

Title: Non-Ionizing Radiation And Human Health

Ravinder Guleria¹, Brijender Bhushan², Ankit Guleria³, Ajay Bhushan⁴, Pawitar Dulari⁵

^{1,5}Dept of Physics

²Corresponding Author, Dept of Zoology

³Dept of CSE

⁴Dept of I.T.

^{1,2}Pandit Sant Ram Government College, Baijnath(H.P.) India-176125

³B. Tech (CSE), National Institute of Technology, Hamirpur (H.P.) India-177005

⁴M. Tech (I.T.), Galgotia's college of engineering and technology, Greater Noida, (U.P.)-201306

⁵Government PG College, Una(H.P.) India-174303

Abstract- We receive an unwanted exposure of non-ionizing radiations on a daily basis from variety of consumer products. Common sources of exposure to non-ionizing radiation include mobile phones and towers, dryers, machinery used in hospitals, Photostat, etc. These radiation no doubt are of low magnitude and literally do no cause any side effect simultaneously to their exposure, but their continuous exposure for long times can definitely cause serious health complications not only to the present but also to the future generations.

I. INTRODUCTION

Non-ionizing radiation includes ultraviolet (UV), visible light, infrared (IR), microwave, radio (and television) waves, and extremely low frequency (ELF or EMF). Non-ionizing radiation is produced by a wide variety of products in the home and in the workplace, from lasers to power lines, tanning beds to household appliances, cellular phones to hand radios. Electromagnetic radiations (EMF) are also a kind of non-ionizing radiation and as the name suggests carry both electric and magnetic properties. EMF's possess wave like nature and are responsible for carrying energy though this energy is not enough to detach electrons from atoms. In our contemporary world, EM radiations are ubiquitous, and are the primary reason for the increase in exposure to radiations. They are emitted by almost all electronic devices including cell phones, computers, microwave ovens, routers, TV, radio towers, military installations. EM radiations are also emitted in medical imaging technologies such as ultrasound and thus pregnant women are also exposed to EM radiations frequently. The electromagnetic radiations were considered to be relatively safe till late as they neither break molecular bonds nor knock off electrons. However, many recent studies on cell phones indicate that even non-ionizing radiations are dangerous and this needs to be avoided as well. EMF emitted by mobile phones is the primary reason for exposure to non-ionizing radiations for most people because of their frequent use too close to the body. There is mounting evidence linking

cell phone use to brain cancer, with tumors tending to appear on the side of the head nearest to where the phone is held (Siniket *al.*, 2013; Ibrahim, 2016; Syzaet *al.*, 2017; Belpommeet *al.*, 2019).

Several governments have already issued caution especially for pregnant women and children while using mobile phones whereas many cancer institutes have called for further investigation. There are many strong evidence to prove that cell phone usage poses a cancer risk for children and thus Russia, India, UK are discouraging use of mobile phones by children and France has banned marketing of cell phones to children (Kim, 2016; Prasad *et al.*, 2017; Pall, 2018).

Few Cases Of Harm Due Toradiation

The Japanese incident of Hiroshima and Nagasaki witnessed people die in agony after their flesh being melted off. The radar beams are also very disastrous and have killed people as they microwave and kill internal organs of the human body within seconds. The cause of all this is the high energy present in the radiations. The effects of slow burn radiation are continual and cumulative as thousands of victims of Hiroshima and Nagasaki died painfully many years after exposure. Another slow burn process is evident in cancer clusters commonly found in communities living near radio towers on exposure to RF/microwave waves. Recent Swedish epidemiological studies confirm that, after 2,000 hours of cellular phone exposure, or a latency period of about 10 years, brain cancer risk rises by 240 percent. Another major problem is that the communications occur at many different frequencies simultaneously. These varied frequencies strike our ears continuously leading to a much high exposure frequently. The issue occurs when DNA on hearing this noise, react in a similar manner as a human ear does to high energy country music. Further, they don't get nourishment; die prematurely split into micronuclei fragments creating a so called tumor. This is the exact process of microwaves affecting our body DNA and hence the tissues ultimately

leading to cancer (Alonso, 2017; Guleria *et al.*, 2019; Mild *et al.*, 2019).

In a shocking conclusion, many surveys have even regarded exposure to UV radiation, high frequency EMFs, radio telephone systems as the highest health risk. In another study it was found that around 2000 people die in Germany yearly due to skin cancer caused solely on exposure to UV radiations and this is an alarming conclusion. The exposure to UV radiation thus needs to be avoided by all humans. People have to be fully aware of the type of radiations and their harms. Awareness among people is the only possible and supreme solution. “Recommended protective measures in the order of their effectiveness are protection by adaptation of behavior, by clothes, sun hats and sunglasses as well as by sun creams”. Our major focus has to be protection of children as they are the most vulnerable target as evident from the above study. In recent times, artificial UV radiation has been used for cosmetic purposes, which needs to be totally avoided considering the posed health risks. Care needs to be taken to distinguish between direct field reactions due to factors such as induced electrical body currents from indirect field reactions (e.g. electrical shocks and burns) due to contact currents or interference with electronic body aids and implants while analyzing health damage caused to the radiations (Othmana *et al.*, 2017; Belpomme *et al.*, 2019; Hargitai *et al.*, 2019).

How radiation can harm us

Radio waves pass through most matter, including living tissue, with very little being absorbed. The high energy radiation like X-rays, Gamma rays used in medical diagnosis and low-intensity radio frequency (EM radiation) radiation is not biologically inert. Medical science illustrates that there are two ways of radiation poisoning: Fast burn and slow burn. The concern here, therefore, is with the very small fraction of incident radio waves absorbed in living tissue. The RF energy absorbed in tissue is converted into heat, that is, it may raise the temperature of that tissue. The rise in temperature being approximately proportional to the quantity of radiation absorbed and this, of course, will depend up the “intensity” of the incident radiation. The microwave oven is a good example of the use of intense RF energy to raise the temperature and cook a roast. It is important to understand that intensity of EM radiation is measure as the power on a surface area and its unit is watts per square meter. Another term that needs explanation is SAR, Specific Absorption Rate, which is a measure of the rate at which the body absorbs RF energy. It is measured as power incident on one unit of mass, W/kg (Lewis, *et al.*, 2011; Kaure *et al.*, 2016; Yang *et al.*, 2017).

Electromagnetic fields(EMFS)

EMFs occur around electronic devices like computers, cell phones, and other commonly used electronics like hair dryer, shaver, microwave ovens etc. EMFs wouldn't be a big deal if they were totally harmless. But research is mounting that EMFs are linked to health issues most of us want to avoid. There are some other harms of the excess radiation exposure. Children born to women with high exposure to EMFs during pregnancy are more than twice as likely to develop asthma. EMFs may cause suppressed immunity. Sperm exposed to EMFs lost motility faster and had more DNA damage than sperm that wasn't exposed. DNA is damaged in the presence of EMFs. Long-term exposure to EMFs is linked to Alzheimer's disease and dementia (Ibrahim 2016; Mild *et al.*, 2019).

Environmental interference(EI)

The growing demand and reliance on the use of electromagnetic transmission systems for IT applications have led to the innovation of new connectivity technologies such as Wi-Fi, other wireless transmissions, cordless phones etc. The number of these devices is increasing continuously and so is the usage of electromagnetic radiation within the electromagnetic spectrum. As seen earlier, these emissions are highly energetic and have been often found to interfere with the natural functionality of communication systems. “The electromagnetic energy disrupting the normal operation or function of electronic devices is known as environmental interference (EI) (Othmana *et al.*, 2017; Pall, 2018).

The environmental interference has been further categorized depending on the source, sources being natural environment, incidental or intentional. EI has many momentous effects, although present engineering and software design patterns have limited the impact of EI on communication. With the introduction of such patterns and technologies we would be able to support more portable and cordless device further increasing the human exposure to electromagnetic radiations. EI can also affect birds, small insects and environment also (Karipidis *et al.*, 2019).

Harms of Sound and Ultrasound(US)waves

The process of ultrasound needs to be clear before analyzing the ill-effects of ultrasound waves. Initially the ultrasound transducer sends sonic waves inside from the belly, the sound enters the body of mother and fetus, but is reflected from the tissues and this echo is precisely measured in the transducer. The measurement of this echo is used to form a

representative image being the main principal of ultrasound (Shankar, 2011; Belpommeet *al.*, 2019).

There are many present applications of ultrasound presently extending in medicine and research from neurosurgery to acceleration of chemical processes. Major applications include “Trans cranial (across the skull) stimulation of brain activity, similar to Trans cranial magnetic stimulation (TMS) or the use of electrodes, Vasodilation, Transdermal (across the skin) delivery of medications which would normally be unable to cross the skin barrier; Wound healing, such as on certain bone fractures and ulcers; Purification of foods via its oxidative potential, etc.”

In addition to these applications, we also have major physical effects of ultrasound whereby the waves create pressure on water present both inside and outside the cell. This may lead to spinning or even breakdown of the bubbles in the fluid, latter being referred to as “cavitation or the creation of a gaseous cavity within the liquid”. The biological damage further caused is much severe as these physical effects tend to create holes in cells, leading to their damage. These cells further stimulate molecular pathways increasing the risk of forming free radicals through oxidation. The harmful consequences of free radicals have already been studied earlier. Moreover, when this gas passes on to surroundings, it leads to the further damage of other cells. There are no proofs strong enough to conclude the deadly effects of ultrasound at diagnostic entry levels although ultrasound waves surely affect the normal mechanism of cells. A prime area of scientific study is presently autism in which there is abnormality in brain growth and associated neuron number. Ultrasound can be the primary reason for this because these waves have the potential to alter cells and promote abnormal growth of cells. No doubt, ultrasound is beneficial during pregnancy and is an essential requirement. With no reasonable and sufficient evidence against ultrasound waves, it is widely used in present world (Chimay and Woradet, 2008; Izadifaret *al.*, 2017).

There still tends to be a concern regarding the heating effect of ultrasonic machines and waves. According to science, an increase of temperature in the range of 1.8-2.7 Fahrenheit is considered safe for human body tissues. With the technology advancement we now have two kinds of ultrasound, one being the traditional regular pulsed and other being the Doppler which emits ultrasound waves continuously. Studies have found that both these kinds may heat body tissues above the maximum limit. In fact, some studies have concluded Doppler ultrasound to as more harmful for the nurturing brain of an infant implying continuous ultrasound waves are more troublesome than standard

ultrasound. An alarming result was reported in a UK study which revealed that mothers and their babies having received two or more Doppler scans showed a greater probability of suffering from perinatal death. Recent studies in China report risks of diseases such as Autism as the after effects of an ultrasound. As it has been successfully proved that increases in body temperature of mother can cause birth defects, ultrasound causing an increase in body temperature and further affecting the baby is a valid conclusion. To support this, there is another statement by FDA in which they discourage 3D and 4D ultrasounds. In their report, they state that “Ultrasounds can heat tissues and in some cases, produce very small bubbles or cavitation in some tissues.” FDA confirms the use of ultrasound only under the presence of a trained and professional medical expert. FDA warns about 3D ultrasounds (Shankar, 2011; Ibrahim, 2016; Mild *et al.*, 2019).

New research shows that even sound may also startle an unborn baby. The researchers say, “Repeated startle responses may be worrisome because they interfere with the known normal cycle of fetal behavior. They are calling for more research into potential adverse pregnancy outcomes related to cell phones and beepers. In her paper she mentioned that, “the most surprising research that I came across was about the possible harmful effects of obstetric ultrasound.

In case of children, the category which is more vulnerable to radiation is the blood vessels in the brain and the surrounding tissue. Continuous exposure of a child’s brain to heating introduces abnormalities in the functionality of brain. Keeping in view the harms of Ultrasoundwaves, the middle way may be to get just a single ultrasound mid-pregnancy, and leave it at that.

Dangers of Radio waves inHospitals

Consequences of radio waves in hospitals are a trending area of research in the contemporary world. Many studies have reported appalling effects of radio waves on machinery as well as patients in the hospitals. In a research, impact of electromagnetic radiations was studied on electronic equipment present in hospitals including pacemakers and ventilators. Signals from mobile phones interfered significantly with medical devices, and more than three-fourth of these were found risky. The major impacts of these interferences comprise “the sudden switching off or restarting of machines which could mean disruption of a patient's feeding tube, ventilator, pacemaker or dialysis machine and majority of these occurred when mobile phones were within 3 cm of critical-care equipment”. In another study, researchers measured the visual field of people having cell phone conversations and to surprise, it was found that radiations

emitted are such that they restrict external peripheral awareness. Thus, it is advised to reduce cell phone usage within hospitals as well as ban it during driving (Kim, 2016; Ibrahim, 2016, Mild *et al.*, 2019).

Harmful Effects of Radio Waves from Cell Phones

Increasing usage of cell phones is solely the cause of many health related problems. The radiation from cell phones has been proved to be a very serious hazard. People residing near mobile towers face tend to face many serious diseases due to continuous exposure to high intensity waves. “Any single cell phone tower may carry a multitude of antennae, each of which emits its own pattern of microwaves on its own set of wavelengths. Consequently, a single tower can emit several different patterns of relatively intense signals to homes, schools and businesses within hundreds of feet from the tower”. Researchers in French conducted a study among people residing within 300 meters from mobile towers. The people were found to be suffering from frequent tiredness. Those within 200 meters reported sleep disturbances and frequent headaches whereas the ones within 100 meters reported alarming problems such as loss of memory, dizziness and depression. Moreover, other studies have also shown brain tumor, cancer, depression, miscarriage, insomnia resulting from exposure to radiations. Thus it is advised to install mobile towers far away from residential areas. Other effects of radiations from mobile towers include television displays showing flickering images. “Massive increase in radiation in the environment due to these towers is associated with increase in the incidence of diseases such as asthma, learning disabilities, anxiety disorders, attention deficit disorder (ADD), autism, multiple sclerosis, amyotrophic lateral sclerosis (ALS), epilepsy, fibromyalgia, chronic fatigue syndrome, cataracts, hypothyroidism, diabetes, malignant melanoma, testicular cancer, heart attacks and strokes”. Radiation to which a person is exposed during a phone call is 10 times more than that on exposure to mobile towers and more adverse is the Wi-Fi radiation as mere moving through Wi-Fi enabled area equals radiation encountered on a 20 minutes phonecall (Anthony *et al.*, 2017; Pall, 2018).

It is well established fact that continues exposure to radiation is related with emergence of cancer, yet we are indiscriminately getting exposed to them. The worst affected community is again the children as their cells are undergoing rapid multiplication making their DNA most vulnerable to damage from these radiations. Present children are also the ones who will face the longest exposure to radiations in entire lifetime.

Hyperactivity, inability to focus, increased distraction in children are majorly contributed by this unnatural bath of

radiation. When the exposed offspring were later tested, they showed signs of ADHD, and reduced transmissions in the prefrontal cortex of the brain. It's widely known that children, due to their thinner skulls, smaller brains, softer brain tissue and far more rapidly dividing cells, are far more susceptible to damage from cell phone use than adults.” This study clearly showed brain patterns are Preliminary “Men talking on the phone for more than an hour a day had 17% fewer highly motile sperm than men who talked less than 15 minutes a day (Kauret *et al.*, 2016; Anthony *et al.*, 2017; Bortkiewicz *et al.*, 2017).

- Men carrying a phone in a hip pocket or on a belt had 11% fewer mobile sperm than men who kept their phone elsewhere on their body.
- Men carrying a cell phone on a belt and using it intensively during a 5-day test period had a 19% drop in highly motile sperm from previous levels”.

A very striking finding which will surprise all of us is that most of the adverse health effects were even observed at levels of exposure far below current SAR values of safety.

Other observed effects of Radiation:

(a) Increased cellular responses

Due to increased permeability of BBB, the leakage of Albumin from blood into the brain takes place, it may produce hearing impairments, the heating effect in the fluid of internal ear, irritability in the eardrum and internal sensory cells of ear due to piercing sound from the speaker specially for waves between 1000 and 6000 Hz for which the human ear is very sensitive (Mild *et al.*, 2019).

(b) Sleep and EEG Effects

The brain waves such as alpha, beta, delta waves are affected due to exposure to radiations in form of pulses.

(c) Microwave Auditory Effect

The radiation may produce the buzzing sound in the head, causes auditory illusion due to the reason that microwave induces electric current in the hearing center of the brain. This may happen if music is heard using earphone or Bluetooth for a long time as human ear has a peak sensitivity at 3000 Hz, which causes a sense of discomfort. That is why the alarms and Mo bring tones ones are designed to sound at 3000 Hz. A sound of this frequency is very penetrating as human ear has a very low threshold of hearing for 3000 Hz.

(d) PhantomPain:

The radiation may cause pain in the ear without any specific reasons like an infection. It may be due to increase in stress on the delicate structure of the internal ear or ear drum.

(e) ElectromagneticHypersensitivity:

In certain cases during and after the use of mobile phone some symptoms of tingling sensation, fatigue, dizziness, loss of mental attention, reduction in reaction time, memory retentiveness, tachycardia etc. have been observed.

II. CONCLUSION

Radiation isn't always dangerous. However, our average annual radiation exposure has increased dramatically –in the recent years. Much of this excess radiation exposure occurs at home, in the workplace, and even in the hospitals. And some forms of it can significant impact our health, and the health of our born and unborn children. There are scientific evidences that overdose of any range of electromagnetic radiation whether from mobile phones or from other wireless technologies including the kitchen gadgets or other EMF devices, all have unquestionable biological, health and mental health effects, which are of great concern especially for children. Few recent studies have shown that even the ultrasounds (especially 3D or 4D) of pregnant ladies cause an increase in temperature of fetus which caused birth defects in child. So overdose of any type of radiation must be avoided especially in born and unborn children as they have very sensitive bodyorgans.

The radiation from mobile phones and Wi-Fi signals has caused diminished reaction time, decreased brain motor function, social and emotional problems, and decreased ability to focus on complex and long-term tasks in children. Mobile phone use has been linked for developing the nine types of cancer and to decays in sperm count and fertility. On basis of well-established DNA impacts, it has been suggested to take effective action to protect children as DNA mutations are irreversible, and are passed down to future generations. Mobile phone radiation has now been associated to erectiledysfunction(ED),lowerspermcountandmaleinfertility,lowerlevelsoftheluteinizing hormone (LH) which is an important reproductive hormone secreted by the pituitary gland in the brain, and higher levels of circulating testosterone.

- There is no doubt that mobile phone is a device of great use. Its radiation produces damaging effects if device is continuously used for a long time. Its controlled use for communication is always safe. The present generation is

widely using the mobile phones beyond the permissible limit of time which has become danger for the present as well as future generations. One should use the mobile phone for communication and not an entertainment. It must be noted that even if it is not in use the cell phone is emitting strong radiation to keep a link with the basestation.

- The excess exposure of the radiation of all the frequencies (high as well as low) is dangerous for our health. The ionizing radiation used in medical diagnosis is undoubtedly more harmful. The radiation from few appliances used in homes can also affect our health. Even the radiation used in ultrasound can affect the health of baby.
- Unfortunately there is no treatment which can reduce the effect of radiation on our body, but we can certainly reduce the harmful effects to large extent of radiation if strict radiation norms are enforced across the globe. This does not mean that we have to stop living near these towers. We all know that automobiles create air pollution... Hence came up with unleaded petrol, CNG driven vehicle, hybrid vehicles, etc. Similarly, the solution to avoid excess radiation is to take precautions and use radiationshields.

REFERENCES

- [1] Alonso, M.M. 2017. Mobile phones, cordless phones and rates of brain tumors in different age groups in the Swedish National Inpatient Register and the Swedish Cancer Register during 1998-2015. *PloS one*. 12(10): e0185461.
- [2] Anthony, L.M., Miller, B.,Sasco, A., Davis, D.L. 2017. Mobile phone radiation causes brain tumors and should be classified as a probable human carcinogen (2A).<https://doi.org/10.3892/ijo.2015.2908>.
- [3] Belpomme, D., Hardell, L., Belyaev, I., Burgio, E., Carpenter, D.O. 2019. Thermal and non-thermal health effects of low intensity non-ionizing radiation: an international perspective. *Env.Poll.* 242 (2018): 643-658.
- [4] Bortkiewicz A, Gadzicka E, Szymczak W.2017. Mobile phone use and risk for intracranial tumors and salivary gland tumors - A meta-analysis. 30(1): 27-43.
- [5] Chaimay, B., Woradet, S. 2008. Does prenatal ultrasound exposure influences the development of children. *Asia Pac. J. Pub.Hlth.* 20 Suppl. 31-8.
- [6] Guleria, R., Bhushan, B., Guleria, A., Bhushan, A., Dulari, P. 2019. Harmful Effects of Ionizing Radiation. *International Journal for Research in Applied Science and Engineering Technology (IJRASET)*: 7(12): *In press*.

- [7] Hargitai R, Roivainen P, Kis D, Luukkonen J, Sáfrány G, Seppälä J, Szatmári T, Virén T, Vuolukka K, Salomaa S, Lumniczky K. 2019. Mitochondrial DNA damage in the hair bulb: can it be used as a non-invasive biomarker of local exposure to low LET ionizing radiation? *Int J Radiat Biol.* 17:1-40.
- [8] Ibrahim D. 2016. The effects of electromagnetic fields on human health. *Physica Medica.* <https://doi.org/10.1016/j.ejmp.2016.07.720>.
- [9] Izadifar, Z., Babyn, P., Chapman, D. 2017. Mechanical and biological effects of ultrasound: A review of present knowledge. *Ultrasound Med Biol.* 43(6): 1085-1104.
- [10] Karipidis, K, Elwood, M., Benke, G., Sanagou, M., Tjong, L., Croft, R.J. 2019. Mobile phone use and incidence of brain tumour histological types, grading or anatomical location: a population-based ecological study. *BMJ Open* 8: 1-8.
- [11] Kaur, S., Kaur, J., Sandhu, M. 2016. Effects of mobile radiation and its prevention. *Int. J. Comp. Sci. Mob. Computing.* 5(2): 298-304.
- [12] Kim, Y. 2016. Are we exposed to radiation in hospital? *Env.HaeltH.Toxicol.* 31: e2016005.
- [13] Levis A.G., Minicuci N., Ricci P., Gennaro V., Garbisa S. 2011. Mobile phones and head tumours. The discrepancies in cause-effect relationships in the epidemiological studies - how do they arise? *Environ Health.* 17;10:59.
- [14] Mild, K.H., Lundstrom, R., Wilen, J. 2019. Non-ionizing radiation in Swedish health care: Exposure and Safety. *Int. J. Environ. Res. Pub. Health.* 16 (7): 1186.
- [15] Othmana, H., Ammariab, M., Rtibic, K., Bensaida, N., Saklya, M., Abdelmeleka, H. 2017. Postnatal development and behavior effects of in-utero exposure of rats to radiofrequency waves emitted from conventional WiFi devices. *Environ. Toxicol.Pharmacol.* 52: 239-247.
- [16] Pall, M.L. 2018. Wi-Fi is an important threat to human health. *Environ. Res.* 164; 405-416.
- [17] Prasad M, Kathuria P, Nair P, Kumar A, Prasad K. 2017. Mobile phone use and risk of brain tumours: a systematic review of association between study quality, source of funding, and research outcomes. *Neurol Sci.* 38(5):797-810.
- [18] Shankar, H. 2011. Potential adverse ultrasound related biological effects: A critical review. *Anesthesiology.* 115: 1109-1124.
- [19] Sinik, V., Despotovic, Z., Radovanovic, L. 2013. Influence of non-ionizing radiation on the environment. *Reporting for Sustainability.* 465-468.
- [20] Syaza, S.K.F., Umar, R., Hazim, S.N., Kamarudin, M.K.A., Hassan, A., Juahir, H. 2017. Non-ionizing radiation as threat in daily life. *Int. J. Fund. Appl. Sci.* 9(2S): 308-316.
- [21] Yang M, Guo W, Yang C, Tang J, Huang Q, Feng S, Jiang A, Xu X, Jiang G. 2017. Mobile phone use and glioma risk: A systematic review and meta-analysis. *PLoSOne.* 12(5):e0175136.