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The effect of electromagnetic radiation from antennas on children in schools in nablus area

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ABSTRACT

This study concerns about the effects of Electromagnetic radiation from antennas on arterial blood pressure (systolic (SBP), diastolic (DBP)), heart pulse rate (HR), blood oxygen saturation (SPO_2%) ofchildren's schools.
The sample consists of 273 students of both genders (91 female, 182 male), classified into two groups; 10-12 years and 13-16 years. The sample was taken from three different schools in Nablus area. The measured power flux density in the first school was 1.862mw/m^2 and 353.166μw/m^2 in the second school and 18.278μw/m^2 in the third one. Measurements of blood oxygen saturation, heart pulse rate, arterial blood pressure (systolic and diastolic) were taken for the selected sample before and an after exposure to Electromagnetic radiation from antennas. Positive correlation (Pearson Correlation Coefficient) was found for all measured variables. The statistical results showed that Pearson correlation coefficient (R) between the dependent variables (SBP, DBP, HR, SPO_2%) before and after the exposure to electromagnetic radiations from antennas is strong and the Probability (P) is < 0.05.
This study shows that there is a significant shift of the measured mean values of arterial blood pressure (systolic and diastolic), heart pulse rate, and blood oxygen saturation of the children due to exposure of electromagnetic radiation from antennas.

INTRODUCTION

The growing use of wireless communication in the last decade has introduced concerns about health risks from the so called man made electro smog. Various epidemiological and experimental studies have been carried out and the results have shown to have a close relation between biological effects and Electromagnetic radiation[1].

An electromagnetic field is a generic term for fields of force generated by electrical charges or magnetic fields. Under certain circumstances EMF can be considered as radiation when they radiate energy from the source of the fields. Electromagnetic waves periodically change between positive and negative. The speed of the changes, or the number of changes per second, is called the frequency and is expressed in hertz (1 Hz = 1 full cycle of change per second)[2].

Often when people think of EMF, they think of radiation that is associated with X-rays, radioactivity or nuclear energy. What people consider as 'radiation' is ionizing radiation that contains sufficient energy to cause ionization; that is, they can dislodge orbiting electrons from atoms or break bonds that hold molecules together, producing ions or charged particles[2].

But these are not the only types of radiation in the electromagnetic spectrum: there is a continuous spectrum of fields. All other types of radiation do not have enough energy to result in ionization and so are referred to as "non-ionizing radiation". Radiation and fields can be divided into discrete bands having different interactions on living organisms: ultraviolet radiation, visible

light, infra-red radiation, microwaves, radiofrequency fields and low frequency fields"[2].

The examples of non-ionizing EMR are divided into frequency (f) bands, namely: radio frequency (RF) (100 kHz < f d" 300 GHz), intermediate frequency (IF) (300 Hz < f d" 100 kHz), extremely low frequency (ELF) (0< f d" 300 Hz), and static (0 Hz)[3].

There are many organizations which studies the effect of exposure to electromagnetic radiation (EMR) on biological systems and human health, such as the International Commission on Non-Ionizing Radiation Protection (ICNIRP), and the World Health Organization (WHO) and others.

Previous studies

Nonionizing electromagnetic fields are among the fastest growing forms of environmental pollution[4], so many of studies shown the relation between Electromagnetic radiation and biological effects on human body.

Kumar has been shown in his research that an increasing risks for brain tumors in children and teenagers, they are five times more likely to get brain cancer, if they use mobile phones[5].

Ahamed and his team showed that mobile phone (MP) has caused changes in heart rate variability (HRV) indices and the change varied with its position. The parameters used in this study for quantifying the effect on HRV are scaling exponent and sample entropy. The result indicates an increase in both the parameters when MP is kept close to the chest and a decrease when kept close to the head[6].

Exposure to electromagnetic fields has shown to be in connection with Alzheimer's disease, motor neuron disease and Parkinson's disease[7].

A study carried out by Hamada and his group was found that when sperm exposure to cell phone electromagnetic waves affect their motility, morphology and even their count[8].

Studies from Israel have found that the risk of parotid gland tumors (a salivary gland in the cheek) is increased with heavy cell phone use[9].

Another study showed that effect of acute 2nd (2G) and 3rd (3G) generation mobile phone exposure on human cognitive function [10].

Cooke reported increased Acute Lymphocytic Leukemia by 1.41-fold risk and Acute MyelogenousLekeumia by 2.08-fold risk with >15 years since first use of mobile phones[11].

Volkow reported that 50 min of use of a mobile phone produces significant change in glucose metabolism in the area of the brain that absorbs the most radiation[12]. Levis founded that long-term mobile phone use doubling the risk of head tumors[13].

Vangelova concluded that the systolic and diastolic blood pressure, total cholesterol and low-density lipoprotein cholesterol higher after exposure to EMF[14] And Szmigielski founded that workers exposed to radiofrequency EMF have lowering in blood pressure and heart rate[15].

The objective of study

In Palestine, there is a lack of information about electromagnetic radiation and human health effect. This study will help to get the effect of EMR density on school student near antennas such as the effect on blood pressure, heart pulse rate and blood oxygen saturation.

METHODOLOGY

Study sample

The sample of this study are 273 students of both genders (91 female, 182 male), distributed in three different schools. The sample's ages were between 10-16 years. The subjects chosen had no history of heartcardiovascular disease. In addition the average exposure hours are 3-5hours per day. Moreover the students were asked not to smoke or to eatsalty food before taking the measurements, because these factors affectblood pressure.

The best value of study sample calculated according to Cochran formula[16]:

$$n = \frac{z^2 pq}{\delta^2} \quad (1)$$

Where; n = best value to select a random sample of students in each school; z = value for selected alpha level of 0.025 in each tail = 1.96; (p)(q) = estimate of variance, q = 1 - p, p = 0.9, q = 0.1; δ = acceptable margin of error for proportion being estimated to be 0.055; n = 114.3

Applying the correction formula[17]:

$$m = \frac{n}{1 + n/N} \quad (2)$$

Where; m = corrected sample size that should be used; n = sample size of selecting student in school; N = population of the total students that founded in each school.

Experimental apparatus

Several instruments and tools were used in performing our study. These instruments are:

1- Spectran of radio frequency (RF) 6080
2- Lux Meter
3- Automatic Blood Pressure Monitor (micro life AG, Modno.BP2BHO)
4- Pulse Oximeter LM-800
5- Sound Pressure Level Meter

TABLE 1: Average light intensityandaveragesound pressure level for three different schools

School**	light intensity dB (A)	sound pressure level lux
S1	46.142	444.75
S2	44.454	339.68
S3	43.110	315.01

**** S1: Yaseed Primary School for Girls, S2: Yaseed Primary School for Boys, S3: Masqat Primary School for Boys**

TABLE 2 : EMR intensity for schools

S	EMR intensity in dB/m^2 (average)	EMR intensity in w/m^2 (average)
S1	-20.67	1862
S2	-26.03	353.2
S3	-39.53	18.28

RESULTS

Light intensity and sound pressure level results

The results of measurement of average light intensityandaveragesound pressure level for three different schools are shown in TABLE 1.

EM intensity results

The results of measurement of EM intensity for all schools are shown in TABLE 2.

Electric and magnetic fields, magnetic flux density and SAR values results

The electric and magnetic fields, magneticflux density, there are two values for σ and ρ, according to these two values SARs were calculated. The results are tabulated in TABLE 3 for three different schools.

Blood oxygen saturation, heart pulse rate, and blood pressure levels (systolic and diastolic) results

The average values of the blood oxygen saturation, heart pulse rate, and blood pressure levels (systolic and diastolic), for males and females in each studied school before (b) and after (a) exposure to EMR from antenna are shown in TABLE 4 and TABLE 5.

Systolic and diastolic blood pressure results

TABLE 3 : Average values of electric and magnetic fields, magnetic flux density and SAR for human brain and reference levels of it

	$E\times10^{-2}$ (V/m)	$H\times10^{-4}$ (A/m)	$B\times10^{-11}$ (Tesla)	$SAR\times10^{-6}$ (W/Kg) ρ =1030 kg/m^3 σ = 1.1531 S/m	$SAR\times10^{-6}$ (W/Kg) ρ = 1700 kg/m^3 σ = 0.7 S/m
Reference level	41.3×10^{2}	1.1×10^{3}	1.4×10^{4}	2×10^{6} (USA) Or 1.6×10^{6} (Europe)	2×10^{6} (USA) Or 1.6×10^{6} (Europe)
S1	83.8	22.0	276.3	786.0	289.0
S2	36.5	9.7	121.8	149.0	54.9
S3	8.4	2.2	27.6	7.9	2.9

TABLE 4 : Average values of diastolic and systolic blood pressure, heart pulse rate, blood oxygen saturation levels for students in each studied school in group 10-12 years

Variables	SBP mmHg		DBP mmHg		HR beats/min		SPO_2%	
	b	a	b	a	b	a	b	a
S1	104	101	64	61	92	86	96	93
S2	112	110	64	64	91	81	98	97
S3	110	107	66	62	82	78	97	94

TABLE 5 : Average values of diastolic and systolic blood pressure, heart pulse rate, blood oxygen saturation levels for students in each studied school in group 13-16 years

variables	SBP mmHg		DBP mmHg		HR beats/min		SPO_2%	
	b	a	b	a	b	a	b	a
S1	115	114	74	68	88	81	97	94
S2	120	114	65	62	86	76	98	96
S3	115	115	64	61	85	80	98	96

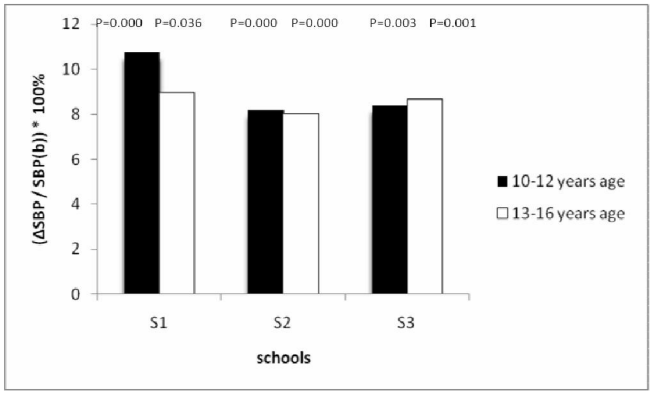

Figure 1 : Percentage differences in systolic blood pressure (SBP) for 10-12 years age group and for 13-16 years age group in each studied school and P values are given of each school

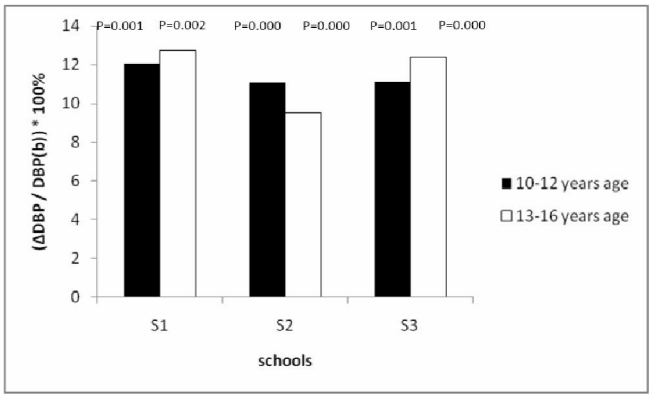

Figure 2 : Percentage differences in diastolic blood pressure (DBP) for 10-12 years age group and for 13-16 years age group in each studied school and P values are given of each school

The percentage differences (decreases) in systolic and diastolic blood pressure for both groups of children in each school are represented in Figures 1 – 4.

Figure 1 shows that for S1 and S2 percentage differences (decreases) of 10-12 years age group more than 13-16 years age group which is contrast with S3.

Figure 2 shows that the percentage differences (decreases) in diastolic blood pressure (DBP) are larger for 13-16 years age group than for 10-12 years age group in S1 and S3, but for S2 percentage differences in DBP are larger for 10-12 years age group than for 13-16 years age group.

Heart pulse rate results

The average values of heart pulse rate for two groups children in each studied school before (b) and after (a) exposure to EMR from antenna are shown in Figure 3.

Figure 3 shows that the percentage differences

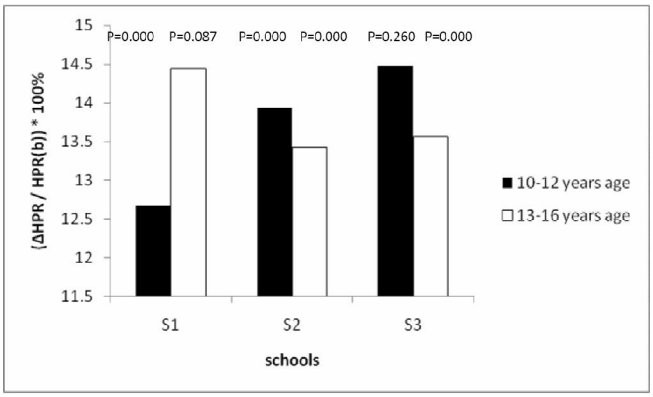

Figure 3 : Percentage difference in heart pulse rate (HPR) for 10-12 years age group and for 13-16 years age group in each studied school and P values are given of each school

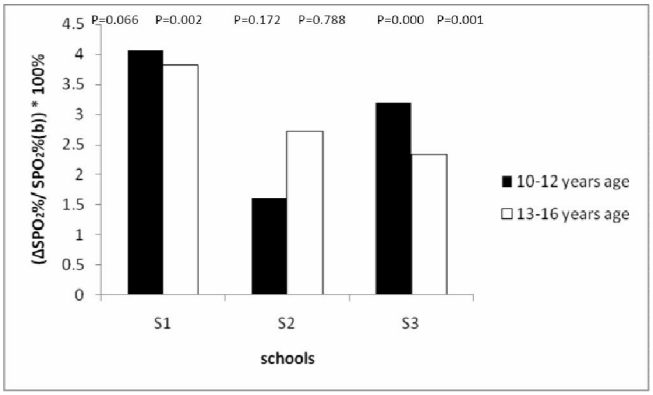

Figure 4 : Percentage difference in blood oxygen saturation (SPO_2%) for 10-12 years age group and for 13-16 years age group in each studied school and P values are given of each school

(decreases) in heart pulse rate (HPR) are larger for 10-12 years age group than for 13-16 years age group in S2 and S3, but for S1 percentage differences in HPR are less for 10-12 years age group than for 13-16 years age group.

Blood Oxygen Saturation (SPO_2%) Results

The effects of the electromagnetic radiation on SPO_2% for studied children of schools are represented in Figure 4.

Figure 4 shows that blood oxygen saturation (SPO_2%) for S1 and S3 percentage differences (decreases) are larger for 10-12 years age group than 13-16 years age group which is contrast with S2.

DISCUSSION

The effect of EMR pollution on arterial blood pressure (Systolic and Diastolic)

Average values of systolic blood pressure are decreased after the child's exposed to EMR. For both groups of children, Yaseed boy school is the most affected school, where Pearson correlation coefficient is R = 0.645 for 10-12 years group and R = 0.590 for 13-16 years group. In this study, the systolic blood pressure decreased by 1-6 mm Hg. Pearson correlation coefficient for all children (10-12 years group) who have been exposed to electromagnetic radiation is R = 0.619, and R = 0.391 for 13-16 years group. Female children are more susceptible to electromagnetic radiation than male children R = 0.538.

There are noticeable decreased in diastolic blood pressure average values as shown in Figures.1– 2. All schools have large R values for 10-12 years group. R for Yaseed girl school 0.510, R for Yaseed boy school is 0. 588 and R for Masqat school 0.638. For 13-16 years group, Yaseed boy school is the most affected school, where Pearson correlation coefficient is 0.617.

In this study, the diastolic blood pressure decreased by 1-6 mm Hg. Pearson correlation coefficient (R) for all children (10-12 years group) who have been exposed to electromagnetic radiation is 0.570 and 0.547 for13-16 years group. Male children are more susceptible to electromagnetic radiation than female children where R is 0.546.

There are studies that showed that workers exposed to radiofrequency EMF have lowering in blood pressure[15].

The effect of EMR pollution on heart pulse rate

Results of heart pulse rate for the selected children showed decrease of HPR values as shown in Figure 3. The most affected children are from Yaseed boy school where Pearson correlation coefficient is R = 0.655 for 10-12 years group and R = 0.649 for 13-16 years group. On one hand, 10-12 years children are more affected than 13-16 years children with R = 0.587. On the other hand, male are more affected than females R = 0.524. HPR values decreased about 4-10 beats/min after the children's exposure to EMR for at least 3 hours. A decrease of the heart rate was observed after 14 days of exposure to EMF[18].

The effect of EMR pollution on blood oxygen saturation SPO_2 %

Average values of blood oxygen saturation SPO_2 % are decreased after the children exposed to EMR from antenna as shown in Figure 4. The most affected children in 10-12 years group were from Masqat school where Pearson correlation coefficient is R = 0.768 and the most affected children in 13-16 years group were from Yaseed girl school where Pearson correlation coefficient is R = 0.421. Children for 10-12 years group are more affected than 13-16 years children with R = 0.460. Male children R = 0.379 are more affected than females R = 0.347. The difference between values of blood oxygen saturation before and after exposed to EMR is 1-3 %. The results of this study are in agreement with Abdel Aziz's study[19]. Abdel Aziz found a decrement of 12.2% in red blood cells (RBC) after exposing to frequency of 900 MHz for two weeks. Accordingly, the blood oxygen saturation was also decreased.

Children in Yaseed boy school are the most affected from the antennas electromagnetic radiation, the second school is Yaseed girl school, as was concluded from R values between the variables before and after exposure to EMR. The results indicate that Children for 10-12 years group are more affected than 13-16 years children because of the vital activity for young children. In this study, male children are more affected from EMR pollution than female children, except for systolic blood pressure where female children are more affected. This result is due to that the male's body contains electromagnetic waves more than a female's body[20] and the monthly period for females[21].

The highest value of EMR is 1862μW/$m^2$and low-

est value is 18.28μW/m^2. In Iran, a group of researcher found that the average power flux density from the base station was 0.02mW/m^2 in urban area and 0.05mW/m^2 in the rural area[22]. According to TABLE 3, the highest value of the magnetic flux density was in Yaseed Primary School for Girls S1 (B = 2.76×10^{-5} G). Comparing the results of SAR values with the standard values of SAR in TABLE 3, it is clear that the results of SAR values in this research were much below the standard levels, where the highest value of SAR is 786μW/kg. According to TABLE 3, the electric field, magnetic field strength and magnetic flux density are much below than the reference levels. Where the highest value of E = 0.838V/m, H = 22×10^{-4}A/m, and B = 2.76 nT.

Values of E, H, B and SAR are too small and changes in SBP, DBP, HPR, SPO_2% parameters are in the normal ranges, so these decrements in measured values are properly not from electromagnetic radiation only, but may also from sound pressure level and light intensity as studied by Al-Sheikh Ibrahim,Al-Sheikh Mohammad, Abo-Ras, Abdelraziq, Sadeq and Ibrahim[23-29].

RECOMMENDATIONS

The following are some recommendationswhich can be carried on to reduce the effect of EMR from antenna on children health:

1 Building schools in locations should be far away from antenna at least 300m.
2 Planting trees around the schools, to decrease the EMR pollution inside the schools.
3 Using a plaster cement form as pre-manufactured tiles in addition to polystyrene, or electrolytic manganese dioxidenandMnZn-ferrite to shield these schools effectively from outside electromagnetic interference.
4 Explaining the results of the EMR risks on children health to the teachers of the schools.
5 Measuring the intensity of the EMR from antenna and other sources periodically and make sure that it does not increase with time.
6 Measuring the different variables such as arterial blood pressure (systolic (SBP), diastolic (DBP)), heart pulse rate (HPR), blood oxygen saturation (SPO_2%) ofchildren schools periodically to make sure that children health is normal.

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