranial magnetic stimulation (TMS) pulses to the dorsolateral prefrontal cortex were determined using a standardized blinded measurement protocol. Cortical excitability parameters were measured by TMS. RESULTS: Discrimination ability was significantly reduced in EHS (only 40% of the EHS but 60% of the controls felt no sensation under sham stimulation during the complete series), whereas the perception thresholds for real magnetic pulses were comparable in both groups (median 21% versus 24% of maximum pulse intensity). Intra-cortical facilitation was decreased in younger and increased in older EHS. In addition, typical EMF-related cognitions (aspects of rumination, symptom intolerance, vulnerability and stabilizing self-esteem) specifically differentiated EHS from their controls. CONCLUSIONS: These results demonstrate significant cognitive and neurobiological alterations pointing to a higher genuine individual vulnerability of electromagnetic hypersensitive patients.

**Landgrebe M, Frick U, Hauser S, Hajak G, Langguth B. Association of tinnitus and electromagnetic hypersensitivity: hints for a shared pathophysiology? *PLoS One.*4(3):e5026, 2009.**

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**BACKGROUND:** Tinnitus is a frequent condition with high morbidity and impairment in quality of life. The pathophysiology is still incompletely understood. Electromagnetic fields are discussed to be involved in the multi-factorial pathogenesis of tinnitus, but data proving this relationship are very limited. Potential health hazards of electromagnetic fields (EMF) have been under discussion for long. Especially, individuals claiming themselves to be electromagnetic hypersensitive suffer from a variety of unspecific symptoms, which they attribute to EMF-exposure. The aim of the study was to elucidate the relationship between EMF-exposure, electromagnetic hypersensitivity and tinnitus using a case-control design. **METHODOLOGY:** Tinnitus occurrence and tinnitus severity were assessed by questionnaires in 89 electromagnetic hypersensitive patients and 107 controls matched for age-, gender, living surroundings and workplace. Using a logistic regression approach, potential risk factors for the development of tinnitus were evaluated. **FINDINGS:** Tinnitus was significantly more frequent in the electromagnetic hypersensitive group (50.72% vs. 17.5%) whereas tinnitus duration and severity did not differ between groups. Electromagnetic hypersensitivity and tinnitus were independent risk factors for sleep disturbances. However, measures of individual EMF-exposure like e.g. cell phone use did not show any association with tinnitus. **CONCLUSIONS:** Our data indicate that tinnitus is associated with subjective electromagnetic hypersensitivity. An individual vulnerability probably due to an over activated cortical distress network seems to be responsible for, both, electromagnetic hypersensitivity and tinnitus. Hence, therapeutic efforts should focus on treatment strategies (e.g. cognitive behavioral therapy) aiming at normalizing this dysfunctional distress network.

## Effects on Critical Organs

**Phelan AM, Neubauer CF, Timm R, Neirenberg J, Lange DG, Athermal alterations in the structure of the canalicular membrane and ATPase activity induced by thermal levels of microwave radiation. Radiat Res 137(1):52-58, 1994.**

Sprague-Dawley rats (200-250 g) were exposed 30 min/day for 4 days to thermogenic levels (rectal temperature increase of 2.2 degrees C) of microwave radiation [2.45 GHz, 80 mW/cm<sup>2</sup>, continuous-wave mode (CW)] or to a radiant heat source resulting in an equivalent increase in body temperature of 2.2 degrees C. On the fifth day after the 4 days of exposure to microwave radiation, the animals were sacrificed and their livers removed. The canalicular membranes were isolated and evaluated for adenosinetriphosphatase (ATPase) activity, total fatty acid composition and membrane fluidity characteristics. Mg(++)-ATPase activity (V<sub>max</sub>) decreased by 48.5% in the group exposed to microwave radiation, with no significant change in the group exposed to radiant heat. The decrease in Mg(++)-ATPase was partially compensated by a concomitant increase in Na<sup>+</sup>/K<sup>+</sup>-ATPase activity (170% increase in V<sub>max</sub> over control) in animals exposed to microwave radiation, while no change occurred in the group exposed to radiant heat. This alteration in ATPase activity in the group exposed to microwave radiation is associated with a large decrease in the ratio of saturated to unsaturated fatty acids. Conversely, the group exposed to radiant heat had an increase in the ratio of

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saturated to unsaturated fatty acids. The most dramatic changes were found in the levels of arachidonic acid. Finally, the electron paramagnetic resonance (EPR) spin label technique used to measure the fluidity of the canalicular membranes of the animals in the three groups (sham, microwave radiation and radiant heat) indicated that the results were different in the three groups, reflecting the changes found in their fatty acid composition. The physiological response to "equivalent" thermal loads in rats is expressed differently for different types of energy sources. Possible mechanisms producing these divergent thermogenic responses are discussed.

**Lange DG, D'Antuono ME, Timm RR, Ishii TK, Fujimoto JM. Differential response of the permeability of the rat liver canalicular membrane to sucrose and mannitol following in vivo acute single and multiple exposures to microwave radiation (2.45 GHz) and radiant-energy thermal stress. Radiat Res 134(1):54-62, 1993.**

Both acute and chronic exposures to microwave radiation altered the function of the rat canalicular membrane. A single acute exposure to microwave radiation [80 mW/cm<sup>2</sup>, **2.45 GHz**, continuous wave, 30 min exposure (SAR approximately equal to 72 W/kg)] or a matched radiant-energy thermal load, both designed to raise core body temperature approximately 3 degrees C, decreased the permeability of the canalicular membrane of male Sprague-Dawley rats to sucrose. The change in canalicular membrane permeability was demonstrated by a significant increase in the percentage of [3H]sucrose recovered in bile following its administration by a segmented retrograde intrabiliary injection. Similar acute exposures to microwave and radiant-energy thermal sources produced no significant alterations in canalicular membrane permeability to [14C]mannitol. In both acute exposure protocols, a rapidly reversible increase in bile flow rate was observed. Four exposures (30 min/day x 4 days) to either microwave radiation (80 mW/cm<sup>2</sup>) or a matched radiant-energy thermal load resulted in a significant depression in bile flow rate at normothermic temperatures. Animals receiving multiple exposures to microwave radiation had significant decreases in canalicular membrane permeability to both [3H]sucrose and [14C]mannitol, while similar exposure to radiant-energy thermal load alone altered canalicular membrane permeability to [3H]sucrose. An examination of the hepatic clearance of sucrose and mannitol following acute microwave exposure demonstrated no significant differences. Thus acute single exposure to microwave and radiant-energy thermal loads produced similar alterations in canalicular membrane permeability. Conversely, multiple exposures produced nonreversible changes in bile flow rate and canalicular membrane permeability, with microwave exposure producing greater alterations in the function of the canalicular membrane than an equivalent radiant-energy thermal load.

**Somogyi Z, Thuroczky G, Kovacs J, Effects of modulated and continuous microwave irradiation on pyroantimonate precipitable calcium content in junctional complex of mouse small intestine. Scanning Microsc 7(4):1255-1261, 1993.**

The pyroantimonate precipitable calcium content of intestinal epithelial cells was investigated in mice following total body irradiation with **2450 MHz** continuous and low frequency (16 Hz) square modulated waves. In the control animals the reaction products

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appeared in the intercellular space of adjacent cells including intermediate junctions and desmosomes and were absent in the area of tight junctions. Immediately after low frequency modulated microwave irradiation at 0.5 and 1 mW/cm<sup>2</sup> power densities, a rapid distribution of pyroantimonate precipitable calcium content was observed. The pyroantimonate deposits were located on the cytoplasmic side of lateral membrane, in the area of junctional complex, including tight junction, and in other parts of lateral plasma membrane. These changes were reversible and 24 hours after the irradiation the distribution of pyroantimonate deposits was similar to the control. Continuous waves with same energy not altered the distribution of precipitable calcium. We conclude the low frequency modulated microwave irradiation can modify the calcium distribution without heat effects.

## Effects on Sleep

**Liu H, Chen G, Pan Y, Chen Z, Jin W, Sun C, Chen C, Dong X, Chen K, Xu Z, Zhang S, Yu Y. (2014) Occupational Electromagnetic Field Exposures Associated with Sleep Quality: A Cross-Sectional Study. PLoS ONE 9(10): e110825. doi:10.1371/journal.pone.0110825.**

**BACKGROUND:** Exposure to electromagnetic field (EMF) emitted by mobile phone and other machineries concerns half the world's population and raises the problem of their impact on human health. The present study aims to explore the effects of electromagnetic field exposures on sleep quality and sleep duration among workers from electric power plant. **METHODS:** A cross-sectional study was conducted in an electric power plant of Zhejiang Province, China. A total of 854 participants were included in the final analysis. The detailed information of participants was obtained by trained investigators using a structured questionnaire, which including socio-demographic characteristics, lifestyle variables, sleep variables and electromagnetic exposures. Physical examination and venous blood collection were also carried out for every study subject. **RESULTS:** After grouping daily occupational electromagnetic exposure into three categories, subjects with long daily exposure time had a significantly higher risk of poor sleep quality in comparison to those with short daily exposure time. The adjusted odds ratios were 1.68 (95%CI: 1.18, 2.39) and 1.57 (95%CI: 1.10, 2.24) across tertiles. Additionally, among the subjects with long-term occupational exposure, the longer daily occupational time apparently increased the risk of poor sleep quality (OR (95%CI): 2.12 (1.23~3.66) in the second tertile; 1.83 (1.07~3.15) in the third tertile). There was no significant association of long-term occupational exposure duration, monthly electric fee or years of mobile-phone use with sleep quality or sleep duration. **CONCLUSIONS:** The findings showed that daily occupational EMF exposure was positively associated with poor sleep quality. It implies EMF exposure may damage human sleep quality rather than sleep duration.

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### Synergistic Health Effects – RF and Other Agents

**Zhang MB, He JL, Jin LF, Lu DQ. Study of low-intensity 2450-MHz microwave exposure enhancing the genotoxic effects of mitomycin C using micronucleus test and comet assay in vitro. Biomed Environ Sci 15(4):283-290, 2002.**

**OBJECTIVE:** To determine the interaction between **2450-MHz microwaves (MW) radiation and mitomycin C (MMC)**. **METHODS:** The synergistic genotoxic effects of low-intensity 2450-MHz microwave and MMC on human lymphocytes were studied using single cell gel electrophoresis (SCGE) assay (comet assay) and cytokinesis-blocked micronucleus (CBMN) test in vitro. The whole blood cells from a male donor and a female donor were either only exposed to 2450-MHz microwaves (5.0 mW/cm<sup>2</sup>) for 2 h or only exposed to MMC (0.0125 microgram/mL, 0.025 microgram/mL and 0.1 microgram/mL) for 24 h; and the samples were exposed to MMC for 24 h after exposure to MW for 2 h. **RESULTS:** In the comet assay, the comet lengths (29.1 microns and 25.9 microns) of MW were not significantly longer than those (26.3 microns and 24.1 microns) of controls ( $P > 0.05$ ). The comet lengths (57.4 microns, 68.9 microns, 91.4 microns, 150.6 microns, 71.7 microns, 100.1 microns, 145.1 microns) of 4 MMC groups were significantly longer than those of controls ( $P < 0.01$ ). The comet lengths (59.1 microns, 92.3 microns, 124.5 microns, 182.7 microns and 57.4 microns, 85.5 microns, 137.5 microns, 178.3 microns) of 4 MW plus MMC groups were significantly longer than those of controls too ( $P < 0.01$ ). The comet lengths of MW plus MMC groups were significantly longer than those of the corresponding MMC doses ( $P < 0.05$  or  $P < 0.01$ ) when the doses of MMC were  $>$  or  $=$  0.025 microgram/mL. In the CBMN, the micronucleated cell (MNC) rates of MW were 5@1000 and 6@1000, which showed no difference compared with those (4@1000 and 4@1000) of controls ( $P > 0.05$ ). The MNC rates of 4 MMC groups were 8@1000, 9@1000, 14@1000, 23@1000 and 8@1000, 8@1000, 16@1000, 30@1000 respectively. When the doses of MMC were  $>$  or  $=$  0.05 microgram/mL, MNC rates of MMC were higher than those of controls ( $P < 0.05$ ). MNC rates of 4 MW plus MMC groups were 12@1000, 13@1000, 20@1000, 32@1000 and 8@1000, 9@1000, 23@1000, 40@1000. When the doses of MMC were  $>$  or  $=$  0.05 microgram/mL, MNC rates of MW plus MMC groups were much higher than those of controls ( $P < 0.01$ ). MNC rates of 4 MW plus MMC groups were not significantly higher than those of the corresponding MMC doses. **CONCLUSION:** The low-intensity 2450-MHz microwave radiation can not induce DNA and chromosome damage, but can increase DNA damage effect induced by MMC in comet assay.

**Zhang MB, Jin LF, He JL, Hu J, Zheng W. [Effects of 2,450 MHz microwave on DNA damage induced by three chemical mutagens in vitro] Zhonghua Lao Dong Wei Sheng Zhi Ye Bing Za Zhi. 21(4):266-269, 2003. [Article in Chinese]**

**OBJECTIVE:** To study the combined damage-effects of low-intensity **2,450 MHz** microwave (MW) with three chemical mutagens on human lymphocyte DNA. **METHODS:** DNA damage of lymphocytes exposed to microwave and(or) with chemical mutagens were observed at different incubation time (0 h or 21 h) with comet assay in vitro. Three

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combination-exposure ways of MW with chemicals were used: MW irradiation before chemical exposures, simultaneously exposed to MW and chemicals and MW irradiation after chemical exposures. The three chemical mutagens were mitomycin C (MMC, DNA crosslinker), bleomycin (BLM, radiometric agent), methyl methanesulfonate (MMS, alkylating agent). The exposure time of MW and chemical mutagens were 2 h and 3 h respectively. RESULTS: The differences of comet tail length between MW group and control group were not significant when lymphocytes were incubated for 0 h or 21 h ( $P > 0.05$ ). However, when lymphocytes were incubated for 21 h with 30.00 micro mol/L of MMC, the comet tail lengths of MW + MMC group, MW-MMC group and MMC + MW group were (18.00 +/- 5.96), (21.79 +/- 11.47) and (22.32 +/- 8.10) micro m respectively; while with 3.00 micro mol/L of MMC, the comet tail lengths were (8.99 +/- 3.75), (12.40 +/- 5.35) and (14.00 +/- 5.38) micro m respectively, which were significantly higher than those of corresponding MMC groups [(9.42 +/- 3.34) and (6.50 +/- 2.89) micro m,  $P < 0.01$  or  $P < 0.05$ ]. The DNA damage of MW plus BLM groups and MW plus MMS groups were not significantly different from the corresponding BLM and MMS groups ( $P < 0.05$ ). CONCLUSION: 2 450 MHz MW (5 mW/cm<sup>2</sup>) did not induce DNA damage directly, but could enhance the DNA damage effects induced by MMC. The synergistic effects of 2 450 MHz MW with BLM and MMS were not obvious.

**Nelson BK, Conover DL, Shaw PB, Snyder DL, Edwards RM, Interactions of radiofrequency radiation on 2-methoxyethanol teratogenicity in rats. *J Appl Toxicol* 17(1):31-39, 1997.**

Concurrent exposures to chemical and physical agents occur in the workplace; exposed workers include those involved with microelectronics industry, plastic sealers and electrosurgical units. Previous animal research indicates that hyperthermia induced by an elevation in ambient temperature can potentiate the toxicity and teratogenicity of some chemical agents. We previously demonstrated that combined exposure to radiofrequency (r.f.; 10 MHz) radiation, which also induces hyperthermia and is teratogenic to exposed animals, and the industrial solvent 2-methoxyethanol (2ME) produces enhanced teratogenicity in rats. A subsequent study replicated and extended that research by investigating the interactive dose-related teratogenicity of r.f. radiation (sham exposure or maintaining colonic temperatures at 42.0 degrees C for 0, 10, 20 or 30 min by r.f. radiation absorption) and 2ME (0, 75, 100, 125 or 150 mg/kg) on gestation days 9 or 13 of rats. The purpose of the present research is to determine the effects of r.f. radiation (sufficient to maintain colonic temperatures at 42.0 degrees C for 10 min) on a range of doses of 2ME (0, 20, 40, 60, 80, 100, 120 and 140 mg kg<sup>-1</sup>) administered on gestation day 13 of rats. Focusing on characterizing the dose-response pattern of interactions, this research seeks to determine the lowest interactive effect level. Day 20 fetuses were examined for external and skeletal malformations. The results are consistent with previous observations. Dose-related developmental toxicity was observed for 2ME both in the presence and absence of r.f. radiation. However, concurrent RF radiation exposure changed the shape of the dose-effect curve of 2ME. These data indicate that combined exposure effects should be considered when developing exposure guidelines and intervention strategies.

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**Nelson BK, Conover DL, Krieg EF Jr, Snyder DL, Edwards RM, Interactions of radiofrequency radiation-induced hyperthermia and 2-methoxyethanol teratogenicity in rats. *Bioelectromagnetics*. 18(5):349-359, 1997.**

Radiofrequency (RF) radiation is used in a variety of workplaces. In addition to RF radiation, many workers are concurrently exposed to numerous chemicals; exposed workers include those involved with the microelectronics industry, plastic sealers, and electrosurgical units. The developmental toxicity of RF radiation is associated with the degree and duration of hyperthermia induced by the exposure. Previous animal research indicates that hyperthermia induced by an elevation in ambient temperature can potentiate the toxicity and teratogenicity of some chemical agents. We previously demonstrated that combined exposure to RF radiation (10 MHz) and the industrial solvent, 2-methoxyethanol (2ME), produces enhanced teratogenicity in rats. The purpose of the present research is to determine the effects of varying the degree and duration of hyperthermia induced by RF radiation (sufficient to maintain colonic temperatures at control [38.5], 39.0, 40.0, or 41.0 degrees C for up to 6 h) and 2ME (100 mg/kg) administered on gestation day 13 of rats. Focusing on characterizing the dose-response pattern of interactions, this research seeks to determine the lowest interactive effect level. Day 20 fetuses were examined for external and skeletal malformations. The results are consistent with previous observations. Significant interactions were observed between 2ME and RF radiation sufficient to maintain colonic temperatures at 41 degrees C for 1 h, but no consistent interactions were seen at lower temperatures even with longer durations. These data indicate that combined exposure effects should be considered when developing both RF radiation and chemical exposure guidelines and intervention strategies.

## Effects on the Environment

**Soran ML, Stan M, Niinemets U, Copolovici L. Influence of microwave frequency electromagnetic radiation on terpene emission and content in aromatic plants. *J Plant Physiol*. 171(15):1436-1443, 2014**

Influence of environmental stress factors on both crop and wild plants of nutritional value is an important research topic. The past research has focused on rising temperatures, drought, soil salinity and toxicity, but the potential effects of increased environmental contamination by human-generated electromagnetic radiation on plants have little been studied. Here we studied the influence of microwave irradiation at bands corresponding to **wireless router (WLAN) and mobile devices (GSM)** on leaf anatomy, essential oil content and volatile emissions in *Petroselinum crispum*, *Apium graveolens* and *Anethum graveolens*. Microwave irradiation resulted in thinner cell walls, smaller chloroplasts and mitochondria, and enhanced emissions of volatile compounds, in particular, monoterpenes and green leaf volatiles (GLV). These effects

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were stronger for WLAN-frequency microwaves. Essential oil content was enhanced by GSM-frequency microwaves, but the effect of WLAN-frequency microwaves was inhibitory. There was a direct relationship between microwave-induced structural and chemical modifications of the three plant species studied. These data collectively demonstrate that human-generated microwave pollution can potentially constitute a stress to the plants.

### Miscellaneous Effects

**Ramundo-Orlando A, Liberti M, Mossa G, D'Inzeo G. Effects of 2.45 GHz microwave fields on liposomes entrapping glycoenzyme ascorbate oxidase: evidence for oligosaccharide side chain involvement. Bioelectromagnetics. 25(5):338-345, 2004.**

Previous observations reported by our group indicate that 2.45 GHz microwave fields at specific absorption rate (SAR) of 5.6 W/kg reduce the enzyme activity rate of ascorbate oxidase (AO) trapped in liposomes. In this study, we report dose-response studies on these AO containing liposomes irradiated at different SAR values (1.4, 2.8, 4.2, and 5.6 W/kg). No response was observed for SAR below 5.6 W/kg. Liposomes entrapping functional AO in its deglycated form (AO-D) were also used. In this case, no MW related enzyme activity changes were observed, demonstrating a direct involvement of oligosaccharide chains of AO. Furthermore, the catalytic properties of both AO and AO-D were not impaired by MW irradiation, neither in homogeneous solution nor loaded in liposomes, excluding possible changes in the conformation of enzyme as a mechanism. Our results suggest that the oligosaccharide chains of AO are critical to elicit the microwave observed effects on lipid membrane.

**Saalman E, Norden B, Arvidsson L, Hamnerius Y, Hojevik P, Connell KE, Kurucsev T, Effect of 2.45 GHz microwave radiation on permeability of unilamellar liposomes to 5(6)-carboxyfluorescein. Evidence of non-thermal leakage. Biochim Biophys Acta 1064(1):124-130, 1991.**

The influence of **2.45 GHz microwave radiation** on the membrane permeability of unilamellar liposomes was studied using the marker 5(6)-carboxyfluorescein trapped in phosphatidylcholine liposomes. The release of the fluorescent marker was followed by spectrofluorimetry after an exposure of 10 minutes to either microwave radiation or to heat alone of the liposome solutions. A significant increase of the permeability of carboxyfluorescein through the membrane was observed for the microwave-exposed samples compared to those exposed to normal heating only. Exposure to 2.45 GHz microwave radiation of liposomes has been previously found to produce increased membrane permeability as compared with heating. However, in contrast to previous studies, the observations reported here were made above the phase transition temperature of the lipid membrane. The experimental setup included monitoring of the temperature during microwave exposure simultaneously at several points in the solution volume using a fiberoptic thermometer. Possible mechanisms to explain the observations

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are discussed.

**Panagopoulos, D. J., Johansson O. & Carlo G.L. Polarization: A Key Difference between Man-made and Natural Electromagnetic Fields, in regard to Biological Activity. *Sci. Rep.* 5, 14914; doi: 10.1038/srep14914 (2015). Published online Oct 12, 2015.**

In the present study we analyze the role of polarization in the biological activity of Electromagnetic Fields (EMFs)/Electromagnetic Radiation (EMR). All types of man-made EMFs/EMR - in contrast to natural EMFs/EMR - are polarized. Polarized EMFs/EMR can have increased biological activity, due to: 1) Ability to produce constructive interference effects and amplify their intensities at many locations. 2) Ability to force all charged/polar molecules and especially free ions within and around all living cells to oscillate on parallel planes and in phase with the applied polarized field. Such ionic forced-oscillations exert additive electrostatic forces on the sensors of cell membrane electro-sensitive ion channels, resulting in their irregular gating and consequent disruption of the cell's electrochemical balance. These features render man-made EMFs/EMR more bioactive than natural non-ionizing EMFs/EMR. This explains the increasing number of biological effects discovered during the past few decades to be induced by man-made EMFs, in contrast to natural EMFs in the terrestrial environment which have always been present throughout evolution, although human exposure to the latter ones is normally of significantly higher intensities/energy and longer durations. Thus, polarization seems to be a trigger that significantly increases the probability for the initiation of biological/health effects.

**Nelson BK, Conover DL, Krieg EF Jr, Snyder DL, Edwards RM, Effect of environmental temperature on the interactive developmental toxicity of radiofrequency radiation and 2-methoxyethanol in rats. *Int Arch Occup Environ Health* 71(6):413-423, 1998.**

OBJECTIVE: This research was conducted to determine if altered environmental temperatures would affect the interactive developmental toxicity of radiofrequency (RF) radiation and the industrial solvent, 2-methoxyethanol (2ME). This is important because RF radiation is used in a variety of workplaces that have poorly controlled environmental temperatures, and many workers are concurrently exposed to various chemicals. Furthermore, we have previously demonstrated that combined exposure to RF radiation (10 MHz) and 2ME produces enhanced teratogenicity in rats. METHODS: RF radiation sufficient to maintain colonic temperatures at the control value (38degrees ), 39.0degrees or 40.0 degrees C for 2 or 4 h combined with either 0 or 100 mg/ kg 2ME at environmental temperatures of 18 degrees , 24 degrees and 30 degrees C (65 degrees , 75 degrees , and 85 degrees F) were given on gestation day 13 to Sprague-Dawley rats. Dams were killed on gestation day 20, and the fetuses were examined for external malformations. RESULTS AND CONCLUSIONS: Environmental temperature does affect the specific absorption rate (SAR) necessary to maintain a specific colonic temperature but does not affect the interactive developmental toxicity of RF radiation and 2ME in rats. These results, consistent with the literature, add to the evidence that the developmental toxicity of RF radiation (combined or alone) is associated with colonic temperature, not with SAR.

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**Nelson BK, Snyder DL, Shaw PB, Developmental toxicity interactions of methanol and radiofrequency radiation or 2-methoxyethanol in rats. *Int J Toxicol* 20(2):89-100, 2001.**

This research was undertaken to determine potential interactions among chemical and physical agents. Radiofrequency (RF) radiation is used in numerous workplaces, and many workers are concurrently exposed to RF radiation and various chemicals. The developmental toxicity of RF radiation is associated with the degree and duration of hyperthermia induced by the exposure. Previous animal research indicates that hyperthermia induced by an elevation in ambient temperature can potentiate the toxicity and teratogenicity of some chemical agents. We previously demonstrated that combined exposure to RF radiation (10 MHz) and the industrial solvent, 2-methoxyethanol (2ME), enhanced teratogenicity in rats. Interactions were noted at even the lowest levels of 2ME tested, but only at hyperthermic levels of RF radiation. The purpose of the present research is to investigate if the interactive effects noted for RF radiation and 2ME are unique to these agents, or if similar interactions might be seen with other chemicals. Because methanol is widely used as a solvent as well as fuel additive, and, at high levels, is teratogenic in animals, we selected methanol as a chemical to address generalizability. Based on the literature and our pilot studies, 0, 2, or 3 g/kg methanol (twice, at 6-hour intervals) were administered on gestation day 9 or 13 to groups of 10 Sprague-Dawley rats. Dams treated on day 9 were given methanol and exposed to RF radiation sufficient to maintain colonic temperature at 41 degrees C for 60 minutes (or sham). Those treated on day 13 were given methanol plus either 0 or 100 mg/kg 2ME. Because we observed that methanol produced hypothermia, some groups were given the initial dose of methanol concurrently with the RF or 2ME, and others were given the first dose of methanol 1.5 hours prior to RF or 2ME. Dams were sacrificed on gestation day 20, and the fetuses were examined for external malformations. The results indicate that RF radiation or methanol on day 9 increased the incidence of resorbed fetuses, but no interactive effects were observed. The resorptions were highest in groups given the experimental treatments 1.5 hours apart. The higher dose of methanol also reduced fetal weights. Administration of 2ME or methanol on day 13 increased the rate of malformations, and there was evidence of a positive interaction between 2ME and methanol. Fetal weights were reduced by 2ME and methanol alone, but no interaction was observed. Also, separation of the dosing with the teratogens did not affect the results. These results point out that interactions in developmental toxicology, such as those of RF radiation, 2ME, and methanol that we have studied, are complex, and such interactions cannot be fully understood or predicted without more research. It is important that combined exposure effects be considered when developing both physical agent and chemical agent exposure guidelines and intervention strategies.

**Solomentsev GY, English NJ, Mooney DA. Effects of external electromagnetic fields on the conformational sampling of a short alanine peptide. *J Comput Chem*. 33(9):917-923, 2012.**

Non-equilibrium molecular dynamics simulations of a solvated 21-residue polyalanine (A21) peptide, featuring a high propensity for helix formation, have been performed at

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300 K and 1 bar in the presence of external electromagnetic (e/m) fields in the microwave region (**2.45 GHz**) and an r.m.s. electric field intensity range of 0.01-0.05 V/Å. To investigate how the field presence affects transitions between the conformational states of a protein, we report 16 independent 40 ns-trajectories of A21 starting from both extended and fully folded states. We observe folding-behavior of the peptide consistent with prior simulation and experimental studies. The peptide displays a natural tendency to form stable elements of secondary structure which are stabilized by tertiary interactions with proximate regions of the peptide. Consistent with our earlier work, the presence of external e/m fields disrupts this behavior, involving a mechanism of localized dipolar alignment which serves to enhance intra-protein perturbations in hydrogen bonds (English, et al., J. Chem. Phys. 2010, 133, 091105), leading to more frequent transitions between shorter-lifetime states.

**Somogy Z, Thuroczy G, Koteles GJ, Kovacs J, Effects of modulated microwave and X-ray irradiation on the activity and distribution of Ca(2+)-ATPase in small intestine epithelial cells. Scanning Microsc 8(3):613-619; discussion 619-620, 1994.**

The distribution and activity of Ca(2+)-ATPase were investigated by histochemical methods in small intestine epithelial cells of mice following total body 2450 MHz low frequency (16 Hz) microwave and X-ray irradiation. In the control animals, enzyme activities were found in the brush border and on lateral membranes, including junctional areas of the cells. The enzyme activity of lateral membranes was inhibited by quercetin, a specific inhibitor of Ca(2+)-ATPase. Immediately after square modulated (16 Hz) 2450 MHz microwave irradiation at 1 mW/cm<sup>2</sup> power densities, we observed a decreased activity of Ca(2+)-ATPase on the lateral membrane regions. The X-ray irradiation (1 Gy) induced a similar decrease of Ca(2+)-ATPase activity which was reversible within 24 hours. "5 Gy" doses resulted in a decrease of enzyme activities on both apical and lateral membrane areas persisting up to 24 hours following irradiation.

**Takashima Y, Hirose H, Koyama S, Suzuki Y, Taki M, Miyakoshi J. Effects of continuous and intermittent exposure to RF fields with a wide range of SARs on cell growth, survival, and cell cycle distribution. Bioelectromagnetics.27(5):392-400, 2006.**

To examine the biological effects of radio frequency (RF) electromagnetic fields in vitro, we have examined the fundamental cellular responses, such as cell growth, survival, and cell cycle distribution, following exposure to a wide range of specific absorption rates (SAR). Furthermore, we compared the effects of continuous and intermittent exposure at high SARs. An RF electromagnetic field exposure unit operating at a frequency of **2.45 GHz** was used to expose cells to SARs from 0.05 to 1500 W/kg. When cells were exposed to a continuous RF field at SARs from 0.05 to 100 W/kg for 2 h, cellular growth rate, survival, and cell cycle distribution were not affected. At 200 W/kg, the cell growth rate was suppressed and cell survival decreased. When the cells were exposed to an intermittent RF field at 300 W/kg(pk), 900 W/kg(pk) and 1500 W/kg(pk) (100 W/kg(mean)), no significant differences were observed between these conditions and intermittent wave exposure at 100 W/kg. When cells were exposed to a SAR of 50 W/kg for 2 h, the temperature of the medium around cells rose to 39.1 degrees C, 100 W/kg

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exposure increased the temperature to 41.0 degrees C, and 200 W/kg exposure increased the temperature to 44.1 degrees C. Exposure to RF radiation results in heating of the medium, and the thermal effect depends on the mean SAR. Hence, these results suggest that the proliferation disorder is caused by the thermal effect.



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# Immunohistopathologic demonstration of deleterious effects on growing rat testes of radiofrequency waves emitted from conventional Wi-Fi devices

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## KEYWORDS

Carcinogenesis tests;  
Infertility;  
Internet;  
Oxidative stress;  
Wireless technology;  
Testes

**Abstract Objective:** To investigate effects on rat testes of radiofrequency radiation emitted from indoor Wi-Fi Internet access devices using 802.11.g wireless standards.

**Methods:** Ten Wistar albino male rats were divided into experimental and control groups, with five rats per group. Standard wireless gateways communicating at 2.437 GHz were used as radiofrequency wave sources. The experimental group was exposed to radiofrequency energy for 24 h a day for 20 weeks. The rats were sacrificed at the end of the study. Intracardiac blood was sampled for serum 8-hydroxy-2'-deoxyguanosine levels. Testes were removed and examined histologically and immunohistochemically. Testis tissues were analyzed for malondialdehyde levels and prooxidant–antioxidant enzyme activities.

**Results:** We observed significant increases in serum 8-hydroxy-2'-deoxyguanosine levels and 8-hydroxyguanosine staining in the testes of the experimental group indicating DNA damage due to exposure ( $p < 0.05$ ). We also found decreased levels of catalase and glutathione peroxidase activity in the experimental group, which may have been due to radiofrequency effects on enzyme activity ( $p < 0.05$ ).

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# Use of laptop computers connected to internet through Wi-Fi decreases human sperm motility and increases sperm DNA fragmentation

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**Objective:** To evaluate the effects of laptop computers connected to local area networks wirelessly (Wi-Fi) on human spermatozoa.

**Design:** Prospective in vitro study.

**Setting:** Center for reproductive medicine.

**Patient(s):** Semen samples from 29 healthy donors.

**Intervention(s):** Motile sperm were selected by swim up. Each sperm suspension was divided into two aliquots. One sperm aliquot (experimental) from each patient was exposed to an internet-connected laptop by Wi-Fi for 4 hours, whereas the second aliquot (unexposed) was used as control, incubated under identical conditions without being exposed to the laptop.

**Main Outcome Measure(s):** Evaluation of sperm motility, viability, and DNA fragmentation.

**Result(s):** Donor sperm samples, mostly normozoospermic, exposed ex vivo during 4 hours to a wireless internet-connected laptop showed a significant decrease in progressive sperm motility and an increase in sperm DNA fragmentation. Levels of dead sperm showed no significant differences between the two groups.

**Conclusion(s):** To our knowledge, this is the first study to evaluate the direct impact of laptop use on human spermatozoa. Ex vivo exposure of human spermatozoa to a wireless internet-connected laptop decreased motility and induced DNA fragmentation by a nonthermal effect. We speculate that keeping a laptop connected wirelessly to the internet on the lap near the testes may result in decreased male fertility. Further in vitro and in vivo studies are needed to prove this contention. (Fertil Steril® 2012; ■:■-■. ©2012 by American Society for Reproductive Medicine.)

**Key Words:** Laptop computer, Wi-Fi, sperm quality, fertility, sperm DNA fragmentation

In recent years, the use of portable computers (laptops, connected to local area networks wirelessly, also known as Wi-Fi) has increased dramatically. Laptops have become indispensable devices in our daily life, offering flexibility and mobility to users. People using Wi-Fi may be exposed to radio signals absorbing some of the transmitted energy in their bodies. Portable computers are commonly used on the lap (1–3), therefore exposing the genital area to radio frequency electromagnetic waves (RF-EMW) as well as high temperatures (3, 4).

Infertility is a common worldwide condition that affects more than 70 million couples of reproductive age (5). It has been suggested that male fertility has declined during the past several decades (6). Such decline has been attributed to the direct or indirect exposure to certain environmental factors such as RF-EMW (7).

Extremely low frequency magnetic fields can initiate a number of biochemical and physiological alterations in biological systems of different species (8–12). Many of these effects have been associated with free-radical production

(13, 14). Free radicals are causative factors of oxidative damage of cellular structures and molecules such as lipids, proteins, and nucleic acids. Free radicals react with polyunsaturated fatty acids in cell membranes promoting a process called lipid peroxidation. In human spermatozoa the presence of unesterified polyunsaturated fatty acids is causally associated with the induction of reactive oxygen species (ROS) generation and lipid peroxidation (15). Damage may occur at the membrane level, leading to immotility and cell death, or at the DNA level. DNA integrity is essential to normal conception. Sperm DNA fragmentation has been associated with impaired fertilization, poor embryonic development, high rates of miscarriage, and increased incidence of morbidity in the offspring, including childhood cancer (16, 17). It has been proposed that genetic and

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## REVIEW ARTICLE

## Oxidative mechanisms of biological activity of low-intensity radiofrequency radiation

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**Abstract**

This review aims to cover experimental data on oxidative effects of low-intensity radiofrequency radiation (RFR) in living cells. Analysis of the currently available peer-reviewed scientific literature reveals molecular effects induced by low-intensity RFR in living cells; this includes significant activation of key pathways generating reactive oxygen species (ROS), activation of peroxidation, oxidative damage of DNA and changes in the activity of antioxidant enzymes. It indicates that among 100 currently available peer-reviewed studies dealing with oxidative effects of low-intensity RFR, in general, 93 confirmed that RFR induces oxidative effects in biological systems. A wide pathogenic potential of the induced ROS and their involvement in cell signaling pathways explains a range of biological/health effects of low-intensity RFR, which include both cancer and non-cancer pathologies. In conclusion, our analysis demonstrates that low-intensity RFR is an expressive oxidative agent for living cells with a high pathogenic potential and that the oxidative stress induced by RFR exposure should be recognized as one of the primary mechanisms of the biological activity of this kind of radiation.

**Keywords**

Cellular signaling, cancer, free radicals, oxidative stress, radiofrequency radiation, reactive oxygen species

**History**

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**Introduction**

Intensive development of wireless technologies during the last decades led to a dramatic increase of background radiofrequency radiation (RFR) in the human environment. Thus, the level of indoor background RFR in industrialized countries increased 5,000-fold from 1985 to 2005 (Maes, 2005). Such significant environmental changes may have a serious impact on human biology and health. As a proof of such impact, a series of epidemiological studies on the increased risk of tumorigenesis in “heavy” users of wireless telephony exists (Hardell et al., 2007, 2011; Sadetzki et al., 2008; Sato et al., 2011). Some studies indicate that long-term RFR exposure in humans can cause various non-cancer disorders, e.g., headache, fatigue, depression, tinnitus, skin irritation, hormonal disorders and other conditions (Abdel-Rassoul et al., 2007; Buchner & Eger, 2011; Chu et al., 2011; Johansson, 2006; Santini et al., 2002; Yakymenko et al., 2011). In addition, convincing studies on hazardous effects of RFR in human germ cells have been published (Agarwal et al., 2009; De Iuliis et al., 2009).

All abovementioned studies dealt with the effects of low-intensity RFR. This means that the intensity of radiation was far below observable thermal effects in biological tissues, and far below safety limits of the International Commissions on Non-Ionizing Radiation Protection (ICNIRP) (ICNIRP, 1998). To date, molecular mechanisms of non-thermal effects of RFR are still a bottleneck in the research on the biological/health effects of low-intensity RFR, although recently many studies have been carried out on metabolic changes in living cells under low-intensity RFR, and comprehensive reviews were published (Belyaev, 2010; Consales et al., 2012; Desai et al., 2009; Yakymenko et al., 2011). In the present work, we analyze the results of molecular effects of low-intensity RFR in living cells and model systems, with a special emphasis on oxidative effects and free radical mechanisms. It might seem paradoxical that, despite being non-ionizing, RFR can induce significant activation of free radical processes and overproduction of reactive oxygen species (ROS) in living cells. We believe that the analysis of recent findings will allow recognition of a general picture of the potential health effects of already ubiquitous and ever-increasing RFR.

**Radiofrequency radiation**

RFR is a part of electromagnetic spectrum with frequencies from 30 kHz to 300 GHz. RFR is classified as non-ionizing,

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## Modulation of wireless (2.45 GHz)-induced oxidative toxicity in laryngotracheal mucosa of rat by melatonin

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**Abstract** It is well known that oxidative stress induces larynx cancer, although antioxidants induce modulator role on etiology of the cancer. It is well known that electromagnetic radiation (EMR) induces oxidative stress in different cell systems. The aim of this study was to investigate the possible protective role of melatonin on oxidative stress induced by Wi-Fi (2.45 GHz) EMR in laryngotracheal mucosa of rat. For this purpose, 32 male rats were equally categorized into four groups, namely controls, sham controls, EMR-exposed rats, EMR-exposed rats treated with melatonin at a dose of 10 mg/kg/day. Except for the controls and sham controls, the animals were exposed to 2.45 GHz radiation during 60 min/day for 28 days. The lipid peroxidation levels were significantly ( $p < 0.05$ ) higher in the radiation-exposed groups than in the control and sham control groups. The lipid peroxidation level in the irradiated animals treated with melatonin was significantly ( $p < 0.01$ ) lower than in those that were only exposed to Wi-Fi radiation. The activity of glutathione

peroxidase was lower in the irradiated-only group relative to control and sham control groups but its activity was significantly ( $p < 0.05$ ) increased in the groups treated with melatonin. The reduced glutathione levels in the mucosa of rat did not change in the four groups. There is an apparent protective effect of melatonin on the Wi-Fi-induced oxidative stress in the laryngotracheal mucosa of rats by inhibition of free radical formation and support of the glutathione peroxidase antioxidant system.

**Keywords** Melatonin · Larynx · Trachea · Oxidative stress · Wireless devices

### Introduction

Wireless devices usages in industrial, scientific, medical, military and domestic applications, with potential leakage, of such radiation into the environment have increased by leaps and bounds in past decade [1]. From being a luxury and limited to the wealthy, wireless devices especially near 2.45 GHz is indispensable in daily lives [2]. However, every technological advance and its overuse possess possible adverse effects [3].

Exposure to electromagnetic radiation (EMR) induces degenerative effects via two ways, namely directly or indirectly. Direct effects of EMR induce production of reactive oxygen species (ROS), including superoxide anion, hydrogen peroxide, and hydroxyl radicals. The ROS contribute to tissue and DNA damages [1]. Exposure to 2.45 GHz EMR causes an increase in lipid peroxidation levels and a decrease in the activity of enzymes that prevent or protect against lipid peroxidation in tissues [4, 5]. The human cells have nonenzymatic and enzymatic antioxidant systems against degenerative effects of ROS. Glutathione

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## Effects of Selenium and L-Carnitine on Oxidative Stress in Blood of Rat Induced by 2.45-GHz Radiation from Wireless Devices

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**Abstract** The levels of blood lipid peroxidation, glutathione peroxidase, reduced glutathione, and vitamin C were used to follow the level of oxidative damage caused by 2.45 GHz electromagnetic radiation in rats. The possible protective effects of selenium and L-carnitine were also tested and compared to untreated controls. Thirty male Wistar Albino rats were equally divided into five groups, namely Groups A<sub>1</sub> and A<sub>2</sub>: controls and sham controls, respectively; Group B: EMR; Group C: EMR + selenium, Group D: EMR + L-carnitine. Groups B–D were exposed to 2.45 GHz electromagnetic radiation during 60 min/day for 28 days. The lipid peroxidation levels in plasma and erythrocytes were significantly higher in group B than in groups A<sub>1</sub> and A<sub>2</sub> ( $p < 0.05$ ), although the reduced glutathione and glutathione peroxidase values were slightly lower in erythrocytes of group B compared to

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# Provocation study using heart rate variability shows microwave radiation from 2.4 GHz cordless phone affects autonomic nervous system

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## Abstract

**Aim:** The effect of pulsed (100 Hz) microwave (MW) radiation on heart rate variability (HRV) was tested in a double blind study. **Materials and Methods:** Twenty-five subjects in Colorado between the ages of 37 to 79 completed an electrohypersensitivity (EHS) questionnaire. After recording their orthostatic HRV, we did continuous real-time monitoring of HRV in a provocation study, where supine subjects were exposed for 3-minute intervals to radiation generated by a cordless phone at 2.4 GHz or to sham exposure. **Results:** Questionnaire: Based on self-assessments, participants classified themselves as extremely electrically sensitive (24%), moderately (16%), slightly (16%), not sensitive (8%) or with no opinion (36%) about their sensitivity. The top 10 symptoms experienced by those claiming to be sensitive include memory problems, difficulty concentrating, eye problems, sleep disorder, feeling unwell, headache, dizziness, tinnitus, chronic fatigue, and heart palpitations. The five most common objects allegedly causing sensitivity were fluorescent lights, antennas, cell phones, Wi-Fi, and cordless phones. **Provocation Experiment:** Forty percent of the subjects experienced some changes in their HRV attributable to digitally pulsed (100 Hz) MW radiation. For some the response was extreme (tachycardia), for others moderate to mild (changes in sympathetic nervous system and/or parasympathetic nervous system). and for some there was no observable reaction either because of high adaptive capacity or because of systemic neurovegetative exhaustion. **Conclusions:** Orthostatic HRV combined with provocation testing may provide a diagnostic test for some EHS sufferers when they are exposed to electromagnetic emitting devices. This is the first study that documents immediate and dramatic changes in both Heart Rate (HR) and HR variability (HRV) associated with MW exposure at levels

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## Effects of 2.4 GHz radiofrequency radiation emitted from Wi-Fi equipment on microRNA expression in brain tissue

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### Abstract

**Purpose:** MicroRNAs (miRNA) play a paramount role in growth, differentiation, proliferation and cell death by suppressing one or more target genes. However, their interaction with radiofrequencies is still unknown. The aim of this study was to investigate the long-term effects of radiofrequency radiation emitted from a Wireless Fidelity (Wi-Fi) system on some of the miRNA in brain tissue.

**Materials and methods:** The study was carried out on 16 Wistar Albino adult male rats by dividing them into two groups such as sham ( $n = 8$ ) and exposure ( $n = 8$ ). Rats in the exposure group were exposed to 2.4 GHz radiofrequency (RF) radiation for 24 hours a day for 12 months (one year). The same procedure was applied to the rats in the sham group except the Wi-Fi system was turned off. Immediately after the last exposure, rats were sacrificed and their brains were removed. miR-9-5p, miR-29a-3p, miR-106b-5p, miR-107, miR-125a-3p in brain were investigated in detail.

**Results:** The results revealed that long-term exposure of 2.4 GHz Wi-Fi radiation can alter expression of some of the miRNAs such as miR-106b-5p (adj  $p^* = 0.010$ ) and miR-107 (adj  $p^* = 0.005$ ). We observed that miR 107 expression is 3.3 times and miR-106b-5p expression is 3.65 times lower in the exposure group than in the control group. However, miR-9-5p, miR-29a-3p and miR-125a-3p levels in brain were not altered.

**Conclusion:** Long-term exposure of 2.4 GHz RF may lead to adverse effects such as neurodegenerative diseases originated from the alteration of some miRNA expression and more studies should be devoted to the effects of RF radiation on miRNA expression levels.

**Keywords:** 2.4 GHz radiofrequency, Wi-Fi, miRNA in brain, diseases, electromagnetic fields

### Introduction

The use of wireless technologies such as Wireless Fidelity (Wi-Fi) communication devices have been growing tremendously over the past years. Accessing Wireless Local Area

Networks (WLAN) in houses, workplaces, public areas and schools has become a routine task in our daily lives. However, rapid development of wireless technologies has steadily increased the environmental electromagnetic field (EMF) levels. Public and scientific awareness that was previously focused on the adverse health effects of EMF emitted from mobile phones has shifted to the biological hazards of wireless equipment such as Wi-Fi. Because the health effects of such equipment are still unclear, the Council of Europe recommends restrictions on the use of mobile phones and internet access in all schools across the continent to protect young children from potentially harmful radiation (Watson 2011). Therefore, understanding the relationship between electromagnetic fields and health diseases such as reproductive disorders, cancer, etc., is very important for the public especially for young children who utilize wireless internet very frequently during adolescent years. In addition, uncontrolled wireless internet usage can turn into a habit and may continue throughout our lives without us being aware of the potential harmful effects of electromagnetic fields.

The relation between radiation and carcinogenesis is a well-known process. However, the underlying mechanism which identifies the radiation-induced genetic instability is still not fully understood. Therefore, to illuminate the underlying mechanism between the radiation and carcinogenesis, more detailed studies, which include double-strand breaks, mutations, gene expression and disruption of mitochondrial processes, cell cycle arrest, and apoptotic cell death, are necessary. In addition, the underlying interaction mechanism between the radiation and microRNA (miRNA) expression, which is a new research field, should be investigated. Several studies have already indicated radiation-induced epigenetic changes including DNA methylation and miRNA expression where miRNA profiles have been shown to be associated with cancer (Jones and Baylin 2007, Tunali and Tiryakioglu 2010, Aypar et al. 2011a, 2011b).

miRNA are small and non-protein-coding RNA molecules. They play critical roles in growth, differentiation,

## COULD MYELIN DAMAGE FROM RADIOFREQUENCY ELECTROMAGNETIC FIELD EXPOSURE HELP EXPLAIN THE FUNCTIONAL IMPAIRMENT ELECTROHYPERSENSITIVITY? A REVIEW OF THE EVIDENCE

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**Myelin provides the electrical insulation for the central and peripheral nervous system and develops rapidly in the first years of life, but continues into mid-life or later. Myelin integrity is vital to healthy nervous system development and functioning. This review outlines the development of myelin through life, and then considers the evidence for an association between myelin integrity and exposure to low-intensity radiofrequency electromagnetic fields (RF-EMFs) typical in the modern world. In RF-EMF peer-reviewed literature examining relevant impacts such as myelin sheath, multiple sclerosis, and other myelin-related diseases, cellular examination was included. There are surprisingly little data available in each area, but considered together a picture begins to emerge in RF-EMF-exposed cases: (1) significant morphological lesions in the myelin sheath of rats; (2) a greater risk of multiple sclerosis in a study subgroup; (3) effects in proteins related to myelin production; and (4) physical symptoms in individuals with functional impairment electrohypersensitivity, many of which are the same as if myelin were affected by RF-EMF exposure, giving rise to symptoms of demyelination. In the latter, there are exceptions; headache is common only in electrohypersensitivity, while ataxia is typical of demyelination but infrequently found in the former group. Overall, evidence from in vivo and in vitro and epidemiological studies suggests an association between RF-EMF exposure and either myelin deterioration or a direct impact on neuronal conduction, which may account for many electrohypersensitivity symptoms. The most vulnerable are likely to be those in utero through to at least mid-teen years, as well as ill and elderly individuals.**

A recent report by the Health Council of the Netherlands highlighted the importance of myelination because of its role in providing electrical insulation to the nerve fibers (Health Council of the Netherlands, 2011). The council raised an important question: Can exposure to external electromagnetic fields, which create an electrical field in the brain, affect natural development and pruning of synapses during human development? This conservative advisory body stated that it is of “great

importance to gather more information on this” (20). The council refers to both radiofrequency and extremely low-frequency electromagnetic field (RF-EMF and ELF-EMF) exposures at intensities too low to produce thermal damage. These are omnipresent, both environmentally (such as from mobile phone base stations and WiFi routers) and individually (such as from mobile phones, tablets, laptops, and iPods). The council’s question is relevant and particularly important in the unborn and very young. The



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## Review Article

Recent Res. Devel. Mol. Cell. Biol., 7(2014): 0-00 ISBN: 978-81-308-0000-0

# 1. Microwave electromagnetic fields act by activating voltage-gated calcium channels: why the current international safety standards do not predict biological hazard

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**Abstract.** Microwave and other low frequency electromagnetic fields (EMFs) have been shown to act by activating voltage-gated calcium channels (VGCCs) with most biological effects being due to elevated intracellular calcium, consequent nitric oxide (NO) elevation and either peroxynitrite or NO signaling. This, the role of excessive intracellular calcium in microwave effects and some 20,000 papers on microwave biological effects show that the current international safety standards do not predict biological hazard. Such standards are based on the false assumption that the predominant effects of microwave and other low frequency EMF exposures are due to heating. A whole series of biological changes reportedly produced by microwave exposures can now be explained in terms of this new paradigm of EMF action via VGCC activation, including: oxidative stress; single and double stranded breaks in cellular DNA; therapeutic effects; blood-brain barrier breakdown; greatly depressed melatonin levels and sleep disruption; cancer; male and

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well below (0.5%) federal guidelines in Canada and the United States (1000 microW/cm<sup>2</sup>).

**Key Words:** heart rate variability, microwave radiation, DECT phone, autonomic nervous system, provocation study, sympathetic, parasympathetic, cordless phone, 2.4 GHz, electrohypersensitivity

## Introduction

A growing population claims to be sensitive to devices emitting electromagnetic energy. Hallberg and Oberfeld<sup>1</sup> report a prevalence of electrohypersensitivity (EHS) that has increased from less than 2% prior to 1997 to approximately 10% by 2004 and is expected to affect 50% of the population by 2017. Whether this is due to a real increase in EHS or to greater media attention, is not known. However, to label EHS as a psychological disorder or to attribute the symptoms to aging and/or stress does not resolve the issue that a growing population, especially those under the age of 60, are suffering from some combination of fatigue, sleep disturbance, chronic pain, skin, eye, hearing, cardiovascular and balance problems, mood disorders as well as cognitive dysfunction and that these symptoms appear to worsen when people are exposed to electromagnetic emitting devices<sup>2-7</sup>.

The World Health Organization (WHO) organized an international seminar and working group meeting in Prague on EMF Hypersensitivity in 2004, and at that meeting they defined EHS as follows<sup>8</sup>:

*“ . . . a phenomenon where individuals experience adverse health effects while using or being in the vicinity of devices emanating electric, magnetic, or electromagnetic fields (EMFs) . . . Whatever its cause, EHS is a real and sometimes a debilitating problem for the affected persons . . . Their exposures are generally several orders of magnitude under the limits in internationally accepted standards.”*

The WHO goes on to state that:

*“EHS is characterized by a variety of non-specific symptoms, which afflicted individuals attribute to exposure to EMF. The symptoms most commonly experienced include dermatological symptoms (redness, tingling, and burning sensations) as well as neurasthenic and vegetative symptoms (fatigue, tiredness, concentration difficulties, dizziness, nausea, heart palpitation and digestive disturbances). The collection of symptoms is not part of any recognized syndrome.”*

Both provocation studies (where individuals are exposed to some form of electromagnetic energy and their symptoms are documented) and amelioration studies (where exposure is reduced) can shed light on the offending energy source and the type and rate of reaction.

Several amelioration studies have documented improvements in the behavior of students and the health and wellbeing of teachers<sup>9</sup>, among asthmatics<sup>10</sup>, and in both diabetics and those with multiple sclerosis<sup>11,12</sup> when their exposure to dirty electricity is reduced. Dirty electricity refers to microsurgs flowing along electrical wires in the kHz

## Replication of heart rate variability provocation study with 2.4-GHz cordless phone confirms original findings

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This is a replication of a study that we previously conducted in Colorado with 25 subjects designed to test the effect of electromagnetic radiation generated by the base station of a cordless phone on heart rate variability (HRV). In this study, we analyzed the response of 69 subjects between the ages of 26 and 80 in both Canada and the USA. Subjects were exposed to radiation for 3-min intervals generated by a 2.4-GHz cordless phone base station ( $3-8 \mu\text{W}/\text{cm}^2$ ). A few participants had a severe reaction to the radiation with an increase in heart rate and altered HRV indicative of an alarm response to stress. Based on the HRV analyses of the 69 subjects, 7% were classified as being “moderately to very” sensitive, 29% were “little to moderately” sensitive, 30% were “not to little” sensitive and 6% were “unknown”. These results are not psychosomatic and are not due to electromagnetic interference. Twenty-five percent of the subjects’ self-proclaimed sensitivity corresponded to that based on the HRV analysis, while 32% overestimated their sensitivity and 42% did not know whether or not they were electrically sensitive. Of the 39 participants who claimed to experience some electrical hypersensitivity, 36% claimed they also reacted to a cordless phone and experienced heart symptoms and, of these, 64% were classified as having some degree of electrohypersensitivity (EHS) based on their HRV response. Novel findings include documentation of a delayed response to radiation. Orthostatic HRV testing combined with provocation testing may provide a diagnostic tool for some sufferers of EHS when they are exposed to electromagnetic emitting devices. The protocol used underestimates reaction to electromagnetic radiation for those who have a delayed autonomic nervous system reaction and it may under diagnose those who have adrenal exhaustion as their ability to mount a response to a stressor is diminished.

**Keywords:** heart rate variability, mobile phone, tachycardia, arrhythmia, microwave radiation, radio frequency radiation, electrohypersensitivity, autonomic nervous system

### Introduction

Individuals who complain of electrical hypersensitivity experience a myriad of symptoms that may include heart palpitation, arrhythmia, tachycardia, pain or pressure in the chest that may or may not be accompanied by anxiety, dizziness, nausea and headaches (Austrian Medical Association, 2012; Bevington, 2010; McCarty et al., 2011; Eltiti et al., 2007; Johansson, 2006). Since we have technology to measure the activity of

# **WI-FI ELECTROMAGNETIC FIELDS EXERT GENDER RELATED ALTERATIONS ON EEG**

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## ***Abstract***

The present study investigated the influence of electromagnetic fields, similar to that emitted by Wi-Fi system, on brain activity. Fifteen female and fifteen male subjects performed a short memory task (Wechsler test), both without and with exposure to a 2.4GHz Wi-Fi signal. For each subject, radiation condition and electrode, the amplitude in the frequency domain of the EEG signal was calculated from the recordings of 30 scalp electrodes, using the Fourier transform.

The presence of radiation had no effect on the energies of alpha and beta band of male subjects, while it reduced these energies of female subjects, resulting in significantly lower energies, as compared to those of males. Delta and theta band energies did not experience any noteworthy effect from gender, radiation condition and their interaction. Conversely, there was a significant interaction effect (gender x radiation) on the energies of alpha and beta rhythms.

Interestingly, this pattern was observed for a number of electrodes, which formed two distinct clusters: one located at right- anterior and the second at occipital brain areas.

The present data support the idea that Wi-Fi signal may influence normal physiology through changes in gender related cortical excitability, as reflected by alpha and beta EEG frequencies.

ORIGINAL ARTICLE

## **Drosophila oogenesis as a bio-marker responding to EMF sources**

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### **Abstract**

The model biological organisms *Drosophila melanogaster* and *Drosophila virilis* have been utilized to assess effects on apoptotic cell death of follicles during oogenesis and reproductive capacity (fecundity) decline. A total of 280 different experiments were performed using newly emerged flies exposed for short time daily for 3–7 d to various EMF sources including: GSM 900/1800 MHz mobile phone, 1880–1900 MHz DECT wireless base, DECT wireless handset, mobile phone-DECT handset combination, 2.44 GHz wireless network (Wi-Fi), 2.44 GHz blue tooth, 92.8 MHz FM generator, 27.15 MHz baby monitor, 900 MHz CW RF generator and microwave oven's 2.44 GHz RF and magnetic field components. Mobile phone was used as a reference exposure system for evaluating factors considered very important in dosimetry extending our published work with *D. melanogaster* to the insect *D. virilis*. Distance from the emitting source, the exposure duration and the repeatability were examined. All EMF sources used created statistically significant effects regarding fecundity and cell death-apoptosis induction, even at very low intensity levels (0.3 V/m blue tooth radiation), well below ICNIRP's guidelines, suggesting that *Drosophila* oogenesis system is suitable to be used as a biomarker for exploring potential EMF bioactivity. Also, there is no linear cumulative effect when increasing the duration of exposure or using one EMF source after the other (i.e. mobile phone and DECT handset) at the specific conditions used. The role of the average versus the peak E-field values as measured by spectrum analyzers on the final effects is discussed.

### **Keywords**

Apoptosis, baby monitor, blue tooth, DECT base, DECT handset, *Drosophila*, EMFs, mobile phones, MW oven, reproduction, Wi-Fi

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### **Introduction**

Wireless communication devices are widely used worldwide at nearly all human activities at home, for entertainment, for education and especially at work. The related devices include the well-known cell phones (nearly 6 billion users globally), the wireless DECT telephones (no records available but apparently their number is considered very high), the wireless local area network routers (no records available), iPads which are increasingly penetrating the market having only Wi-Fi (and not wired) internet access, not to mention the baby monitors and the also newly developed “smart meters”. Apart from the above “electromagnetic pollution” sources, there is also direct or indirect radiation exposure of humans by FM and TV broadcast stations, cell phone network mast stations, TETRA police and fire department antennae and many more. Because people may be adversely affected by the environmental impact of such electromagnetic fields (EMFs), it is of great scientific and social interest to explore the

possible health hazards (Behari, 2010) potentially caused by this radiation spectrum. Major research is associated mainly with cell phones, while at the same time the other sources have been neglected with the exception of the epidemiological and partially clinical studies involving DECT phones (Hardell & Carlberg, 2009; Hardell et al., 2004, 2006, 2011; Khurana et al., 2010). Mobile phone-like radiation studies have been performed during the last decades investigating a variety of biological effects, in humans with clinical studies and experimental work with rodents, flies and cell cultures. Assessing the possible link between exposure to electromagnetic fields and genotoxic effects, a number of studies have reported DNA damage, cell malformations, apoptotic cell death, changes in chromatin conformation and micronucleus formation in different cell types or organisms (Lai & Singh, 1996; Lixia et al., 2006; Ruediger, 2009; Zhao et al., 2007). However, in other studies, no genotoxic effects from exposure to EMF were observed (Belyaev et al., 2006; Verschaeve, 2005).

Mobile phone radiation has been also found to cause broad changes in gene and protein expression in certain cell types (Belyaev et al., 2006; Nylund & Leszczynski, 2006; Nylund et al., 2009; Remondini et al., 2006). Our group using

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## Modulator effects of L-carnitine and selenium on wireless devices (2.45 GHz)-induced oxidative stress and electroencephalography records in brain of rat

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### Abstract

**Purpose:** Electromagnetic radiation (EMR) from wireless devices may affect biological systems by increasing free radicals. The present study was designed to determine the effects of 2.45 GHz EMR on the brain antioxidant redox system and electroencephalography (EEG) records in rat. The possible protective effects of selenium and L-carnitine were also tested and compared to untreated controls.

**Materials and methods:** Thirty rats were equally divided into five different groups, namely Group A<sub>1</sub>: Cage control, Group A<sub>2</sub>: Sham control, group B: 2.45 GHz EMR, group C: 2.45 GHz EMR + selenium, group D: 2.45 GHz EMR + L-carnitine. Groups B, C and D were exposed to 2.45 GHz EMR during 60 min/day for 28 days. End of the experiments, EEG records and the brain cortex samples were taken.

**Results:** The cortex brain vitamin A ( $p < 0.05$ ), vitamin C ( $p < 0.01$ ) and vitamin E ( $p < 0.05$ ) concentrations values were lower in group B than in group A<sub>1</sub> and A<sub>2</sub> although their concentrations were increased by selenium and L-carnitine supplementation. Lipid peroxidation, levels were lower in group C ( $p < 0.05$ ) and D ( $p < 0.01$ ) than in group B where as reduced glutathione levels were higher in group C ( $p < 0.05$ ) than in group A<sub>1</sub>, A<sub>2</sub> and B. However, B-carotene levels did not change in the five groups.

**Conclusions:** L-carnitine and selenium seem to have protective effects on the 2.45 GHz-induced decrease of the vitamins by supporting antioxidant redox system. L-carnitine on the vitamin concentrations seems to more protective affect than in selenium.

**Keywords:** Wireless devices, lipid peroxidation, brain, vitamin E, L-carnitine, selenium, electroencephalography records

**Abbreviations:** ANOVA, analysis of variance; EEG, electroencephalography; EMF, electromagnetic fields; EMR, electromagnetic radiation; GSH, glutathione; GSH-Px, glutathione peroxidase; L-CAR, L-carnitine; LP, lipid peroxidation; LSD, least significance test; ROS, reactive oxygen species; SAR, specific absorption rate; SD, standard deviation; Se, selenium

### Introduction

In present times there is widespread use of 2.45 GHz irradiation-emitting devices in industrial, scientific, medical, military and domestic applications, with potential leakage of such radiation into the environment (Crouzier et al. 2007). Several studies have suggested that biological systems might be sensitive to such form of radiation (Koyu et al. 2005, Köylü et al. 2006). Today there is widespread use of 2.45 GHz radiation from common household devices likemicrowave ovens, wireless access points, and

computers, which in some cases were shown to be carcinogenic (Omura and Losco 1993).

Reactive oxygen substances (ROS) are produced by a free radical chain reaction, which can also be initiated by ROS (Naziroğlu 2007a). The ROS, i.e. singlet oxygen, superoxide anion radical and hydroxyl radical, contribute to tissue damage (Naziroğlu 2007b). ROS also cause injury by reacting with biomolecules such as lipids, proteins and nucleic acids as well as by depleting enzymatic and/or non-enzymatic antioxidants in the brain (Halliwell 2006, Naziroğlu et al. 2008). Memory and learning

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## 2.45-Gz wireless devices induce oxidative stress and proliferation through cytosolic $\text{Ca}^{2+}$ influx in human leukemia cancer cells

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### Abstract

**Purpose:** Electromagnetic radiation from wireless devices may affect biological systems by increasing free radicals. The present study was designed to determine the effects of 2.45 GHz radiation on the antioxidant redox system, calcium ion signaling, cell count and viability in human leukemia 60 cells.

**Materials and methods:** Twelve cell cultures were equally divided into two main groups as controls ( $n = 6$ ) and irradiated ( $n = 6$ ) and then subdivided into four different subgroups depending on the duration of exposure, namely 1, 2, 12 and 24 hours. The samples were analyzed immediately after the experimental period.

**Results:** The extent of lipid peroxidation, cytosolic free  $\text{Ca}^{2+}$  and cell numbers were higher in 2.45 GHz groups than in the controls. The increase of cytosolic free  $\text{Ca}^{2+}$  concentrations was radiation time-dependent and was highest at 24-h exposure. The reduced glutathione, glutathione peroxidase, vitamin C and cell viability values did not show any changes in any of the experimental groups. 2-aminoethyl diphenylborinate inhibits  $\text{Ca}^{2+}$  ions influx by blockage of the transient receptor potential melastatin 2.

**Conclusions:** 2.45 GHz electromagnetic radiation appears to induce proliferative effects through oxidative stress and  $\text{Ca}^{2+}$  influx although blocking of transient receptor potential melastatin 2 channels by 2-aminoethyl diphenylborinate seems to counteract the effects on  $\text{Ca}^{2+}$  ions influx.

**Keywords:** Wireless devices, oxidative stress,  $\text{Ca}^{2+}$  influx, TRPM2 channels, blood cancer

### Introduction

In present times there is widespread use of 2.45 GHz irradiation-emitting devices in industrial, scientific, medical, military and domestic applications, with potential leakage of such radiation into the environment (Crouzier et al. 2007). Common household devices like microwave ovens, wireless access points, and computers were in some cases shown to be carcinogenic (Omura and Losco 1993). Other studies have

suggested that biological systems might be sensitive to such form of radiation (Nazırođlu and Gumlral 2009, Nazırođlu et al. 2012, Gumlral et al. 2009).

Reactive oxygen species (ROS) are produced by a free radical chain reaction, which in some cases can be auto-initiated (Nazırođlu 2007a, 2007b). These species cause injury by reacting with lipids, proteins and nucleic acids as well as by depleting antioxidants in cancer cells (Reuter et al. 2010). There are various antioxidant mechanisms in cells that neutralize the harmful effects of ROS. In contrast, exposure to electromagnetic radiation (EMR) results in increases of ROS due to loss of efficiency of antioxidants mechanisms and alterations in mitochondrial electron transfer chain (Kovacic and Somanathan 2008).

Glutathione peroxidase is responsible for the reduction of hydro- and organic peroxides in the presence of reduced glutathione (Whanger 2001). Vitamin C is a free radical scavenger that also transforms vitamin E to its active form (Nazırođlu 2007a). We recently reported that 2.45 GHz radiation induced oxidative stress in brain and blood cells of rats (Nazırođlu and Gumlral 2009, Gumlral et al. 2009). However, whether 2.45 GHz EMR also induces oxidative stress in cancer cells is still unknown and deserves further study. The homeostasis of  $\text{Ca}^{2+}$  ions is one of the most important factors of cellular physiological function. It is involved in such diverse functions as cellular proliferation, apoptosis, induction of oxidative stress and physiological signal transductions (Putney 2009). The cytosolic free calcium ion concentration  $[\text{Ca}^{2+}]_i$  is controlled by a number of membrane-bound ion channels located both in the plasma and intracellular membranes. Transient receptor potential (TRP) channels are a group of non-selective cation channels that play important functions in sensory neurons (Nazırođlu 2011a). One subgroup of TRP melastatin is TRP melastatin 2 (TRPM2), which has two distinct domains with one functioning as an ion channel and the other as an adenosine diphosphate ribose-specific



# Melatonin modulates wireless (2.45 GHz)-induced oxidative injury through TRPM2 and voltage gated $Ca^{2+}$ channels in brain and dorsal root ganglion in rat

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## ABSTRACT

We aimed to investigate the protective effects of melatonin and 2.45 GHz electromagnetic radiation (EMR) on brain and dorsal root ganglion (DRG) neuron antioxidant redox system,  $Ca^{2+}$  influx, cell viability and electroencephalography (EEG) records in the rat. Thirty two rats were equally divided into four different groups namely group A1: Cage control, group A2: Sham control, group B: 2.45 GHz EMR, group C: 2.45 GHz EMR + melatonin. Groups B and C were exposed to 2.45 GHz EMR during 60 min/day for 30 days. End of the experiments, EEG records and the brain cortex and DRG samples were taken. Lipid peroxidation (LP), cell viability and cytosolic  $Ca^{2+}$  values in DRG neurons were higher in group B than in groups A1 and A2 although their concentrations were increased by melatonin, 2-aminoethylidiphenyl borinate (2-APB), diltiazem and verapamil supplementation. Spike numbers of EEG records in group C were lower than in group B. Brain cortex vitamin E concentration was higher in group C than in group B. In conclusion, Melatonin supplementation in DRG neurons and brain seems to have protective effects on the 2.45 GHz-induced increase  $Ca^{2+}$  influx, EEG records and cell viability of the hormone through TRPM2 and voltage gated  $Ca^{2+}$  channels.

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## 1. Introduction

In present times there is widespread use of 2.45 GHz irradiation-emitting devices in industrial, scientific, medical, military and domestic applications, with potential leakage of such radiation into the environment [1]. Several studies have suggested that biological systems might be sensitive to such form of radiation [2,3]. Today there is widespread use of 2.45 GHz radiation from common household devices like microwave ovens, wireless access points, and computers, which in some cases were shown to be carcinogenic [4].

Reactive oxygen substances (ROS) are produced by a free radical chain reaction, which can also be initiated by ROS [5]. ROS also cause

injury by reacting with biomolecules such as lipids, proteins and nucleic acids as well as by depleting enzymatic antioxidant such as glutathione peroxidase (GSH-Px) and/or nonenzymatic antioxidants such as reduced glutathione (GSH), vitamins A, C, E and  $\beta$ -carotene in the brain and neuronal cells [6]. Pain and brain diseases are impaired in individuals with brain and sensory neuron-related neurodegenerative diseases; this is believed to be, in part, the result of excessive production of ROS [7]. The brain and neurons consume the highest amount of oxygen in the human body [6] although most of the oxygen used in brain tissues is converted to  $CO_2$  and water, small amounts of oxygen form ROS [5]. The existence of polyunsaturated fatty acids which are targets of the ROS in the brain makes this organ more sensitive to oxidative damage [8]. ROS may be involved in the action of cell phone-induced electromagnetic radiation (EMR) on biological systems [2,9–11].

Neuropathic pain states severely limit the quality of life. There are several types of sensory neurons in dorsal root ganglion (DRG) neurons with responsiveness to different kinds of external and internal stimuli. These stimuli such as nociceptive, thermal and mechanical activate different receptors and ion channels that are present in the nerve terminals at the sensory receptive fields. Their expression in selective subsets of DRG neurons determines the response profile of individual neurons to a given stimulus [12].  $Ca^{2+}$  homeostasis is one of the most important factors of cellular physiological function. It

*Abbreviations:* 2-APB, 2-aminoethylidiphenyl borinate; DRG, dorsal root ganglion; EEG, electroencephalography; EMF, electromagnetic fields; EMR, electromagnetic radiation; FFA, flufenamic acid; GSH, glutathione; GSH-Px, glutathione peroxidase; LP, lipid peroxidation; ROS, reactive oxygen species; SAR, specific absorption rate.

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## ORIGINAL ARTICLE

**Protective effects of melatonin against oxidative injury in rat testis induced by wireless (2.45 GHz) devices**T. Oksay<sup>1</sup>, M. Nazıroğlu<sup>2</sup>, S. Doğan<sup>2</sup>, A. Güzel<sup>1</sup>, N. Gümral<sup>3</sup> & P. A. Koşar<sup>4</sup><sup>1</sup> Department of Urology, Suleyman Demirel University, Faculty of Medicine, Isparta, Turkey;<sup>2</sup> Department of Biophysics, Suleyman Demirel University, Faculty of Medicine, Isparta, Turkey;<sup>3</sup> Department of Physiology, Suleyman Demirel University, Faculty of Medicine, Isparta, Turkey;<sup>4</sup> Department Medical Biology and Genetics, Suleyman Demirel University, Faculty of Medicine, Isparta, Turkey**Keywords**

Melatonin—oxidative stress—rat—testis—wireless devices

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**Summary**

Wireless devices have become part of everyday life and mostly located near reproductive organs while they are in use. The present study was designed to determine the possible protective effects of melatonin on oxidative stress-dependent testis injury induced by 2.45-GHz electromagnetic radiation (EMR). Thirty-two rats were equally divided into four different groups, namely cage control (A1), sham control (A2), 2.45-GHz EMR (B) and 2.45-GHz EMR+melatonin (C). Group B and C were exposed to 2.45-GHz EMR during 60 min day<sup>-1</sup> for 30 days. Lipid peroxidation levels were higher in Group B than in Group A1 and A2. Melatonin treatment prevented the increase in the lipid peroxidation induced by EMR. Also reduced glutathione (GSH) and glutathione peroxidase (GSH-Px) levels in Group D were higher than that of exposure group. Vitamin A and E concentrations decreased in exposure group, and melatonin prevented the decrease in vitamin E levels. In conclusion, wireless (2.45 GHz) EMR caused oxidative damage in testis by increasing the levels of lipid peroxidation and decreasing in vitamin A and E levels. Melatonin supplementation prevented oxidative damage induced by EMR and also supported the antioxidant redox system in the testis.

**Introduction**

There is widespread use of 2.45-GHz irradiation emitting wireless devices in industrial, scientific, medical, military and domestic applications, in the recent century. Therefore, the leakage of irradiation into the environment is inevitable (Wang *et al.*, 2005; Crouzier *et al.*, 2007). Studies had already shown the effects of 2.45-GHz electromagnetic radiation on different body parts like nervous system, body weight, tissue morphology and histology, blood biochemical parameters, hormones, immune system and reproductive system (Aweda *et al.*, 2003; Hossmann & Hermann, 2003; Kim *et al.*, 2007; Nazıroğlu & Gümral, 2009; Kumar *et al.*, 2011a; Saygin *et al.*, 2011). There is a consequence that exposure to electromagnetic radiation (EMR) is with enhanced production of reactive oxygen species (ROS), including superoxide anion, hydrogen peroxide and hydroxyl radicals (Murphy *et al.*, 1993; Aweda *et al.*, 2003). These species and/or other free radicals may be involved in the interactions of EMR on biological systems, but the cellular and molecular mecha-

nisms involved in this process are not totally clear (Kim & Rhee, 2004; Gumral *et al.*, 2009; Nazıroğlu & Gümral, 2009). Some studies showed exposure to 2.45-GHz EMR may cause an increase in lipid peroxidation levels and a decrease in antioxidant enzymes that prevent or protect against lipid peroxidation (LPO) in reproductive tissues of male rats (Kumar *et al.*, 2011b).

Melatonin (N-acetyl-5-methoxy-tryptamine) is synthesised mainly by the pineal gland and has been considered a potent antioxidant, even more potent than vitamin E, which detoxifies a variety of ROS in many pathophysiological states (Pieri *et al.*, 1994; Ekmekcioglu, 2006). The direct effects of melatonin on the male reproductive system and testosterone synthesis from Leydig cells have also been examined in studies on animals. Because melatonin binding sites have been detected in the reproductive system of different species, it seems reasonable to assume that melatonin exerts its actions not only as an antioxidant but also through direct interaction with the steroidogenic cells of the reproductive organs (Oner-Iyidogan *et al.*, 2001; Armagan *et al.*, 2006).

## EFFECTS OF WI-FI SIGNALS ON THE P300 COMPONENT OF EVENT-RELATED POTENTIALS DURING AN AUDITORY HAYLING TASK

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The P300 component of event-related potentials (ERPs) is believed to index attention and working memory (WM) operation of the brain. The present study focused on the possible gender-related effects of Wi-Fi (Wireless Fidelity) electromagnetic fields (EMF) on these processes. Fifteen male and fifteen female subjects, matched for age and education level, were investigated while performing a modified version of the Hayling Sentence Completion test adjusted to induce WM. ERPs were recorded at 30 scalp electrodes, both without and with the exposure to a Wi-Fi signal. P300 amplitude values at 18 electrodes were found to be significantly lower in the response inhibition condition than in the response initiation and baseline conditions. Independent of the above effect, within the response inhibition condition there was also a significant gender X radiation interaction effect manifested at 15 leads by decreased P300 amplitudes of males in comparison to female subjects only at the presence of EMF. In conclusion, the present findings suggest that Wi-Fi exposure may exert gender-related alterations on neural activity associated with the amount of attentional resources engaged during a linguistic test adjusted to induce WM.

*Keywords:* Wi-Fi; P300 ERP component; Hayling; gender; EMF.

### 1. Introduction

Concern of health effects due to EMF, specifically radiofrequency (RF) exposure is currently arising. Numerous studies have investigated the potential effects of EMF,

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## 2.45 GHz Microwave Irradiation-Induced Oxidative Stress Affects Implantation or Pregnancy in Mice, *Mus musculus*

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**Abstract** The present experiment was designed to study the 2.45 GHz low-level microwave (MW) irradiation-induced stress response and its effect on implantation or pregnancy in female mice. Twelve-week-old mice were exposed to MW radiation (continuous wave for 2 h/day for 45 days, frequency 2.45 GHz, power density=0.033549 mW/cm<sup>2</sup>, and specific absorption rate=0.023023 W/kg). At the end of a total of 45 days of exposure, mice were sacrificed, implantation sites were monitored, blood was processed to study stress parameters (hemoglobin, RBC and WBC count, and neutrophil/lymphocyte (N/L) ratio), the brain was processed for comet assay, and plasma was used for nitric oxide (NO), progesterone and estradiol estimation. Reactive oxygen species (ROS) and the activities of ROS-scavenging

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enzymes— superoxide dismutase, catalase, and glutathione peroxidase—were determined in the liver, kidney and ovary. We observed that implantation sites were affected significantly in MW-irradiated mice as compared to control. Further, in addition to a significant increase in ROS, hemoglobin ( $p<0.001$ ), RBC and WBC counts ( $p<0.001$ ), N/L ratio ( $p<0.01$ ), DNA damage ( $p<0.001$ ) in brain cells, and plasma estradiol concentration ( $p<0.05$ ), a significant decrease was observed in NO level ( $p<0.05$ ) and antioxidant enzyme activities of MW-exposed mice. Our findings led us to conclude that a low level of MW irradiation-induced oxidative stress not only suppresses implantation, but it may also lead to deformity of the embryo in case pregnancy continues. We also suggest that MW radiation-induced oxidative stress by increasing ROS production in the body may lead to DNA strand breakage in the brain cells and implantation failure/resorption or abnormal pregnancy in mice.

**Keywords** Microwave radiation · Reactive oxygen species (ROS) · Nitric oxide · Antioxidant enzyme activity · Implantation failure

## Introduction

Microwaves (MW) are non-ionizing electromagnetic radiation (EMR) (wavelength ranging from 1 mm to 1 m and frequency between 0.3 and 300 GHz), which unlike ionizing radiation, do not contain sufficient energy to break the bond or chemically change the substances by ionization. In general, non-ionizing radiations are associated with two major potential hazards, i.e., electrical and biological. In recent times, the level of EMR in our environment has increased manifold due to a large-scale expansion of communication networks such as mobile phones, base stations, WLAN, Wi-Fi, Wi-MAX, etc. Radiations emitted from these modern devices are reported to induce various types of biological effects which are of great concern to human health due to its increased use in daily life. MW radiation primarily increases the temperature of the biological system, i.e., thermal effects [1], but its nonthermal effects have also been noted and studied in detail [2–8]. Nonthermal effects occur when the intensity of the MW radiation is sufficiently low so that the amount of energy involved would not significantly increase the temperature of a cell, tissue, or an organism, but may induce some physical or biochemical changes [9]. Prolonged exposure to low intensity 2.45 GHz microwave radiation may affect the cholinergic activity in the rat [2], brain development in mice [10], DNA breakage in rat brain [11], and histone kinase activity in rat [12], which results in neurological problems and reproductive disorders [13–15], in addition to changes in hematopoiesis of pregnant mice [16] and micronucleated erythrocytes in rats [17]. The International Agency for Research on Cancer has also kept radiofrequency electromagnetic fields in the list of factors causing cancer to humans. Some studies performed in this context suggest that people heavily exposed to these radiations are more prone to nonmalignant tumors [18]. It has been reported that mobile phone or cell phone radiation (a type of MW radiation) causes changes in cognitive function [19]. A German study has indicated an increase in cancer around base stations. Mobile phones use electromagnetic radiation in a microwave range (2G—900/1,800 MHz, 3G—2,100 MHz frequency band) which some believe may be harmful to human health. People living close to 2G and mostly 3G mobile phone masts or base stations frequently report symptoms of electromagnetic hypersensitivity such as dizziness, headaches, skin conditions, allergies, and many other problems. Hardell and groups [20, 21] have reported the health implications of mobile phone exposure (800–2,200 MHz). They found that cell phone users had an increased risk of

## Selenium and L-Carnitine Reduce Oxidative Stress in the Heart of Rat Induced by 2.45-GHz Radiation from Wireless Devices

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**Abstract** The aim of this study was to investigate the possible protective role of selenium and L-carnitine on oxidative stress induced by 2.45-GHz radiation in heart of rat. For this purpose, 30 male Wistar Albino rats were equally divided into five groups namely controls, sham controls, radiation-exposed rats, radiation-exposed rats treated with intraperitoneal injections of sodium selenite at a dose of 1.5 mg/kg/day, and radiation-exposed rats treated with intraperitoneal injections of L-carnitine at a dose of 1.5 mg/kg/day. Except for the controls and sham controls, the animals were exposed to 2.45-GHz radiation during 60 min/day for 28 days. The lipid peroxidation (LP) levels were higher in the radiation-exposed groups than in the control and sham control groups. The lipid peroxidation level in the irradiated animals treated with selenium and L-carnitine was lower than in those that were only exposed to 2.45-GHz radiation. The concentrations of vitamins A, C, and E were lower in the irradiated-only group relative to control and sham control groups, but their concentrations were increased in the groups treated with selenium- and L-carnitine. The activity of glutathione peroxidase was higher in the selenium-treated group than in the animals that were irradiated but received no treatment. The erythrocyte-reduced glutathione and  $\beta$ -carotene concentrations did not change in any of the groups. In conclusion, 2.45-GHz

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electromagnetic radiation caused oxidative stress in the heart of rats. There is an apparent protective effect of selenium and L-carnitine by inhibition of free radical formation and support of the antioxidant redox system.

**Keywords** 2.45-GHz electromagnetic radiation · Oxidative stress · Antioxidant enzymes · Antioxidant vitamins · L-Carnitine · Selenium

## Introduction

Many devices that emit 2.45-GHz radiation are in use for industrial, scientific, medical, military, and domestic purposes present a potential health and environmental problem [1]. Several studies have suggested that biological systems could exhibit a specific sensitivity to 2.45-GHz electromagnetic radiation [2–4]. Other studies were extended to electromagnetic radiation (EMR) generated from common household devices like microwave ovens, wireless access points, and computers which were also shown to have negative health effects, and that antioxidants showed a protective effect on 900-MHz mobile phone emissions [5, 6].

These types of radiation positively correlate to generation of oxygen-derived radicals (ROS) such as superoxide radical ions. The heart is the organ that consumes the greatest amount of oxygen, which makes it at greatest risk of oxidative stress and, in consequence, most susceptible to oxidative damage [1, 6, 7]. Superoxide ion radicals and other free radical species may be involved in the interactions of EMR on biological systems, but the cellular and molecular mechanisms involved in this process are still poorly understood [8, 9].

Exposure to 2.45-GHz EMR caused an increase in lipid peroxidation levels and a decrease in the activity of enzymes and vitamins that prevent or protect against lipid peroxidation in blood [8] and brain [9].

The body has enzymatic and non-enzymatic antioxidant systems. Enzymatic antioxidants neutralize excessive ROS, preventing them from damaging the cellular structure. Among those are superoxide dismutase (SOD), catalase (CAT), and glutathione peroxidase (GSH-Px) [10, 11]. In particular, GSH-Px is a selenium (Se)-containing enzyme responsible for the reduction of hydro- and organic peroxides in the presence of reduced glutathione (GSH) [12]. Se is also required for the catalytic activity of another critical antioxidant enzyme, mammalian thioredoxin reductase (TR). Along with vitamins C and E, Se is widely recognized as an essential part of the antioxidant system [11–13].

L-Carnitine (L-Car) is a low molecular weight compound obtained from the diet or biosynthesized from lysine and methionine. It has been identified in a variety of mammalian tissues and has an essential role in the mitochondrial oxidation of long-chain fatty acids through the action of specialized acyltransferases. Other roles for carnitine include buffering of the acyl coenzyme A/coenzyme A ratio, branched-chain amino acid metabolism, removal of excess acyl groups, and peroxisomal fatty acid oxidation [14]. L-Car has also been found to attenuate free radical-induced oxidative stress in various pathological conditions of heart [15]. The growing body of evidence about carnitine function in heart has led to increased understanding and identification of heart disorders associated with altered carnitine metabolism. However, there is no report on L-Car and 2.45 GHz-induced antioxidant redox system in heart.

There are no reports on the effects of wireless devices emitting 2.45 GHz radiation in the heart of experimental animals. The aim of the present study was to investigate the effects of

# Wi-Fi technology – an uncontrolled global experiment on the health of mankind

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The twenty-first century is marked with exponentially increasing development of technologies that provide wireless communications. To the pollution of the atmosphere with radio and TV signals, not only satellite communications but also any varieties of the Wi-Fi networks are added. By 2010 in the USA, 285 million mobile phone subscribers have been registered (for a little bit more than 300 million inhabitants). The estimate for the world is more than 5 billion mobile phone users at approximately 7 billion people living on this planet. Approximately 2 years ago, the International Agency of Research on Cancer (IARC) classified the electromagnetic fields used in mobile communication as a possible cancerogene. This paper discusses the potential health hazard and lack of scientific assessment and regulatory actions in protection of the life on the planet.

**Keywords:** WiFi, pollution, hazard, Radiofrequency electromagnetic fields

## The problem: Ionizing versus nonionizing radiation

Contemporary science is increasingly using and investigating two physical factors such as ionizing and nonionizing radiation, with an attempt to search for common mechanisms of action and evaluation of the public benefit and health hazard. What is common here is the word “radiation.” However, from the viewpoint of physics, these are two different factors that might be found in an environment. Importantly, they act simultaneously, but are discussed separately, entirely neglecting the existing background of the other factor.

It has been well established that ionizing radiation usually provokes effects based on energetic mechanisms and ionization of tissues. This action is characterized with threshold levels and could develop within short time after irradiation. Speaking on ionizing radiation, scientists and public health experts, based on decades of investigation, have come to know about a large variety of unfavorable, potentially harmful effects that developed hours (sometimes days) after irradiation. This was well confirmed in the evaluation of health effects and care for personnel and population after Chernobyl accident a quarter of century ago (Grigoriev, 2012a,b; Sage, 2012). Throughout the world, interest was also excited by the recent Fukushima disaster in March 2011.

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# Does prolonged radiofrequency radiation emitted from Wi-Fi devices induce DNA damage in various tissues of rats?

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## Abstract

Wireless Internet (Wi-Fi) providers have become essential in our daily lives, as wireless technology is evolving at a dizzying pace. Although there are different frequency generators, one of the most commonly used Wi-Fi devices are 2.4 GHz frequency generators. These devices are heavily used in all areas of life but the effect of radiofrequency (RF) radiation emission on users is generally ignored. Yet, an increasing share of the public expresses concern on this issue. Therefore, this study intends to respond to the growing public concern. The purpose of this study is to reveal whether long term exposure of 2.4 GHz frequency RF radiation will cause DNA damage of different tissues such as brain, kidney, liver, and skin tissue and testicular tissues of rats. The study was conducted on 16 adult male Wistar-Albino rats. The rats in the experimental group ( $n = 8$ ) were exposed to 2.4 GHz frequency radiation for over a year. The rats in the sham control group ( $n = 8$ ) were subjected to the same experimental conditions except the Wi-Fi generator was turned off. After the exposure period was complete the possible DNA damage on the rat's brain, liver, kidney, skin, and testicular tissues was detected through the single cell gel electrophoresis assay (comet) method. The amount of DNA damage was measured as % tail DNA value. Based on the DNA damage results determined by the single cell gel electrophoresis (Comet) method, it was found that the % tail DNA values of the brain, kidney, liver, and skin tissues of the rats in the experimental group increased more than those in the control group. The increase of the DNA damage in all tissues was not significant ( $p > 0.05$ ). However the increase of the DNA damage in rat testes tissue was significant ( $p < 0.01$ ).

In conclusion, long-term exposure to 2.4 GHz RF radiation (Wi-Fi) does not cause DNA damage of the organs investigated in this study except testes. The results of this study indicated that testes are more sensitive organ to RF radiation.

**Key Words:** 2.4 GHz Radiofrequency radiation, DNA damage, Wi-Fi, Comet assay



## OPEN

## SUBJECT AREAS:

CENTRAL PATTERN  
GENERATORS

MOTOR CORTEX

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# Long-lasting changes in brain activation induced by a single REAC technology pulse in Wi-Fi bands. Randomized double-blind fMRI qualitative study

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The aim of this randomized double-blind study was to evaluate in healthy adult subjects, with functional magnetic resonance imaging (fMRI), long lasting changes in brain activation patterns following administration of a single, 250 milliseconds pulse emitted with radio-electric asymmetric conveyer (REAC) technology in the Wi-Fi bands. The REAC impulse was not administered during the scan, but after this, according to a protocol that has previously been demonstrated to be effective in improving motor control and postural balance, in healthy subjects and patients. The study was conducted on 33 healthy volunteers, performed with a 1.5 T unit while operating a motor block task involving cyclical and alternating flexion and extension of one leg. Subsequently subjects were randomly divided into a treatment and a sham treatment control group. Repeated fMRI examinations were performed following the administration of the REAC pulse or sham treatment. The Treated group showed cerebellar and ponto-mesencephalic activation components that disappeared in the second scan, while these activation components persisted in the Sham group. This study shows that a very weak signal, such as 250 milliseconds Wi-Fi pulse, administered with REAC technology, could lead to lasting effects on brain activity modification.

The Radio electric asymmetric conveyer (REAC) is a new technology for bio and neuro modulation. The REAC technology is based on the production of weak radiofrequency electromagnetic fields in the Wi-Fi bands (2.4–5.8 GHz) in order to generate a flow of electric micro currents in the body of the subject being treated. This current flow can be focused, as required, on specific areas through a probe-conveyer, peculiar of the REAC technology. In previous functional magnetic resonance imaging (fMRI) studies<sup>1,2</sup> on healthy subjects, brain activity has been shown to be sensitive to modulation by REAC treatment administered according to a protocol named Neuro Postural Optimization (NPO), which has been proven to be effective in the correction of motor disorders (Fig. 1). In fact REAC-NPO is thought to modulate and optimize motor<sup>2</sup> and postural strategies<sup>3</sup>. Also in patients with advanced Alzheimer's Disease<sup>4</sup>, REAC-NPO improved gait and number of steps × seconds. Cumulated experience derived from other studies supports the feasibility, safety and efficacy of this brain neuromodulation technique.

## Results

Two subjects, one of NPO-Treated group and one of Sham group, were excluded during statistical analysis due to the presence of artifacts that degraded the functional images. The average patterns of activation areas before treatment were similar in the NPO-Treated and Sham groups in that they were concordant with regard to the topography of the areas activated<sup>5</sup>. This similarity was expected given that the subjects in the two groups were performing an identical motor task. However, slight variations, statistically non-significant, between the groups with respect to the conspicuity and extent of activation were observed (Fig. 2a vs.2b). Compared to the group-averaged activation patterns before REAC-NPO or sham treatment, those recorded for the two groups after NPO-REAC or sham treatment showed a decrease in the magnitude of activation, a reduction in the conspicuity of the activated areas, and a disappearance of the thalamic activation component<sup>6,7</sup> (Figs. 3a vs.3b). These changes were more marked in the NPO-treated group than in the Sham group. Furthermore, the cerebellar and ponto-



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Review

## Effect of mobile telephones on sperm quality: A systematic review and meta-analysis <sup>☆</sup>



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ABSTRACT

Mobile phones are owned by most of the adult population worldwide. Radio-frequency electromagnetic radiation (RF-EMR) from these devices could potentially affect sperm development and function. Around 14% of couples in high- and middle-income countries have difficulty conceiving, and there are unexplained declines in semen quality reported in several countries. Given the ubiquity of mobile phone use, the potential role of this environmental exposure needs to be clarified. A systematic review was therefore conducted, followed by meta-analysis using random effects models, to determine whether exposure to RF-EMR emitted from mobile phones affects human sperm quality. Participants were from fertility clinic and research centres. The sperm quality outcome measures were motility, viability and concentration, which are the parameters most frequently used in clinical settings to assess fertility.

We used ten studies in the meta-analysis, including 1492 samples. Exposure to mobile phones was associated with reduced sperm motility (mean difference  $-8.1\%$  (95% CI  $-13.1, -3.2$ )) and viability (mean difference  $-9.1\%$  (95% CI  $-18.4, 0.2$ )), but the effects on concentration were more equivocal. The results were consistent across experimental *in vitro* and observational *in vivo* studies. We conclude that pooled results from *in vitro* and *in vivo* studies suggest that mobile phone exposure negatively affects sperm quality. Further study is required to determine the full clinical implications for both sub-fertile men and the general population.

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Abbreviations: CI, confidence interval; RF-EMR, radiofrequency electromagnetic radiation, SAR, specific absorption rate; EEG, electroencephalography; ROS, reactive oxygen species; FEM, fixed effect model; REM, random effects model.

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Dear Maryland Children's Environmental Health and Protection Advisory Council Members,

Please enter my comments on the draft Wi-Fi Report into the record. I am a mother of two in Montgomery County and **strongly** support efforts to reduce environmental health risks and especially radio frequency radiation. My children have special needs and it is essential that we protect them and all children from the known and yet to be discovered health risks associated with wifi.

Technology in classrooms should be *hardwired (not wireless)* to significantly reduce radiation exposures in the classroom. Students and staff should know that wireless devices emit radio frequency radiation and that solutions exist to minimize this exposure.

Please send a strong positive *solution focused* statement to schools to protect children's health and future.

**Please put into the Wi-Fi report** the Austrian Medical Association's official recommendations to reduce radiofrequency radiation. Students and staff should be informed of this and cell phones should be turned off in classrooms to reduce exposures to children. Please note that a class of 30 children -each with a transmitting cell phone- will result in several streams of radiation absorbed into a child's body.

Cell phones should be turned off in classrooms or used on airplane mode only and safe corded phones should be installed in all classrooms for making telephone calls if needed and for security. Please also ensure that pediatricians are given this information to inform the children they care for.

January 2016 : [Vienna Medical Association has issued new Ten Cell Phone Guidelines.](#)

1. **Make calls as short and little as possible** - use a landline or write SMS. Children and teenagers under 16 years old should carry cell phones *only for emergencies!*
2. **Distance is your friend-** Keep the phone away from body during connection of Phone. Pay attention to the manufacturer's safer distance recommendation in the manual, keep a distance during the call set-up from the head and body. Take advantage of the built-in speakerphone or a headset!
3. **When using headsets or integrated hands-free, do not position mobile phones directly on the body** - special caution applies here for pregnant women. For men, mobile phones are a risk to fertility if Mobile is stowed in Trouser pockets. Persons with electronic implants (pacemakers, insulin pumps et cetera) must pay attention to distance. Unless otherwise possible, use coat pocket, backpack or purse.
4. **Not in vehicles (car, bus, train) calls** - without an external antenna, the radiation in the vehicle is higher. In addition, you will be distracted and you bother in public transport the other passengers!
5. **During the car when driving should be an absolute ban on SMS** and internetworking - the distraction leads to self-endangerment and endangering other road users!

6. **Make calls at home and at work via the fixed corded (not wireless) network** - Internet access via LAN cable (eg via ADSL, VDSL, fiber optic) no Radiation, is fast and secure data transfer. **Constant radiation emitters like DECT cordless telephones, WLAN access points, data sticks and LTE Home base stations (Box, Cube etc.) should be avoided!**
7. **Go offline more often or use Airplane mode** - Remember that for functions such as listening to music, camera, alarm clock, calculator or offline games an internet connection is not always required!
8. **Fewer apps means less radiation** - Minimize the number of apps and disable the most unnecessary background services on your smartphone. Disabling "Mobile services" / "data network mode" turns the smartphone again into a cell phone. You can still be reached, but avoid a lot of unnecessary radiation by background traffic!
9. **Avoid Mobile phone calls in places with poor reception** (basement, elevator etc) as it increases transmission power. Use in poor reception Area a headset or the speakerphone!
10. **For buyers of mobile phones, Look out for a very low SAR value** and an external antenna connection!

See the full poster from the Austrian Medical Association here <http://ehitrust.org/cell-phone-guidelines/>

Thank you so much,

Zena Carmel-Jessup