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Comparisons of Non specific Health Symptoms Faced by Inhabitants Exposed to High and Low Power Density from Mobile Phone Tower Radiation

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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 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 questionnaire 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 six (6) symptoms. Women were statistically more affected ($p < 0.05$) than male in muscle pain.

Keywords - frequency spectrum, health complaints, mobile tower radiation, power density, RF radiation.

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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. 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].

II. MATERIALS AND METHODS

The mobile base station in Ramhlun 'N' was erected in 2006 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 eight (8) years. Whereas in Lawipu, there is no mobile tower ever.

A. 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. 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 – Ramhlun 'N' and Lawipu where the inhabitants had been exposed and not exposed respectively. In Ramhlun 'N' a tower is installed on a roof top in 2006, 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 Ramhlun 'N' (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

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studied symptoms was expressed by using a scale of : 0 = never, 1 = sometimes, 2 = often, 3 = very often.

B. Power density measurement

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 -50 dBm in Ramhlun 'N', -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. The power density P_d of the RF energy is given by[11]:

$$P_d = \frac{nP_tG}{4\pi D^2}$$

where, n, is number of transmitters; P_t, maximum power from each transmitter; G, antenna gain (decibel); D, distance of the site from the transmitter. However, power density measurement was done with the instrument HF-60105V4, manufactured by Aaronia, Germany.

C. 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

A. 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 Ramhlun 'N'. It has been observed that those living within 100 m from the base station in Ramhlun 'N' 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 Ramhlun 'N' are given. In figs. 1 & 2 comparisons between health complaints of inhabitants of Lawipu and Ramhlun 'N' are given (for all the males and females participated in the questionnaire). From each locality fifty (50) individuals each were participated. In Ramhlun 'N', 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 Ramhlun 'N' and Lawipu is given in table 3. 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 six (6) health symptoms - Fatigue, Sleep disruption, Headache, Cramp, Dizziness and Muscle pain out of the studied thirteen (13) symptoms. Out of the six (6) significant symptoms, four (4) of them - Fatigue, Sleep disruption, Cramp, Dizziness are significant ($p < 0.05$) in one scale each - on scale 2 (Fatigue, Sleep disruption, Dizziness) or 3 (Cramp). Two health symptoms headache and muscle pain are significant in both the 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.

TABLE I. Comparison of health complaints (on scales 2 and 3) between inhabitants in Lawipu and Ramhlun 'N' for all those who participated in Questionnaire. Lawipu : Total = 50, Ramhlun 'N': Total = 50 (from those living within 100m from the mobile tower).

Reference : 0 = never, 1= sometimes, 2 = often, 3 = very often.

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

In nine different health symptoms – Fatigue, Nausea, Sleep disruption, Discomfort, Difficulty in concentration, Memory loss, Visual disruption, Dizziness, Hearing problem no comparison were done as the response was zero (0) in scale 2 or 3 in Lawipu. In feeling of discomfort, the response is zero from Lawipu in scale 2. From the other remaining eight (8) symptoms the responses are zero each from Lawipu in scale 3.

TABLE II : Comparison of health complaints (on scales 2 and 3) between male and female inhabitants of Ramhlun 'N'. Male (24), Female (26) (from those living within 100 m from the mobile tower).

Reference : 0 = never, 1= sometimes, 2 = often, 3 = very often.

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

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Due to high significant variations of health complaints in Ramhlun 'N' comparison between health complaints of male and female has been done (table II). Statistical analysis of the comparison is given in table 4. It has been found that only in muscle pain the comparison is significant which is in both scales 2 and 3. Females are having more complaints than male. The same trend was also observed by R.Santini [10].

B. Power density measurement

Power density of the mobile phone tower radiation from the selected tower was measured at thirteen (13) different selected sites in Ramhlun 'N'. The lowest measured value was 1.2mW/m^2, highest measured value was 109 mW/m^2. The average value of the measured power density was 14.67 mW/m^2. All 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 7430 times lower than the corresponding value in Ramhlun 'N'). The average value of the measured power density was 11 µW/m^2 (which is 1333 times lower than the corresponding value in Ramhlun 'N'), 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 questionnaires of Lawipu and Ramhlun 'N' on scales 2 and 3 using Kruskal Walli's t-test.

Ref : * or S = Significant NS = Not significant NC = No comparison

Symptom	Scale	t value	df	p value	Remark
Fatigue*	2	-2.151	18	0.045	S
	3				*NC*
Nausea	2	-1.897	18	0.074	*NS*
	3				*NC*
Sleep disruption*	2	-2.753	18	0.013	S
	3				*NC*
Discomfort	2				*NC*
	3				*NC*
Headache*	2	-2.151	18	0.045	S
	3	-3.130	18	0.006	S
Cramp*	2	-1.897	18	0.074	*NS*
	3	-2.611	18	0.018	S
Difficulty in concentration	2	-2.053	18	0.054	*NS*
	3	-0.600	18	0.600	*NS*
Memory loss	2	-0.949	18	0.355	*NS*
	3				*NC*
Skin problem	2	-1.406	18	0.177	*NS*
	3	-1.095	18	0.288	*NS*
Visual disruption	2	-1.567	18	0.135	*NS*
	3				*NC*
Hearing problem	2	-0.885	18	0.355	*NS*
	3				*NC*
Dizziness*	2	-2.611	18	0.018	S
	3				*NC*
Muscle pain*	2	-4.093	18	0.001	S
	3	-4.371	18	0.001	S

C. 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 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.

TABLE IV. Determination of significance level of the comparisons between questionnaires of Male and Female in Ramhlun N on scales 2 and 3 using Kruskal Walli's t-test.

Ref : * or S = Significant NS = Not significant NC = No comparison

Symptom	Scale	t value	df	p value	Remark
Fatigue	2	-0.447	18	0.660	NS
	3	-0.949	18	0.355	NS
Nausea	2	-0.949	18	0.355	NS
	3	-0.496	18	0.628	NS
Sleep disruption	2	-1.852	18	0.081	NS
	3				NC
Discomfort	2	-0.496	18	0.628	NS
	3	-0.496	18	0.628	NS
Headache	2	-1.342	18	0.196	NS
	3	-0.885	18	0.388	NS
Cramp	2				NC
	3				NC
Difficulty in concentration	2	0.493	18	0.628	NS
	3				NC
Memory loss	2				NC
	3	-0.600	18	0.556	NS
Skin problem	2	-0.493	18	0.628	NS
	3	-0.600	18	0.556	NS
Visual disruption	2	-1.095	18	0.288	NS
	3				NC
Hearing problem	2	-0.493	18	0.628	NS
	3	-0.600	18	0.556	NS
Dizziness	2	-0.949	18	0.355	NS
	3	-1.095	18	0.288	NS
Muscle pain*	2	-3.674	18	0.002	S
	3	-2.611	18	0.018	S

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IV. CONCLUSION

It has been observed that in Ramhlun 'N' 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 2006. 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 Ramhlun 'N', 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.

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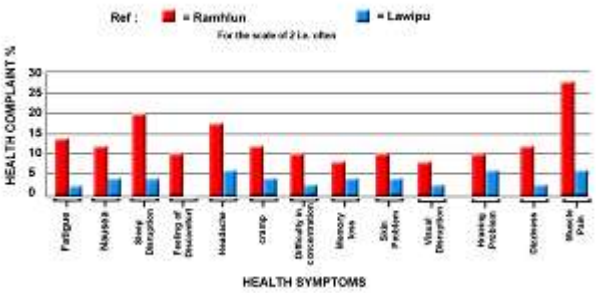

Fig. 1 : Comparison of complaints between Lawipu and ramhlun 'N' for the scale of 2 (all the figures are in percentage)

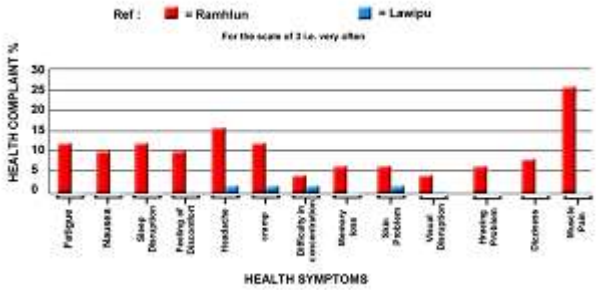

Fig. 2 : Comparison of complaints between Lawipu and ramhlun 'N' for the scale of 3 (all the figures are in percentage)

Fig. 3 : Frequency spectrum taken in Ramhlun 'N'

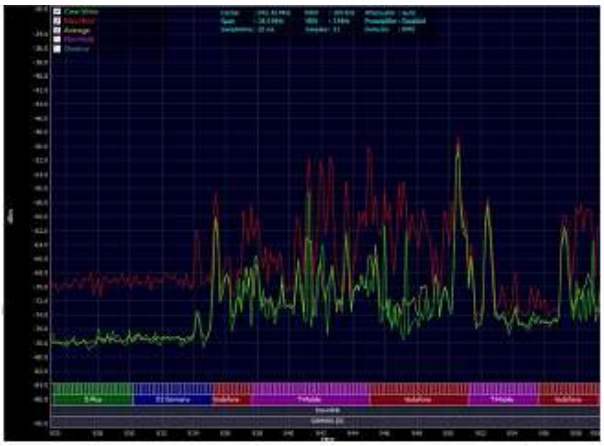

Fig. 4 : Frequency spectrum taken in Lawipu