Evaluation of Electromagnetic Radiation Level in the Outdoor from Wireless Transmission Systems in Northern West Bank – Palestine

تقييم مستويات الالع舞台上 الكهرومغناطيسي في المناطق الخارجية الصادرة عن أنظمة الارسال اللاسلكية في شمال الضفة الغربية – فلسطين

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Abstract: Exposure to electromagnetic fields is a major public concern due to the possible hazardous effects on health caused by exposure to these radiations. The aims of this study were to measure radiofrequency radiation levels from different wireless systems and to compare the results with the recommended limits by the World Health Organization (WHO) which should be less that 450 µw/cm². The study was a cross-sectional study that was conducted in different cities and villages from the northern governorates in the West Bank; Jenin, Tulkarm, Nablus, Qalqilya, Tubas and Salfit. To measure the radiation levels ranging from 80 MHz to 2 GHz, a Portable Field Strength Meter with the suitable set of antennas was used. This frequency range covers the radiations from different sources as mobile phone base stations, local radio and television stations, mobile phones, Wireless Local Area Network, Bluetooth, wireless computer periphery and even microwave ovens. Points close to mobile phone base stations and local radio and television stations in addition to randomly selected points were included. The scanning process for each point was done twice and the higher reading was included in the analysis. The results were compared to the recommended limits of radiations by WHO. Also, a questionnaire was distributed to evaluate people knowledge and perception regarding radiations. A total of 2000 readings were obtained with a mean ± SD = 0.25 ± 0.214 µw/cm². The highest reading was 1.91 µw/cm². All the readings were below the limits of radiations recommended by the WHO. Most of the readings in the tested area 1184 (59.2%) were between 0.1 -0.45 µw/cm² which are 1000-4500 time less than the maximum allowed level (450 µw/cm²), 527 (26.35%) readings were <0.1 µw/cm², 271 (13.55%) reading were between 0.45-1 µw/cm² and the rest 17 (0.85%) were >1 µw/cm² which were still 236-450 times less than the allowed WHO level. Regarding the questionnaire part, most of the participants use mobile phones frequently, they think radiations are dangerous and can cause cancer, they prefer not to have mobile base stations close to their living places. In this study, a scanning for all electromagnetic radiation sources caused by different sources of wireless communication systems showed theoretically no dangerous radiation levels and all the recorded levels were much lower than the recommended levels by the WHO. Most people feel afraid from radiations and think they are dangerous.
INTRODUCTION:

The use of wireless systems is increasing more and more. Cellular phones (800-2100 MHz), amplitude modulation-AM (550-1720 kHz) and frequency modulation-FM (88-108 MHz) local radio stations, television local stations (54-806 MHz), cordless phones (900-928 MHz), walkie talkie systems (136-900 MHz), Wireless Local Area Network-WLAN Routers (2.4, 3.6, 4.9, 5, and 5.9 GHz), Global Positioning Systems-GPS (1575.42 and 1227.60 MHz) and microwave ovens (2,450 MHz) are all considered as sources of Electromagnetic (EM) waves radiation. Many people consider these radiations as a possible cause of serious complications on health as cancer (Moulder JE, Foster KR et al. 2005, Blettner M, Schlehofer B et al. 2009). Due to this possible risk, the World Health Organization (WHO) and Federal Communication committee (FCC) put restrict limitations for the maximum level of radiations that may be harmless for the human beings, based on scientific research in this field (International Commission on Non-Ionizing Radiation Protection 1998, Physicians for safe technology 2020). This radiation level must not be exceed. Most of the wireless systems manufactures ensure that their products do not exceed the...
maximum levels of radiations. In our country, some researchers have studied the radiations from mobile communication base stations to evaluate if they are below the limits (Yassin S, Musleh M. et al. 2019). These previous studies have focused on only one radiation source, but in real life, people are affected by radiations from different wireless systems mentioned above, so it is important to evaluate the safety of exposure to all these sources at the same time (Snawder JE 1999). In this study, all wireless systems will be tested at the same time.

Many people all over the world think that exposure to mobile phone base stations and other sources of radiations many cause adverse health effects (Blettner M, Schlehofer B et al. 2009). The epidemiological evidence for a causal association between cancer and radiofrequency (RF) energy is limited. Epidemiologic evidence sometimes show a possible link between exposure to EM field and an increased risk for certain types of cancer (Snawder JE 1999). However, the evidence is limited and more studies are needed (Moulder JE, Foster KR et al. 2005). There is evidence that long term, low level exposure to high frequency EM field may result in a number of symptoms as headaches, fatigue, sleep disorders, memory impairments, they were called “microwave sickness syndrome” (Hutter HP, Moshammer H et al. 2006). In a previous review, some studies showed increased prevalence of adverse neurobehavioral symptoms or cancer in populations living at distances < 500 meters from base stations (Khurana VG, Hardell L et al. 2010). Surveys among people living close to base stations reported some complaints as sleep disturbances, irritability, depression, blurred vision, concentration difficulties, nausea and headache. They showed a relationship between the symptoms, the level of exposure, and the distance from base stations (Bortkiewicz A, Zmyślony M et al. 2004). In another study, there was a significant relation between headache and power density. Perceptual speed increased, while accuracy decreased insignificantly with increasing exposure levels, so they concluded that despite very low exposure to HF-EMF, effects on wellbeing cannot be ruled out (Hutter HP, Moshammer H et al. 2006).

The prevalence headache, memory changes, dizziness, depression and sleep disturbance were significantly higher among people living near mobile phone base stations than controls in a study from Egypt. People near mobile base stations showed significantly lower performance in tests of attention and short-term auditory memory (Abdel-Rassoul G, El-Fateh OA et al. 2007).

In the Palestinian society, there has been great concern about the consequences of radiation on the human health. People have always connected between the increasing number for cancer patients and the radiations, which causes many disturbances when mobile companies want to install new base stations, especially in urban areas or areas close to kids’ schools.

Most of the researches that have been done in this field –to remove the fear- are sponsored by mobile companies, which make them not accepted by the public. This study should be considered as a reliable study as it is done and sponsored by third party. The aims of this study were to measure radiofrequency radiation levels from different wireless systems and to compare the results with the recommended limits by the World Health Organization (WHO), in addition to evaluating people knowledge and perception regarding radiations.
MATERIAL AND METHODS:

The study was a cross-sectional study covering an area of about 2000Km2 that was conducted in different cities and villages from the northern governorates in the West Bank; Jenin, Tulkarm, Nablus, Qalqilya, Tubas and Salfit in order to determine the dangerous places (if found). The targeted area was shown in Figure (1).

To measure the radiation levels ranging from 80 MHz to 2 GHz, a Portable Field Strength Meter with the suitable set of antennas was used. This frequency range covers the radiations from different sources as mobile phone base stations, local radio and television stations, mobile phones, Wireless Local Area Network, Bluetooth, wireless computer periphery and even microwave ovens. Points close to mobile phone base stations and local radio and television stations in addition to randomly selected points were included.

The scanning process for each point was done four times: summer-day, summer-night, winter-day and winter-night, in order to include the weather effects and to ensure that no temporarily disabled system is excluded from the study, the higher reading of the four readings was included in the analysis. The results were compared to the recommended limits of radiations by WHO.

In the second part of the study, a short questionnaire was distributed to evaluate community knowledge and perception regarding radiations. A cross-sectional design was used to collect a convenient sample.

RESULTS:

A total of 2000 readings were obtained from different locations in the targeted area as shown in Table (1), with a mean ± SD = 0.25 ± 0.214 µw/cm2. The highest reading was 1.91 µw/cm2.

<table>
<thead>
<tr>
<th>Governate</th>
<th>Urbans</th>
<th>Locations</th>
<th>Readings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nablus</td>
<td>46</td>
<td>385</td>
<td>1540</td>
</tr>
<tr>
<td>Tulkarm</td>
<td>29</td>
<td>260</td>
<td>1040</td>
</tr>
<tr>
<td>Qalqilia</td>
<td>28</td>
<td>228</td>
<td>912</td>
</tr>
</tbody>
</table>
All the readings were below the limits of radiations recommended by the WHO. Most of the readings in the tested area (59.2%) were between 0.1 - 0.45 µw/cm² which are 1000-4500 time less than the maximum allowed level (450 µw/cm²). 527 (26.35%) readings were <0.1 µw/cm², 271 (13.55%) reading were between 0.45 - 1 µw/cm² and the rest 17 (0.85%) were >1 µw/cm² which were still 236-450 times less than the allowed WHO level. Table (2) and Figure (2) summarize these results.

### Table (2): Ranges of radiation values from different parts of northern West Bank

<table>
<thead>
<tr>
<th>Range</th>
<th>Number</th>
<th>Percentage</th>
<th>Ratio &lt; the allowed WHO level</th>
</tr>
</thead>
<tbody>
<tr>
<td>x&lt;0.1</td>
<td>527</td>
<td>26.35%</td>
<td>&lt;4500 µw/cm²</td>
</tr>
<tr>
<td>0.1&lt;x&lt;0.45</td>
<td>1185</td>
<td>59.25%</td>
<td>1000-45000 µw/cm²</td>
</tr>
<tr>
<td>0.45&lt;x&lt;1</td>
<td>271</td>
<td>13.55%</td>
<td>450-1000 µw/cm²</td>
</tr>
<tr>
<td>x&gt;1</td>
<td>17</td>
<td>0.85%</td>
<td>236-450 µw/cm²</td>
</tr>
</tbody>
</table>

The questionnaire part of the study included 1354 participants, among them 718 (53%) were males, around half of them (52%) were from the age group 18-25 years, most of them (72%) had bachelor degree, 70% of them either strongly agreed or agreed that they use mobile phones several times daily, 91% either strongly agreed or agreed that radiations around us are dangerous, 72% either strongly agreed or agreed that radiations from mobile devices are dangerous. A high percentage of participants thought that radiations from mobile base stations are more dangerous that mobile phones, radiations may cause cancer and that the increase in cancer cases is due to the increased use of mobile phones, so they prefer not to have mobile base stations close to their living places. Table (3) below summarizes these results.

### Table (3): Response of participants to questions related to EM radiations

<table>
<thead>
<tr>
<th>Question</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I use mobile phones several times daily</td>
<td>40</td>
<td>30</td>
<td>25</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Radiations around us are dangerous</td>
<td>62</td>
<td>29</td>
<td>2</td>
<td>6</td>
<td>1</td>
</tr>
</tbody>
</table>
Radiations from mobile devices are dangerous  49  23  15  9  4
Radiations from mobile base stations are more dangerous than mobile phones  59  21  6  4  10
Mobile communication systems may cause cancer  30  35  5  22  8
The increase in cancer cases is due to the increased use of mobile phones  33  39  12  7  9
I prefer not to have mobile base stations close to my living place  42  37  14  6  1
Radiations from mobile communication systems is the major source of environmental pollution  63  18  2  10  7
There is government control over the radiation levels from communication towers  12  15  21  24  28
The level of radiation from the mobile phone is not affected by the distance between you and the service tower  6  9  3  45  37

DISCUSSION:

All the 2000 readings from different cities and villages in the Northern part of the West Bank in this research were lower than the electromagnetic radiation level allowed by the WHO. This is similar to a previous study from Tulkarm city where all the reading were also less than the maximum allowed level (Khatib M 2014). This is similar to some other studies from other countries that measured electromagnetic radiofrequency radiation exposure and found that they were below international limits as in Poland (Gryz K, Karpowicz J et al. 2014), Saudi Arabia (Alhekail ZO, Hadi MA et al. 2012) and most European countries (Gajšek P, Ravazzani P et al. 2015). In an updated systematic review to evaluate the exposure patterns between different types of environments in Europe. Mean outdoor exposure values ranged from 0.07 to 1.27 V/m and RF-EMF exposure levels were highest in the transportation systems followed by outdoor and private indoor environments. They concluded no noticeable increase in everyday RF-EMF exposure since 2012 despite increasing use of wireless communication devices (Jalilian H, Eeftens M et al. 2019). In another updated study from Turkey, RF-EMF measurements were conducted between 2016 and 2018; measurement results were compared with the limit values by Turkey’s Information and Communication Technologies Authority (ICTA) and International Commission on Non-Ionizing Radiation Protection (ICNIRP). They found that overall, RF-EMF values did not exceed these limits and they were below levels that threaten public health (Kurnaz C and Mutlu M 2020).

The questionnaire part shows that most of the participants feel afraid from electromagnetic radiations and they think they are a cause of cancer, their fear was mainly from mobile base stations as most of them refused to have them close to their living places. In fact, this topic is complicated because conflicting results can be found. Some reviews show a relationship between EMR exposure and some cancers as brain cancer or leukemia in children, they confirm that more studies with larger sample size are needed (Bielsa-Fernández P and Rodríguez-Martin B 2018). On the other hand, a review from 2019 concluded
that there is no consistent evidence supporting important health effects caused by exposure to low intensities of radiofrequencies among general population (Elwood M and Wood AW 2019). The radiation readings in this study may be used to decrease the fear among the community, the causes of cancer are complicated and studies were not able to find direct connection between allowed levels of electromagnetic radiations around us and cancer. Although more clinical studies are needed, theoretically these levels of radiations are safe.

Regarding other symptoms as headache and loss of concentration, some studies showed that long term, low level exposure to high frequency EM field may result in some symptoms (Bortkiewicz A, Zmyslony M et al. 2004, Hutter HP, Moshammer H et al. 2006, Abdel-Rassoul G, El-Fateh OA et al. 2007, Khurana VG, Hardell L et al. 2010). As these effects cannot be ruled out until more data is available, it is recommended to limit exposure to EM as much as possible specially for children who spend hours on mobile phones and tablets. Most respondents in this study thought that radiations from mobile devices are dangerous. Data about this subject is also inconsistent. Some studies recommend to keep the mobile phones more than 10 cm from the body during calls (Buckus R, Strukcinskiene B et al. 2014) as most public exposure to EM radiations comes from mobiles and wireless portable devices (Gajšek P, Ravazzani P et al. 2015).

CONCLUSION:

In this study, a scanning for all electromagnetic radiation sources caused by different sources of wireless communication systems which covers the commercial communication systems, WiFi, television, FM stations and mobile base stations showed theoretically no dangerous radiation levels and all the recorded levels were much lower than the recommended levels by the WHO. Most people feel afraid from radiations and think they are dangerous.

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