



STUDENT GUIDE: CELL PHONES, WIRELESS, AND YOUR HEALTH



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>>> What is cell phone radiation?

Cell phones have wireless antennas that send and receive signals invisibly carrying data such as text, voice, data, music, or video through the air to and from cell phone towers and other wireless networks. These signals are microwaves, a type of electromagnetic radiation called radiofrequency (RF). Unlike natural sources of electromagnetic radiation such as the sun, wireless technology uses man-made pulsed signals.

Cell phones were not evaluated for safety before they first came on the market in 1983. Because RF is non-ionizing radiation at a much lower power than X-rays or UV rays, it was assumed to be safe when the technology was first developed. Now there is much more completed research to understand the health impacts of cell phone radiation emissions. Recent science suggests that our daily exposure to RF radiation poses serious health risks.

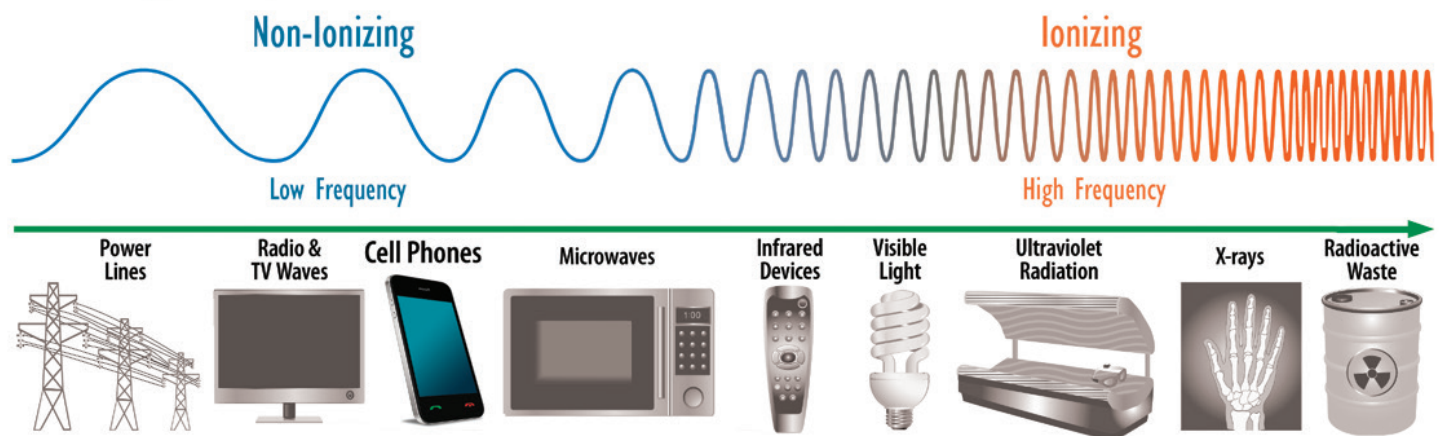
Many governments, doctors, and scientists recommend the public reduce RF exposure, especially for children whose brains are developing.

>>> What are the health impacts?

Scientific research links radiofrequency radiation exposure to a broad range of effects including:

- cancer
- headaches
- oxidative stress
- brain tumors
- sleep problems
- impacts on reproductive systems.
- memory problems
- impacts on brain development

Electromagnetic Spectrum



RFR used in cell phones is at the lower frequency and lower energy end of the electromagnetic spectrum.

Image: National Institute of Environmental Health Sciences

The Cancer Connection

In 2011, the World Health Organization's International Agency for Research on Cancer (WHO/IARC) ranked RF-EMF as "possibly carcinogenic to humans" (Group 2B) due to research that found increased risk (a doubling) of a type of brain cancer called glioblastoma in persons who have used cell phones heavily for more than 10 years. However, in these studies, "heavy" use was defined as about 30 minutes of cell phone use against the head per day. The scientific evidence linking radiofrequency radiation with cancer has significantly increased since 2011.

For persons who started using cell phones as teenagers, tumor risks four to five times higher were found. Studies also found that persons who used cell phones heavily had higher rates of acoustic neuroma, also known as vestibular schwannoma, which is a tumor that grows on the nerve that connects the inner ear to the brain.

In 2018, the U.S. National Toxicology Program (NTP) issued their final reports from a \$30M large scale animal study of about 3,000 rats and mice exposed for 2 years to 9 hours of cell phone radiation per day. The exposed male rats developed increases in two types of cancers: gliomas in the brain and schwannomas in the heart. None of the control (unexposed) rats developed these tumors. DNA damage was also found in brain regions of the mice and rats.

In 2018, the Ramazzini Institute of Italy published findings from their study in which they exposed rats to RF at much lower radiation levels than used in the NTP study. The Ramazzini Institute found increased incidence of the very same tumors that the NTP found: statistically significant increased schwannomas of the heart in male rats. These two studies are the largest animal studies ever done about cell phone radiation and found the same tumor types.

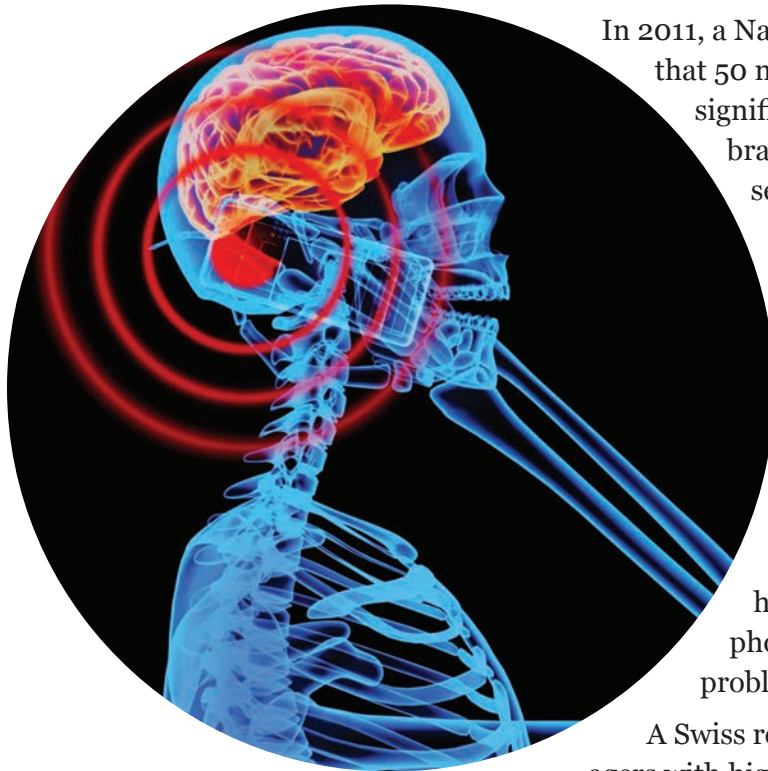
The schwannoma of the heart found in these two animal studies is considered by scientists to be comparable to the vestibular schwannomas (also known as acoustic neuroma) that researchers have found increased in humans who used cell phones long-term. When scientists find the same types of tumors in multiple animal studies as well as in multiple human studies, they consider the findings very important.

As a result of these studies about cell phone radiation and cancer, many scientists consider cell phone radiation to be a human carcinogen, and they are calling for the public to reduce exposure to radiofrequency radiation.

Breast Cancer

Doctors are reporting cases of young women who stored their cell phones in their bra for years and developed unusual tumors directly underneath the location of the cell phone antennas. These women had no history of breast cancer and no genetic predisposition to the disease, and the cancer is an unusual type. Now, many breast surgeons recommend against carrying cell phones in the bra.

Brain Impacts



In 2011, a National Institutes of Health study of 47 people found that 50 minutes of cell phone radiation exposure to the head significantly changed brain activity in the parts of the brain closest to the phone's antenna. This is one of several studies that provides scientific evidence that the human brain is sensitive to even short-term cell phone radiation exposures.

A Yale Medicine study found that exposing pregnant mice to RF increased hyperactivity, impaired memory, and abnormal brain development in the offspring. This Yale University study is one of several published experiments that found wireless radiation exposure can damage brain development and decrease brain cells. In humans, researchers have found pregnant women with higher use of cell phones had children with higher risk for behavioral problems.

A Swiss research study found decreased memory among teenagers with higher cell phone exposures to the brain after one year of repeated exposure.

Studies also have found persons who use cell phone more often have more headaches. Studies also have repeatedly found that RF can change brain waves during sleep and impact sleep.

Synergistic Effects

Electromagnetic fields (EMF) are found to have a stronger effect when combined with other toxic exposures. This is called a synergistic effect. Just like mixing drugs can be harmful, a synergistic effect means that the effects of mixing EMF with other exposures has a more harmful effect than if you only added together the effects from one exposure at a time. For example, a study found children with blood levels of the heavy metal lead (known to damage the brain) combined with higher cell phone exposures was associated with increased symptoms of ADHD. Experimental animal studies that combined EMF with a known carcinogen found that the EMF exposure accelerated the tumor growth.

Reproduction

A cell phone in the pants pocket results in high RF exposure to male and female reproductive organs. The testicular barrier is known to be more sensitive than most other membranes in the human body. Scientists at major research centers around the world have repeatedly found cell phone radiation effects on sperm. As an example, studies have found sperm from healthy men who are exposed to cell phone radiation die three times more quickly and develop more damage than sperm from the same men when they are not exposed. Research on animals has found damage to testes and ovarian development, raising critical questions about cell phone radiation effects to young boys and girls whose reproductive organs are still developing.

How could non-ionizing radiation cause harm?

Although non-ionizing radiation does not directly damage DNA as ionizing radiation does, there are many ways that non-ionizing radiation could start a chain reaction in the body that can increase cancer risk and promote disease. Very small amounts of this radiation have been found to cause biochemical changes at the cellular level and alter the way living cells communicate with each other. Over time, with repeated exposure, these effects build up and lead to other effects.

EMF exposure has been found to increase oxidative stress in the body and this can weaken the body's ability to repair damage from everyday toxic exposures. Oxidative stress is understood to contribute to the development of cancer, immune problems, neurodegenerative disease, and many other health issues.

Studies also have found that very low levels of RF can weaken membranes including the blood-brain barrier (BBB). The BBB protects the brain from toxins that circulate in the blood. A weaker BBB allows toxins and metals to penetrate into the brain more easily..

>>> Why should we read our cell phone manuals?

All cell phones have clear instructions in their manuals to keep the phone at a specific distance away from your body because when phones are placed in contact with your body the radiation that will penetrate into your body could be at levels that exceed government recommended limits.

Most people assume phone and wireless device radiation emissions tests are conducted in the same ways people use these devices, such as in positions touching the body. However, phones are not tested touching the body. Phones are radiation tested with a space—a separation distance—between the phone and a body dummy.

The separation distances used in cell phone radiation tests can range from 5 to 15 millimeters. That is why cell phone companies recommend keeping a specific distance in their user manuals. The separation distance stated in manuals is the exact distance that manufactures use between the phone and the body when they test the radiation emissions of a new phone model before placing it on the market.



Cell phone radiation tests were developed decades ago, and the way people use phones has dramatically changed. Although 5 mm may seem like a short distance, when it comes to RF radiation every millimeter makes a huge difference in the rate that the radiation is absorbed into the body. The government of France decided to test phones the way they are used, touching the body. They tested hundreds of cell phones and found most exceed European radiation limits in body contact positions. found high radiation absorption levels at body contact. A 2019 study analyzed the test results and found that the phones could exceed US limits up to eleven times.

So when you rest a phone on your leg or tuck a phone inside your stretchy pants or sleep with the phone on your chest, you risk exposing your body to radiation intensities that can exceed U.S. government recommended limits. That is why scientists recommend that cell phones stay away from the body and out of your pocket or bra.

Remember that government cell phone radiation laws are outdated and do not protect people from long-term effects. Scientists recommend cell phones be as far away as possible (with even more distance than the manuals recommend) and choosing wired connections (not wireless) whenever possible.

>>> Cell phone radiation penetrates deeper into children's brains.

Children have thinner skulls, smaller heads, and higher water content in their developing tissues. Their unique physiology allows cell phone radiation to penetrate deeper and more intensely into their brains as compared to an adult.

"In children using mobile phones, the average deposition of RF energy may be two times higher in the brain and up to ten times higher in the bone marrow of the skull," according to the World Health Organization's International Agency for Research on Cancer.

Childhood is a time of rapid brain growth and even small disruptions can have large effects later on, making children more at risk from cell phone radiation. The American Academy of Pediatrics has written several letters to the U.S. government to strengthen cell phone radiation exposure limits because of children's increased vulnerability to this radiation.



“Body-worn SAR testing has been carried out at a separation distance of 1.0 cm. To meet RF exposure guidelines during body worn operation, the device should be positioned at least this distance away from the body.” – Samsung Galaxy S5

“Usage precautions during 3G connection: Keep safe distance from pregnant women's stomach or from lower stomach of teenagers. Body worn operation: Important safety information regarding radiofrequency radiation (RF) exposure. To ensure compliance with RF exposure guidelines the Notebook PC must be used with a minimum of 20.8 cm antenna separation from the body.”
– Samsung 3G Laptop



>>> What are the main ways people are exposed to radiofrequency radiation?

People are mainly exposed to RF from their cell phones, cordless phones, and other wireless devices powered on in close proximity to their body. When a cell phone connects to a network tower or Wi-Fi router, the RF sprays out of the phone's antenna in all directions, and about half of the RF is absorbed into the head and body of the person who is using the phone.

Wireless phones emit radiation, even when you are not using them. A phone might be sitting quietly, but it is always radiating. Apps are updating, texts are incoming, and notifications are arriving. The phone is always automatically "checking in" via a "digital handshake" to the nearest cell network tower, each time exposing your body to more of the pulsed radiation.

Similarly, every type of wireless device (whether it's large like a wireless desktop computer or tiny like blue-tooth earpiece) is checking in with the nearby Wi-Fi router/cell phone/cell tower and by always emitting RF. This is why doctors recommend against sleeping near a cell phone, cordless phone base, wireless game/entertainment system, wireless baby monitor, or Wi-Fi router.

A simple step to reduce this unnecessary exposure is to turn your cell phone or digital device on airplane mode with Bluetooth and Siri OFF which will disable the antennas. Wi-fi connectivity can be disabled in the settings of your computer. You still can do word processing, take pictures and play music while the device is on airplane mode.

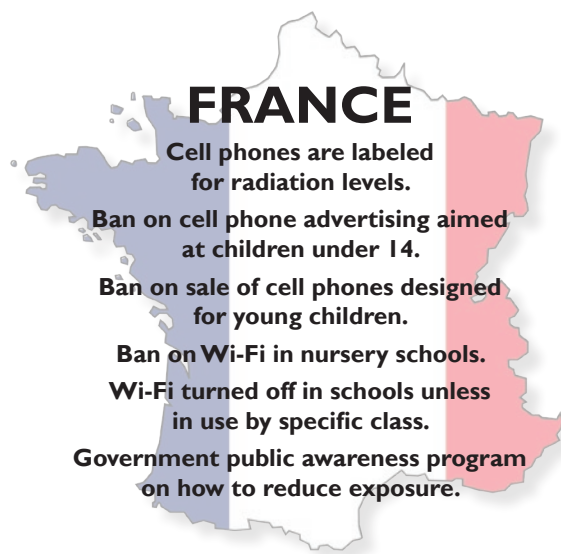
Research has found that if you are in an area of low reception and you have under two bars on your phone – such as in a basement, elevator or car – the cell phone must work harder to connect to the network and therefore the radiation emissions can be increased up to 10,000 times. In this situation it is recommended to turn off or airplane mode the phone/device and wait until the signal is better.

At home, your cordless phone base unit is also always radiating. If you replace your home cordless phone system with a corded phone that does not have any wireless features, you eliminate this radiation exposure.

"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."

Berkeley Cell Phone
Right To Know Ordinance





>>> What policies are in place by governments?

Over a dozen countries such as India, Russia, France, Belgium, Cyprus and Israel have issued clear recommendations to reduce RF exposure from cell phones. India, France and Korea label phones with their cell phone radiation levels. Many countries have policies in place to reduce exposures to children in schools. However US agencies only give the public two tips to reduce exposure “if you are worried.”

In the United States, the City of San Francisco passed a 2010 law to inform people how to reduce cell phone radiation. The law would make stores share information whenever someone went to buy a phone at a store. The wireless industry sued the City and halted implementation of the law but the City still has

a website with information on how to reduce cell phone exposure. The City of Berkeley passed a similar law in 2015 and again, the Wireless Industry sued and took it to the Supreme Court. Some towns like Pembroke Pines Florida and Jackson Hole Wyoming passed cell phone proclamations to raise awareness about the issue.

>>> How can we decrease exposure to radiofrequency radiation?

The American Academy of Pediatrics, California Department of Health, Maryland Council on Children’s Environmental Health, Connecticut Department of Health, and several international medical organizations such as the Vienna Medical Association, Athens Medical Association and the International Society of Doctors for the Environment all recommend reducing exposure to radiofrequency radiation.

>>> Recommendations to Reduce Exposure to Cell Phone Radiation

- Use cell phones in speaker mode or with the use of airtube headset.
- Keep phone at a distance from your head and body as general rule of thumb.
- 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.
- If you plan to watch a movie on your device, have movies pre-downloaded rather than streaming. Prefer wired computers to watch movies and do social media.
- 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.
- 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.
- Children should be given toys, not cell phones to play with.
- Make only short or essential calls on cell phones.
- Stop sleeping with your phone or wireless device.
- Turn the phone on airplane mode if you need to use your phone as an alarm clock.
- Use a hardwired cabled (not wireless) mouse, speaker, printer and keyboard with your computer.
- Turn Wi-Fi off and unplug wireless devices at night or when not in use.
- Hard-wire devices in your home that connect to the internet whenever possible.
- Use corded phones (with a curly cord from headset to base) instead of cell phones/ home cordless phones whenever possible, especially for your long voice calls.
- Remove screens and electronics from the bedroom for a healthier sleep.
- Educate your elected officials for policy changes that inform and protect the community.

When Do Cell Phones >>> Expose You to Higher RF?

When the cell phone is on your body >>>

- The closer the cell phone is to your body, the higher the amount of RF that will penetrate into your body and brain.



Connecting in areas of low signal >>>

- If the connection is weak, and when there is less than two bars on your phone, the cell phone must work harder to connect to the network (cellular antennas) and emits higher RFR.

Traveling in a moving car, bus, or train >>>

- The phone emits stronger RF to avoid dropping calls as it switches connections from each cell tower it passes.
- The metal surroundings of a vehicle (also including elevators, aircraft, and watercraft) can cause the radiation to bounce around, which increases your exposure.
- Research finds that if one passenger is using a cell phone or other wireless device, the radiation penetrates into the other passengers in the vehicle.

Streaming audio or video, or downloading large files >>>

- The larger the amount of data moving wirelessly, the more RF exposure.
- The more apps, the more updates, which means higher RF.
- Wireless internet connections for transferring data files (instead of streaming) are slower, which means longer RF exposure. (Also, wireless connections are less secure than corded connections.)

Several apps are active >>>

- The more applications open or running in the background on your device, the more connections and RF radiation the device is making.
- Apps are always updating (even when you are not actively using them), and social media is always sending you notifications.

Solutions

- > Do not hold phone up to your head. Instead use speakerphone or air tube headset.
- > Keep cell phones and wireless devices at a distance from your body.
- > Do not carry phones in your pocket, bra, or sock. Power OFF the phone more often.
- > If you want to take pictures or video, set the phone to airplane mode with Wi-Fi OFF and Bluetooth OFF.
- > Use a corded phone whenever possible rather than a cell phone.
- > Turn OFF antennas you are not using, and only turn on individual antennas one at a time as needed.

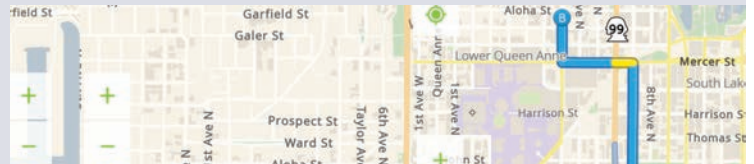
- > Unless it is an emergency, wait until the signal is stronger before using the phone.
- > Better yet, find a corded phone to make the call.
- > Turn phone and device off or on airplane mode.

- > Before you enter a vehicle or elevator, turn ON airplane mode and turn OFF Bluetooth and Wi-Fi.
- > Choose a non-wireless GPS model for navigation.
- > Do not stream inside vehicles. Passengers can use electronics with pre-loaded movies and applications (instead of streaming).



- > Learn how to use ethernet cords to connect laptops, tablets, and cell phones to networks with wireless turned OFF, so that you can listen to audio, watch video, or download large files for use anywhere.
- > Video chat only when you are at a computer with a corded internet connection (with both Wi-Fi and Bluetooth turned OFF).
- > If you want to listen to music or watch a video, first download the files (preferably by using a corded connection) onto your device (instead of streaming) so that you can watch and listen without continuous RF.
- > Prefer to use social media (with photos and video) when you have a corded internet connection rather than on a cell phone.

- > Delete apps you do not use.
- > Close apps whenever you are not using them.
- > Turn OFF social media notifications



>>> What about other types of electromagnetic radiation?

Scientists have long investigated another type of electromagnetic radiation called extremely low frequency fields (ELF-EMF). ELF-EMF is a lower frequency than RF-EMF and is found where ever electricity flows from high voltage transmission lines to plugged in appliances. Magnetic fields are generated from electricity so scientists will often measure the magnetic field level while researching health effects.

In 2001, the World Health Organization's International Agency for the Research on Cancer classified ELF magnetic fields as "possibly carcinogenic to humans" based on the consistent research finding a two-fold increase in childhood leukaemia associated with residential exposure to magnetic fields. The research finding effects has increased since that date. For example, replicated research has linked ELF-EMF to leukemia and miscarriage. Studies on pregnant women exposed to ELF-EMF found those women with higher exposures during their pregnancy had children with a higher risk for asthma and obesity.

People are exposed to ELF-EMF when their homes are close (such as within 50 feet) of high voltage power lines. People are also exposed to this type of EMF from appliances and electronics in their homes and work. The ELF-EMF field drops off rapidly from the source so it is relatively easy to reduce exposure from everyday electronics. All you need to do to reduce exposure is keep a distance. Scientists are most concerned about cumulative exposures rather than the unavoidable short term exposures.

Laptops and tablets have ELF-EMF emissions from the power supply and even if you have the Wi-Fi and other RF-EMF features OFF, they still emit ELF-EMF radiation. However you can easily minimize the exposure by using the computer on a table rather than on your lap or body. In addition, when you plug your phone into the charger, the phone and wire can generate large fields so do not make calls until the phone is fully charged and unplugged from the charger.

Several European countries have recommendations to reduce exposure to this type of electromagnetic radiation and when new homes or schools are built, they cannot be built in areas where the ELF-EMF levels are higher than the level linked to leukemia in children. However, the United States does not have any regulatory limits for this type of radiation.

REDUCE EXPOSURE TO ELF-EMF

- > **Do not charge phones and devices by your bedside or working space.**
- > **Use a battery-powered alarm clock**
- > **Use laptops and tablets on a table- not lap.**
- > **Unplug heating blankets and waterbed heaters before getting into bed.**
- > **Do not stare into microwave watching food cook.**
- > **Sleep away from all electronics, utility meters and large appliances.**
- > **Get professional measurements. Correct electrical wiring errors. Remove electronics and screens from bedroom.**





FREQUENCY:

The number of waves that pass a certain point per second, every second.

RF-EMF frequency is usually expressed in units called hertz (Hz).

1 Hz = 1 wave per second.

1 kilohertz (kHz) =
1 thousand waves per second.

1 megahertz (MHz) =
1 million waves per second.

1 gigahertz (GHz) =
1 billion waves per second.

Electricity 60 Hz in

North America = **60** waves per second
(50 Hz Internationally)

Microwave Oven 2.45 GHz =

2,450,000,000 waves per second

Wi-Fi 2.45 GHz = **2,450,000,000**
waves per second

Wi-Fi 5 GHz = **5,000,000,000**
waves per second

Cell Phones 900 MHz to 2.45

GHz = **900,000,000** to
2,450,000,000 waves per second

RESOURCES:

Environmental Health Trust

Database of International Policy Recommendations to Reduce EMF Exposure

American Academy of Pediatrics Recommendations

World Health Organization's International Agency for Research on Cancer.

New Jersey Education Review on Minimizing Health Effects of Digital Devices

Maryland State Council on Children and Environmental Health Protection

California Department of Health Cell Phone Advisory

Connecticut Department of Health Recommendations on Cell Phones

U.S. National Toxicology Program Study on Cell Phone Radiation

Ramazzini Institute Study on Base Station Radiation