



Environmental Science

An Indian Journal

Current Research Paper

ESAIJ, 10(4), 2015 [136-141]

The exposure effect of the signals of cell phones on the employees of Nablus and Jenin municipalities

I.R.Abdelraziq*, O.M.Abu Subha, Z.N.Qamhieh
Physics Dept. An-Najah National University, (NABLUS)

ABSTRACT

This study focuses on the effect of EMR emitted by cell phone towers on some of the dependent variables, such as tympanic temperature (T), blood oxygen saturation (SPO₂%), heart pulse rate (HPR), systolic blood pressure (SBP) and diastolic blood pressure (DBP).

The sample is 136 employees of both genders (56 female, 80 male), with mean age 40 Yrs., and the mean duration of employment 14 Yrs., were randomly chosen as a sample to reach the desired objective. This sample was taken from two municipalities in Nablus and Jenin cities. The values of power flux density were 52.58 $\mu\text{W}/\text{m}^2$ and 31.76 $\mu\text{W}/\text{m}^2$ in Nablus and Jenin municipalities respectively. The electric field and the magnetic field values were calculated from the measured power flux density, which were less than the standard levels for exposure to EMR of cell phone towers.

The measurements of tympanic temperature, blood oxygen saturation, heart pulse rate and arterial blood pressure of the selected employees were measured before and after exposure to signals of cell phone towers. This study shows that the health effects of signals of cell phone towers is remaining within the normal range and international standards.

The statistical results showed that Pearson correlation coefficient (R) between power flux density and the dependent variables are varying from 0.294 to 0.657, and the probabilities (P) are < 0.05 for all health factors.

© 2015 Trade Science Inc. - INDIA

INTRODUCTION

The last three decades have witnessed a rapid growth in various areas of technology has been noticed especially in wireless communications, which had a large role in facilitating human life. The most important aspect of this development is the evolution of cellular networks, which are designed to service cell phones. Almost everyone has a mobile phone nowadays. The need for the use of mobile phones increases daily with population growth, this led to increase towers mobiles on the roofs of buildings. The proliferation of use has not been tempered with health concerns, rather on the

technical development in this area.

The International Agency for Research on Cancer (IARC), the World Health Organization (WHO), and Occupational Safety and Health Administration (OSHA) classified the cell phone radiations as a potential cause of cancer for humans^[1].

The lack of information about the exposure effect of the signals of cell phones in Palestine is the main motivation for this study. The power flux density was measured, to find out its impact on some of the variables of the humans.

Previous studies

The spread of concerns between the people from

the effects of mobile radiation on human health this motivation for researchers in several countries to discuss the potential effects of exposure to radiation from cell phones and their towers.

Several studies have shown a clear relationship between different kinds of the cancer and mobile phone use. These studies have shown an increase in the risk of glioma and acoustic neuromas with the use of mobile phones, also increases the risk of malignant brain tumors^[2]. Adilza found that the people who live near 500m from the cell phone towers are at risk of neoplasia cancer^[3].

Nervous system studies have shown that the people who live near towers have suffered from migraine headaches, feeling tired, sleep disturbance, irritability, depression, memory loss, dizziness, loss of libido, and Alzheimer's disease^[4].

A study showed a clear increase in the temperature of the head influenced radiation 250 milliwatts (mW) and 900 MHz frequency, so the temperature in skin was increased 1.6°C^[5]. Another study found a significant increase in the percentage of calcium ions^[6].

The effects of the signals of cell phone on the circulatory system show that red blood cells (RBC) and white blood cells (WBC) are broken after exposed phone's signals^[7]. Another study showed that was an increase in WBC, but it was a decrease in RBC^[8]. Infants and newborns were suffered from increase in heart pulse rate (HPR) and reduction in brain volume^[9].

Aruna showed that mobile phone serving global system for mobile (GSM) has the largest effect on brain compared to mobile phone serving code division multiple accesses (CDMA)^[10]. Ala'a Aldine in his research found that the sources of radiation pollution in the West Bank, including FM radio, TV broadcasting and cell phone base stations. FM radio contributes the largest part of the dose that the personnel are exposed to in the West Bank^[11].

Al-Faqeeh studied the effect of the EMR from high voltage transformers on student's health in Hebron district. She found that the measured values of power flux density were within slight concern limit. In addition, there was increasing in tympanic temperature, heart pulse rate, arterial blood pressure, on the other hand the blood oxygen saturation was decreased^[12].

Theoretical

Electromagnetic field (EMF) of the electric field and the magnetic field; it is a physical output of electrically charged objects. EMF spreads around the source in all directions, extends to infinity. The electric field strength (\vec{E}) and the magnetic field strength (\vec{H}) are related by the Poynting vector (\vec{P})^[13]:

$$\vec{P} = \vec{E} \times \vec{H}$$

The Poynting vector is called power flux density measured in W/m². The following formula used to calculate electric field, assuming ζ the intrinsic impedance taken to be 377Ω.

$$P = E^2 / \zeta$$

The permissible exposure limits of electric field strength, magnetic field strength, and power flux density for the cell phone towers operating at 935 MHz are given in TABLE 1.

TABLE 1 : The permissible exposure limits of electric field strength, magnetic field strength and power flux density for the cell phone towers operating at 935 MHz ^{[14][15]}.

E-field strength (V/m)	H-field strength (A/m)	Power flux density (W/m ²)
42.04	0.11	4.68

Specific Absorption Rate (SAR) is a measure of the rate at which energy is absorbed by the body when exposed to radio frequency (RF) electromagnetic field. It is defined as the power absorbed per mass of tissue and has units of watts per kilogram (W/kg). SAR values are calculated by using the following formula for each tissue^[16]:

$$SAR = \frac{\sigma E^2}{2\rho}$$

The Federal Communications Commission (FCC) in United States of America (USA) suggests that 1.6 W/Kg is the maximum level of SAR. While the European Union Council and the International Commission on Non-Ionizing Radiation Protection (ICNIRP) in Europe suggests its value from 0.0 to 2.0 W/Kg^[17].

Cellular Network

Wireless communication is based on the cellular network. The cellular network is based on following: mobile phone technology, mobile phone towers and Cell

Current Research Paper

TABLE 2 : Average values of power flux density (P), electric fields strength (E), and magnetic fields strength (H)

Measured and calculated values	Nablus municipality	Jenin Municipality
P (W/m ²)measured	52.58×10 ⁻⁶	31.76×10 ⁻⁶
E (V/m)calculated	140.79×10 ⁻³	109.42×10 ⁻³
H (A/m)calculated	0.37×10 ⁻³	0.29×10 ⁻³

phones.

In Palestine, the cell phone companies use the 900 MHz band in GSM digital technology. The 900 MHz band is divided into two regions^[18]: The uplink band (890 MHz to 915 MHz) which is used by the cell phones, and the downlink band (935 MHz to 960 MHz) which is used by cell phone towers. Lattice, monopole and guyed towers are types of towers used in Palestine. The cell phones take different shapes and sizes. The most importantly, they differ in the SAR values.

RESULT

The distance from towers to both municipalities of Nablus and Jenin, is 70 m and 50 m respectively. The sample was applied on 136 employees, 80 male and 56 female, with ages between 25 to 60 years. The heart diseases and blood vessels diseases were the most important factors that led to the exclusion of some employees, so the health problem employees were neglected.

Spectran RF 6080 was used to measure the power flux density. The measured values of power flux density were used to calculate the electric fields, magnetic fields, and SAR values for some organs of human body; these values are shown in TABLE 2 and TABLE 3.

Diastolic blood pressure (DBP), systolic blood pressure (SBP), heart pulse rate (HPR), blood oxygen saturation (SPO₂%) and tympanic temperature were measured three times at (8:15 – 8:45) a.m. before (b) exposure to the signals of phone towers, and the measurement was repeated at (13:15– 13:45) p.m. after (a) exposure to the signals of phone towers.

The measurements of heart pulse rate, systolic blood pressure and diastolic blood pressure were taken by using Automatic Blood Pressure Monitor. The effect of the signals of cell phone towers on the heart pulse rate, systolic blood pressure and diastolic blood pressure of employees in Nablus and Jenin municipalities are shown in Figures. (1-3).

TABLE 3 : The calculated values of SAR for some organs of the employees in Nablus (SAR_N) and Jenin (SAR_J) municipalities

Organs	SAR _N (W/Kg)	SAR _J (W/Kg)
Cerebellum	12.21×10 ⁻⁶	7.38×10 ⁻⁶
eye sclera	10.57×10 ⁻⁶	6.38×10 ⁻⁶
Muscle	9.03×10 ⁻⁶	5.46×10 ⁻⁶

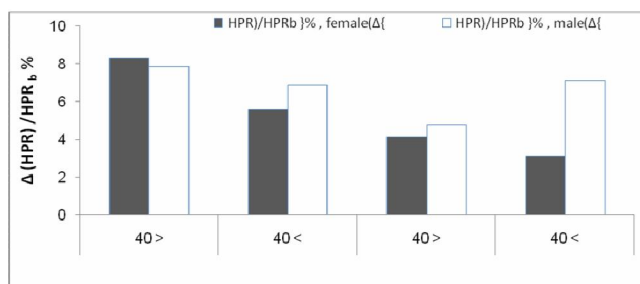


Figure 1 : The percentage changes of heart pulse rate of female and male employees in Nablus and Jenin municipalities after (a) exposure the signals of cell phone towers

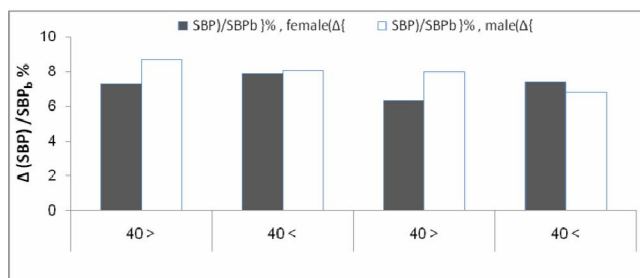


Figure 2 : The percentage changes of systolic blood pressure of female and male employees in Nablus and Jenin municipalities after (a) exposure to the signals of cell phone towers

Blood oxygen saturation was measured for each employee in both municipalities by using Pulse Oximeter LM-800. The effect of the signals of phone towers on the blood oxygen saturation of employees in Nablus and Jenin municipalities are shown in Figure 4.

Ear Thermometers is a device was used to measure the tympanic temperature of employees. The effect of the signals of phone towers on the tympanic temperature of employees in Nablus and Jenin municipalities are shown in Figure 5.

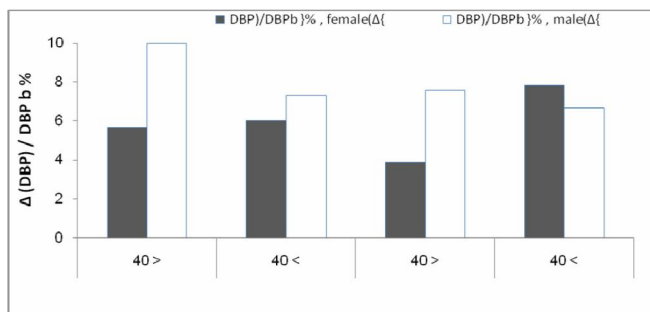


Figure 3 : The percentage changes of diastolic blood pressure of female and male employees in Nablus and Jenin municipalities after (a) exposure to the signals of cell phone towers

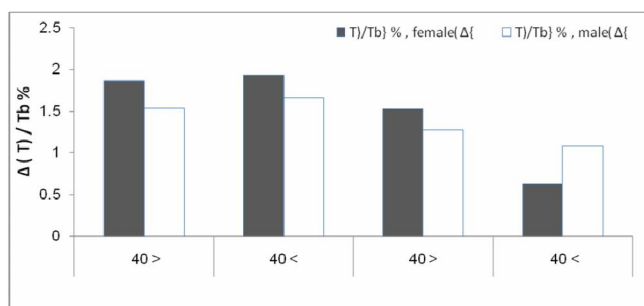


Figure 5 : The percentage changes of tympanic temperature of female and male employees in Nablus and Jenin municipalities after (a) exposure to the signals of cell phone towers

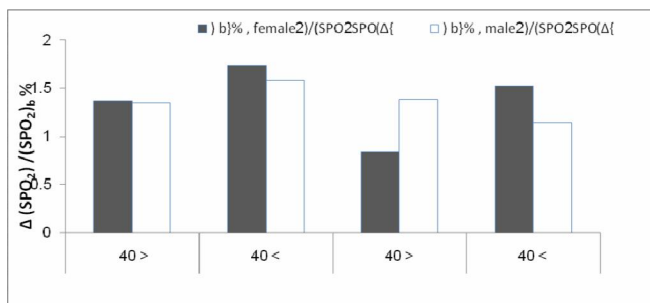


Figure 4 : The percentage changes of blood oxygen saturation of female and male employees in Nablus and Jenin municipalities after (a) exposure to the signals of cell phone towers

Analysis

Microsoft Excel and SPSS programs were used to analyze data. Pearson correlation coefficient (R) and the Probability (P) were used to measure the strength correlation between power flux density and the dependent variables, before and after signals from phone towers. If R values in range 0.40 d'' R d'' 0.59, so there is moderate correlation, but if R in range 0.60 d'' R d'' 0.79, so there is strong correlation^[19]. The P-value less than 0.050 means there is significant relationship between two variables^[20]. The following TABLE 4 shows Person correlation coefficient (R) and the probability

(P) between power flux density and dependent variables.

DISCUSSION

The measured power flux density in Nablus municipality was 52.58 μW/m², while the measured value in Jenin municipality was 31.76 μW/m². This difference is due to that the distance between cell phone towers and Nablus municipality (70 m) is more than the distance from Jenin municipality (50 m); this increment is applicable between 50 m and 300 m^[21]. Comparing these two values with international standard indicates that both values are less than the permissible limit which is 4.68 W/m² for cell phone towers working at 935 MHz^[15].

The results of the measurements indicate that the net changes of the tympanic temperature, blood oxygen saturation, heart pulse rate, diastolic blood pressure, and systolic blood pressure are increased for selected employees, after they are exposure to signals of phone towers. The Pearson correlation coefficient (R) is ranged from 0.312 to 0.657 and P-values is < 0.05. R and P values indicate that is significant correlation

TABLE 4 : Person correlation coefficient (R) and the probability (P) for females and males in Nablus and Jenin municipalities

Probability (P)				Correlation Pearson (R)				Paired variables
Nablus municipality		Jenin municipality		Nablus municipality		Jenin municipality		
Males	females	males	Females	males	females	males	females	
0.006	0.022	0.014	0.173	0.405	0.337	0.411	0.468	P (μW/m ²) and T (°C)
0.017	0.047	0.016	0.039	0.355	0.294	0.403	0.657	P (μW/m ²) and SPO ₂ %
0.019	0.010	0.002	0.044	0.348	0.377	0.505	0.645	P (μW/m ²) and HPR beats/min
0.037	0.006	0.038	0.049	0.312	0.401	0.351	0.634	P (μW/m ²) and DBP mmHg
0.007	0.001	0.011	0.042	0.394	0.477	0.423	0.649	P (μW/m ²) and SBP mmHg

Current Research Paper

between power flux density and an increase in all studied variables of employees after exposure to phone tower signals.

This study agrees with the study conducted by Ibrahim, who was found the increase of the temperature in skin is 1.6°C ^[5]. This study also, supports the result of Abdel Aziz's study, who was found a significant decrease in red blood cells (RBC), so the blood oxygen saturation was decreased^[8]. Furthermore, agree with that the infants and newborns were suffered from increase in heart pulse rate (HPR)^[9]. However, the results of this study are in agreement with a study by El-Bediwi. He found a significant change on blood components and its viscosity which effects on a blood circulation due to many body problems^[7].

CONCLUSION AND RECOMMENDATIONS

As a conclusion, when human being is exposed to power flux density of cell phone towers, the body absorbs EMR. The increment in the percentage changes of the tympanic temperature, blood oxygen saturation, heart pulse rate, and blood pressure (systolic and diastolic) indicate that the risk of exposure to EMR increases in the long term. This increment is remaining within the normal range and international standards.

Department of Health in the municipalities should be measure the power flux density of cell phone towers regularly, to maintain the safety and health of its employees. More scientific research should be focused on this field to gain more insight of EMR health effects and the means for better and safer human life.

REFERENCES

- [1] IARC International Agency for Research on cancer, IARC classifies radiofrequency electromagnetic fields as possibly carcinogenic to humans, Press release N208, (2011).
- [2] L.Hardell, M.Carlborg, K.Hansson; Mobile phone use and the risk for malignant brain tumors: A case-control study on deceased cases and controls, *Neuroepidemiology*, **35**, 109–114 (2010).
- [3] D.Adilza, L.Monica, T.Francisco, G.Antonio, D.Daiana, D.Michael, M.Cristina, C.Vania, A.Claudia, C.Waleska; Mortality by neoplasia and cellular telephone base stations in the Belo Horizonte municipality minas Gerais state, Brazil, *Science of the Total Environment*, **409(19)**, 3649–3665 (2011).
- [4] J.Schüz, G.Waldemar, J.Olsen, C.Johansen; Risks for Central Nervous system diseases among mobile phone subscribers, *PLOS One*, **4(2)**, 89-94 (2009).
- [5] A.Ibrahim, C.Dale, W.Tabbara, J.Wiart; Analysis of the temperature increase linked to the power induced by RF source, *Progress In Electromagnetics Research*, *PIER*, **52**, 23-46 (2005).
- [6] V.Rao, A.Titushkin, G.Moros, F.Pickard, S.Thatte, R.Cho; Nonthermal effects of radiofrequency-field exposure on calcium dynamics in stem cell-derived neuronal cells: Elucidation of calcium pathways, *Radiat. Res.*, **169(3)**, 319–329 (2008).
- [7] A.El-Bediwi, M.Saad, E.Eid, A.El-kott; Influence of electromagnetic radiation produced by mobile phone on some biophysical blood properties in rats, *Cell Biochem & Biophys*, **65(3)**, 297-300 (2013).
- [8] I.Abdul Aziz, H.El-khozondar, M.Shabat, K.Elwasife, A.Osman; Effect of electromagnetic field on body weight and blood indices in albino rats and the therapeutic action of vitamin C or E "Romanian J. Biophys.", 20(3):235–244, (2010).
- [9] A.Rezk, K.Abdulqawi, R.Mustafa, T.Abo El-Azm, H.Al-Inany; Fetal and neonatal responses following maternal exposure to mobile phones, *Saudi Med J.*, **29(2)**, 218-228 (2008).
- [10] T.Aruna, M.Duhan, D.Bhatia; Effect of mobile phone radiation on brain activity GSM vs CDMA", *IJSTM*, **2(2)**, 1-5 (2011).
- [11] A.Hammash; Exposer of the Palestinian population from environmental electromagnetic fields, B.Sc. in electronic engineering, Al-Quds University, Jerusalem, Palestine, (2004).
- [12] I.Al-Faqeeh; The effect of the electromagnetic radiation from high voltage transformers on student's health in Hebron district, Master Thesis, Physics Dept., An-Najah National University, Palestine, (2013).

Current Research Paper

- [13] R.Simon; Antenna and propagation for wireless communication, 2nd Ed., John Wiley & Sons Ltd, (2007).
- [14] ICNIRP International Commission on Non-Ionizing Radiation Protection, "Guidelines for limiting exposure to time varying electric and magnetic field (1Hz to 100 2000MHz)", Health Physics, **99(6)**, 818-836 (2010).
- [15] IEEE, Standard for safety level with respect to human exposure to radio frequency electromagnetic fields, 3KHz to 300GHz. IEEE, **9**, (1999).
- [16] L.Angelone, A.Potthast, F.Segonne, S.Iwaki, J.Belliveau, G.Bonmassar; Metallic electrodes and leads in simultaneous EEG-MRI: specific absorption rate (SAR) Simulation Studies, Bioelectromagnetics, **25(4)**, 285-295 (2004).
- [17] ICNIRP, ICNIRP guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields (up to 300GHz), Health Physics, **74(4)**, 494-522 (1998).
- [18] G.Sempere; An overview of the GSM system, University of Strathclyde Glasgow, Scotland, (1999).
- [19] K.Brown, P.Cozyby, D.Kee, P.Worden; Research methods in human development, 2ed Edition, Mayfield publishing company, London, 60-70 (1998).
- [20] C.William, T.Betty, N.Paul; Statistics for Business and Economics, 6th Edition, New Jersey, (2007).
- [21] J.Kamil; Measurements of Electromagnetic Fields Emitted from Cellular Base, Tikrit Journal of Engineering Sciences, **20(1)**, 51-61 (2013).