

Effects of Electromagnetic Radiation from Microwave Ovens on Workers' Health at Cafeterias in Some Higher Educational Institutions in Palestine

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ABSTRACT

This study highlights the effects of electromagnetic radiation from microwave ovens on the health of the workers who are exposed to microwave radiation during their work at cafeterias in four higher educational institutions in northern part of Palestine. The sample consists of 28 workers in all cafeterias. Measurements of heart pulse rate, blood oxygen saturation, tympanic temperature, systolic and diastolic blood pressure were taken three times between (8:00-8:30) am and another three times at the same day (2:00 till 2:30 pm) at the end of their shift. The results demonstrate that the average of the measured values of radiation leakage equals 46.126 mW/m^2 . The average values of radiation leakage are small compared with the standard value which equals 510^4 mW/m^2 recorded by American National Standard Institute. It has been concluded that there is a correlation between radiation leakage from microwave ovens with oven's age, distance from oven, and the duration of use. Using measurable health parameters to detect the effect on workers' health reveals that there is no dangerous health effects of microwave radiation from microwave ovens used in the cafeterias of the university under study.

INTRODUCTION

The worldwide technology development is dramatically increased. This generates a great interest by people to follow the evolution.

Environmental pollution occurs in different forms, air, water, soil, radioactive, noise, thermal, and light pollution. Pollution in its various types doesn't simply negatively affect the natural world, but they can have measurable impact on human being^[1].

Microwave radiations are used in many areas of science and technology such as television, radar, and microwave ovens^[2]. Moreover microwave radiation is used to treat muscle soreness, but the most commonly used is in microwave ovens^[3].

Despite the benefits resulting from the use of microwave radiation application, there are many risks that threaten people lives and affect human health. The intensive used of electromagnetic radiation technology make the pollution of electromagnetic field of radio frequency generate by telecommunication system is the biggest environmental problems of twentieth century^[4].

Literature Survey

During recent years, a large number of studies on the effect of electromagnetic radiation emitted by many sources had been carried out.

Alhekail in his study argued that user exposure to RF radiation from microwave ovens is much less than the public exposure limit set by most international standard at 2.45 GHz which is 10^4 mW/m², and that a detrimental effect on health is an unlikely result of exposure to radiation from microwave ovens^[5].

Radio frequency signals at an average specific absorption rate (SAR) of at least 5.0W/kg under extended exposure conditions are capable of inducing chromosomal damage in human lymphocytes. This research has been studied by Tice and his group^[6].

Han and his group in their study demonstrate that watching TV and using mobile phone during the first term pregnancy may increase risk of embryo growth ceasing significantly^[7]. A study was done by Mousa to measure the electromagnetic radiation from some cellular base station around the city of Nablus. He summarized that the measured and calculated values of electric field, magnetic field, and the power density were small compared to the international standards^[8].

People thought that, there is a dangerous health problem due to radiation leakage from microwave ovens. As a result of experiments, it's found that the maximum allowable leakage from a microwave oven is 5mW/cm^2 at 5 cm distance from the surface of microwave oven. So the only danger from the exposure to the radiation emitted by an oven is a thermal effect^[9]. Lahham and Sharabati in their study found that, the amount of radiation that can be leakage from microwave ovens at a distance 1 m vary from 0.43 to $16.4\mu\text{W/cm}^2$ with an average value equals to $3.64\mu\text{W/cm}^2$. They conclude that there is a linear relation between the amount of leakage with both oven age, and operating power^[10].

Objectives of the Study

The aims of this study are:

- To measure the amount of radiation leakage as a function of oven age, operating power and distance from ovens.
- To calculate the electric fields, magnetic fields, and SAR.
- To detect the effects of the electromagnetic radiation leakage on the workers by measuring the health factors which are heart pulse rate, blood oxygen saturation, tympanic temperature, and blood pressure.

METHDOLOGY

Study Sample

The sample population of this study consists of 28 workers distributed in some of cafeterias in four higher educational institutions in the northern part of Palestine. These workers are the only workers which use microwave ovens while working inside cafeterias. The study focuses on cafeterias in specific higher educational institutions which are An-Najah National University that is in Nablus city, the Arab American University which is located in Jenin city, Hisham Hijawi College is in Nablus city, and Palestine Technical University which is in Tulkarm city.

The workers' ages range between 20 to 55 years. The shift time of the workers is 6 hours per day. The chosen workers have good health records.

The sample population of this study also involves 15 microwave ovens with uniform size used in the cafeterias of the selected higher educational institutions.

Stages of the Study

Stages that have been adopted in this study are as follows:

- Visiting the higher educational institutions and take the permission for examination on workers and microwave ovens.
- Inform the workers about the nature of the study and taking their agreement for doing the measurements.
- Collecting the necessary information of the study concerning information about ovens such as dates of manufacturing, country of origin, operating power, and age, number of users, daily use, and location of the oven relative of the public and physical condition. Information about workers age, and employment duration.
- Measuring the light intensity of the cafeterias.
- Measuring the sound pressure levels in the cafeterias.
- Measuring the power flux density of the electromagnetic radiation in the cafeterias.
- Measuring several health parameters as:

- Heart pulse rate
- Blood oxygen saturation
- Tympanic temperature
- Arterial blood pressure (Systolic and Diastolic)

Experimental Apparatus

Sound Level Meter 2900

Measuring of noise level in the selected cafeterias was obtaining by using sound level meter (Instruction manual, 1998). It has an accuracy of ± 0.5 dB at 25 °C, with precision of 0.1 dB.

Lux Hitester

Hioki 3423 lux Hitester Digital illumination meter was used to measure the light intensity in different region in the selected cafeterias. It measures a broad range of luminosities.

Acoustimeter RF Meter

Acoustimeter AM-10 RF Meter was used to measure radiation from different sources. Power flux density in this study was measured by using this device. It is measures RF radiation from 200 MHz right up to 8 GHz ± 3 dB.

Micro Life Blood Pressure Meter

Automatic Blood Pressure Monitor (Instructions Manual, 1998a) was used to determine arterial blood pressure systolic, diastolic and heart pulse rate values.

Measuring range is 30-280 mmHg, with accuracy ± 0.02 mm-Hg, and $\pm 2\%$ for reading heart pulse rate with operating temperature range of $+10\text{ }^{\circ}\text{C}$ to $+40\text{ }^{\circ}\text{C}$.

Pulse Oximeter

Pulse Oximeter LM-800(Instructions manual, 2012).Finger Oximeter with accuracy $+ 1\%$ was used to measure the blood oxygen saturation of each worker in the cafeterias.

TempScan Thermometer

The GT-302/GT-302-1 ear thermometer instrument was used to measure human body temperature through the tympanic temperature of the ear. The display temperature range is 32.0 to $42.9\text{ }^{\circ}\text{C}$ with accuracy range $\pm 0.01\text{ }^{\circ}\text{C}$.

Scan Probe

Scan Probe was used to detect the presence of an electromagnetic field. It provides audio and visual indication of relative field strength.

RESULTS

Measurements of Light Intensity and Sound Pressure Levels

Table 1: Average values of light intensity level and sound pressure level in the cafeterias of the selected university

| Higher Educational Institutions Cafeterias | Light intensity level (Lux) | Sound pressure level (dB) |
|--|-----------------------------|---------------------------|
|--|-----------------------------|---------------------------|

| | | |
|---|--------|-------|
| An Najah National University Cafeterias | 424.93 | 54.03 |
| The Arab American University Cafeterias | 417.05 | 54.19 |
| Hisham Hijawi Cafeterias | 552.47 | 52.01 |
| Palestine Technical University Cafeterias | 200.51 | 52.73 |

It has been found that there are effects from sound level, light intensity and other electromagnetic waves ^{[11][12][13][14][15][16][17][18][19][20][21][22][23][24][25][26][27]}.

Calculation of Specific Absorption Rate (SAR)

Table 2: Average values of power flux density, electric field, magnetic field strength, magnetic flux density in the selected cafeterias.

| Cafeterias of higher education institutions | S(mW/m ²) (Measured) | E(V/m) (Calculated) | H(A/m) 10 ⁻³ (Calculated) | B(G) 10 ⁻⁸ (Calculated) |
|---|-------------------------------------|------------------------|--|--|
| NU | 65.67 | 5 | 13.20 | 1.66 |
| AU | 60.14 | 4.76 | 12.63 | 1.59 |
| HC | 31.50 | 3.45 | 9.14 | 1.15 |

| | | | | |
|----|-------|------|------|------|
| PU | 27.20 | 3.20 | 8.49 | 1.07 |
|----|-------|------|------|------|

The calculated values of electric field and magnetic field strength are small compared with the standard values which equal 137 V/m for electric field and 0.364 A/m for magnetic field strength.

Radiation Leakage with Distance

Fig. 1 Radiation leakage from microwave ovens as a function of distance

Radiation Leakage with Operating Power

Fig. 2 Average values of radiation leakage against ovens operating power

Radiation Leakage with Duration of Use

Fig. 3 Average radiation leakage from microwave ovens as a function of duration of use

Measurements of Health Parameters

Table 3: Average values of heart pulse rate, oxygen saturation, tympanic temperature, and arterial blood pressure systolic and diastolic, before (b) and after (a) exposure to microwave radiation for the tested workers.

| Health parameter | Average values (b) | Average values (a) | Normal Range |
|--------------------|-----------------------|-----------------------|-----------------|
| HPR(beats/min) | 78 | 81 | 60–100 |
| SPO ₂ % | 98 | 98 | 95%–100% |
| T(°C) | 33.0 | 33.6 | 33.6–37.6 |
| SBP(mmHg) | 134 | 132 | 120 |
| DBP(mmHg) | 78 | 81 | 80 |

Heart Pulse Rate Result

Fig. 4 Average values of heart pulse rate of workers before and after exposure to microwave radiation from microwave ovens of G₁ and G₂ of groups.

Blood Oxygen Saturation Result

Fig. 5 Average values of blood oxygen saturation of workers before and after exposure to microwave radiation of G₁ and G₂ groups.

Tympanic Temperature Results

Fig. 6 Average values of temperature of workers before and after exposure to microwave radiation of G₁ and G₂ of groups.

Blood Pressure Results

Fig. 7 Average values of systolic blood pressure of workers before and after exposure to microwave radiation of G₁ and G₂ groups.

Fig. 8 Average values of diastolic blood pressure of workers before and after exposure to microwave radiation of G₁ and G₂ groups.

Discussion

In this study a small change in the average values of the studied parameters has been observed. The normal range of the measured health parameter was set in table 3. The changes in the studied variables remain in the normal range of human beings. The average value of radiation leakage was small compared with the standard values set by the American National Standard Institute.

In Conclusion, there are no serious health effects of microwave radiation from microwave ovens on the workers of the cafeterias of the universities examined in this research.

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