

## Personal Exposure to Electromagnetic Fields Emitted from Household Electrical Appliances in Alexandria

Fadia A El-Marakby\*

### ABSTRACT

**Background:** While the benefits of electricity in everyday life are unquestionable, the public becomes increasingly concerned about the health effects of exposure to electromagnetic fields (EMF) at the power frequencies from common household current at 50-60 Hz range. Electromagnetic fields at homes depend on many factors including the distance from the local power lines, the number and type of electrical appliances in use at home, and the configuration and position of household electrical wiring. **Objective:** To determine levels of exposure to EMF at home. **Methods:** Thirteen electrical appliances which are most commonly used at home were selected. For each appliance two sets of measurements were taken. The first set was at a distance of 3 centimeters (cm) and the second set was at a distance of 100 cm. **Results:** The highest level of EMF was obtained from the vacuum machine and the hair dryer with a range of 154.6-198.3mG and 129.9-183.1mG respectively. Levels emitted from the CRT monitor were much more than those emitted from the LCD one. Field levels were substantially greater at small distances but they decreased rapidly with distance. There was a statistically significant difference between levels of electric appliances and background EMF except for terrestrial phone. **Conclusion:** People live in a bowl of electromagnetic radiation which affects the body. General consumption of electricity should be managed and unused electric appliances should be unplugged.

### INTRODUCTION

While the enormous benefits of using electricity in everyday life are unquestionable, the general public has become increasingly concerned about potential adverse health effects of exposure to electric and magnetic fields (EMF) at extremely low frequencies (ELF). Such exposures arise mainly from the transmission and use of electrical energy at the power frequencies from common household current at 50-60 Hz range. Electric and magnetic fields at homes depend on many factors including the distance from the local power lines, the number and type of electrical appliances in use at home, and the configuration and position of household electrical wiring. Electric fields around most household appliances and equipment typically do not exceed 500 V/m and magnetic fields

---

\*Occupational Health and Air pollution Department, High Institute of Public Health, Alexandria University.

typically do not exceed 150  $\mu$ T. In both cases, field levels may be substantially greater at small distances but they decrease rapidly with distance.<sup>(1)</sup>

Electromagnetic field radiation, both inside and outside the bedroom, is an important factor in poor sleep and consequently poor health. The TV screen, for example, will radiate energy all night, even after it has been unplugged. It can take hours, or even days, for the built-up voltage in TV to dissipate. Scientists have established that a simple clock radio or electric alarm clock near your head can radiate EMF into your brain and body. In the state of sleep, the body is 100-150 times more vulnerable to electromagnetic radiation hazard than when awake. Children are often up to 1000 times more sensitive to these fields when asleep.<sup>(2)</sup> The commonly reported chronic symptom in children and adolescents was fatigue.<sup>(3)</sup> Recent animal experimental studies have investigated the promotion of mammary tumors by exposure to magnetic fields. In these studies, a chemical initiated the

tumors then these tumors were exposed to the magnetic field but the results were inconsistent.<sup>(4)</sup>

One of the most common daily sources of EMF radiation is the cell phone. Cell phone electromagnetic radiation health hazards may include cancer, genetic damage, brain and other neurological problems, birth defects, increased blood pressure, impaired learning and short-term memory, disturbed sleep, headache and stress. Also if cell phone is used while driving, it can result in accidents or even death due to slowed reaction time. Body contact with a cell phone may also knock down brain speed in people who are sensitive to electromagnetic radiation. In fact, people are exposed to EMF 24 hours a day from a multitude of sources used regularly such as TVs, stereos, video cassette recorders, radios, mobile phones, computers, copiers, toasters, ovens, electric heaters, lamps, fluorescent lighting, dimmer switches, home and office wiring, electric toothbrushes, hair

dryers, electric shavers, and other electrical appliances.<sup>(5,6)</sup>

Epidemiologic studies revealed a causal relationship between mobile phone use and cancer. In addition, studies showed an increased risk of brain tumors following heavy cell phone use, and very early life exposure. The incidence of rare subtypes of brain tumors may be increased and thus further monitoring of brain tumors, especially during childhood is needed. There is a weak evidence of a causal relationship provided by some animal and in vitro studies, but genotoxicity assays, both in vivo and in vitro, are inconclusive.<sup>(7)</sup>

Electromagnetic hypersensitivity (ES) is a physiological disorder characterized by symptoms directly brought on by exposure to EMFs. It produces neurological and allergic symptoms including headache, eye irritation, dizziness, nausea, skin rash, facial swelling, weakness, fatigue, joint and muscle pain, buzzing/ringing in the ears, numbness, abdominal pain, breathing difficulty, and irregular heartbeats. Affected persons may

experience an abrupt onset of symptoms following exposure to a new EMF, such as fields associated with a new computer, or new fluorescent lights, or a new home or work environment.<sup>(9)</sup>

The medical and electric power communities have differing views on EMF exposure health effects but they all agree that there is no minimum daily safe level for EMF. In other words, no amount of EMF exposure can be considered safe. However, some voluntary guidelines exist. Russian researchers believe that 1/1000ths of mG (MilliGauss) should be the standard. In the US, where the usual background level of 60 Hz magnetic field is 0.5 mG, most states have adopted a 3 mG cutoff point. The US Environmental Protection Agency proposed a safety standard of 1 mG. Sweden has set a maximum safety limit of 1 mG. When electricians try to solve a magnetic field problem, they do their best to drop the level to 1 mG. Health studies indicated that EMFs over 100 mG can most certainly produce health

effects. Fields, as low as 1 mG, can be dangerous if body exposure is for a long period of time. Several international authorities (such as International Commission on Non-ionizing Radiation and European Committee for Electro-technical Standardization) have also set safety limits for public and occupational EMF exposure to 50-60 Hz. <sup>(8)</sup>

### **AIM OF THE STUDY**

The aim of the present study was to determine the levels of EMF emitted from electrical appliances at 30 and 100 cm.

### **MATERIALS AND METHODS**

**Study Design:** Descriptive environmental study.

**Study Setting:** The study was carried in a residential area to the East of Alexandria.

### **MATERIALS**

Thirteen electrical appliances which are most commonly used at home were selected. These appliances were laptop, television (TV), washing machine, hair dryer, electric iron, personal computer (PC), cell phone, electric

fan, electric oven, refrigerator, vacuum cleaner, deep freezer, and terrestrial phone.

### **Measurement Location and Duration:**

- 1- For each appliance two sets of measurements were taken. The first set was at a distance of 3 centimetres (cm). The second set was at a distance of 100 cm. These two sets were needed to declare the effect of distance on the strength of the EMF.
- 2- A trial was made to assess if different models of the same appliance have different strengths of EMF but no meaningful difference was found; so, only one model of each appliance was selected.
- 3- The duration of taking measurements was about six months.

### **MEASUREMENTS**

- 1- For each appliance, twenty measurements were taken. Ten measurements were at a distance of 3cm, and the other ten measurements were at a distance of 100 cm.

- 2- In case of the PC, measurements were done twice. First, when the appliance was connected to the Cathode Ray Tube (CRT) monitor, and second when connected to the Liquid Crystal Display (LCD).
- 3- In case of the washing machines, measurements were taken in different washing steps such as normal wash and wrung out.
- 4- In case of the electric fan, measurements were taken in different locations especially in the backward where the motor is located.
- 5- Measurements were taken using an EMF tester type DER EE, model DE-1008, and serial number F0010509.(10)
- 6- The background EMF level exposure which arises mainly from the transmission and use of electrical energy at the power frequencies from common household current at 50-60 Hz range were measured in a closed

room that did not contain any electrical appliances.

### **Statistical Analysis**

Data were entered and analyzed using the Statistical Package for Social Science (SPSS-13). Descriptive statistics and tests of significance were done.

### **RESULTS AND DISCUSSION:**

Table (1) and figure (1) represent the levels of exposure to EMF at home as a result of different electronic appliances. The highest level of EMF was obtained from the vacuum cleaner followed by the hair dryer with a range of 154.6-198.3mG, a mean of  $179.2 \pm 16.9$  and a range of 129.9-183.1mG, a mean of  $162.6 \pm 19.7$  respectively. There was a statistically significant difference between the levels of exposure to EMF at home as a result of different electronic appliances and the background levels of EMF that resulted from electric current and were measured at a room containing no appliances and having a range of 0.0 - 0.3 mG.

**Table 1: Different electromagnetic field levels at different distances from the selected electrical appliances**

Number	Electrical appliance	EMF§ (at 3 Cm)	EMF§ (at 100 Cm)	P-value#
1	Laptop (**n=10)	(1.9-12.6) 6.9±4.0	(0.2-2.5) 1.1±0.8	0.001*
2	TV (n=10)	(10.6-109.1) 46.7±30.7	(1.1-8.5) 3.1±2.2	0.001*
3	Washing machine (n=10)	(3.1-148.4*) 33.2±9.7	(0.2-19.4) 4.0±0.4	0.001*
4	Hair dryer# (n=10)	(129.9-183.1) 162.6±19.7	(0.2-4.8) 1.5±1.4	0.001*
5	Electric iron (n=10)	(17.3-79.2) 49.2±20.1	(0.1-1.1) 0.6±0.4	0.001*
6	Personal computer (CRT Monitor) (n=5)	(19.0-44.0) 29.08±9.7	(1.1-7.5) 4.42±2.86	0.011*
	Personal computer (LCD Monitor) (n=5)	(2.3-8.3) 3.1±0.55	(0.4-2.2) 1.36±0.71	0.0032*
7	Cell phone (n=10)	(1.8-24.6) 7.1±7.0	(0.1-1.6) 0.6±0.4	0.028*
8	Electric fan (n=10)	(3.2-129.1) 47.3±44.1	(0.2-2.0) 1.0±0.8	0.001*
9	Electric oven (n=10)	(38.1-80.1) 57.6±13.7	(0.4-1.9) 1.1±0.5	0.001*
10	Refrigerator (n=10)	(1.1-4.1) 1.8±0.8	(0.4-1.4) 0.7±0.3	0.021*
11	Vacuum cleaner# (n=10)	(154.6-198.3) 179.2±16.9	(0.8-4.9) 2.3±1.2	0.001*
12	Deep freezer (n=10)	(4.8-35.5) 10.8±9.7	(0.5-1.7) 1.2±0.4	0.031*
13	Terrestrial phone (n=10)	(5.1-29.1) 15.9±7.8	(0.1-0.8) 0.3±0.2	0.236

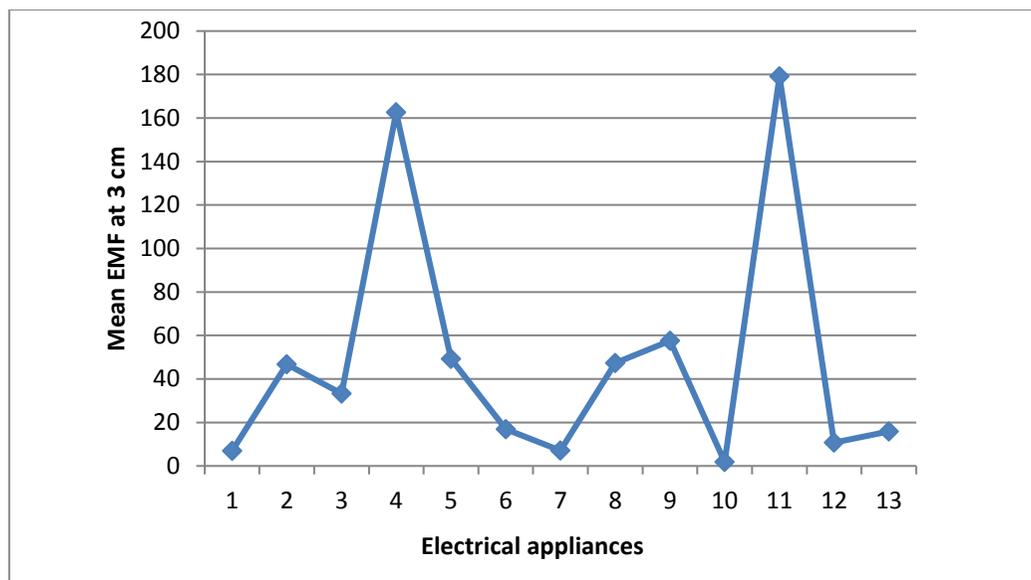
\*\*n: Number of readings for each appliance

§: EMF Strength is expressed in Milligauss (mG)

♣: Measured during Wrung out

#: The values may exceed the EMF-Tester level (200 mG)

#: Measurements of EMF at 3Cm were compared to background EMF(0.0 -0.3mG)



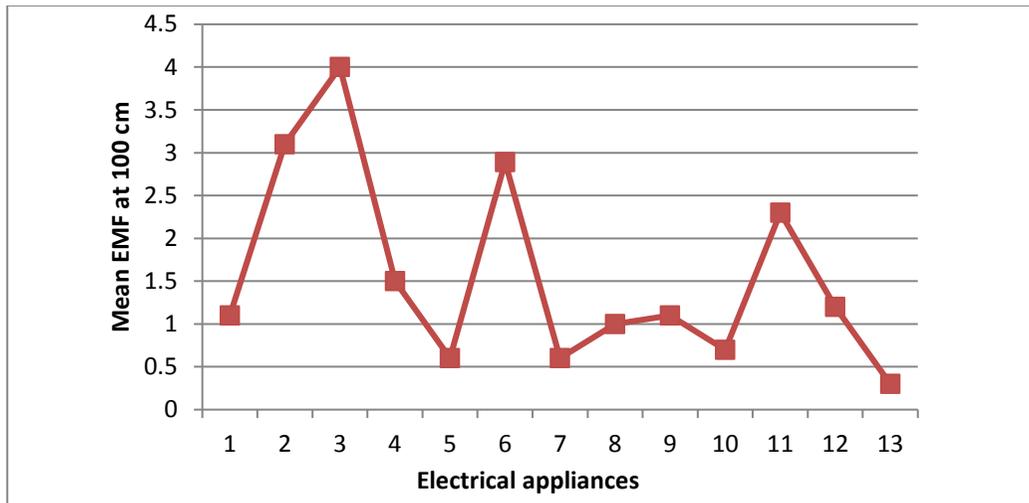
**Figure 1: Different electromagnetic field levels at 3 cm distance from the selected electrical appliances**

- |                       |                        |
|-----------------------|------------------------|
| (1) Laptop            | (8) Electric fan       |
| (2) TV                | (9) Electric oven      |
| (3) Washing machine   | (10) Refrigerator      |
| (4) Hair dryer        | (11) Vacuum cleaner    |
| (5) Electric iron     | (12) Freezer           |
| (6) Personal computer | (13) Terrestrial phone |
| (7) Cell phone        |                        |

Figure (2) shows the decline of EMF levels by distance away from the electrical appliances. According to figure (2); although the strengths of EMFs decreased dramatically by distance, they were still exceeding the EPA recommended levels of exposure (0.5 -2.5 mG) especially in case of TV, washing machine, and hair dryer.

The greatest concern about EMFs was not from a one-time use of a hair dryer, or an hour in front of a computer, but from cumulative exposures: hour after hour, day after day, continuous high levels of EMFs. The EMF exposure from hair dryers, heaters, electric shavers, and other appliances can be injurious to health over time. Food mixers, hair dryers, and vacuum cleaners emit EMFs that are 30 to 100 times greater than the suggested safe limit. Ordinary household appliances tended to generate larger cumulative EMF exposures than power lines. The reason was the

proximity; most people do not live close enough to power lines to be greatly affected by their EMFs, but the situation was different with kitchen appliances, computers, cell phones, TVs, and even electrical outlets if located behind the head of a bed. Although EMFs from appliances drop off at a distance of about 16 feet, people often stand or sit closer than this to the source of EMFs, typically 18 inches from computers, few feet from TVs, and almost no distance from cell phones. For safety, the EPA recommends limiting magnetic field exposure to 0.5 mG to 2.5mG. After more than 25 years of intensive study, the Swedish government established a safety limit for exposure to ELF magnetic field at 2.5 mG, and for very low frequency (VLF) magnetic fields at only0.25 mG. The Swedish standard is generally accepted throughout the world.<sup>(11)</sup>



**Figure 2: The decline of electromagnetic field levels\* by distance away from the electrical appliances (at 100 cm)**

\* Recommended levels of exposure are (0.5 – 2.5mG) according to EPA.

- |                       |                        |
|-----------------------|------------------------|
| (1) Laptop            | (8) Electric fan       |
| (2) TV                | (9) Electric oven      |
| (3) Washing machine   | (10) Refrigerator      |
| (4) Hair dryer        | (11) Vacuum cleaner    |
| (5) Electric iron     | (12) Freezer           |
| (6) Personal computer | (13) Terrestrial phone |
| (7) Cell phone        |                        |

## CONCLUSION

People live in a virtual fish bowl of electromagnetic radiation which affects every living cell of body. This exposure is increasing dramatically with the increasing use of telecommunications, electrical equipment and general consumption of electricity. Although the EMFs from appliances drop off by

distance, people often stand or sit closer to the source of EMFs.

## RECOMMENDATIONS

Powerful and simple tips to help lower your EMF risks include:

- Increase the distance between Yourself and the EMF source.

- Sit at an arm length from your computer terminal.
- Avoid unnecessary proximity to high EMF sources.
- Don't let children play directly under power lines or on top of power transformers for underground lines.
- Reduce time spent in the field.
- Turn off your computer monitor and other electrical appliances when you aren't using them especially in the bedrooms.

## REFERENCES

- 1- World Health Organization. Electromagnetic fields and public health: extremely low frequency (ELF). Geneva: WHO; 1998 Nov; Fact Sheet No: 205.
- 2- World Health Organization. Electromagnetic Fields (EMF). What is electromagnetic fields? Typical exposure levels at home and in the environment [Internet]. Geneva: WHO; 2013 [cited 2013 Jan 18]. Available from: <http://www.who.int/peh-emf/about/WhatisEMF/en/index3.html>.
- 3- Heinrich S, Thomas S, Heumann C, von Kries R, Radon K. The impact of exposure to radio frequency electromagnetic fields on chronic well-being in young people--a cross-sectional study based on personal dosimetry. *Environ int.* 2011;37(1):26-30.
- 4- Thomley PW. EMF at home: The National Research Council Report on the health effects of electric and magnetic fields [Internet]. Florida: Florida State University Journal of Land Use & Environmental Law; 1998 [cited 2013 Feb 28]. Available from: <http://www.law.fsu.edu/journals/landuse/Vol132/Thom.htm>
- 5- Johansson A, Nordin S, Heiden M, Sandström M. Symptoms, personality traits, and stress in people with mobile phone-related symptoms and electromagnetic hypersensitivity. *J Psychosom Res.* 2010; 68(1):37-45.
- 6- International Agency for Research on Cancer, World Health Organization (WHO/IARC). IARC classifies Radiofrequency Electromagnetic fields as possibly carcinogenic to humans [Internet]. Lyon: IARC; 2011 [cited 2013 Feb 13]. Available from: [http://www.iarc.fr/en/media-centre/pr/2011/pdfs/pr208\\_E.pdf](http://www.iarc.fr/en/media-centre/pr/2011/pdfs/pr208_E.pdf).
- 7- Awadalla H. Health effects of Mobile Phone. *Webmed Central Public Health.* 2013; 4(1). WMCID: 003946.
- 8- The International Commission on Non-Ionizing Radiation Protection (ICNIRP). New ICNIRP EMF exposure guideline released. In: *Health Physics.* 1998; 74 (4):494-522. Available from: <http://www.icnirp.de/documents/emfgdl.pdf>; retrieved at 18/ 1/2013
- 9- International Association of Certified Home Inspectors (Intern CHI). EMFs in the Home. *Electromagnetic Fields* [Internet]. Colorado: International Association of Certified Home Inspectors, Inc.; c2006-2013 [cited 2012 Dec 27]. Available from: <http://www.nachi.org/emfs.htm#ixzz2GDNhdS16>.
- 10- EMFields. How to measure EMFs from house wiring and appliances [Internet]. Sutton: EMFields; c2005 - 2013 [cited 2013 Mar 31]. Available from: <http://www.emfields.org/howto/measure-wiring-appliances.asp>.

11- ScanTech EMF Inspections. EMF RE Electric field Radiation Sound Safety Levels [Internet]. Dallas: Scan Tech EMF Inspections; c 2002-2013 [cited

2013 Dec 12]. Available from: [http://www.scantech7.com/EMF\\_RF\\_Electric\\_Field\\_Safety\\_Levels\\_Dallas\\_Fort\\_Worth.htm](http://www.scantech7.com/EMF_RF_Electric_Field_Safety_Levels_Dallas_Fort_Worth.htm).