

Evaluation of Electromagnetic Radiation Safety from Wireless Transmission Systems in Tulkarm City - Palestine

Mutamed Khatib

Palestine Technical University – Kadoorie, Palestine

Abstract—*Electromagnetic fields of all frequencies represent one of the most common and fastest growing environmental influences, about which anxiety and speculation are spreading. There is a general concern on the possible hazardous health effects of exposure to these radiations. This paper aims to measure radiofrequency radiation levels from different wireless systems at the same time and to compare the results with the recommended limits by the International Commission on Non-Ionizing Radiation Protection (INCRIP) and the World Health Organization (WHO), and to develop a radiation scale for the city of Tulkarm to determine the dangerous places (if found) and give recommendation to the society. After taking 150 readings from all over Tulkarm city in the frequency range 100 KHz to 3GHz, all the readings were below $1.6\mu\text{w}/\text{cm}^2$, which are below the limits of radiations recommended. Most of the readings in tested area (62% of the area) were below $0.1\mu\text{w}/\text{cm}^2$, which are > 4500 time less than the maximum allowed level ($450\mu\text{w}/\text{cm}^2$), which is equivalent to less than 0.022% of that level.*

Index Terms—Palestine, Radiation, Safety, Wireless Communications.

I. INTRODUCTION

Wireless systems are penetrating into our society at an explosive growth rate. Cellular communications base stations, Amplitude Modulation (AM) and frequency Modulation (FM) local radio stations, television (TV) local stations, cordless phones, mobile units, wireless communication systems, walkie talkie systems, Wireless Local Area Network (WLAN) Routers, Global Positioning Systems (GPS) and microwave ovens are all considered as sources of Electromagnetic (EM) radiations. There is a general concern on the possible hazardous health effects of exposure to radiofrequency electromagnetic radiations (RFR) on the humans. These radiations are always believed to be a potential cause of serious problems on human health such as cancer [1,2]. For this reason, many world organizations such as the International Commission on Non-Ionizing Radiation Protection (INCRIP) and the World Health Organization (WHO) have published guidelines (exposure limits) for a maximum exposure. They are based on an extensive number of related scientific publications [3,4]. Electromagnetic fields (EMF) of all frequencies represent one of the most common and fastest growing environmental influences, about which anxiety and speculation are spreading. All populations are

now exposed to varying degrees of EMF, and the levels will continue to increase as technology advances. The WHO has recommended investigating the effects of exposure to emissions from mobile phone base stations and other sources to address public concerns [3]. A substantial proportion of the population is concerned about adverse health effects caused by exposure to mobile phone base stations and other sources of radiations, and many attributed their personal adverse health effects to this exposure [2]. The epidemiological evidence for a causal association between cancer and RF energy is limited. Epidemiologic evidence has demonstrated a putative link between exposure to EMF and an increased risk for certain types of cancer in some studies [5]. However, the existing epidemiology is limited and the possibility of epigenetic effects has not been thoroughly evaluated [1]. There is evidence that long term, low level exposure to HF-EMF may result in a number of symptoms (for example, headaches, fatigue, sleep disorders, memory impairments), attributed as microwave sickness syndrome [6]. In a review in 2010, a total of 10 epidemiological studies that assessed for putative health effects of mobile phone base stations were found, eight of the 10 studies reported increased prevalence of adverse neurobehavioral symptoms or cancer in populations living at distances < 500 meters from base stations [7]. The results of questionnaire surveys revealed that people living in the vicinity of base stations reported various complaints mostly of the circulatory system, but also of sleep disturbances, irritability, depression, blurred vision, concentration difficulties, nausea, lack of appetite, headache and vertigo. The performed studies showed the relationship between the incidence of individual symptoms, the level of exposure, and the distance between a residential area and a base station [8]. For example, in a study by Hutter et al there was a significant relation of some symptoms to measured power density; this was highest for headaches. 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 and performance cannot be ruled out [6]. In another study from Egypt, the prevalence of neuropsychiatric complaints as headache (23.5%), memory changes (28.2%), dizziness (18.8%), tremors (9.4%), depressive symptoms (21.7%), and sleep disturbance (23.5%) were significantly higher among exposed inhabitants living nearby mobile

phone base stations than controls: (10%), (5%), (5%), (0%), (8.8%) and (10%), respectively ($P < 0.05$). The exposed inhabitants exhibited a significantly lower performance than controls in one of the tests of attention and short-term auditory memory. They concluded that inhabitants living nearby mobile phone base stations are at risk for developing neuropsychiatric problems and some changes in the performance of neurobehavioral functions either by facilitation or inhibition [9]. Most wireless phones and their corresponding base stations operate at a very low power output and in the radiofrequency range of 800 to 2000 Megahertz. Current international guidelines protect against thermal biological effects in terms of the local or whole-body specific absorption rate (SAR). Potential non-thermal bio-effects resulting from the use of wireless phones are not established and laboratory (i.e., in vitro, in vivo) studies have shown conflicting results. Epidemiological studies of potential human health effects are few but are expected to emerge in the near future. Challenges to epidemiological research include difficult exposure assessment, selection of appropriate controls, potential confounding bias, and validation of outcome [10]. Until further data is available, it is important not to exceed the exposure limits in the current international guidelines. In Palestine - similar to other parts of the World- the consequences of exposure to radiations on the human health are major public health concern. 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 schools and universities. In our country, there are very few studies in this field; some researchers have studied the mobile communication base stations to verify that the radiation levels from these stations are below the limits. These previous studies have focused on only one radiation source to test its compatibility, but in real life, the human body is always affected by the sum of radiations caused by the wireless systems mentioned above, so it is important to evaluate the safety of exposure to all these sources at the same time. Most of the researches that have 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 a third party. The objectives of this study are to measure radiofrequency radiation levels from different wireless systems at the same time and to compare the results with the limits recommended by the INCRIP and the WHO. Another objective is to develop a radiation scale for the city of Tulkarm to show the radiation levels at each point, especially around the base stations of Jawwal and Wataniya mobile companies, TV and FM local stations transmitter, class rooms with too many mobile units inside them and buildings with WLANs service, in order to determine the dangerous places (if found) and give recommendation to the society.

II. METHODOLOGY

A Portable Field Strength Meter with the appropriate set of antennas (available in my department at Palestine Technical University) were used to measure the radiation levels, which covered the frequency range from 80 MHz to 2 GHz. This frequency range covers most of the operating antennas and devices used for different applications. This instrument system has the ability to measure the radiations from any source. This research study took into consideration the radiations from different sources like mobile phone base stations, local radio and TV stations, in addition to cordless phones, WLAN, TV, Bluetooth, wireless computer periphery and microwave ovens. Measurements were done in streets and neighborhoods to all mobile phone base stations and local radio and TV stations in addition to randomly selected points in the city. The scanning process for each point was done twice at two different times to ensure that no temporarily disabled system is excluded from the study and the mean of them was registered. The results were compared to the recommended limits of radiations by the International Commission on Non-Ionizing Radiation Protection (INCRIP) and the World Health Organization (WHO) [3,4]. Two teams (two qualified telecommunication engineers in each team) participated in data collection, which took around four months.

III. TESTED AREA

Tulkarm ($32^{\circ}18'42''N$ $35^{\circ}01'38''E$) is one of the major cities in the north of West Bank, Palestine. The city is situated on the western edge of northern West Bank, in the foothills of the Samarian Mountains about 15 kilometers (9.3 mi) west of Nablus and Jenin and 15 kilometers (9.3 mi) east of the Israeli coastal town of Netanya. It is bordered by the 1948 cease-fire line, with Haifa District in the west, and Qalqiliya and Ramallah Districts to the south. [15]. Tulkarm is considered as an important trade center in the north of Palestine, with population of about 70000 citizens live in an area of 5Km^2 , so, Tulkarm is considered as a high density population city. In Tulkarm, wireless communication towers can be easily found. There are transmission towers for three local TV stations, two FM radio stations and mobile base stations for two different mobile companies. WiFi routers are widely used, and almost each house contains a wireless router. Also, wireless signals are detected from other neighborhood Israeli cities.



Fig. 1: West Bank, Palestine [15]

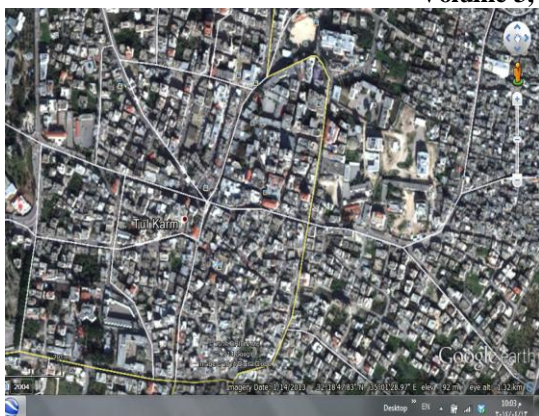


Fig.2: Tested area in the center of Tulkarm [16]

IV. RESULTS AND DISCUSSION

After taking 150 readings from all over Tulkarm city in the frequency range 100 KHz to 3GHz, all the readings were below $1.6\mu W/cm^2$, which are below the limits of radiations recommended by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) and the World Health Organization (WHO). As shown in Table 1, most of the readings in tested area (62% of the area) were below $0.1\mu W/cm^2$, which are > 4500 time less than the maximum allowed level ($450\mu W/cm^2$), which is equivalent to less than 0.022% of that level.

In the places where mobile stations or TV stations were placed, a rise in the radiation level was noticed. In 24% of the test area, the radiation levels were between $0.1\mu W/cm^2 - 0.450\mu W/cm^2$, which is considered very low also when compared with the maximum allowed level. This range is about 2000 times (in average) less than the maximum, or 0.05% of it. Going up to high places in Tulkarm, specially in the old market, more radiations could

be measured (specially from the Israeli mobile stations), that increased the readings to the range $0.450\mu W/cm^2 - 1\mu W/cm^2$. Comparing these readings to the limit showed that we are still far away from the maximum (dangerous) level, which is considered about 750 times less than the danger level, or 0.15% of the maximum. The highest reading was measured on the top of the buildings in Paris street, which was $1.6\mu W/cm^2$ (281 times less than the maximum, or 0.356% of it) So, according to the international guidelines, the levels of radiations from wireless systems in Tulkarm city are far below the allowed levels and are considered safe. The community must be educated about this important issue, in order to remove the fear from wireless communications and its effect on human health, and open their eyes on other possible causes that may increase the risk of cancer. In other countries, studies carried out throughout the world concentrated on mobile base stations only and have not revealed excessive values of standards adopted by the ICNIRP [8,9]. For example, in Austria, total HF-EMF and exposure related to mobile telecommunication were far below recommended levels (max. 4.1 mW/m²). Distance from antennae was 24-600 meter in the rural area and 20-250 meter in the urban area. Average power density was slightly higher in the rural area (0.05 mW/m²) than in the urban area (0.02 mW/m²) [6]. In Saudi Arabia, exposures from mobile base stations in Riyadh were generally found to be in the range of 0.313 to 0.00000149% of the ICNIRP general public reference level, and the greatest exposure near any of the base stations was 21.96 mW/m² for a wideband measurement in the 75-3000 MHz frequency range [11].

Table 1: Summary of Results

	Area (%)	Radiation Range	Times less than max	Reading/max (%)
1	62%	$< 0.1\mu W/cm^2$	<4500	<0.022%
2	24%	$0.1\mu W/cm^2 - 0.450\mu W/cm^2$	1000-4500	0.022%-0.1%
3	12%	$0.450\mu W/cm^2 - 1\mu W/cm^2$	450-1000	0.1%-0.22%
4	02%	$1\mu W/cm^2 - 1.60\mu W/cm^2$	281-450	0.22%-0.356%

From the United Kingdom, Cooper et al found that exposures near GSM microcell and picocell base stations were generally in the range 0.002-2% of the ICNIRP general public reference level, and the greatest exposure quotient near any of the base stations was 8.6%. Exposures close to microcell base stations were found to be generally greater than those close to microcell base stations [12]. In a study from China, the results showed that the GSM band EMF level near 827 base stations was very low and within the

limits also [13]. In our country, we could find Master thesis from al-Quds University, which measured the radiations near 33 mobile base stations for Jawwal Company and they found that the levels of electromagnetic emission was well below recommended ICNIRP's limit for general public. The maximum electromagnetic emission from a single site was $0.413\mu W/cm^2$ and found at Hizma site near Jerusalem [14]. The findings of this study give base-line data about the radiation levels in the Palestinian cities. Although this study

has been done in one city only, it gives an idea about the situation in the West Bank in general because the sources of radiations in our cities are expected to be similar. This study can be helpful in increasing the awareness of the community and remove the fears about the effect of wireless communication systems on the human health. The findings from this study tell that the levels of radiations are below the international recommended guidelines which reflect safe levels theoretically. However, other studies and opinions tell that harmful effects are possible even with these very low levels of radiations. So, other clinical studies are needed to show if these levels of radiations are completely safe or not.

V. CONCLUSION

In this paper, a scanning for all the electromagnetic radiation sources caused by wireless communication systems generated inside Tulkarm city, or arrive from outside it were done. A wide frequency range that cover the commercial communication systems, WiFi, TV and FM stations and mobile base stations are taken into consideration. No dangerous radiation levels were found, and all the recorded levels where found to be under the recommended levels.

VI. ACKNOWLEDGMENT

Author would like to thank Palestinian American Research Center (PARC) for supporting this project, and Palestine Technical University – Kadoorie for allowing using their equipments.

REFERENCES

[1] Moulder JE, Foster KR, Erdreich LS, McNamee JP. Mobile phones, mobile phone base stations and cancer: a review. *Int J Radiat Biol.* 2005; 81(3):189-203.

[2] Blettner M, Schlehofer B, Breckenkamp J, Kowall B, Schmiedel S, Reis U, Potthoff P, Schüz J, Berg-Beckhoff G. Mobile phone base stations and adverse health effects: phase 1 of a population-based, cross-sectional study in Germany. *Occup Environ Med.* 2009; 66(2):118-23.

[3] World Health Organization. International EMF Project, Agenda for research. Available at: <http://www.who.int/peh-emf/research/agenda/en>

[4] International Commission on Non-Ionizing Radiation Protection. Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz). *Health Phys* 1998; 74:494–522.

[5] Snawder JE. Effect of magnetic field exposure on anchorage-independent growth of a promoter-sensitive mouse epidermal cell line (JB6). *Environ Health Perspect.* 1999; 107(3):195-8.

[6] Hutter HP, Moshammer H, Wallner P, Kundi M. Subjective symptoms, sleeping problems, and cognitive performance in subjects living near mobile phone base stations. *Occup Environ Med.* 2006; 63(5):307-13.

[7] Khurana VG, Hardell L, Everaert J, Bortkiewicz A, Carlberg M, Ahonen M. Epidemiological evidence for a health risk from

mobile phone base stations. *Int J Occup Environ Health.* 2010; 16(3):263-7.

[8] Bortkiewicz A, Zmyslony M, Szykowska A, Gadzicka E. Subjective symptoms reported by people living in the vicinity of cellular phone base stations: review. *Med Pr.* 2004; 55(4):345-51.

[9] Abdel-Rassoul G, El-Fateh OA, Salem MA, Michael A, Farahat F, El-Batanouny M, Salem E. Neurobehavioral effects among inhabitants around mobile phone base stations. *Neurotoxicology.* 2007;28(2):434-40.

[10] Masley ML, Habbick BF, Spitzer WO, Stuchly MA. Are wireless phones safe? A review of the issue. *Can J Public Health.* 1999; 90(5):325-9.

[11] Alhekail ZO, Hadi MA, Alkanhal MA. Public safety assessment of electromagnetic radiation exposure from mobile base stations. *J Radiol Prot.* 2012; 32(3):325-37.

[12] Cooper TG, Mann SM, Khalid M, Blackwell RP. Public exposure to radio waves near GSM microcell and picocell base stations. *J Radiol Prot.* 2006; 26(2):199-211.

[13] Wu T, Shao Q, Yang L, Qi D, Lin J, Lin X, Yu Z. A large-scale measurement of electromagnetic fields near GSM base stations in Guangxi, China for risk communication. *Radiat Prot Dosimetry.* 2012.

[14] Jehad Abu Lekbash. Assessment of Environmental Electromagnetic Radiation from Mobile Telephone Base Station Towers in the West Bank and Gaza Strip. Master thesis, Al-Quds University, 2005.

[15] <http://en.wikipedia.org/wiki/Tulkarm>

[16] Google Earth, v. 7.1.2.2041, build date 10/7/2013

AUHTOR'S PROFILE

Mutamed Khatib Received B.Sc. in Telecommunication Engineering from Yarmouk University, Irbid, Jordan in 1996 and M.Sc. in Electrical & Electronic Engineering from Jordan University for Science & Technology, Irbid, Jordan in 2003. He received his Ph.D. Degree in Wireless and Mobile systems from University Sains Malaysia (USM), Malaysia in 2009. His research Interests are in the field of mobile networks and coding such as: Broadband Access Network and Services, Adaptive Signal Processing for Wireless Communications and Cellular Networks.

From 1996 to 2005, he worked as Transmission, Outside Broadcasting & Studio Engineer in Palestinian Broadcasting Corporation (PBC). From 2005 to 2009 he worked as an instructor in the Department of Electrical Engineering, Palestine Technical University (Kadoorie), Tul Karm – Palestine. Since September 2009, Dr Mutamed Khatib is working as Assistant professor in the same university and he is the dean of college of engineering and technology there, in where he is teaching advanced courses in telecommunications and coding.

Dr. Khatib has a number of publications to his credit in various international journals and conference proceedings. He is the editor of a book titled “Advanced Trends in Wireless Communications” published by INTECH Open Access Publisher from Croatia in 2011, and he is the author of two scientific books and two book chapters. Dr. Khatib is an editor and reviewer for many international journals in his field, a member of IEEE, Palestinian Engineers Association.