Analytical Study on the Effects of Electromagnetic Waves on Human Beings

Vijay Kumar, Mohd. Shah, Jasmeet Kalra, Bhaskar Pant

Abstract: ***All electrical and electronic devices radiate electromagnetic waves. These EM waves are categorized into two groups, Ionizing, and non-Ionizing. In this manuscript, health effects due to radiation are studied. UG and PG students are worked in physics, electrical and electronics labs. Magnetic and electric fields are generated around us, when electromagnetic waves penetrate inside the body of students it may affect the organs. The radiation which is produced by apparatus is low frequency and exposure of these types of radiation may because of childhood leukemia, headache, stress, etc. Certain tissues/cells of the body absorb the energy-specific absorption rate (SAR). After the permissible limit of SAR, the radiation becomes harmful. It is concluded that some types of radiation may become harmful to the health of body tissues/cells.***

Keywords:

I. INTRODUCTION

Electromagnetic fields (EMFs) are present world widely among humans for a long time since 1888. And we are surrounded by these electromagnetic fields in a large number of ways. Even the human body is also capable of producing its Electromagnetic waves. EM waves are emitted by accelerating charged particles [1], which are traveling with the speed of light 'C' through the vacuum. Electromagnetic waves have been a boon to mankind but it has acute health effects (burning of human tissues, etc) and sometimes become major health risks (such as cancer, cataract, etc) to the human body, can be termed as Electromagnetic Pollution.Generally, those EM waves which are having less frequency are denoted by electromagnetic fields EMFs whereas EMW of greater frequencies is referred to as electromagnetic radiation [2]. With the advancement in technology, the production of electromagnetic radiation also increases drastically day by day. Since the 19th century, several studies had been performed about the hazardous effects of electromagnetic waves [5]. In abundant places, a large amount of various electromagnetic radiation flux levels is present which is causing a major health effect on us. So it is important to know, how Electromagnetic Radiation [EMR] affects the human body. The purpose of this paper is to present various effects of EMR on human beings and which band of EMR affects which part of the body. .

1.3 Electromagnetic Waves

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Even though he passed on youthful, Maxwell not just figured a total electromagnetic hypothesis, spoke to by Maxwell's conditions, he likewise built up the active hypothesis of gaseous states of the rings around the Saturn planet. Scottish , J.C Maxwell from (1831–1879) was one of the hypothetical physician in the nineteenth century. Even though he passed on youthful, Maxwell not just figured a total electromagnetic hypothesis, spoke to by Maxwell's conditions, he likewise built up the active hypothesis of gaseous states of the rings around the Saturn planet. Maxwell united those works which were finished by splendid physicians, for example Faraday, Gauss, Coulomb and Oersted and build up an overall hypothesis of electromagnetism. Hence Maxwell's works were reworded because of their scientific of this content. Notwithstanding with those conditions shows how straightforward scientific proclamations can exquisitely join together and express a large number of ideas—why arithmetic is the language of science. Maxwell's finished and symmetric hypothesis demonstrated that electric and attractive powers are not isolated, yet various indications of something very similar—the electromagnetic power. This old-style unification of powers is one inspiration for flow endeavors to bind together the four essential powers in nature—the gravitational, electrical, solid, and feeble atomic powers. The idea of electromagnetic waves was given by Maxwell and experimental verification was provided by Hertza other scientists. A brief history of electromagnetic waves is as follows: On the basis of experimental study of electromag. netic induction, Faraday concluded that a magnetic field changing with time at a point produces a time varying electric field at that point. Maxwell in 1864 pointed out an electric field changing with time at a point also produces a time varying magnetic field. The two fields are mutually perpendicular to each other.

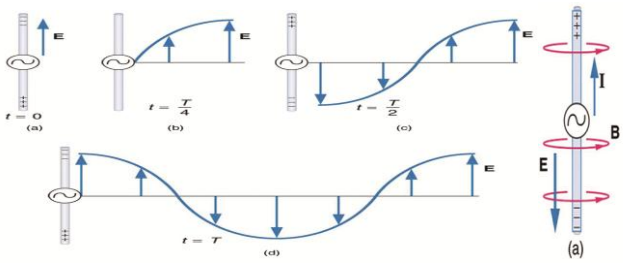

Fig. 1 **Fig. 2**

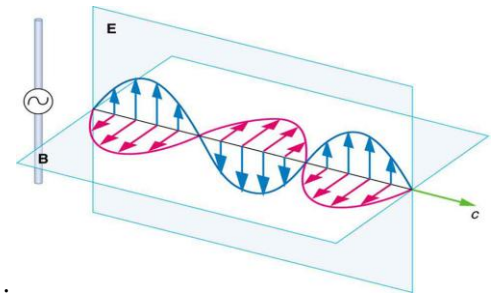

Fig. 3

A piece of the electromagnetic wave conveyed from the radio wire at one moment in time. The electric and magnetic fields (E and B) are in the stage, and they are opposite to each other and the heading of engendering. For clearness, the waves are indicated uniquely along one heading, however, they spread out in different ways as well. Electromagnetic waves by and large spread out from a source every which way, here and there framing a mind-boggling radiation design. A straight radio wire like this one won't transmit corresponding to its length, for instance. The wave is appeared one way from the radio wire in Figure 3 to delineate its essential qualities.

We have seen that electromagnetic waves consists of a sin soidally varying electric and magnetic field. These fields act right angles to each other as well as right angles to the direction of propagation of waves. These fields are repre sented by E-E sin x - c) and-B san eXI- ve) respectively. The two fields combine to constitute electro- magnetic wave. The electromagnetic wave propagates in space in a direction perpendicular to the directions of both fields as shown in figure. The electric field vectors (E) is along Y-axis and magnetic field vector (B) along Z-axis while the wave propagation direction is along X-axis. As both the fields are perpendicular to the direction of propa gation of electromagnetic wave and hence the electromag netic waves are transverse in nature

Rather than the AC generator, the reception apparatus can likewise be driven by an AC circuit. Truth be told, charges emanate at whatever point they are quickened. Be that as it may, while a current in a circuit needs a total way, a reception apparatus has a differing charge dispersion shaping a standing wave, driven by the AC. The components of the radio wire are basic for deciding the recurrence of the emanated electromagnetic waves. This is a resounding marvel and when we tune radios or TV, we fluctuate electrical properties to accomplish suitable thunderous conditions in the receiving wire.

2.1 Production of Electromagnetic Waves

Electromagnetic waves divert vitality from their source, like a sound wave diverting vitality from a standing wave on a guitar string. A reception apparatus for accepting EM signals works backward. What's more, similar to reception apparatuses that produce EM waves, collector receiving wires are exceptionally intended to reverberate at specific frequencies. An approaching electromagnetic wave quickens electrons in the reception apparatus, setting up a standing wave. On the off chance that the radio or TV is turned on, electrical parts get and intensify the sign shaped by the quickening electrons. The sign is then changed over to sound as well as video group. At times huge beneficiary dishes are utilized to center the sign onto a receiving wire.

Previously, an electromagnetic wave has a recurrence and a frequency related to it and goes at the speed of light, or c. The relationship among these wave attributes can be portrayed by $v = f\lambda$, where v is the velocity of the wave, f is the recurrence, and λ is the frequency. Here v= c, so that for every single electromagnetic wave, $c = f\lambda$. In this manner, for every electromagnetic wave, the more prominent the recurrence, the littler the frequency.

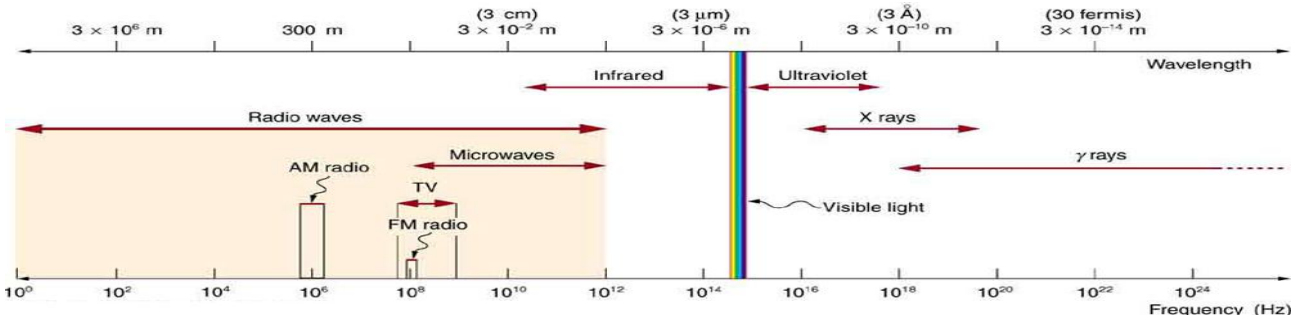

Figure 1. The EM spectrum, the different sorts of EM waves is arranged by their frequencies. A considerable lot of the qualities of the different kinds of EM waves are identified with respect totheir frequencies.

Type of EM wave	Production	Applications	Life sciences aspect	Issues
Radio & TV	Accelerating charges	Communications Remote controls	MRI	Requires controls for band use
Microwaves	Accelerating charges & thermal agitation	Communications Ovens Radar	Deep heating	Cell phone use
Infrared	Thermal agitations & electronic transitions	Thermal imaging Heating	Absorbed by atmosphere	Greenhouse effect
Visible light	Thermal agitations & electronic transitions	All pervasive	Photosynthesis Human vision	
Ultraviolet	Thermal agitations & electronic transitions	Sterilization Cancer control	Vitamin D production	Ozone depletion Cancer causing
X-rays	Inner electronic transitions and fast collisions	Medical Security	Medical diagnosis Cancer therapy	Cancer causing
Gamma rays	Nuclear decay	Nuclear medicineSecurity	Medical diagnosis Cancer therapy	Cancer causing Radiation damage

2.3 Radio Waves

There is a continuous contention in regards to potential wellbeing perils related to introduction to these electromagnetic fields (E-fields). A few people presume that living close to such transmission lines may cause an assortment of sicknesses, including malignancy. In any case, segment information are either uncertain or don't bolster the danger hypothesis. Late reports that have taken a gander at numerous European and American epidemiological examinations have discovered no expansion in chance for malignant growth because of introduction to E-fields. Incredibly low recurrence (ELF) radio floods of around 1 kHz are utilized to speak with lowered submarines. The capacity of radio waves to infiltrate saltwater is identified with their frequency (much like ultrasound entering tissue)— the more extended the frequency, the farther they infiltrate. Since saltwater is a decent conductor, radio waves are firmly consumed by it, and long frequencies are expected to arrive at a submarine under the water surface.

2.4 Microwaves

Microwaves are the most noteworthy recurrence electromagnetic waves that can be created by flows in plainly visible circuits and gadgets. Microwave frequencies extend from around 109 Hz to the most elevated down to earth LC reverberation at almost 1012 Hz. Since they have high frequencies, their frequencies are short contrasted and those of other radio waves—thus the name "microwave." Microwaves can likewise be delivered by particles and atoms. They are, for instance, a segment of electromagnetic radiation created by warm unsettling. The warm movement of iotas and particles in any article at a temperature above outright zero makes them transmit and retain radiation.

Radar is a typical use of microwaves that was first evolved in World War II. By distinguishing and timing microwave echoes, radar frameworks can decide the separation to objects as differing as mists and airplanes. A Doppler move in the radar reverberation can be utilized to decide the speed of a vehicle or the power of a rainstorm. Complex radar frameworks are utilized to outline Earth and different planets, with a goals restricted by frequency. (See Figure 7.) The shorter the frequency of any test, the littler the detail it is conceivable to watch.

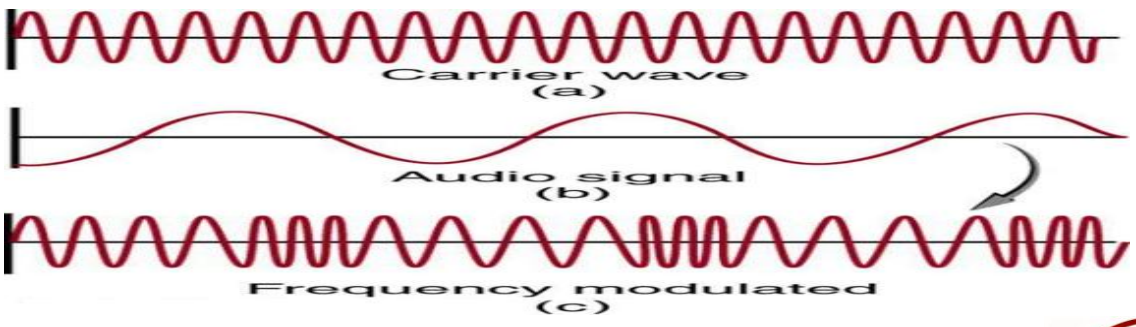

Figure 5. Recurrence balance for FM radio

FM radio waves are additionally utilized for business radio transmission, however in the recurrence scope of 88 to 108 MHz. FM represents recurrence adjustment, another technique for conveying data. (See Figure 5.) Here a transporter wave having the fundamental recurrence of the radio broadcast, maybe 105.1 MHz, is adjusted in recurrence by the sound sign, creating a flood of consistent sufficiency yet shifting recurrence. The TV video signal is AM, while the TV sound is FM. Note that these frequencies are those of free transmission with the client using a good old rooftop reception apparatus. Satellite dishes and link transmission of TV happens at altogether higher

2.5 Visible Electromagnetic Light

Noticeable light is the thin fragment of the electromagnetic range to which the ordinary natural eye reacts. Obvious light is created by vibrations and pivots of particles and particles, just as by electronic changes inside iotas and atoms. The recipients or indicators of light generally use electronic advances. We state the particles and atoms are energized when they ingest and loosen up when they emanate through electronic changes. Figure 6 shows this piece of the range, along with the hues related to specific unadulterated frequencies. We for the most part allude to noticeable light as having frequencies of between 400 nm and 750 nm. (The retina of the eye reacts to the most minimal bright frequencies, yet these don't typically arrive at the retina since they are consumed by the cornea and focal point of the eye.). Red light has the most reduced frequencies and longest frequencies, while violet has the most elevated frequencies and briefest frequencies. Blackbody radiation from the Sun tops in the noticeable piece of the range however is more extraordinary in the red than in the violet, showing up.

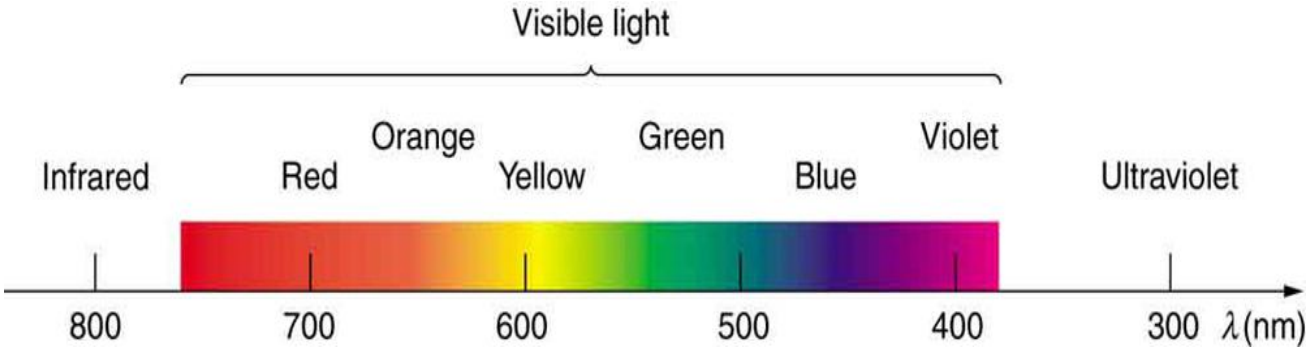

Figure 6. Electromagnetic Bands

Living organism such as creatures and plants have advanced to use and react to parts of the electromagnetic range they are inserted in. Noticeable light is the most overwhelming and we appreciate the excellence of nature through obvious light. Photosynthesis utilizes portions of the noticeable range to make its food.

2.6 Impact of today's techno technology (mobile phone)

Advantages of EM waves are countless but as we know anything have both advantage and disadvantage. Many researchers show on their research that the electromagnetic field generated from their source which was all around us effect human body some papers said the long time exposure effect human body and some paper suggest it can cause various types of cancer and disorders in human internal organs like brain ,kidney, lungs and many more one side we see huge population using phone and above we see they have very great impact on human beings but if they really harming people then it is really a good matter on which we should talk about otherwise we may loss a whole generation. Some paper research suggests that they are agreeing with the fact that the electromagnetic waves really effecting physically human body and also effecting human mentally. If we talk about mobile phones, they now becoming tool to get relaxation in doing work .The average time which most of the people giving from their 24 hour time to mobile is greater than the time which should be given to others important works and in this category youngsters rank is number one. Now a day's youngsters demand on mobile phone and it's demand is day by day increasing more than half of world population is using mobile phones according to 2020 data there are approximately 5.16 billion unique mobile phones users in world from which 3.8 are Smartphone users, according to 2018 data in India we have 390 million mobile phone users. According to American 2019 survey American people spending 3rd quarter of their time on mobile phones 49% on social media, 36% on email and 32% percent on browsers. Some research papers also suggest that children are in danger due to mobile phone radiation since they spend lots of time playing online games according to research children under 20 age are in great risk due to radiation, research said this radiation is effecting there brain some researchers said the children having their own mobile phones before 20 having risk that brain tumor may occur in their brain. Some researchers said the children who are not mentally well are the children whose mother use mobile phone during their pregnancy, plus some according to some papers it is advisable to pregnant woman should not kept their mobile phones near them while sleeping. In mobile phones, oscillation of electrical and magnetic field creates radio Frequency (RF). When you make call the radio waves generated by transmitter in your cell phone spread the radio waves in all directions, the waves can be absorb or reflected by the material present in the vicinity of them, before reaching to their nearest base station.

II. REVIEW AND LITERATURE

EMR based on the ability of quantum or photon to ionize the chemical bonds of an atom or molecule [3], can be classified majorly into two categories that are Ionizing Radiation and Non-Ionizing Radiation

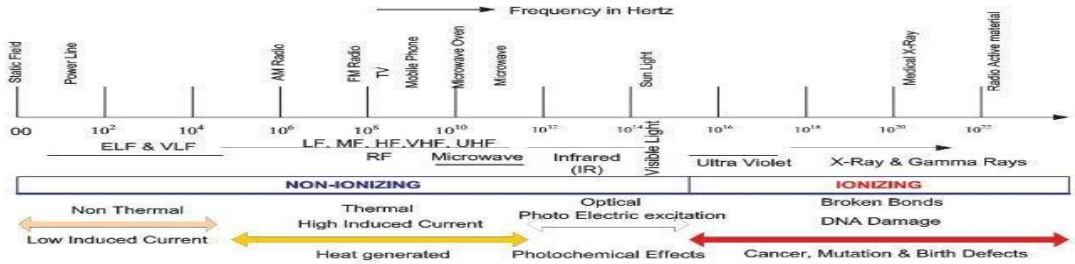

Figure 1. Showing band of electromagnetic radiation of IR and NIR [4].

3.1 Types of Radiation:

Ionizing radiation (IR) carries the required amount of energy to detach electrons to ionize atoms or molecules. Ionizing radiation results in **tissue** damage such as **cancer** and some examples of these fields are X-Rays, Gamma Rays, and so many others.

Non –Ionizing radiation (NIR) is another type of electromagnetic radiation that does not carry the required amount of energy to ionize the atoms. Since non-ionizing radiations cant able to ionize atoms but studied said that they produce some biological effects on humans by inducing amount of current in tissues or cells [2], Ionizing originates from various sources such as sunlight, lightning discharges, Manmade application (such as wireless communication, industrial, scientific and medical application). Non-ionizing radiation includes ultraviolet radiation (UV), infrared radiation, radiofrequency, and microwave.

Electromagnetic radiation fields can further be classified into four subgroups of electromagnetic radiation fields with frequency and intensity [6, 7, and 8].

Frequency range	Frequencies	Some examples of exposure sources
Static	0 Hz	VDU (video displays); MRI and other diagnostic / scientific instrumentation; Industrial electrolysis; Welding devices
ELF	0-300 Hz	Powerlines; Domestic distribution lines, Domestic appliances; Electric engines in cars, train and tramway; Welding devices
IF	300 Hz – 100 kHz	VDU; anti theft devices in shops, hands free access control systems, card readers and metal detectors; MRI; Welding devices
RF	100 kHz – 300 GHz	Mobile telephony; Broadcasting and TV; Microwave oven; Radar, portable and stationary radio transceivers, personal mobile radio; MRI

Figure. The table shows the range of frequency for various electromagnetic radiations [9].

Static Field-

Static fields, when a charge is accumulated or present in the surface of material produces its electric field but when there is a physical movement of the charge it also produces a magnetic field. The external electromagnetic field may force the charge to do motion and when this charge moves it creates some potential difference. And that potential difference is so less (<2000 volts) that the human body cannot feel. Generally, frequencies of these types of fields are almost 0 HZ.

Sources- Industrial electrolysis, video displays, MRI and other scientific instrumentation, welding devices, etc.

Extremely Low Frequency (ELF)-

Extremely low frequency describes the frequency of less than 300HZ. This type of field is almost useful to humans. In this range, electric power is also supplying throughout the word (50 Hz-60Hz) [10, 11].

Sources- Power lines, Domestic Distribution lines, domestic appliances, electric engines in cars, busses, trains, etc.

Possible Health Effects- WHO, in October 2005, set a group of some members and kept them for a long time in the ELF electric field and magnetic field of about (0.3 to 0.4 Microtesla) in the frequency range 0Hz-100 kHz for concerning childhood leukemia [12]. And they estimated that roughly about only between 1% and 4% of children live in such type of conditions [13]. there is no such study that has evidence that supports the hypothesis that long term ELF exposure is a contributing factor to leukemia in children [14][15].

III. INTERMEDIATE FREQUENCY(IF)-

Intermediate frequency describes the frequencies between 300 Hz-100 kHz. A long term exposure to this type of radiation is hazardous for humans. Now a day's use of this type of frequencies is rising gradually.

Sources- Video displays, CFLs, in radio transmitters, anti-theft devices in shops, hands-free access control systems, card readers and metal detectors, etc.

Possible Health Effects- There was a research paper about the long term exposure to the magnetic field in the IF range of 50 Hz for 20 years on the immune system and blood diseases in the human. It was estimated that there is no effect which had been observed on immune or blood functions [16].

RADIO FREQUENCY(RF)-

Radiofrequency describes the frequencies between 100 kHz-300GHz. This type of frequency range has a global use in communications.

SOURCES- Typical examples are mobile telephony, Broadcasting and TVs, Microwave oven, MRI and other medical and industrial applications, etc.

IV. EFFECTS OF ELECTROMAGNETIC WAVES ON THE HUMAN BODY

While the positive part of technologic advancement makes the existence simpler, it might likewise include segments that disable the personal satisfaction using its specific adverse impacts. Electromagnetic waves can be created by numerous methods by humans also. Coming about because of the mechanical developments, the utilization of electromagnetic fields step by step increments, and in this way individuals are presented to these EM waves at higher extent. Especially, drastically expanding the cell phone client's numbers raises critical worries because of its latent capacity harm on individuals uncovered by RF waves.

The general feeling is that there is no immediate proof of risky consequences for humans when brought near to low radiofrequency waves. A few examinations uncovered that various elements of EM fields did not demonstrated the deoxyribonucleic acid harm on various cells. In an exhaustive audit distributed, Brusick et al have announced no proof in regards to the direct mutagenic impact of radiofrequency flags on cells. Then again, there is a great deal of opposite investigation distributed as of late. The vast majority studies worried on proof of cell impacts due to Electromagnetic waves. Marino and Becker have indicated that static or exceptionally low-recurrence electromagnetic fields may prompt organic impacts related to the redistribution of particles. Besides, numerous investigations exhibited that organic impacts of low-recurrence attractive fields may enter into more profound tissues.

Foletti et al. indicated that ELF-EMF may affect a few cell capacities, for example, cell multiplication and separation, which was trailed by numerous different scientists. Electromagnetic fields of high recurrence has low and greater consequences on natural frameworks. Numerous papers showing that low frequency EMF has no noteworthy impacts on organic frameworks. Notwithstanding, apparently these investigations have a poor plan all in all, and they need proper benchmark groups, and they are additionally joined by bewildering factors.

V. CONCLUSION

From the above analysis, it is concluded that most of the negative impacts are especially in the spectrum of Radiofrequency (RF) band which is use in wireless communication. Alongside the across the board utilization of mechanical items in everyday life, the natural impacts of electromagnetic waves have started to be all the more broadly examined. Advantages of EM waves are countless but as we know anything have both advantage and disadvantage. Many researchers show on their research that the electromagnetic field generated from their source which was all around us effect human body some papers said the long time exposure effect human body and some paper suggest it can cause various types of cancer and disorders in human internal organs like brain ,kidney, lungs and many more one side we see huge population using phone and above we see they have very great impact on human beings but if they really harming people then it is really a good matter on which we should talk about otherwise we may loss a whole generation. The general sentiment is that there is no immediate proof of perilous impacts on human by radiofrequencies. Major Studies found that moderately high frequency electromagnetic radiation, exhibit unfortunate impacts. As of late, there are a ton of learns about impacts of EMF on cell level; DNA, RNA atoms, a few proteins, and hormones, intracellular free radicals, and particles have appeared. Especially, the drastically expanding number of cell phone clients rise noteworthy worries because of its latent capacity harm on individuals RF fields. In the previous decade people begins to demonstrate some expanded hazard, specifically for mind tumors, from cell phone use. Greater uses of cell phones harm our cerebrum tissue. And increases the extent of the mind tumor in human beings.

REFERENCES

1. Cloude, Shane (1995). An Introduction to Electromagnetic Wave Propagation and Antennas. Springer Science and Business Media. pp. 28–33. ISBN 978-0387915012.
2. Electromagnetic Waves and Human Health
3. By Feyyaz Ozdemir and Aysegul Kargi Submitted: October 9th 2010Reviewed: May 10th 2011Published: June 21st 2011 DOI: 10.5772/16343
4. Cleveland, Jr., Robert F.; Ulcek, Jerry L. (August 1999). Questions and Answers about Biological Effects and Potential Hazards of

Radiofrequency Electromagnetic Fields (PDF) (4th ed.). Washington, D.C.: OET (Office of Engineering and Technology) Federal Communications Commission. Retrieved 29 January 2019.
5. Electromagnetic Radiation and Human Health.
6. May 2015, DOI: 10.13140/RG.2.2.13195.28962, M M Zaman Tanim**,** Tampere University of Applied Sciences
7. Ved Parkash. Sharma Neelima R. Kumar 2010 Changes in honeybee behavior and Biology under the influence of cellphone radiations. Current Science, 98 10
8. Possible effects of Electromagnetic Fields (EMF) on Human Health. 2010 Scientific Committee On Emerging And Newly Identified Health Risks (SCENIHR) http://pages.prodigy.net/unohu/electro.htm
9. Cifra M. Fields J. Z. Farhadi A. 2010 Electromagnetic cellular interactions. Progress In Biophysics and Molecular Biology. 1 24
10. Guidelines On Limits Of Exposure To Static Magnetic Fields. In: International Commission On Non-Ionizing Radiation Protection ICNIRP Guidelines Health Physics April 2009 96 4
11. Possible effects of Electromagnetic Fields (EMF) on Human Health, Publisher: European Commission DG SANCO, Mats-Olof Mattsson, Anders Ahlbom, Karolinska Institutet, Possible effects of Electromagnetic Fields (EMF) on Human Health. Scientific Committee On Emerging And Newly Identified Health Risks (SCENIHR) 19 July 2006 MRI: Magnetic Resonance Imaging
12. Possible effects of Electromagnetic Fields (EMF) on Human Health. 2010 Scientific Committee On Emerging And Newly Identified Health Risks (SCENIHR)
13. Burr HS Northrop F.S.C. 1935 The electrodynamic theory of life. The Quarterly Review of Biology 10(3), 322 EOF -333.
14. "Electromagnetic fields and public health". Fact Sheet No. 322, June 2007. [World Health Organization], Accessed 7 February 2010.
15. Kheifets, L (2010). "Pooled analysis of recent studies on magnetic fields and childhood leukemia". Br J Cancer. **103** (7): 1128–1135. DOI:10.1038/sj.bjc.6605838. PMC 3039816. PMID 20877339.
16. Salvan, A; Ranucci, A; Lagorio, S; Magnani, C (2015). "Childhood Leukemia and 50 Hz Magnetic Fields: Findings from the Italian SETIL Case-Control Study". Int J Environ Res Public Health. **12** (2): 2184–
204. DOI:10.3390/ijerph120202184. PMC 4344719. PMID 25689995 Scientific Committee on Emerging; Newly Identified Health Risks-SCENIHR (January 2009). "Health Effects of Exposure to EMF" (PDF). Brussels: Directorate-General for Health & Consumers - European Commission: 4–5. Retrieved 27 April 2010.
17. Clinical Biochemistry, Volume 46, Issues 1–2, January 2013, Pages 59-63, Long-term (up to 20 years) effects of 50-Hz magnetic field exposure on the immune system and hematological parameters in healthy men, Author links open overlay panelYvanTouitouaYasminaDjeridaneaJacquesLambrozobFrançoiseCamusaBrahimSelmaouiac
18. Numerous studies are currently undertaken to explain the possible health effects of weak, “non-thermal” radiofrequency electromagnetic fields2).
19. IARC Monographs on the identification of carcinogenic hazards to humans. International Agency for Research on Cancer. WHO. https://monographs.iarc.fr/agents-classified-by-the-iarc/.
20. Scientific Committee on Emerging and Newly Identified Health Risks − SCENIHR9)
21. Mobile phone use and glioma risk: A systematic review and meta-analysis.,Yang M, Guo W, Yang C, Tang J, Huang Q, Feng S, Jiang A, Xu X, Jiang G, PLoS One. 2017; 12(5):e0175136.
22. Mobile phone use and risk of brain tumors: a systematic review of the association between study quality, source of funding, and research outcomes.,Prasad M, Kathuria P, Nair P, Kumar A, Prasad K, Neurol Sci. 2017 May; 38(5):797-810.
23. Evaluation of Mobile Phone and Cordless Phone Use and Glioma Risk Using the Bradford Hill Viewpoints from 1965 on Association or Causation.,Carlberg M, Hardell L, Biomed Res Int. 2017; 2017().
24. Probabilistic Multiple-Bias Modeling Applied to the Canadian Data From the Interphone Study of Mobile Phone Use and Risk of Glioma, Meningioma, Acoustic Neuroma, and Parotid Gland Tumors.,Momoi F, Siemiatycki J, McBride ML, Parent MÉ, Richardson L, Bedard D, Platt R, Vrijheid M, Cardis E, Krewski D, Am J Epidemiol. 2017 Oct 1
25. Mobile phone use and risk for intracranial tumors and salivary gland tumors - A meta-analysis. Bortkiewicz A, Gadzicka E, Szymczak W, Int J Occup Med Environ Health. 2017 Feb 21