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Comparison of Non Specific Health Symptoms Faced by Inhabitants Exposed to High And Low Power Densities from Mobile Tower–Case Study

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Abstract—*In the present paper, we presented the study of complaints on thirteen (13) different non specific health symptoms faced by inhabitants living near and far from mobile tower – Global System for Mobile communication (GSM 900 and GSM 1800) in twelve different localities/villages in Mizoram within Aizawl city (where power densities were relatively high) and Serchhip district. The study was conducted in the year 2014 - 2016. For the study, questionnaire surveys were conducted in all the localities which included 600 participants. Power densities were measured in different places in all the localities. Health complaints were compared between that of one locality in Aizawl city called Lawipu where power density was very low with that of Aizawl city and Serchhip district. Significance of the comparisons were tested with t – sample test from SPSS software version 16.0. It was observed that power densities were very low compared to that of the current Indian standard and International Commission on Non Ionizing Radiation Protection (ICNIRP). There were large differences in power densities between that of Aizawl city and Serchhip district. Power densities were much higher in Aizawl city than that of Serchhip district. It was found that inhabitants living in Aizawl city were having more significant health complaints than those inhabitants in Serchhip district. Out of the thirteen (13) different symptoms studied it was found that the comparisons were statistically significant with $p < 0.05$ in six (6) symptoms. There was positive correlation between power density and significant health complaints in Aizawl city whereas no such correlation was observed in Serchhip district. What we concluded is that more is power density, more is health complaint.*

1. INTRODUCTION

The introduction in the 1990s of mobile phone using the digital Global System for Mobile Communication (GSM) bandwidths 900 and 1800 megahertz (MHz) and the subsequent introduction of the Universal Mobile Telecommunications System (UMTS) have led to widespread use of this technology. This development has raised public concerns and substantial controversy about the potential health effects of the radiofrequency electromagnetic field emissions of this technology [1]. 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 [2]. A small portion of the population attributes non specific symptoms of ill health, such as sleep disturbance, headache, fatigue etc. [3] to exposure to electromagnetic fields. This phenomenon is described as electromagnetic hypersensitivity or 'idiopathic environmental intolerance with attribution to electromagnetic fields [4]. Additionally, individuals who are hypersensitive to electromagnetic fields often claim to be able to perceive radiofrequency electromagnetic fields in their daily life [5]. With the significant increase in mobile phone usage, possible health risks related to RF exposure have become the subject of considerable attention [6].

People are generally exposed to mobile tower radiation under far-fields conditions, i.e. radiation from a source located at distance more than one wavelength. Mobile tower radiation exposure can occur continuously but the levels are considerably lower than the local maximum level that occur when someone uses a mobile phone handset [7].

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 [8]. 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 [6]. 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 [9]. 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 [10].

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 [11].

When electromagneti wave is incident on dielectric media such as human, it propagates to to the media through a small distance known as skin depth which is given by [12]

$$\delta = \left(\frac{1}{\omega}\right)\left\{\left(\frac{\mu\varepsilon}{2}\right)\left[\left(1+\left(\frac{\sigma}{\varepsilon\omega}\right)^2\right)^{1/2}\right]\right\}^{1/2}$$

where δ is skin depth, ω is frequency of the radiation, μ is permeability of the medium, ε is per mitivity of the medium and σ is electrical conductivity of the medium.

Propagation of electromagnetic waves in materials such as dielectrics and conductors is determined by their electrical parameters. In the case of dielectrics, the parameters of greatest interest are the conductivity, σ, and the permittivity, ε, since these govern the dielectric attenuation.

When electromagnetic wave incidents on dielectric, Debye relaxation occurs. Relaxation occurs when the free energy stored in the system is degraded into heat, in other words, if entropy is created irreversibly. The irreversibility is related to the fact that the free energy of the field is used to increase the total amount of heat stored in the dielectric plus the heat reservoir surrounding it. The degradation of nergy stored into heat is suspected to be responsible for the health prblems faced by individuals in the long run.

In frequency domain, Debye relaxation equation can be presented as [13]

$$\varepsilon_r = \varepsilon_\infty + \frac{\varepsilon_s - \varepsilon_\infty}{1 + j\omega\tau}$$

where ε_r = complex relative permittivity, ε_∞ = relative permittivity at infinite frequencies, ε_∞ = static relative permittivity, τ is the time constant.

2. MATERIAL AND METHODS

2.1 Power Density measurement

The amount of energy passing through unit area per unit time is called Power density (P). 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 surface area increases by the square of the radius, therefore power density decreases by the square of the radius.

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 of transmitter, we have [14]

$$P = \frac{nP_tG}{4\pi R^2}$$

Power density measurement was carried out at

different places in each locality using Spectran HF-60105V4, manufactured by Aaronia, Germany. Power density and questionnaire response from one locality called Lawipu was taken as reference for comparison with that of others. The main purpose of the measurement was to find whether there is correlation between the health complaints and the measured power densities.

2.2 Questionairre Survey

To study the health hazards and problems faced by the inhabitants living close to the base station, questionnaire survey was conducted on 13 different symptoms in different localities of Aizawl. The questionnaire was similar to that developed for the study on mobile phone users by Santini et al. [15]. One of the localities where the survey was done was called Lawipu which is situated in the outskirt of Aizawl. In Lawipu there was no mobile phone tower. Hence, the questionnaire responses from Lawipu was used as the reference for comparing with all other localities as the power density was so low compared to different international standards. The level of complaints for the studied symptoms was expressed by using a scale of : 0 = never, 1= sometimes, 2 = often, 3 = very often.

3. RESULTS AND DISCUSSIONS

3.1 Power Density measurements

Power density of RF radiation from mobile towers were measured at different places randomly in each locality. The measured average values of each locality was compared with that of Lawipu and different standards like ICNIRP, Indian standard, Bioinitiative report 2012 and Salzburg resolution 2000. Many of the measured values were higher than that of the safe limits recommended by Bioinitive Report 2012 (0.5mW/m^2) [16], Salzburg resolution 2000 (1mW/m^2) [17], EU (STOA) 2001 (0.1mW/m^2) [17]. However, all the measured values were well below the current ICNIRP safe level (4700mW/m^2) [17] and the current Indian Standard (450mW/m^2) [18].

Table 1: Summary of power density measurements from all the localities and villages

Locality	No. of measure ments	Average power density (mW/m^2)		Average power density of GSM 900 & 1800	wrt Lawipu GSM 900	% wrt ICNIRP GSM 900	% wrt Indian standard GSM 900	% wrt Bioinitiative 2012 GSM 900	% wrt Salzburg resolution GSM 900
		GSM-900	GSM-1800						
Aizawl District									
Lawipu	11	0.0088	0.0754	0.042	1	0.00018	0.0019	1.76	0.88
Tanhril	12	1.980	5.480	3.73	222	0.042	0.44	396	198
Maubawk	12	10.50	7.35	8.92	1193	0.2234	2.333	2100	1050
Luangmual	12	0.220	22.33	11.27	25	0.0044	0.0488	44	22
Chawlhhmun	12	1.160	1.930	1.54	131	0.0246	0.2578	232	116
Kulikawn VT	12	2.63	1.790	2.21	284	0.0559	0.584	526	263
Serchhip District									
Baktawng	12	0.707	0.638	0.672	80.3	0.015	0.157	141	70.7
Chhiahtlang	12	0.126	0.257	0.191	14.3	0.003	0.028	25.2	12.6
New Serchhip	12	0.905	2.34	1.622	102.8	0.019	0.201	181	90.5
Serchhip Veng	12	0.048	1.05	0.549	5.45	0.001	0.011	9.6	4.8
E.Lungdar	12	0.955	3.88	2.417	108.5	0.02	0.212	191	95.5
N.Vanlaiphai	12	0.171	0.017	0.094	19.4	0.004	0.038	34.2	17.1

In Lawipu, where there are no mobile tower, the average value of power density of GSM 900 and GSM

1800 was 0.042 mW/m^2 which was well below Bioinitive Report 2012, Salzburg resolution 2000, EU (STOA) 2001, the ICNIRP safe level and the current Indian Standard. Measurements of power density in different localities are given in table 1.

3.2 Questionairre analysis

Analysis of the questionnaire from all the participants is given in Table 2. T-test analysis was performed for the comparison of health complaints. Scale numbers 2 and 3 are given more considerations as they are positive responses. The table shows comparison of questionnaire responses between that of Lawipu inhabitants and of inhabitants of other localities. Those inhabitants living near base stations in other localities are having more health complaints than those in Lawipu who are exposed to very weak RF Radiation. From each locality fifty (50) individuals participated, 24 males and 26 females, and in Lawipu the same number participated in the questionairre.

When questionnaire analysis were done with t-test it has been observed that the health complaints are significant ($p < 0.05$, where p is significant level) in six (6) different health symptoms in at least one of the scales 2 or 3 or both (Table 2). Muscle pain is the most common complaint, it is significant on both scales 2 and 3 in three (3) different localities out of the 11 different localities which were compared with Lawipu. All the localities where significant health complaints were found were only in Aizawl city where mobile towers had been erected for at least the last five years.

Outside Aizawl city, significant health complaint was not found when compared to Lawipu locality. In fact, power density outside Aizawl city were very low. Out of the eleven localities compared with Lawipu, significant health complaints were found in four (4) localities, all of them were in Aizawl city where power densities were relatively high. In Serchhip district, no significant health complaints were found when compared to Lawipu.

Table 2 : Statistical comparison of reponses from Lawipu versus other localities. * = significant health complaints.

Sl No.	Symptoms	1		2		3		4		5		6		7		8		9		10		11		12		13	
		Fatigue		**Nausea**		**Sleep disruption**		**Feeling of discomfort**		**Headache**		**Cramp**		**Difficulty in concentration**		**Memory loss**		**Skin problem**		**Visual disruption**		**Hearing problem**		**Dizziness**		**Muscle pain**	
	Scale	2	3	2	3	2	3	2	3	2	3	2	3	2	3	2	3	2	3	2	3	2	3	2	3	2	3
	Aizawl District																										
1	Lawipu																										

2	Tanhril	*								*												*		*	*
3	Maubawk					*				*	*		*												*	*
4	Luangmual					*					*															*
5	Chawlhhmun																									
6	Kulikawn VT																								*	*
	Serchhip District																									
7	Baktawng																									
8	Chhiahtlang																									
9	New Serchhip																									
10	Serchhip BV Veng																									
11	E.Lungdar																									
12	N.Vanlaiphai																									

Table 3: Summary for significant health complaints versus power density

Sl. No.	Locality	Average Power Density (mW/m^2)		Mean value of average power density of GSM 900 & GSM 1800	Health complaints significant in			Total no. of significant Health complaints
		GSM 900	GSM 1800		Scale 2 only	Scale 3 only	Both the scales 2 & 3	
Aizawl District								
1.	Lawipu	0.0088	0.0754	0.042	-	-	-	-
2.	Tanhril	1.980	5.480	3.73	Fatigue, Dizziness	Headache	Muscle pain	4
3.	Maubawk	10.50	7.35	8.92	Sleep disruption	Cramp	Headache, Muscle pain	4
4.	Luangmual	0.220	22.33	11.27	Sleep disruption	Headache, Muscle pain	-	3
5.	Chawlhhmun	1.160	1.930	1.54	-	-	-	-
6.	Kulikawn vengthlang	2.63	1.790	2.21	-	-	Muscle pain	1
Serchhip District								
7.	Baktawng	0.707	0.638	0.672	-	-	-	-
8.	Chhiahtlang	0.126	0.257	0.191	-	-	-	-
9.	New Serchhip	0.905	2.34	1.622	-	-	-	-
10.	Serchhip BV	0.048	1.05	0.549	-	-	-	-
11.	E.Lungdar	0.955	3.88	2.417	-	-	-	-
12.	N.Vanlaiphai	0.171	0.017	0.094	-	-	-	-

4. CONCLUSION

It has been observed that all the measured values of power density in all the localities were lower than the safety limit recommendation of ICNIRP and the department of Telecommunications, Govt. of India. However, in five (5) different localities in Aizawl city and two (2) localities in Serchhip district the average values of the measured power densities were higher than the recommendations of Bioinitiative report 2012, Salzburg resolution 2000 and EU (2001). Although the measured power densities were very low compares to the recommendations of ICNIRP and the current Indian standard, it has been observed that many inhabitants were still having complaints on the non specific health symptoms since the erection of the tower.

The most common complaint was muscle pain. However, there are many other factors which could have contributed to the health complaints other than RF/MW radiation. It is not wise to conclude that all the observed health complaints were due to the radiation alone. However, it has been observed that more is power density, more is health complaints. The lowest value of power density where sihnificant health complaint was

observed was 2.21 mW/m^2 which is comparable to that recommended by Bioinitiative 2012 and Salzburg resolution 2000.

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