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Health Effects of High And Low Power Densities of Mobile Phone Tower Radiation On Nearby Inhabitants – Case Study

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Abstract : - In the present paper, we presented the study of complaints on thirteen (13) different health symptoms faced by inhabitants living near mobile tower – Global System for Mobile Communication (GSM 900) and those inhabitants living in the area where there is no mobile tower. The study was conducted in two different localities in Aizawl city in the year 2014. 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. Health complaints between the two localities were compared. It was found that power density is much higher in the area where there is mobile tower than the area where there is no mobile tower. Inhabitants living near mobile tower are having more health complaints than those inhabitants living in the area where there is no mobile tower. Responses from inhabitants who participated in the questionnaires from both the localities were statistically analysed and compared by performing Kruskal Walli's t-test. Out of the thirteen (13) different symptoms studied it was found that the comparisons are statistically significant with $p < 0.05$ in four (4) symptoms. Women were statistically more affected ($p < 0.05$) than male in headache and muscle pain.

Keywords*: - frequency spectrum, mobile tower radiation, power density, RF radiation.*

I. INTRODUCTION

Cellular wireless telephones have become ubiquitous. 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],[2],[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. Health concerns can be divided into two main categories : short term and long term effects. The short term effect includes brain electrical activity, cognitive function, sleep, heart rate and blood pressure[6]. However, the long term effects includes tinnitus, headache, dizziness, fatigue, sensations of warmth, dysesthesia of the scalp, visual symptoms, memory loss and sleep disturbance, muscle problem and epidemicological effects including cancer and brain tumours[7],[8].

In May 2011, International Agency for Research on Cancer (IARC) has classified RF field 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].

II. MATERIALS AND METHODS

The mobile base station in Maubawk was erected in 2007 in Aizawl, Mizoram, India. The present study was carried out in 2014, i.e. the inhabitants had been exposed to RF radiation for a period of seven (7) years. Whereas in Lawipu, there is no mobile tower ever.

2.1 Questionnaire

To study the health hazards and problems faced by the inhabitants living close to the base station (all living within 100m), questionnaire surveys were conducted on 13 different symptoms at two different localities in Aizawl city. The questionnaire was similar to that developed for the study on mobile phone users by Santini et al [10]. The surveys were conducted in two different localities – Maubawk and Lawipu where the inhabitants had been exposed and not exposed respectively. In Maubawk a tower is installed on a roof top in 2007, 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 100m from the tower are considered in Maubawk (as another tower comes within 100 m if we go farther). 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 (Pd). 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

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

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]

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

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

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

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 both the localities. No mobile phone was turned on in the vicinity while taking readings. Background radiation was measured to be -60 dBm in Maubawk, - 78dBm 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.

III. RESULTS AND DISCUSSIONS

3.1 Analysis of questionnaire

Analysis of the questionnaire from all the participants is given in Table I. Scale numbers 2 and 3 are given more considerations. From the table it has been observed that health complaints are very few in Lawipu in comparison to that of Maubawk. It has been observed that those living within 100 m from the base station in Maubawk are having more health complaints than those in Lawipu who are exposed to very weak RF Radiation. In table II, comparisons of health complaints between male and female in Maubawk are given. In figs. 1 & 2 comparisons between health complaints of inhabitants of Lawipu and Maubawk are given (for all the males and females participated in the questionnaire). From each locality fifty (50) individuals each were participated. In Maubawk, 24 males and 26 females, and in Lawipu the same number 24 males and 26 females participated in the questionnaire.

The detail analysis of comparison of questionnaires between Maubawk and Lawipu is given in table III. For the analysis Kruskal-Walli's t-test is used. It has been observed that the health complaints are significant ($p < 0.05$, where p is significant level) in different four (4) health symptoms – Sleep disruption, Headache, Cramp and Muscle pain out of the studied thirteen (13) symptoms. Out of the three (3) significant symptoms, two (2) of them – Sleep disruption and cramp are significant ($p < 0.05$) only on scale 2 and 3 respectively. Headache and Muscle pain each are significant on both scales 2 and 3. The significance shows that the inhabitants living in the

area where mobile tower is located are having more chance of developing those health problems than the inhabitants living in the area where there is no mobile tower.

In eight (8) different health symptoms – Fatigue, Nausea, Sleep disruption, feeling of discomfort, memory loss, visual disruption, hearing problem and dizziness no comparison were done as the response was zero (0) in scale 2 or 3 in Lawipu from each of these symptoms.

Due to high significant variations of health complaints in Maubawk comparison between health complaints of male and female has been done (table II). Statistical analysis of the comparison is given in table IV. It has been found that in Headache and Muscle pain the comparisons are significant on both scales 2 and 3. Females are having more complaints than male. The same trend was also observed by R.Santini [10] and Lalrinthara Pachuau and Zaithanzauva Pachuau [15].

Table I . Comparison of health complaints (on scales 2 and 3) between inhabitants in Lawipu and Maubawk for all those who participated in Questionnaire.
Reference : 0 = never, 1= sometimes, 2 = often, 3 = very often.

Sl. No.	Symptom	2		3	
		Lawipu	Maubawk	Lawipu	Maubawk
1.	Fatigue	1	5	0	4
2.	Nausea	2	4	0	5
3.	Sleep disruption	2	8	0	5
4.	Feeling of	0	5	0	4
5.	Headache	3	8	1	7
6.	Cramp	2	5	1	6
7.	Difficulty in	1	4	1	2
8.	Memory loss	2	4	0	3
9.	Skin problem	2	4	1	3
10.	Visual disruption	1	3	0	3
11.	Hearing problem	3	5	0	2
12.	Dizziness	1	5	0	4
13.	Muscle pain	3	11	2	12

Table II. Comparison of health complaints (on scales 2 and 3) between Male (M) and Female (F) inhabitants in Maubawk. **Reference :** 0 = never, 1= sometimes, 2 = often, 3 = very often

Sl. No.	symptoms	2		3	
		M	F	M	F
1.	Fatigue	2	3	2	2
2.	Nausea	2	2	2	3
3.	Sleep disruption	3	5	2	3
4.	Feeling of discomfort	2	3	2	2
5.	Headache	1	7	1	6
6.	Cramp	2	3	2	4
7.	Difficulty in concentration	2	2	1	1
8.	Memory loss	2	2	3	0
9.	Skin problem	2	2	1	2
10.	Visual disruption	1	2	2	1
11.	Hearing problem	3	2	1	1
12.	Dizziness	2	3	1	3
13.	Muscle pain	2	9	3	9

Fig. 1 : Comparison of complaints between Lawipu and Maubawk for the scale of 2 (all the figures are in percentage).

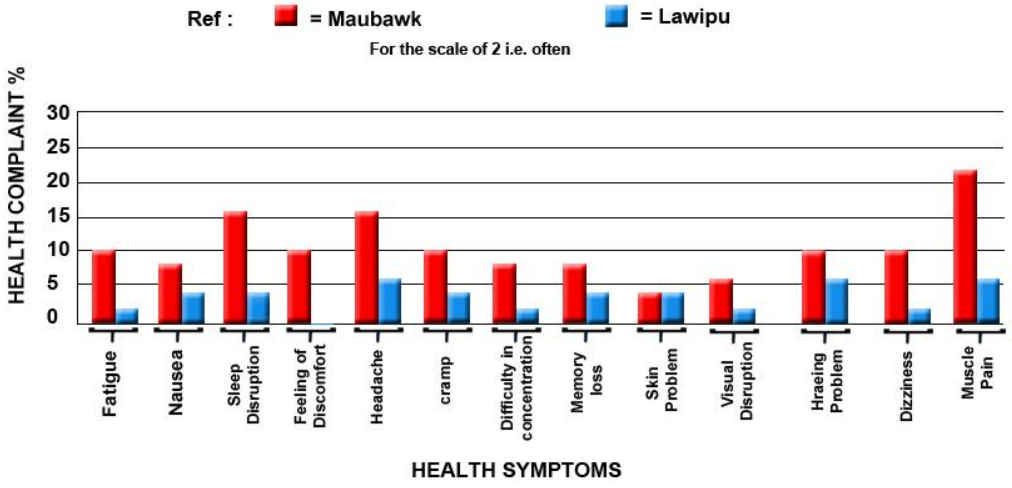
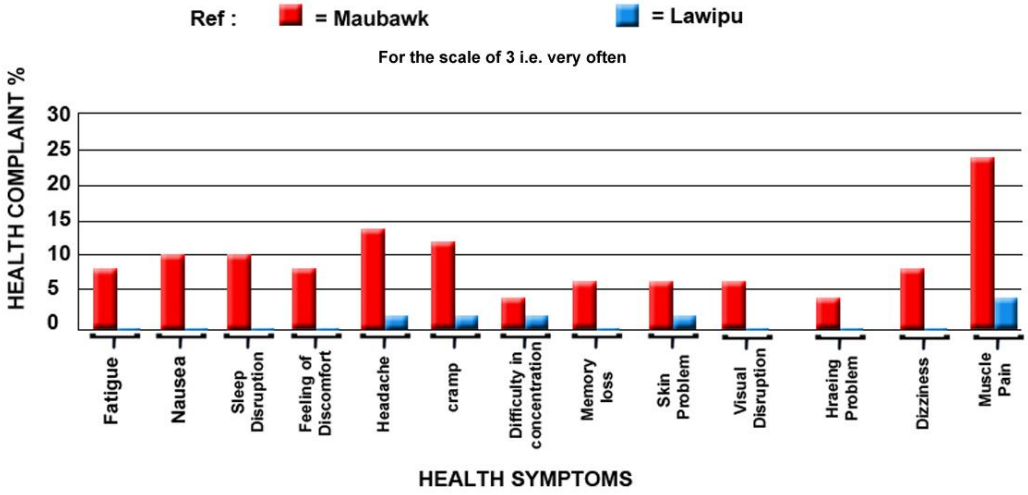


Fig. 2 : Comparison of complaints between Lawipu and Maubawk for the scale of 3 (all the figures are in percentage).



3.2. Power density measurement

Power density of the mobile phone tower radiation from the selected tower was measured at twelve (12) different randomly selected sites in Maubawk (within 100 m from the tower). The lowest measured value was 133μW/m^2, highest measured value was 133.60 mW/m^2. The average value of the measured power density was 10.45 mW/m^2. Most of the measured values are higher than that of the safety 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 was no mobile tower, power density was measured in twelve (12) different places selected randomly. The lowest measured value was 0.711μW/m^2, the highest measured value was 22μW/m^2 (which is 6072 times lower than the corresponding value in Maubawk). The average value of the measured power density was 11 μW/m^2 (which is 950 times lower than the corresponding value in Maubawk), 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).

Table III. Determination of significance level of the comparisons between health complaints of inhabitants of Lawipu and Maubawk on scales 2 and 3 using Kruskal-Walli's t-test.
Ref : NS = Not Significant, NC = No comparison, S = Significant

Sl.	Symptom	Scale	t value	df	p	Remark
1.	Fatigue	2	-2.058	18	0.054	NS
		3				NC
2.	Nausea	2	-0.949	18	0.355	NS
		3				NC
3.	Sleep disruption*	2	-3.182	18	0.005	S
		3				NC
4.	Discomfort	2				NC
		3				NC
5.	Headache*	2	-2.466	18	0.024	S
		3	-3.286	18	0.004	S
6.	Cramp*	2	-1.406	18	0.177	NS
		3	-2.611	18	0.018	S
7.	Difficulty in concentration	2	-1.567	18	0.135	NS
		3	-0.600	18	0.556	NS
8.	Memory loss	2	-0.949	18	0.355	NS
		3				NC
9.	Skin problem	2	-0.949	18	0.355	NS
		3	-1.095	18	0.288	NS
10.	Visual disruption	2	-1.095	18	0.288	NS
		3				NC
11.	Hearing problem	2	-0.885	18	0.388	NS
		3				NC
12.	Dizziness	2	-2.058	18	0.054	NS
		3				NC
13.	Muscle pain*	2	-2.869	18	0.010	S
		3	-3.536	18	0.002	S

Table IV. Determination of significance level of the comparisons between health complaints of Male and Female inhabitants in Maubawk on scales 2 and 3 using Kruskal-Walli's t-test.
Ref : NS = Not Significant, NC = No comparison, S = Significant

Sl.	Symptom	Scale	t value	df	p	Remark
1.	Fatigue	2	-0.493	18	0.628	NS
		3				NC
2.	Nausea	2				
		3	-0.493	18	0.628	NS
3.	Sleep disruption	2	-0.885	18	0.388	NS
		3	-0.493	18	0.628	NS
4.	Discomfort	2	-0.493	18	0.628	NS
		3				
5.	Headache*	2	-3.286	18	0.004	S
		3	-2.611	18	0.018	S
6.	Cramp	2	-0.493	18	0.628	NS
		3	-0.949	18	0.355	NS
7.	Difficulty in concentration	2				NC
		3				NC
8.	Memory loss	2				NC
		3				NC
9.	Skin problem	2				NC
		3	-0.600	18	0.556	NS
10.	Visual disruption	2	-0.600	18	0.556	NS
		3	0.600	18	0.556	NS
11.	Hearing problem	2	0.493	18	0.628	NS
		3				NC
12.	Dizziness	2	-0.493	18	0.628	NS
		3	-1.095	18	0.288	NS
13.	Muscle pain*	2	-2.605	18	0.018	S
		3	-2.151	18	0.045	S

3.3 Frequency spectrum

Frequency spectrum of the mobile tower was taken at both the localities and shown in figs. 3 and 4. Many frequency peaks are observed at each site with peak frequencies at around 945MHz and 950MHz. 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.

Fig. 3 : Frequency spectrum taken in Lawipu

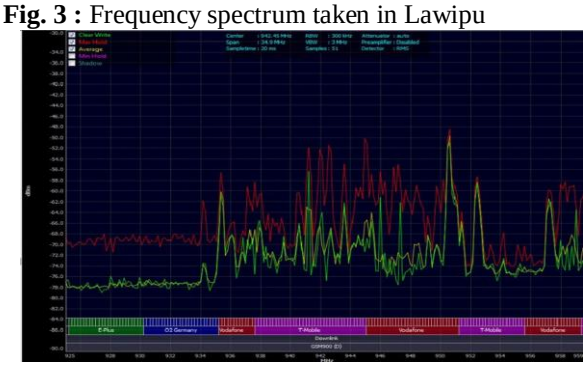


Fig. 4 : Frequency spectrum taken in Maubawk

IV. CONCLUSION

It has been observed that in Maubawk the measured average value of power density is higher than that of the safety limit recommendations of Bioinitiative 2012, Salzburg resolution 2000, EU (STOA) 2001; but well below the safety limit recommendations of ICNIRP and the Department of Telecommunications, Govt. of India. However it has been found that many inhabitants are still having health complaints on different symptoms after the tower had been erected in 2007. The most common health complaint is muscle pain. The same trend was also observed by R.Santini[10], Lalrinthara Pachuau & Zaithanzauva Pachuau[15]. In Lawipu, power density is very low, the inhabitants are having very few health complaints. Whereas in Maubawk, power density is much higher, health complaints are much more compared to those of Lawipu. As it is observed, muscle pain is significant both in scales 2 and 3, the authors suggested that the effect of RF radiation on muscle be more studied. We conclude that inhabitants exposed to high power densities are having more chance of developing the studied health symptoms; hence mobile tower should not be located in populated area.

REFERENCES

[1]. JF Viel, S Clerc, C Barrera, R Rymzhanova, M Moissonnier, M Hours, E Cardis, Residential exposure to Radiofrequency Fields from Mobile Phone Base stations, and Broadcast Transmitters: A population-Based Survey with Personal Meter, Occup Environ Med *66* (2009) 550-556.

[2]. AM Martinez-Gonzalez, A Fernandez-Pascual, Practical Procedure for Verification of Compliance of Digital Mobile Radio Base Stations to Limitations of Exposure of the General Public to Electromagnetic Fields, IEEE Proceedings on Microwaves, Antennas and Propagation (USA) 149 (2002) 218-228.

[3]. A Ahlbom, A Green, et al, Epidemiology of Health Effects of Radiofrequency Exposure, Environmental Health Perspectives 112(17), (2004), 1741-1754.

[4]. U.S Food and Drug Administration (FDA), Radiation emitting Products: Reducing Exposure : Hands-Free Kits and Other Accessories, 2009.http://www.fda.gov/Radiation-Emitting Products/Radiation Emitting Productsand procedures/ Home Businessand Entertainment/ CellPhones/ucm116338.htm

[5]. Nora D. Volkow, Dardo Tomasi, Gene-Jack Wang, Paul Vaska, Joanna S. Fowler, Frank Telang, Dave Alexoff, Jean Logan and Christopher Wong, Effects of Cell Phone Radiofrequency Signal Exposure on Brain Glucose Metabolism, Journal of American Medical Association, 305(8), 2011, 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/

[7]. Chia SE, Chia H.P, Tan J.S, Prevalence of Headache Among Handheld Cellular Telephone Users in Singapore : A community Study, Environmental Health Perspectives 108(11), 2000, 1059-1062.

[8]. [Oftedal G, Wilen G, Sandstrom M, Mild K.H, Symptoms experienced in Connection with Mobile Phone use, Occupational Medicine, 50(4), 2000, 237-245.

[9]. International Agency for Research on Cancer, Press release N^{o} 208, Lyon, France, 31st May 2011. www.iarc.fr/en/media-centre/pr/2011/pdfs/pr208_E.pdf

[10]. R 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 50, 2002, 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 Engineering Technology, 2, 2011, 221-229.

[12]. Cindy Sage, David O. Carpenter, Key Scientific Evidence and Public Health Recommendations, in Cindy Sage and David O. Carpenter (Ed) Bioinitiative 2012 : A Rationale for Biologically-based Public Exposure Standards for Electromagnetic Radiation, edited by (Bioinitiative Working Group, 2012), 1424. www.bioinitiative.org

[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/access-services/journey-emf

[15]. Lalrinthara Pachuau, Zaithanzauva Pachuau, Study of Cell Tower Radiation and its Health Hazards on Human Body, IOSR-JAP, vol.6, 2014, pp 1-6.