STUDY AND COMPARISON OF HEALTH SYMPTOMS FACED BY INHABITANTS NEAR MOBILE TOWER AND THOSE WHO WERE NOT EXPOSED

Lalrinthara Pachuau*[1] and Zaithanzauva Pachuau[2]
[1]Department of Physics, Pachhunga University College, Mizoram University, Aizawl – 796001
[2]Department of Physics, Mizoram University, Tanhril - 796004
*For correspondence. (rinapachuau@yahoo.com)

Abstract: In the present paper, we presented the study of complaints on thirteen (13) different nonspecific health symptoms faced by inhabitants living near mobile tower and those inhabitants living in the area where there is no mobile tower. The study was conducted in two different localities in Aizawl in the year 2013. For the study, questionnaires were conducted in both the localities. Power densities were measured in different places in both the localities. Frequency spectrum was taken in each locality. It was found that those living near mobile tower were having more complaints on the nonspecific health symptoms than those living in the area where there is no mobile tower.

Keywords: RF; power density; health complaints; frequency spectrum

1. Introduction:

Mobile communications have become very important. Wireless technology is based on extensive networks of base stations that connect the users through Radio Frequency (RF) signals. Over the last decade, there has been a great deal of concern about possible health consequences caused by human exposure to RF in general and radiations from base stations in particular[1-3]. It is believed that mobile phones produce RF energy of non-ionizing radiation which is too low to heat the body's tissues, and hence is unlikely to have the same impact on human health as those produced by ionizing radiations such as X-rays[4]. Nonetheless, there is still a need to determine the level of health risks caused by RF radiations. Many studies address the impact of mobile phone radiations on human body, only a few consider the effect of human exposure to base stations although such an effect may be greater as more body parts can absorb RF energy[2].

With the significant increase in mobile phone usage, possible health risks related to RF exposure have become the subject of considerable attention[3,5]. This includes effect from exposure to both cell phones and base stations. The present paper aims to study different symptoms of health effects of RF radiation from mobile tower on nearby inhabitants and those who were not exposed. Health concerns can be divided into two main categories: short term and long term effects. The short term effects include brain electrical activity, cognitive function, sleep, heart rate and blood pressure[6]. However, the long term effects include tinnitus, headache, dizziness, fatigue, sensations of warmth, dysesthesia of the scalp, visual symptoms, memory loss and sleep disturbance, muscle problem and epidemiological effects including cancer and brain tumours[7,8].

In May 2011, International Agency for Research on Cancer (IARC) has classified RF radiation as possibly carcinogenic to human (group 2B) based on increased risk for glioma, a malignant type of brain cancer associated with wireless phone use[9].

2. Materials and methods:

The Global System for Mobile communication – 900 (GSM-900) mobile base station in College veng was erected in 2009 in Aizawl, Mizoram, India. The present study was carried out in 2014, i.e. inhabitants are exposed to RF radiation for a period of five (5) years. Whereas in Lawipu, there was no mobile tower ever.

2.2. Questionnaire:

To study the health hazards and problems faced by the inhabitants living close to the base station, questionnaire surveys were conducted on 13 different symptoms at two different localities in Aizawl. The questionnaire was similar to that developed for the study on mobile phone users by Santini et al[10]. The surveys were conducted in College veng (all living within 100m) and Lawipu where the inhabitants are exposed and not exposed respectively. In College veng a tower is installed on a roof top in 2009, whereas in Lawipu there is no mobile phone tower, the nearest tower is located in another locality called Maubawk which is about 1 km away. Questionnaires from those inhabitants living within 100 m from the tower are considered here. The health complaints of both the localities are compared. The level of complaints for the studied symptoms was expressed by using a scale of : 0 = never, 1= sometimes, 2 = often, 3 = very often.

2.2. Power density measurement**:**

The amount of energy passing through unit area per unit time is called Power density (P_d). If the transmitter is isotropic, it radiates energy uniformly in all directions. The power of a transmitter that is radiated from an isotropic antenna will have a uniform power density in all directions. The power density at any distance (R) from an isotropic antenna is the transmitter power divided by the surface area of a sphere ($4\pi R^2$) at that distance. The surface area increases by the square of the radius, therefore power density decreases by the square of the radius. Power density form an isotropic antenna is given by

$$P_d = \frac{P_t}{4\pi R^2} \quad (1)$$

Where P_t = Transmitter power (peak or average depending on how Pd is to be specified), R = radius of the sphere.

If G be gain of the antenna which is the ratio of power radiated in the desired direction as compared to the power radiated from the antenna, and let n be the number transmitter, we have[11]

$$P_d = \frac{nP_tG}{4\pi R^2} \quad (2)$$

If the antenna gain is given in dB rather than dimensionless number, it can be convert back to dimensionless number by using the formula

$$G = [10]^{\left(\frac{x}{10}\right)} \quad (3)$$

where x is the antenna gain given in dB, G is the antenna gain expressed in dimensionless number.

Power density measurement was carried out at different houses in close proximity to the base station. No mobile phone was turned on in the vicinity while taking readings. Background radiation was measured to be -50 dBm in College veng, - 70dBm in Lawipu. At the same time, absolute power (in dBm) was measured at each site. The main purpose of the measurement is to ensure that RF field emission from each site does not exceed the safe public limits and to find whether there is relation between the health complaints and the measured power densities. Power density measurement was done with the instrument HF-60105V4, manufactured by Aaronia, Germany.

2.3. Frequency spectrum:

Frequency spectrum of the RF radiation has been taken at both the localities. The frequency peak for each measurement had been recorded. The same instrument HF-60105V4, manufactured by Aaronia, Germany was used to analyse frequency spectrum. The instrument is capable of measuring non-ionizing radiation for frequency in the range of 1 MHz - 9.4 GHz. In the selected site, other than RF radiation, the other electromagnetic signals present were of TV and radio, which lie outside the GSM-900 frequency range. Hence, it has been assumed that the peaks observed were of RF radiation from the tower only.

3. Results and discussions:

3.1. Analysis of questionnaire:

Analysis of the questionnaire is given in Tables 1, 2 and 3. Statistical comparison of the responses from all the individuals from the two localities are done with Kruskal Walli's t-test and the result of the analysis is given in table 4. Scale numbers 2 and 3 are given more considerations. It has been observed that out of the thirteen non specific health symptoms studied, nine of them are statistically significant in scale 2 or 3 alone or in both. Muscle pain and cramp are significant both in scales 2 and 3 (with $p < 0.05$). Fatigue, sleep disruption, difficulty in concentration, memory loss, dizziness and visual disruption are significant in scale 2 each. Skin problem is significant in scale 3 alone. From each table, Health complaints are very few in Lawipu in comparison to that of College veng. It has been observed that those living within 100 m from the base station in College veng are having more health complaints than those in Lawipu who are not exposed to the RF Radiation from the tower. In figures 1 & 2 comparison between health complaints of inhabitants of Lawipu and College veng are given (for all the males and females participated in the questionnaire).

Table 1: Comparison of health complaints (on scales 2 and 3) between inhabitants in Lawipu and College veng for all those who participated in Questionnaire (all the figures are in percentage).cLawipu : Total = 50, College Veng : 50 (from those living within 100m from the base station). Reference : 0 = never, 1= sometimes, 2 = often, 3 = very often.

Sl. No.	Symptom	2		3	
		Lawipu	College veng	Lawipu	College veng
1.	Fatigue	2.5	13	0	15
2.	Nausea	3.5	13	0	6.5
3.	Sleep disruption	4.5	22	0	26
4.	Feeling of discomfort	0	13	0	6.5
5.	Headache	5.5	11	2	8
6.	Cramp	4.5	19.6	2	11
7.	Difficulty in concentration	2.5	17.3	2	6.5
8.	Memory loss	4.5	19.6	0	6.5
9.	Skin problem	4.5	13	2	13
10.	Visual disruption	2.5	13	0	11
11.	Hearing problem	5	6.5	0	6.5
12.	Dizziness	2.5	22	0	15
13.	Muscle pain	5.5	27.5	4	20

Table 2 : Comparison of complaints between Female inhabitants of Lawipu and College veng (all the figures are in percentage). Lawipu : Total = 26 College Veng : 26 (from those living within 100m from the base station) Reference : 0 = never, 1= sometimes, 2 = often, 3 = very often.

Sl. No.	Symptom	2		3	
		Lawipu	College veng	Lawipu	College veng
1.	Fatigue	0	20	0	12
2.	Nausea	0	12	0	4
3.	Sleep disruption	0	20	0	24
4.	Feeling of discomfort	0	6	0	12
5.	Headache	4	12	0	0
6.	Cramp	4	16	0	20
7.	Difficulty in concentration	0	16	0	12
8.	Memory loss	0	16	0	8
9.	Skin problem	0	12	0	20
10.	Visual disruption	0	12	0	16

11.	Hearing problem	4	4	0	12
12.	Dizziness	0	24	0	24
13	Muscle pain	4	30	0	24

Table 3: Comparison of complaints between Male inhabitants of Lawipu and College veng (all the figures are in percentage). Lawipu : Total = 24, College Veng : Total = 24 (from those living within 100m from the base station). Reference : 0 = never, 1= sometimes, 2 = often, 3 = very often

Sl. No.	Symptom	2		3	
		Lawipu	College veng	Lawipu	College veng
1.	Fatigue	5	9	0	19
2.	Nausea	7	14	0	9
3.	Sleep disruption	9	24	0	24
4.	Feeling of discomfort	0	19	0	0
5.	Headache	7	9	4	19
6.	Cramp	5	24	4	0
7.	Difficulty in concentration	5	19	4	0
8.	Memory loss	9	24	0	5
9.	Skin problem	9	14	4	5
10.	Visual disruption	5	14	0	5
11.	Hearing problem	6	9	0	0
12.	Dizziness	5	19	0	5
13.	Muscle pain	7	25	4	15

Table 4 : Determination of significance level of the comparisons between questionnaires of Lawipu and College veng on scales 2 and 3 using Kruskal Walli's t-test. Ref : S – Significant, NS – Non significant, NC – No comparison.

Sl.	Symptom	Scale	t value	df	p value	Remark
1.	Fatigue*	2	-2.611	18	0.018	S
		3				NC
2.	Nausea	2	-1.897	18	0.074	
		3				NC
3.	Sleep disruption*	2	-2.929	18	0.009	S
		3				NC
4.	Discomfort	2				NC
		3				NC
5.	Headache	2	-0.885	18	0.388	NS
		3	-1.567	18	0.135	NS
6.	Cramp*	2	-2.449	18	0.025	S
		3	-2.717	18	0.014	S
7.	Difficulty in concentration*	2	-2.717	18	0.014	S
		3	-1.095	18	0.288	NS
8.	Memory loss*	2	-2.449	18	0.025	S
		3				NC
9.	Skin problem*	2	-1.897	18	0.074	NS
		3	-2.611	18	0.018	S
10.	Visual disruption*	2	-2.611	18	0.018	S
		3				NC
11.	Hearing problem	2				NC
		3				NC
12.	Dizziness*	2	-3.939	18	0.001	S
		3				NC
13.	Muscle pain*	2	-2.952	18	0.009	S

		3	-2.449	18	0.025	S

.

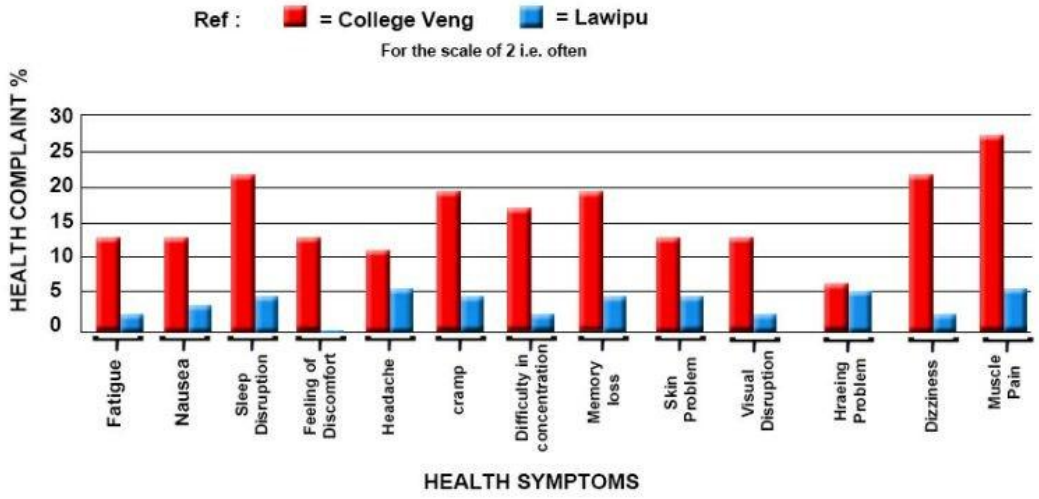

Figure 1: Comparison of complaints between Lawipu and College veng for the scale of 2

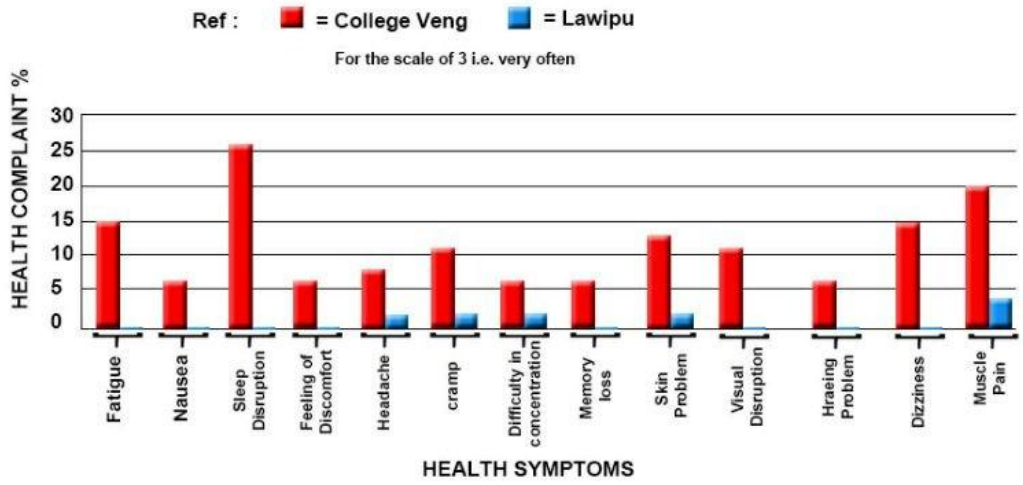

Figure 2: Comparison of complaints between Lawipu and College veng for the scale of 3.

3.2. Power density measurement:

Power density of the RF radiation from the selected tower was measured at fifteen (15) different selected places in College veng. The lowest measured value was 1.8 $\mu W/m^2$, highest measured value was 21 mW/m^2. The average value of the measured power density was 12 mW/m^2. Most of the measured values are higher than that of the safe limits recommended by Bioinitive Report 2012 (0.5 mW/m^2)[12], Salzburg resolution 2000 (1 mW/m^2), EU (STOA) 2001 (0.1mW/m^2)[13]. However, all the measured values were well below the current ICNIRP safe level (4700 mW/m^2)[13] and the current Indian Standard (450 mW/m^2)[14]. In Lawipu, where there were no mobile tower, power density was measured in twelve (12) different places selected randomly. The lowest measured value was 0.711$\mu W/m^2$, the highest measured value was 22$\mu W/m^2$ (about 1000 times lower than the highest value in College veng). The average value of the measured power density was 11 $\mu W/m^2$ (about

1090 times lower than the average value in College veng), which is well below Bioinitive Report 2012 (0.5mW/m^2), Salzburg resolution 2000 (1mW/m^2), EU (STOA) 2001 (0.1mW/m^2), the current ICNIRP safe level (4700mW/m^2) and the current Indian Standard (450mW/m^2)[14].

3.3. Frequency spectrum:

Frequency spectrum of the mobile tower was taken at different places and shown in Figures 4 and 5. It has been observed that the peak frequency changes at different places over time. This change in peak may be due to time varying nature of the wave. Many frequency peaks are observed at each site with peak frequencies at around 936MHz and 942MHz. In the selected sites, other than RF radiation, the other electromagnetic signals present were of TV and radio, which lie outside the GSM 900 frequency range. Hence, it has been assumed that the peaks observed were of RF radiation only.

Figure 3: Frequency spectrum of GSM 900 taken in College veng

Figure 4: Frequency spectrum of GSM 900 taken in Lawipu

4. Conclusion:

It has been observed that almost all the measured values of power density in college veng are higher than the safety limit recommendation of Bioinitiative report 2012, Salzburg resolution 2000 and EU (2001), but well below the safety limit recommended by ICNIRP and the department of Telecommunications, Govt. of India. However, it has been observed that many inhabitants are still having complaints in college veng on non specific health symptoms mentioned before since the erection of the tower. It has also been observed that females are having more complaints than males. Complaints from inhabitants of Lawipu (where there is no mobile tower) are very less compared to that of college veng. We suggested deeper study of the effect of RF radiation on human body at molecular level.

Acknowledgement:

The authors greatfully acknowledged Mr. Lalrindika and Mr. F.Vanlalhlimpuia of Zoram Educational Trust (Z.E.T) for preparing necessary figures and graphs. The authors also acknowledge ZET for providing necessary grant through minor research project.

References:

[1] J.F Viel, S.Clerc, C.Barrera, R.Rymzhanova, M.Moissonnier, M.Hours & E.Cardis, Residential exposure to radio frequency fields from mobile phone base stations, and broadcast transmitters: A population-based survey with personal meter, Occup Environ Med (UK), 66 (2009) pp 550-556.
[2] A.M Martinez-Gonzalez, A.Fernandez-Pascual, E.de los Reyes , W.Van Loock , C.Gabriel & D.Sanchez Hernandez, Practical procedure for verification of compliance of digital mobile radio base stations to limitations of exposure of the general public to electromagnetic fields, IEE Proc Microw, Antennas Propag (UK), 149 (2002) pp 218-228.
[3] A.Ahlbom, Adele Green, Leeka Kheifets, David Savitz & Anthony Swerdlow, Epidemiology of health effects of radiofrequency exposure, Environ Health Perspect (USA), 112 (17) (2004) pp 1741-1754.
[4] US Food and Drug Administration (FDA), Radiation emitting products - Reducing exposure: Hands-free kits and other accessories, 2009, http://www.fda.gov/RadiationEmittingProducts/RadiationEmittingProductsandprocedures/HomeBusinessandEntertainment/CellPhones/ucm116338.htm.
[5] D.Volkow Nora, Tomasi Dardo, Wang Gene-Jack, Vaska Paul, S.Fowler Joanna, Telang Frank, Alexoff Dave, Logan Jean & Wong Christopher, Effects of cell phone radiofrequency signal exposure on bain glucose metabolism, J Am Med Assoc (USA), 305 (8) (2011) pp 808-813.
[6] World Health Organisation (WHO) Media Centre, Electromagnetic fields and public health: Mobile phones, 2011, http://www.who.int/mediacentre/factsheets/fs193/en/index.html.
[7] S.E Chia, H.P Chia & J.S Tan, Prevalence of headache among handheld cellular telephone users in Singapore: A community study, Environ Health Perspect (USA), 108 (11) (2000) pp 1059-1062.
[8] G.Oftedal, G.Wilen, M.Sandstrom & Mild K H, Symptoms experienced in connection with mobile phone use, Occup Med (UK), 50 (4) (2000) pp 237-245.
[9] International Agency for Research on Cancer, IARC Classifies Radiofrequency Electromagnetic Fields as Possibly Carcinogenic to Humans, Press release No 208, Lyon, France, 31 May 2011, www.iarc.fr/en/media centre/pr/2011/pdfs/pr208_E.pdf.
[10] R.Santini, P.Santini, P.Santini, J.M Danze & P.Le Ruz, Study of the health of people living in the vicinity of mobile phone base stations I: Influences of distance and sex, Pathol Biol (France), 50 (2002) pp 369-373.
[11] Muoaaz Nahas & Mohammed T Simsim, Safety Measurements of electromagnetic fields radiated form mobile base stations in the Western region of Saudi Arabia, Wireless Eng Technol (USA), 2 (2011) pp 221-229.
[12] Sage Cindy & Carpenter David O, Key scientific evidence and public health recommendations, Bioinitiative 2012: A Rationale for Biologically-based Public Exposure Standards for Electromagnetic Radiation, edited by Cindy Sage and David O. Carpenter (Bioinitiative Working Group, USA), 2012, 1424.
[13] Haumann Thomas, Munzenberg Uwe et al, HF radiation levels of GSM cellular phone towers in residential areas, hbelc.org/pdf/memdocs/cellularphoneradiation.pdf.
[14] Department of Telecommunications, Govt of India, Advisory Guidelines for State Governments for Issue of clearance for installation of Mobile Towers, 2013, http://www.dot.gov.in/ac