

Symptomatic Influence of Advancement in Technology and an Indicative Effect on Human Health

S.Bhagyashri, Kanimozhi.G, Umayal.C, Xiao-Zhi Gao

Abstract: *Endless human evolution had led to certain level of change in mankind. Advancement in technology has minimized human effort and time. Eluding side effects due to technology growth has direct or indirect impact on human health. One such side effect caused by electrical devices is sensitiveness to Electromagnetic (EM) waves termed as Electro Magnetic Hypersensitivity (EHS). Cause, effects, symptoms, diagnosis, and treatment of EHS is discussed in this paper. The evidence of causality of exposures in effect is evaluated by means of criteria list. Other functional impairments with similar symptoms, causes and effects are also discussed. This paper discusses the e-survey conducted on different age group affected due to the effect of EHS. Hence from a limited quantity of research in this area concludes that diagnosis and awareness of EHS need to be improved to safeguard the mankind.*

Index Terms: *Electromagnetic waves, hypersensitivity, medical symptom, radiowave sickness*

I. INTRODUCTION

Electromagnetic hypersensitivity deals with health symptoms that one faces, when exposed to excessive electromagnetic fields beyond one can tolerate. As the world is marching towards the latest technological advancements, innovations, inventions which have bestowed mankind with better living standards such as communicating information several miles apart have become a piece of cake. The increasing utilization of these technologies often leads to side effects on human health which is most often misdiagnosed due to lack of medical facilities. The evidence for various medical, psychological, behavioral, and alternative treatments is evaluated by UK health protection agency (2005) review and a systematic review (2006). The results proved that the evidence base is not generalizable, but the best evidence favored is cognitive behavioral [1] therapy.

Numerous people from various countries claim to be suffering from symptoms that are nonspecific, which attributes to exposure of low-frequency EM fields. The frequency of the symptoms in the public has been analyzed and reported in this paper. From different methodologies

carried in Sweden and China, it is found 3% of the general public is allergic to radiations from a variety of sources -electrical devices, power lines. European Commission [2] due to frequency and severity problems has decided to focus on this topic in upcoming years for better tomorrow. The people exposed to EHS have been put into different categories and factors are analyzed. With this basis, the factors that can aid or synergies the exposure to radiations of the electric field and magnetic field [3] have been reported. With respect to demographic factors, from the population studies conducted in US and Sweden [3], it has been found that more victims tend to be women, old-aged people and those who tend to have lower income with different ethnic background. Several personal factors and physiological factors have been considered. The major issue associated with this topic is that there is no proper definition. Mainly it is self-reported and no structural diagnostic method is listed. As a result, the European commission has sponsored some self-aid groups and centers for occupational medicine in order to analyse the severity and its frequency observed in general population. The occurrence [2] is found to vary between countries. According to WHO [4], variety of non-specific symptoms are categorised under EHS, which afflicted individuals attribute to the electromagnetic field exposure. The collection of the symptoms is not part of any recognized syndrome to be categorised under any ailment. The commonly experienced symptoms by people suffering from EHS include neurasthenic difficulties in concentration, fatigue, dizziness, tiredness, increased rapid heartbeat, nausea, and digestive problems. It also includes dermatological symptoms redness in skin, prickling, and burning sensations. The wide range of symptoms does not narrow down the conclusions of the symptoms attributed to EHS. EHS is mostly related with other similar sounding syndromes, due to its nonspecific symptoms. EHS is often comprehended with Multiple Chemical Sensitivities (MCS) which attributes to low-level chemical exposure in environment. Both EHS and MCS apparently lack physiological toxicological basis or independent verification. Idiopathic Environmental Intolerance (IEI), another syndrome similar to EHS which also associates with sensitivity to the environmental factors. The evolution and perceptions of EHS are shown in Fig 1.

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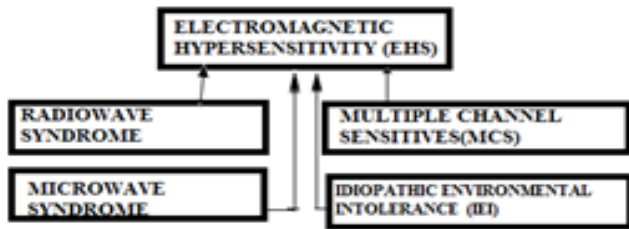


Fig.1- Syndromes related to EHS

The main motive of the study is to create awareness about the electromagnetic hypersensitivity (EHS) which is commonly referred to as Electro Sensitivity (ES). At some situation, due to negligence at the initial stages of EHS, it leads to complete disability and hospitalization due to the aggravation of pre-existing medical conditions. Also there is a high chance of development of tachyarrhythmias resulting loss of consciousness and other acute neurological problems. The major problem of EHS suffers is the lack of government support. World Health Organization (WHO) has not yet identified EHS as a medical diagnosis [4]. Hence the symptoms are often misdiagnosed or ignored by the patients. EHS is recognized as a functional impairment only in Sweden.

II. ELECTROMAGNETIC HYPERSENSITIVITY

Referred to as microwave sickness and radio wave sickness during 1970's, EHS has evolved as a functional impairment which is well known among scientific communities. Among 120 studies conducted on EHS, 69 studies emerged with positive findings, 27 studies emerged with null findings and 24 studies fetched neither positive or null results, but offered important insights about the topic. Human beings are under the constant exposure to EMF radiations. There are various sources of EMF radiations. Generally, it can be categorized into natural and man-made sources. However, the effects of radiations [9] from man-made source exceeds the effects of natural sources. The sources include high voltage power lines, televisions, RF sealers, glue dryers, radio broadcast towers, electrical welding and much more. Human within 100 meters of any wireless facility has experienced symptoms such as rise in blood pressure, dizziness, memory loss, nausea, itchy systemic rash, joint pains moving around the body, high-pitched noises in their ears, inability to concentrate, irritability, peculiar pressure behind the eyeballs, hurt of feet sole, even internal bleeding. According to the survey [5], there is an increase in respiratory illnesses such as bronchitis, flu, pneumonia, and asthma.

Microwave sickness or RF syndrome is a specific symptomatology at low level of radio frequency linked to radar exposure. The statistical analysis and the power density of microwave measured at the homes of the respondents significantly proved the correlation between the measured power density and declared severity of the symptoms. An increase in the intensity in the group is observed with the higher exposure. The results revealed the clinical entities such as brain tumours, insomnia, cancer, leukemia in children. Military and occupational studies revealed the consequences of radiation such as radar also have impact on sensitivity towards EM waves [6]. Radio wave sickness, neurasthenic or

asthenic syndrome includes some of the central nervous functional disturbances with few exceptions. Fatigue, loss of appetite, irritability, headache, over sleep, and depression, difficulties in focusing or concentrating, and emotional instability are some symptoms and signs that are common with radio wave sickness and EHS. If RF signal is discontinued, the clinical syndrome is reversible. The evidence of biological mechanisms [7] supports the conclusion of causal, logical, probable relationship between neurological disease and RF exposure.

III. CAUSES AND SOURCES

The effect of EHS is realized and felt by those respondents near cellphone towers, high voltage transmission lines and power stations. Mobile phones, desktop computers, Wi-Fi or Bluetooth enabled laptop, DECT cordless landlines, Wi-Fi routers, fluorescent lights, Smart meters, RFID systems, wireless gaming consoles, Tablets etc. which emit electromagnetic field is known to cause EHS. Table 1 gives the sources and types of radiations. All the sources are discussed and mobile phones, laptop computers are explained in detail with their biological effect.

Sources	Types of radiations
Laptops	Low-frequency radiation Radio frequencies(RF) Heat radiation
Mobile phones	Radio frequencies(RF)
Desktop computers	Extremely low-frequency radiation(ELF) Microwave radiation
Television	Low-frequency EM radiation
VDUs	Very low-frequency radiation(VLF) Extremely low-frequency radiations(ELF) Radio frequencies(RF)

Table 1: Sources and type of radiation

A. Personal computers

Personal computers (PC) have become an integral part of a human life in a modern world. Next, to mobile phones, PCs seem to be the next major cause Electromagnetic Hypersensitivity. From the study it is found that, number of people reported various symptoms on exposure to EM radiations from computers. Computers produce extremely low-frequency radiation that can cause allergic reactions, cancer, sleep disturbance and even heart diseases. If women are exposed to radiation from CRT screens of desktop computers it can lead to miscarriage during their pregnancy. UPS can produce a 1 milli-gauss magnetic field at a distance of even 1 meter. So it is generally advisable to use UPS at a distance of 5m. Also, LCD or led screens generally used provide 0.3 milli gauss magnetic field which is less compared to that of CRT screens[21].

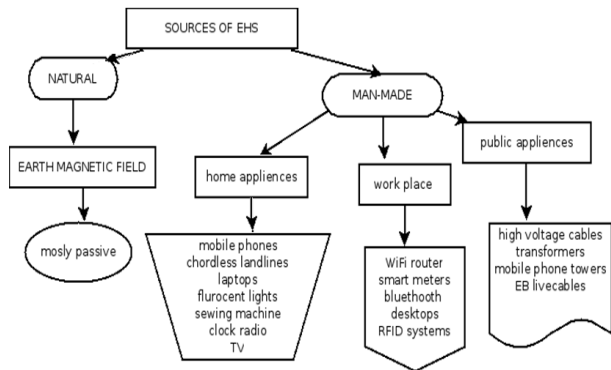


Fig 2: Sources of EHS

B. Television:

Exposure to RF field is common scenario in radio and TV transmission. Comparatively, the exposure levels near the towers are quite less as the antenna towers are usually high as the emissions are directed for travelling a long distance. Ultra High Frequency TV broadcasting has the highest input power. Amplitude - modulated video signal and a modulated frequency audio signal makes up a TV signal. 30 kW of power is utilized for the video signal and about 5 kW is used for the audio signal in Sweden. The range of electric field strength usually differs from a few volts per meter in the near zone (1 km) to a few hundreds of volt per meter (V/m) at 50 km.

C. High Voltage power lines:

Transmission of power from generation to the distribution is a necessity. The overhead high voltage transmission lines have more Electromagnetic interference compared to other sources. Voltage, distance and load carried between two phases and tower height determines the field strength. Usually at the middle of two towers, field strength shoots up to few kilovolts per meter (kV/m) as the fields are stronger when near to ground. Because of the shielding effect of the walls of the building, people inside the building is expected to feel low effects of EM interference, but still this very negligible. The magnetic field experienced inside the house is almost the same as outside because of the reduced shielding effect of buildings. According to the WHO workshop report [21], 0.2 μT extra flux density could be found up to 100m, for a 400kV line with a full load of 1200A.

D. Electrical appliances:

All electrical components and appliances have international standards and guidelines to ensure the quality. Very rarely the appliances may exceed the international standards and guidelines. But it exceeds only at a distance of 0.5 to 1m. The EM field does not exceed more than tenths of μT. The field produced depends upon the power utilization of the equipment. WHO [21], has listed some examples of flux densities near various equipment and appliances. A clock radio with a worse electrical design may give rise to exposure of EM waves in the order of 100 μT. This can be experienced by a sensitive observer close to the equipment. As clock radio are usually kept close to people, like placing them beneath the pillow in the bedroom. In this case a large magnetic exposure is experienced by the head which exceeds the normal level. Accumulated ELF-EMF exposures, increase in magnetic fields near sewing machines can also be

experienced. Depending upon the type of machine used, the values differ accordingly. The order of several tenths of μT is logged as the mean average value recorded during working hours. The sources of EHS are shown in Figure.2.

E. Mobile Phones:

In the past decades, the usage of mobile phones has increased manifolds. The effects of interaction of emf radiations on human tissues due to increased use of mobile phones have been studied. Numerous negative impacts as shown in Fig.3 have been discussed here.

F. Biological effect:

- **Reproductive Health:** Diverse studies have been performed which analyses the adverse effects of mobile phones on the reproductive health. The study performed by Osman et al. using the vitro model revealed significant changes in the sperm motility when exposed to EM radiations from cellphones. The samples collected from 27 males are divided into two parts-one exposed to EM radiations of 900MHz from cellphones for 5 minutes leaving the other portion of samples unexposed. It is observed that there is a decrease in the fast progressive, slow progressive and no motility movement of sperm. Long-term exposure to non-ionizing radiations from mobilephones has been found to cause various changes in the structure of germ cell of the males [14]. Certain studies have also revealed a decrease in semen quality [15] and mitochondrial genome in [16] DNA on exposure to cellphone EM radiations.

- **Brain tumor and DNA damage:** It is found that there is an increased risk of brain tumour [17] among the frequent analog cellular phone users both sexes aged from 20-80 years. It has been found that a relationship exists between cell phone usage and certain brain tumours [18].The time gap between the usage of mobile phones and the detection of brain tumour may be roughly around 8 to 20 years. These RF radiations from mobile phones [19] can cause DNA damage. It also triggers the breakage of chromosomes and cerebral tumour mainly on that side where one uses the phone.

- **Headache and depression:** Johansson A et al.[20], drew a comparison between the symptoms between mobile phone related symptoms and exposure to general electrical equipment. The group suffering from mobile phone related symptoms reported headache and depression.

G. Laptop Computers

Laptops are in common use nowadays and they are operated in lap. The radiations emitted from them can easily affect human being by penetrating deep into the body. These are usually EM fields of lower frequency range. They radiate out from the computer during a number of operations such as the activity of the processor, operations of hard drive, storage of memory and various other functions. On internet connectivity, laptops transmitter produces and emits higher Radio Frequency (RF) radiation directly into the body.



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Heat and Electronic radiation exposure [21] for long periods of time cause fatigue, dizziness, headache, skin rashes, muscle soreness and infertility, breathlessness and various types of cancer. The best way is to ensure that the laptops are kept at a minimum distance of 30 to 35 cm and should be placed on the desks. The semen samples are collected from 29 donors and samples they are categorized into the control and experimental groups. A vitro model is considered for this study where the various semen samples are collected, processed and is incubated beneath a laptop which is connected to a Wi-Fi network. The incubation is done for a period of 4 hours at a temperature of 25° C. After the process of incubation, a thorough analysis of the motility and the vitality of sperm are carried out. The DNA fragmentation in the samples is also assessed.

The progressive sperm motility shows a significant decrease in the experimental group with no visible changes in the non-progressive motility. Corresponding increase in non-motility is observed. In the exposed groups, there is an escalation in DNA fragmentation.

IV. MAJOR SYMPTOMS OF RADIOWAVE SICKNESS AND EHS

The following [Fig.4] shows the major symptoms of radio waves sickness and EHS.

- **Neurological Effects :** Depression, dizziness, vomiting, concentration difficulties, loss of memory, irritation, itching, headache, increased nervousness and anxiety, fatigue and tiredness, weakness, spasms in muscles, difficulties in sleeping, nausea, numbness, tingling sensations, leg/foot pain, knee and joint pain. Severe reactions include paralytic attack; changes in brain activity, stroke and mental disorders like psychosis are also common.

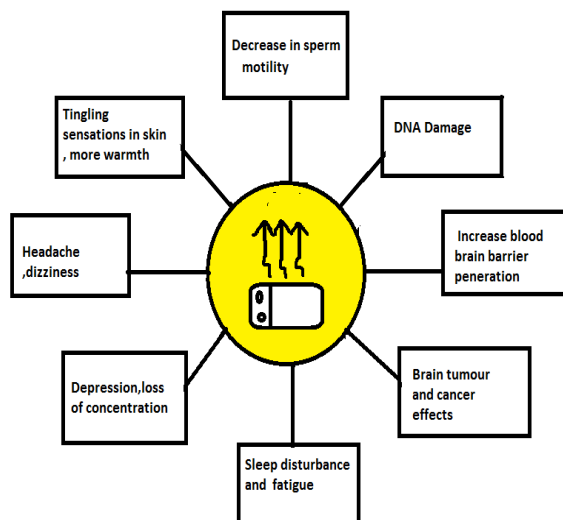


Fig 3 -Harmful effects of mobile phones

- **Effect on Cardiac:** Sudden pressure and shooting pain in the chest, slower or faster heart rate, Palpitations, abnormal heart rhythm, excessive increase or decrease in BP, breathlessness.
- **Effect on Respiratory system:** Difficulties in breathing, fatal diseases like bronchitis and pneumonia may also be developed.
- **Dermatological:** Rashes in the skin, itching, burning and tingling sensations, redness in skin, severe irritations.

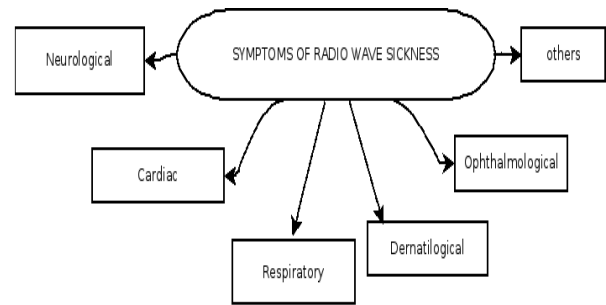


Fig 4: Symptoms of Radio wave symptoms and EHS.

- **Ophthalmological effects:** Difficulties in vision, a sudden sensation or intensive pressure behind the eye, cataracts.
- **Others [8]-[9]:** Pain in abdomen, digestive issues, changes in metabolism, increased size of thyroid, pain in ovaries and testes, frequent drying of lips, mouth and eyes, increased feeling of thirst, dehydration, bleeding of nose, abnormalities in the immune system, excessive loss of hair, tooth pain, ringing sensation in the ears and difficulties in proper smelling. The symptoms of radio wave syndrome and EHS are shown in Fig 2. In addition to the above effects, numerous patients have reported some generalized symptoms such as dizziness, memory loss, neurological symptoms, fatigue which they associate with EMF exposure in their work place and house.

The people with EHS has been divided into two major categories-people suffer from VDT skin related symptoms (VSS) and with the general syndrome or electrical hypersensitivity (EH). This provides a more complex picture. The VSS patients declare that TV screens, fluorescent tubes are the major causes for their condition. EH patients claim their primary cause to be cell phones, PCs, laptop computers, power lines and watch batteries. Facial and various skin symptoms associated with VDTs have been reported in Great Britain [3].

A study conducted in 2011 and 2012 on the people of Finland who reported to be suffering from EHS. From the study, it is reported that PCs (50.8%) and mobile phone (47%) held the top spot when it came to the major sources. Most of the respondents to the study are women and people in the age group 60-69 (28%). The study is analysed in two phases, one phase-before onset of EHS and the other-during acute phase. Most of the symptoms in the initial onset stage are allergy related issues whereas most of the issues in the acute stage are stress and nervous system related. Abnormal fatigue, dizziness, backaches and sleeping disorders are the most common health effects [10].

Some people are more prone to EHS compared to others. This is because of unnatural bio frequencies present in their bodies. This could be by birth or due to constant exposure to certain materials such as heavy metals. If the cells contain metals, the metals can attract, evoke and intensify the electrical frequencies, thereby increasing the chances of a person getting EHS. So it has been said, the greater the heavy metals present inside one's body [12], the greater the chances that the person may develop health issues related to electromagnetic fields.

V. KEY ISSUES FACED

Main issues faced by EHS suffer are:

- The general public and the medical professionals lack knowledge of EHS and its causes.
- Medical specialists often do not have right devices or the methodologies to diagnosis or treat the sufferers.
- Lack of RF safety.
- Very less research is done to prove the existence of EHS.
- Misconception or misdiagnoses of EHS with problems such as a migraine which exhibits similar symptoms.
- Lack of clarity whether if EHS is a psychological illness.
- Heterogeneity exists when it comes to the identifying criteria for EHS.

After the EMF perception test in the lab, self-rated sensitivity towards EHS has been depicted in the Fig5. The sensitivity of EHS before the test is more than that after the test in Fig.6. From another research by Austrian Medical Association (2012), the common symptoms and sources have been listed [22]. Mobile phone stations are the main cause for EHS followed by cell phones. Sleep problems and Headache is reported among the respondents.

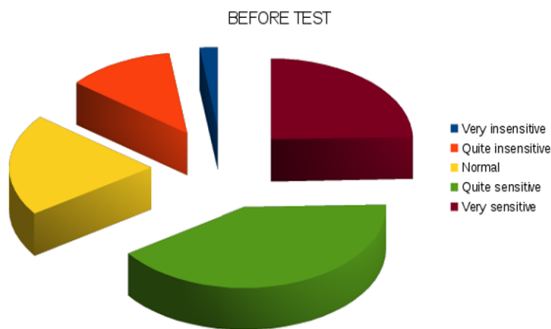


Fig.5: Survey before test

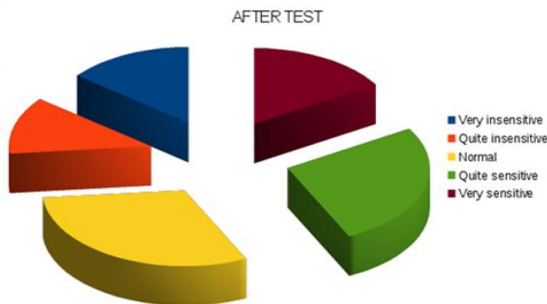


Fig.6: Survey after test

Among two-third of them have taken measures to reduce their symptoms. Fig 7 shows the survey of symptoms caused by EHS and Fig 8 represents the major sources of EHS.

Fig.9 illustrates the case study taken in Finland [10]. This survey notifies that main source that causes EHS is mobile phones. The second cause is due to the usage of PCs followed by a power line.

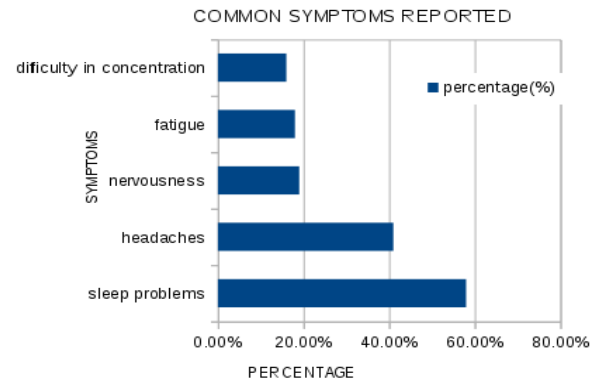


Fig. 7: Common symptoms reported

VI. E-SURVEY IN INDIA

On the e-survey taken, the effect of sensitivity towards electronic gadgets resulted in various conclusions. The survey is conducted to all age groups from 15-70 years. Though there are many responses from diversified age group; 68% of the people from age group 15-23 years. Rest 32% is from age groups 24 -76 years.

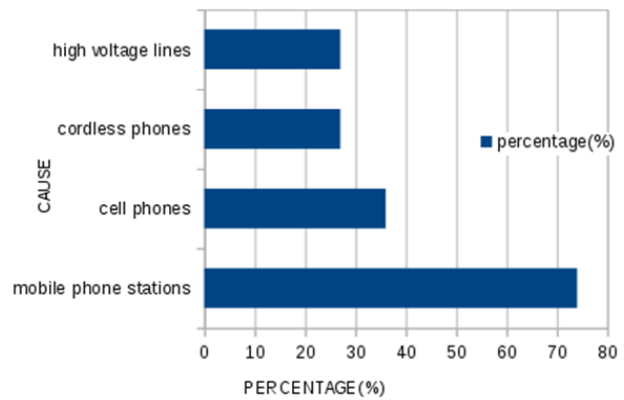


Fig.8: Sources of EHS

percentage of victims during acute stage of EHS

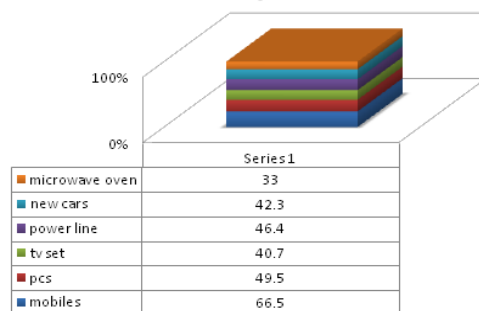


Fig.9: Causes reported from case study in Finland [10]. The survey depicts that majority of people are frequent users of electronic gadgets, like mobiles, personal PCs, laptops, etc. Since most of the people are late teens and early 20s, 96% of people are frequent users of electronic gadgets (from Fig 10(a)). Only 4% of people are found to be using the electronic gadgets rarely.



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In the range of 15-26 years, almost everyone is found to be a frequent user of electronic gadgets. From Fig 10(b), 64% of the population faced EHS problems and are uncomfortable speaking in mobile phones for long hours. This signifies that, sensitivity developed by the people due to over use of mobile phones is predominant. Fig 10(c) illustrates that 60% of the population has voted positively towards the usage of laptop on tables. Only 40% of the population are found using laptops on laps. This has signified that majority of the responses are aware of the hypersensitivity issues due to use of laptops on laps. 80% of the population felt inconvenient to have used earphones and headphones for a long period of time (Fig 10(d)). 54% of population suffered from sleeplessness, headache and sensitivity due to the use of gadgets (Fig10 (e)). From the data collected 24% of the population, suffer from headache, nausea & tingling sensation due to electrical interference of Wi-Fi (Fig10 (f)).

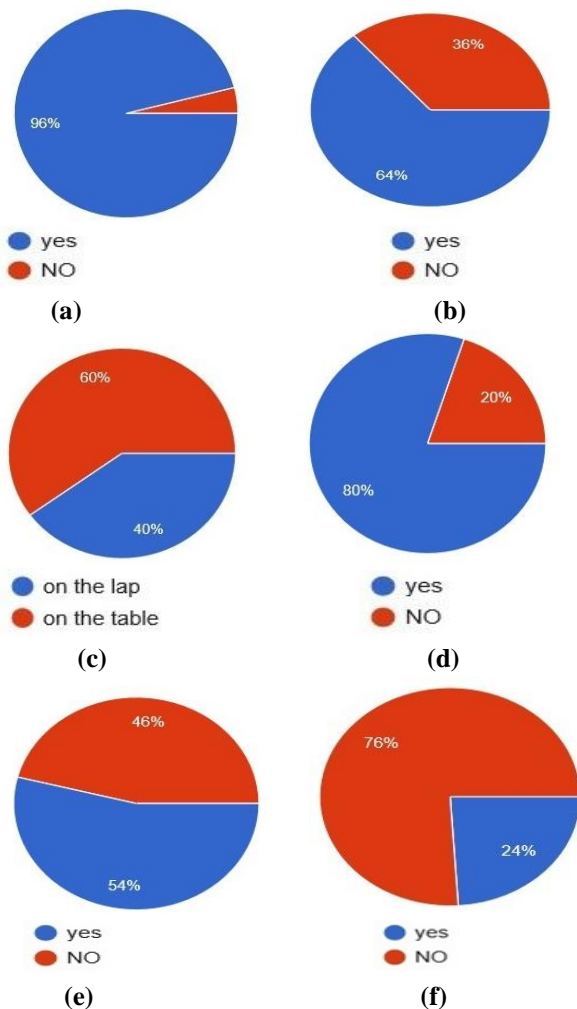


Fig 10(a) Frequent user of electronic gadgets (b) Percentage of people uncomfortable using phone for long hours (c) Position of laptop during working (d) Cases found uncomfortable using earphones for long time (e) Cases reported with difficulty in sleeping due to usage of electronic gadgets (f) cases reported suffering from Wi-Fi sensitivity. Nearly 65% of people in the 15-26 age group feel uncomfortable using phone for long period of time. Nearly 30% of people in 15-26 age groups are found with symptoms

like headache, nausea & tingling sensation due to electrical interference. Among the age group 15-26, suffering from symptoms of hypersensitivity and sensitivity of Wi-Fi signals, 91% of them used laptop on lap and speaking on phone for long hours.

VII. DISCUSSIONS

Several treatment methods are undertaken by the sufferers such as traditional bone setting therapies, chiropractic and reflexing therapies. For the working population, the psychotherapy and medical based medication are not significantly helpful. A change in diet with more nutrition, reducing the exposure to sources, increased physical exercises are more fruitful. Also, it is observed that the response of the people to wireless media remained unchanged even after the acute phase is over, however to basic electrical apparatus their reaction is reduced [10]. It is suggested to get heavy metals out of one's body. This has a synergistic effect that can increase the effect of electromagnetic radiation. Also, intake of iodine is considered to be quite helpful. Overgrowth of lymph bacteria can prove to be dangerous as it draws more unwanted radiations. It is better to use landlines rather than mobile phones. Rubin et al [1], assessed the results of a therapy relating to conscious intellectual activity in four studies. Two studies are performed on VDU filters. A study is performed on shielding emitters. Therapies that implement antioxidants and acupuncture have also been evaluated. From the results, it has been found that the therapy dealing with cognitive behaviors has better effects than that without any treatment.

VIII. CONCLUSION

Thus this paper enlightens the cause, effects, symptoms, diagnosis, and treatment of EHS. A limited number of studies have been published on exposure and treatment of EHS between the years 2000-2017. The case of EHS is often self-reported and misunderstood as nocebo effect. Since the symptoms often vary, the treatment methods remain unclear. Some researchers have yielded contradictory results on certain effects of EM radiation from electrical/ electronic devices. In order to have a more clear biological effect, further research has to be done by taking various specific effects into consideration to safeguard the mankind. Based on the survey taken up, it is found that the frequent usage of electronic gadgets is high among the age group 15-26 and has been subjected to high level of sensitivity because of electrical interference. In this demography, the responses overall has proved that an increase in WIFI sensitivity among people is predominant compared to other results. Necessary steps must be taken to avoid the impact of EHS on human race.

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