The Exposure Effect of the Signals of Cell Phones on the Employees of Nablus and Jenin Municipalities

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Abstract

This study focuses on the effect of EMR emitted by cell phone towers onsomeof the dependent variables, such astympanic temperature (T), blood oxygen saturation (SPO_2%), heart pulse rate (HPR), systolic blood pressure (SBP) and diastolicblood 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 $\mu W/m^2$ and 31.76 $\mu W/m^2$ in Nablus and Jenin municipalities respectively. The measurements were taken for the selected sample before and after exposure to signals of mobile towers. These measurements were including tympanic temperature, blood oxygen saturation, heart pulse rate and arterial blood pressure (systolic and diastolic) at different power flux density.

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.

This study shows that the health effects of signals of cell phone depend on the power flux density.

Introduction

The last three decadeshave 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.(IRAC, 2011).

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 is a motivation for researchers in several countries to discuss the potential effects of exposure to radiation from cell phones and their towers.

Several studies haveshown 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 (Hardell, 2010). Adilza found that the people who live near 500m from the cell phone towers are at risk of neoplasia cancer (Adilza, 2011) .

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, (Schüz, 2009).

A study showed a clear increase in the temperature of the head influenced radiation 250 millwatts (mW) and 900 MHz frequency, so the temperature in skin was increased 1.6^0C (Ibrahim, 2005). Another study found a significant increase in the percentage of calcium ions (Rao, 2008).

The effects of the signals of cell phone on the circulatory system show that red blood cells (RBC) andwhite blood cells (WBC) are broken after exposed phone's signals, (El-Bediwi, 2013).Another study showed that was an increase inWBC,but it was a decrease in RBC,(Abdul Aziz, 2010). Infants and newborns were suffered from increase in heart pulse rate (HPR) and reduction in brain volume (Rezk, 2008).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 (Al-Faqeeh, 2013).

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) (Aruna, 2011).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 it in the West Bank (Hammash, 2004).

Theoretical

Electromagnetic field (EMF)composed 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 ($\vec{P}$) (Simon, 2007)**:**

$$\vec{P} = \vec{E} \times \vec{H} \qquad (1)$$

The Poynting vector is called power flux density measured in W/m^2.The following formula used tocalculate electric field strength and magnetic field strength, assuming the intrinsic impedance taken to be 377Ω.

$$P = \frac{E^2}{\eta} \qquad (2)$$

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

Table 1 Thepermissible exposure limits of power flux density, electric field strength and magnetic field strength for the cell phone towersoperating at 935 MHz (ICNIRP, 2010; IEEE, 1999).

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

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, (Angelone, 2004):

$$SAR = \frac{\sigma E^2}{2\rho} \qquad (3)$$

The Federal Communications Commission (FCC) in United States of America (USA) suggests that 1.6 W/Kgis the maximum level of SAR. While the European Union Council and the International Commission on Non-Ionizing Radiation Protection (ICNIRP) in Europe suggestsits value from 0.0 to 2.0 W/Kg, (ICNIRP, 1998).

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 phones.

The Global System for Mobile Communications (GSM) is the mobile technology used in Palestine. Jawwal phones transmit signals with frequency band (910.2 MHz to 915 MHz) but Jawwal towers transmit signals with frequency band (955.2 MHz to 960 MHz) (Abdelati, 2005).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 vesselsdiseases were the most important factors that led to the exclusionof some employees, so the health problemployees 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, magnetic flux density, and SAR values for human body; these values are shown in table 2**.**

Table 2 Average values of power flux density, electric fields, magnetic fields, magnetic flux density and SRA

Measured and calculated values	Nablusmunicipality	Jenin Municipality
P ($\mu W/m^2$)measured	52.58	31.76
E (mV/m)calculated	140.79	109.42
H (mA/m)calculated	0.37	0.29
SAR(μW/kg) calculated	9.45	4.97

Diastolic blood pressure (DBP), systolic blood pressure (SBP), heart pulse rate (HPR), blood oxygen saturation (SPO_2%) 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 diastolic blood pressure, systolic blood pressure and heart pulse rate were taken by using Automatic Blood Pressure Monitor.The effect of the signals

of phone towers on diastolic blood pressure, systolic blood pressure and heart pulse rate of employees in Nablus and Jenin municipalities are shown in Fig.(1-3).

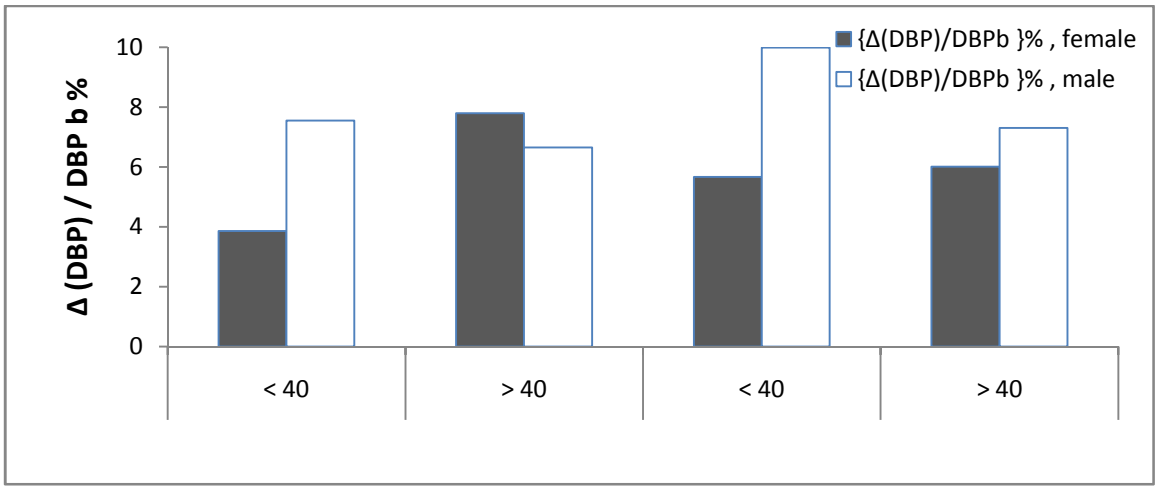

Fig. 1 Thepercentage changes of diastolic blood pressure of female and male employees in Jenin and Nablus municipalities after (a) exposure to the signals of cell phone towers

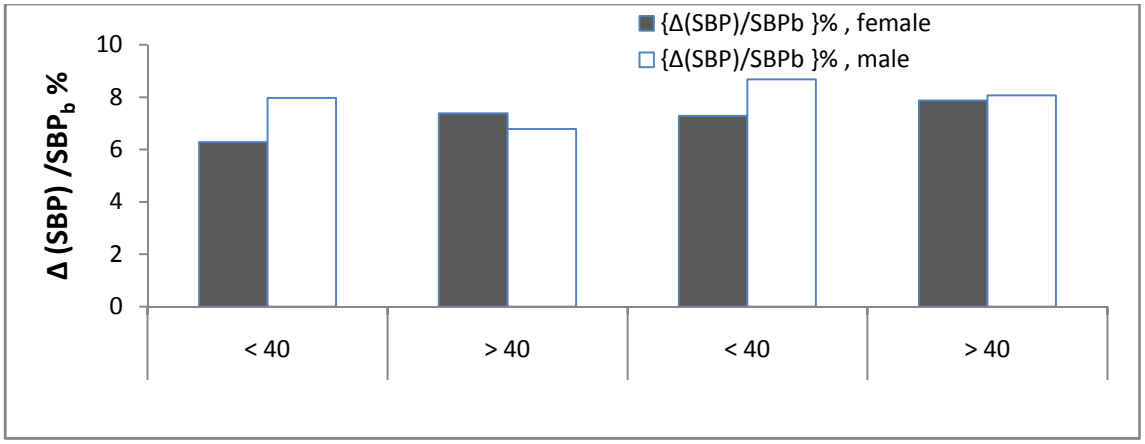

Fig. 2 Thepercentage changes of systolic blood pressure of female and male employees in Jenin and Nablus municipalities after (a) exposure to the signals of cell phone towers

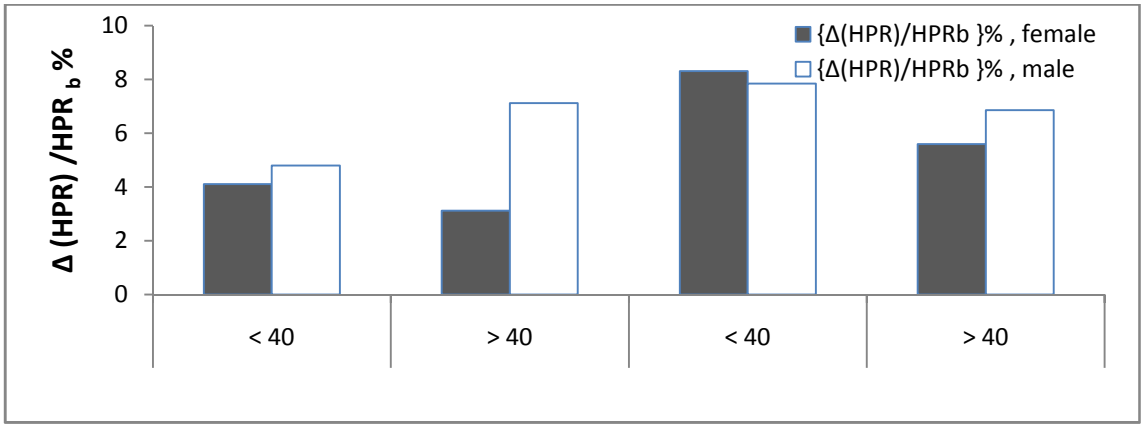

Fig. 3 The percentage changes of heart pulse rate of female and male employees in Jenin and Nablus municipalities after (a) exposure the signals of cell phone towers

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 Fig. 4.

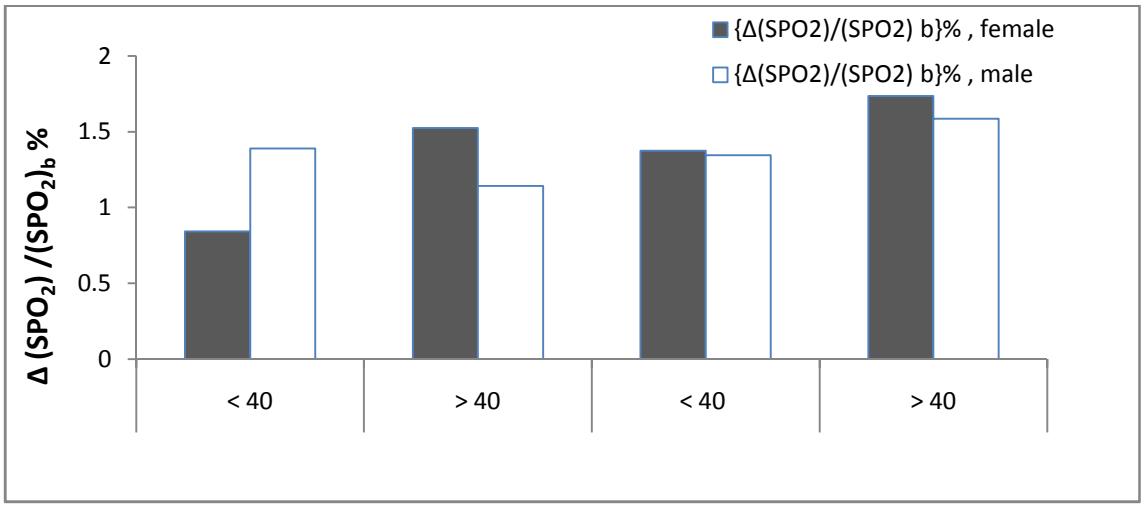

Fig. 4 Thepercentage changes of blood oxygen saturation of female and male employees in Jenin and Nablus municipalities after (a) exposure to the signals of cell phone towers

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 Fig. 5.

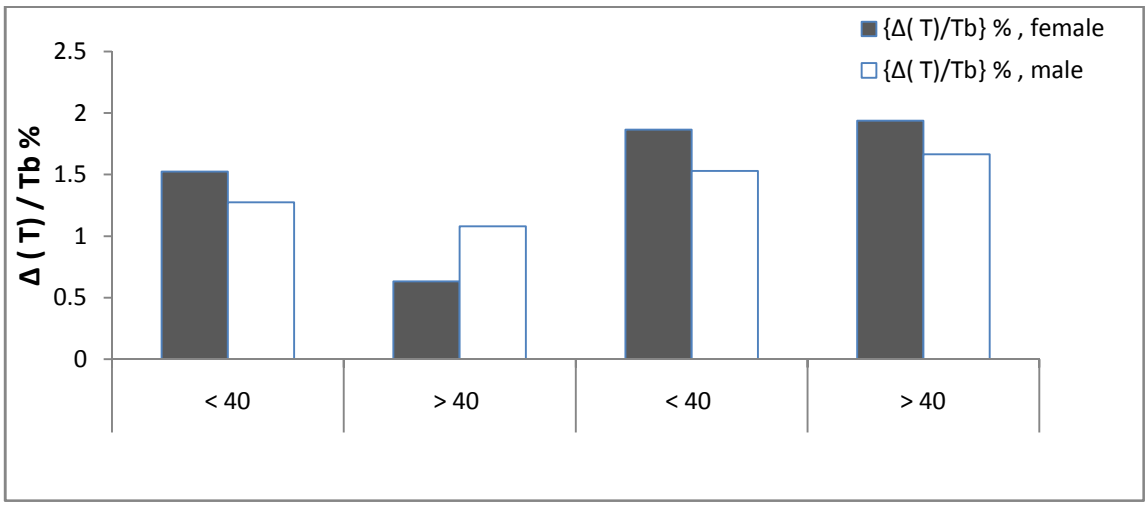

Fig. 5 Thepercentage changes of tympanic temperature of female and male employees in Jenin and Nablus municipalities after (a) exposure to the signals of cell phone towers

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 $0.40 \leq R \leq 0.59$, so there is moderate correlation, but if R in range $0.60 \leq R \leq 0.79$, so there is strong correlation (Brown, 1998).The P-value less than 0.050 means there is significant relationship between two variables (William, 2007). The following table 3 shows Person correlation coefficient (R) and the probability (P) between power flux density and dependent variables.

Table 3 Person correlation coefficient (R) and the probability (P) for femalesand males in Nablus and Jenin municipalities

Paired variables	Correlation Pearson (R)				Probability (P)			
	Jenin municipality		Nablus municipality		Jenin municipality		Nablus municipality	
	females	males	Females	males	Females	males	females	males
P ($\mu W/m^2$) and T (^oC)	0.468	0.411	0.337	0.405	0.173	0.014	0.022	0.006
P($\mu W/m^2$) and SPO_2 %	0.657	0.403	0.294	0.355	0.039	0.016	0.047	0.017
P (μW/m2) and HPR beats/min	0.645	0.505	0.377	0. .348	0.044	0.002	0.010	0.019
P ($\mu W/m^2$) and DBP mmHg	0.634	0.351	0.401	0.312	0.049	0.038	0.006	0.037
P ($\mu W/m^2$) and SBP mmHg	0.649	0.423	0.477	0.394	0.042	0.011	0.001	0.007

Discussion

The measured power flux density in Nablus municipality was 52.58 $\mu W/m^2$, while the measured value in Jenin municipality was 31.76 $\mu W/m^2$, thesevalues are less than the permissible limit which is 4.68 W/m2 for cell phone towers working at 935 MHz, (IEEE, 1999). The calculated electric fields were 140.79 mV/m and 109.42 mV/m in Nablus and Jenin municipalities, respectively. These values are less than the international standards value which is 42.04 V/m for the electric field (ICNIRP, 2010). The calculated magnetic fields strength in Nablus was 0.37 mA/m and in Jenin was 0.29 mA/m. These values are less than the international standards which

is 0.11 A/m for magnetic field strength (ICNIRP, 2010). The maximum SAR value of human bodywas 9.45 µW/Kg.It is less than Europe standard2W/Kg and USA standard 1.6 W/Kg. (ICNIRP, 1998).

The result of this study show that all values of power flux density, electric fields strength, magnetic fields strength, and SAR were much below the international standard.

The results of the measurementsindicate 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 cell phone towers. The Pearson correlation coefficient (R) is ranged from 0.312to 0.657 and P-values is < 0.05. R and P values indicate that is a correlation between power flux density and an increase inall 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 1.6^0C, (Ibrahim, 2005).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, (Abdul Aziz, 2010).Furthermore, agree with that the infants and newborns were suffered from increase in heart pulse rate (HPR) (Rezk, 2008). 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, (El-Bediwi, 2013).

Conclusion and Recommendations

The overall results in this study indicate the following points:The measured power flux density was 52.58 µW/m^2 and 31.76 µW/m^2in Nablus and Jenin municipality respectively. The SAR values in two municipalities are less than the international standard levels. There are a significant correlation between power flux density and changes oftemperature, blood oxygen saturation, heart pulse rate, systolic blood pressure and diastolic blood pressure.

The effects of signalsof cell phone towers will be minimized by build cell phonetowersfar away from the vitality areas and residential buildings.Comprehensive education also, must be providing to the citizens of the

risks resulting from signals of cell phones towers.Some of materials can be add to building materials, to increase the absorption of radiation, examples of these materialsa polystyrene or electrolytic manganese dioxide and MnZn-ferrite.

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. The government should guide the cellular phone companies to put cell phone towers away from the human populations.

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.

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