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Evaluation of Electromagnetic Field Levels and Student Exposure at Aydın Adnan Menderes University Central Campus

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Keywords

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Abstract

With the effect of developing technology, humanity is constantly exposed to more electromagnetic fields. Regional studies are gaining importance for determining the possible problems. In this study, extremely low-frequency electromagnetic field (ELF-EMF) measurements were carried out in Aydın Adnan Menderes University Central Campus in areas where university students are frequently found, at 25 randomly selected points, in the region where high voltage lines pass and around transformers, and to evaluate the awareness of university students about the ELF-EMF they are exposed to. For this purpose, the necessary magnetic field and electric field strength measurements were made and a questionnaire was applied to determine the awareness level of the students. Results were evaluated by comparing them with the ICNIRP limit values. Accordingly, it has been concluded that Aydın Adnan Menderes University Central Campus can be accepted as a relatively safe area since electromagnetic field exposure values are within the ICNIRP safe limit values. In addition, as a result of the questionnaire, it was determined that the young people were conscious to a certain extent about ELF-EMF, but they did not pay attention to protect themselves against the possible effects of ELF-EMF. It is important to make the necessary initiatives in order to raise awareness of young people on this issue.

Cite

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1. INTRODUCTION

Radiation is electromagnetic wave (EMW) propagation and is associated with a center, radial direction with respect to the source. EMW is nothing but visible or invisible light according to its frequency and hence energy. In this respect, the speed of EMW in vacuum is 300000km per second (SI unit system). While anything with a temperature above zero degrees Kelvin (absolute zero) emits radiation and EMW, this can be for example infrared emission, radio wave emission, or nuclear radiation, depending on the energy of the emitted EMW. On the other hand, EMW is a wave with an electric and magnetic component. Electric field and magnetic field are transverse waves in terms of propagation direction and oscillation direction, oscillating in directions perpendicular to the EMW's propagation direction and to each other. When EMWs come together, electromagnetic field (EMF) is formed. Ionizing and non-ionizing radiation are the types of radiation. This distinction is made according to whether they have quanta carrying energy to ionize atoms or molecules (Umaç,

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2019). While non-ionizing radiation does not create charged ions in the material it passes through, ionizing radiation with higher frequency and shorter wavelength can pose a serious threat to health.

The presence of EMF in our environment is inevitable, and with the rapid development of technology and the increase in the place of devices that make life easier, we are exposed to EMF at a high rate. Non-ionizing radiation includes two types due to the frequency components they contain: extremely low-frequency EMF (ELF-EMF) and radio frequency magnetic fields (RF-MF) (Alkayyali et al., 2021). Energy transmission lines (high voltage lines and transformers) and household electrical appliances (refrigerator, vacuum cleaner, hair dryer, iron, electric blanket, computer, etc.) are sources of ELF-EMF (Evci et al., 2007). RF-MF is produced by base stations, cellular phones and radio-television transmitters. The effects of both types of EMF on human health have been reported (Gupta et al., 2022). Changes in nervous system activity, neurotransmitter release disorders, and functional changes in balance and learning are common examples of these effects (Kivrak et al., 2017).

The limit values for the possible effects of EMF on human health have been determined (Table 1) and accepted by the Commission on Non-Ionizing Radiation Protection (ICNIRP), which is also accepted by the World Health Organization (ICNIRP, 2002). Accordingly, the electric field strength limit value for high voltage lines and transformers is 5000V/m and the magnetic field strength limit value is 80A/m, which corresponds to approximately 1G. Electric field and magnetic field values decrease with distance from the ELF-EMF source (Raj et al., 2020). Therefore, it is accepted that being close to ELF-EMF sources will increase the health risk, and distance is considered an important variable in addition to the exposure level.

Table 1. *The frequency-dependent limit values of ICNIRP*

Frequency (f) Range	**Electric Field Strength (V/m)**	**Magnetic Field Strength (μT)**
Up to 1 Hz	-	4×10^4
1-8 Hz	10.000	$4 \times 10^4/f^2$
8-25 Hz	10.000	5.000/f
0.025-0.8 kHz	250/f	5/f
0.8-3kHz	250/f	6.25
3-150 kHz	87	6.25
0.15-1 MHz	87	0.92/f
1-10 MHz	$87/f^{1/2}$	0.92/f
10-400 MHz	28	0.092
400-2000 MHz	$1.375f^{1/2}$	$0.0046 \times f^{1/2}$
2-300 GHz	61	0.20

ELF-EMF was classified in the 2B category, which means "possibly carcinogenic" for humans, in accordance with the "precautionary principle" by the International Cancer Research Center (IARC) in 2002 (IARC, 2002). Although some epidemiological studies describe a relationship between various types of cancer and the use of ELF-EMF sources, there are also studies reporting opposite results (Franke et al., 2005; Kuribayashi et al., 2005; Barati et al., 2020). The main reason for these differences is the differences in electromagnetic field exposure times and control methods in these studies. For these reasons, the possible effects of electromagnetic field exposure on humans are one of the current problems that are still intensively researched and discussed today. In addition, symptoms such as psychological disorders (such as headaches, depression, etc.), immune system disorders, and effects due to decreased melatonin levels (such as sleep disorders) are also encountered due to exposure to ELF-EMF (Bolte et al., 2015). Considering such possible adverse effects, it is inevitable to locate EMF emitting devices and sources as far away from living areas as possible and to raise awareness about the electrical devices used.

The aim of the study was to perform ELF-EMF measurements in Aydın Adnan Menderes University Central Campus in areas where university students are frequent, at 25 randomly selected points, in the region where high voltage lines pass and around transformers, and to evaluate the awareness of university students about ELF-EMF they are exposed to.

2. MATERIAL AND METHOD

2.1. ELF-EMF Measurements

There are approximately 25000 students, 1500 personnel and more than 100 faculties, institutes, libraries, research hospitals, dormitories, rectorate, kindergartens, social facilities, mosques and shopping centers in Aydın Adnan Menderes University Central campus. In this study, electromagnetic field strength measurements were carried out at 25 randomly selected points in Aydın Adnan Menderes Central Campus and in areas where students are frequently found (classrooms, canteen, etc.) for 7 days in the morning and evening.

Magnetic field strength values were measured with Sypris gaussmeter (USA) and electric field strength values were measured with Narda EMR-300 (Germany) non-ionizing radiation meter. In addition, measurements were made in the areas under the energy transmission lines passing through the northern border of the campus and at a distance of 5 m from both sides, and around the transformers in the campus.

The measurements were made with Narda EMR-300 device and electric field probe in the 100 kHz-3 GHz frequency band in accordance with the regulation "Determination, measurement methods and inspection of limit values of electromagnetic field intensity originating from fixed telecommunication devices operating in the 10 kHz-60 GHz frequency band" (Official newspaper 12.07.2001). The data obtained were compared with the limit values announced by the international commission on non-ionizing radiation protection (ICNIRP).

2.2. Survey Study

Within the scope of our study, a questionnaire containing 25 questions was applied to 922 students studying at Aydın Adnan Menderes University Faculty of Medicine and Aydın Vocational School of Health. This application was carried out between May 2013 and March 2016. The age of the participants ranges between 19 and 25, with 57.5% female and 42.5% male. Before the study, the students were informed about the questionnaire. While no questions were asked about the identity of the students in the questionnaire, their personal information such as age, gender, which school they attended, which class they were in, were evaluated with 5 questions and their knowledge levels about ELF-EMF and energy transmission lines were evaluated with 20 questions. The study was approved by the Aydın Adnan Menderes University Ethics Committee at its meeting dated 22.05.2014 (Protocol no: 2014/370) and was carried out in accordance with the Declaration of Helsinki.

2.3. Statistical Analysis

All data obtained were analyzed using SPSS v.17.0. Survey data are expressed in percentiles of the participants. Measurements made at Adnan Menderes University Central Campus are given as arithmetic mean ± standard error. $P \leq 0.05$ was considered statistically significant.

3. RESULTS AND DISCUSSION

3.1. ELF-EMF Measurement Results

Magnetic field and electric field measurements were made in 3 different areas (D1, D2, D3) where students are frequently found in Aydın Adnan Menderes University Central Campus (Figure 1). Accordingly, the magnetic field value was measured as 0.087±0.015 mG on average, and the electric field strength value was measured as 0.037±0.006 V/m on average. The magnetic field and electric field strength values measured at each point are given in Table 2 in detail. In addition, the average magnetic field value at 25 randomly selected points in the campus area was determined as 0.091±0.011 mG and the electric field strength value as 0.461±0.011 V/m. Table 2 shows the magnetic field and electric field strength values measured at these points.

In addition to these measurements, measurements were taken from 3 different points (Y1, Y2, Y3) under the energy transmission lines passing through the northern border of the Central Campus. Accordingly, the mean magnetic field values at the zero point are 5.56±0.12 mG in Y1, 8.90±0.14 mG in Y2 and 7.40±0.17 mG in Y3, 5.34±0.11 mG for Y1, 7.61±0.09 mG for Y2, 4.43±40 for Y3 at 5m right. 0.13 mG was determined as 6.44±0.11 mG for Y2 and 4.89±0.22 mG for Y3 (Figure 2).

The mean magnetic field values measured from the front of the transformers (from 0 meters) shown in Figure 1 as T1, T2 and T3 were determined as 7.34±1.12 mG at T1, 5.64±0.75 mG at T2 and 4.30±0.78 mG at T3. Similarly, the average magnetic field values measured from 5 meters away from the transformer building were determined as 5.90±0.99 mG at T1, 5.11±0.66 mG at T2 and 3.37±0.67 mG at T3 (Figure 3).

Figure 1. *Measurement points in Adnan Menderes University Central Campus*

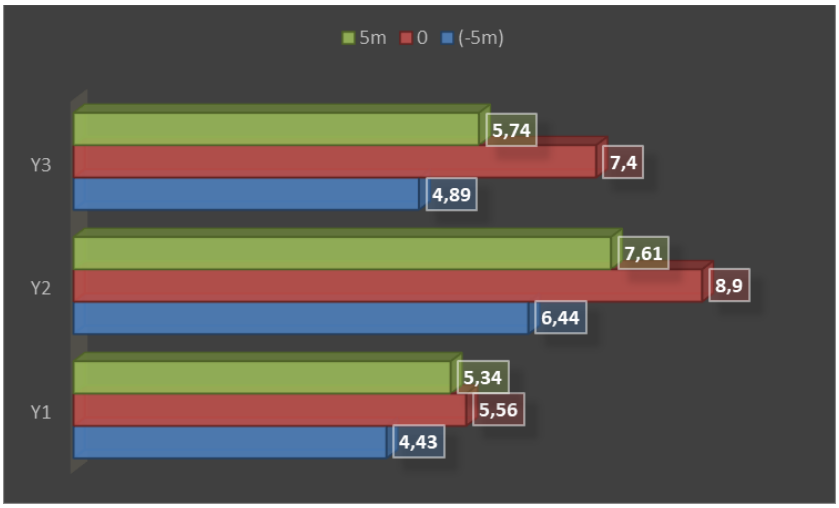

Figure 2. *Magnetic field values (mG) measured at -5m, 0 and 5m distances from three different energy transmission line points*

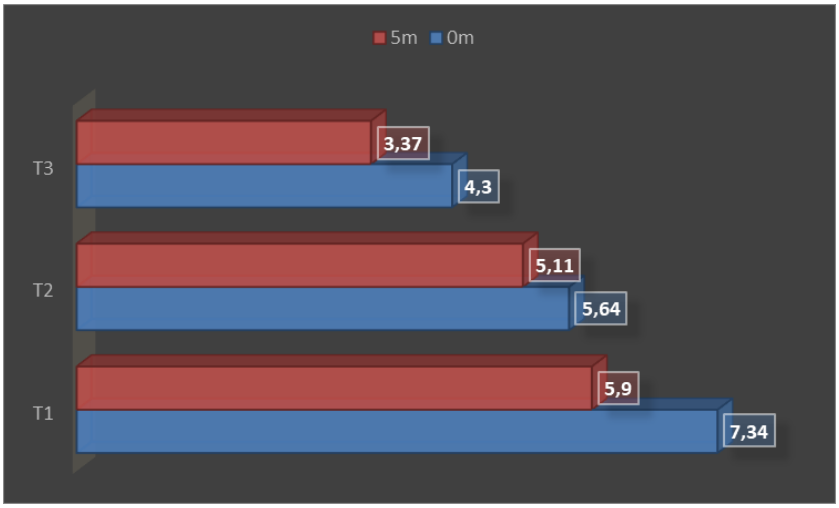

Figure 3. *Magnetic field values (mG) measured at 0 and 5m distances from three different transformer points*

Table 2. *Magnetic field and electric field strength mean values*

Measurement Point	E (V/m)	B (mG)
D1	0.08	0.26
D2	0.00	0.00
D3	0.03	0.00
1	0.11	0.17
2	0.12	0.13
3	0.14	0.23
4	0.07	0.14
5	0.14	0.09
6	0.15	0.10
7	0.15	0.14
8	0.20	0.16
9	0.17	0.20
10	0.13	0.30
11	0.27	0.00
12	1.08	0.00
13	0.27	0.00
14	0.33	0.00
15	0.08	0.03
16	0.23	0.03
17	2.41	0.07
18	1.34	0.00
19	1.53	0.00
20	1.16	0.00
21	0.21	0.13
22	0.23	0.13
23	0.48	0.13
24	0.18	0.03
25	0.35	0.07

3.2. Survey Study Results

21% of the medical faculty and Health Vocational School students correctly stated that X-rays are not an example of non-ionizing radiation, while the others gave different answers and this shows that the students do not fully comprehend the electromagnetic spectrum. While 75% of the students stated that electrical devices create both electric and magnetic fields, the percentage of students who have no idea about the subject was found to be 7 (Figure 4). In addition, 46% of the students have more than one electrical device (TV, radio, alarm clock, etc.) in their bedrooms, while 38% do not have any electrical devices (Figure 5).

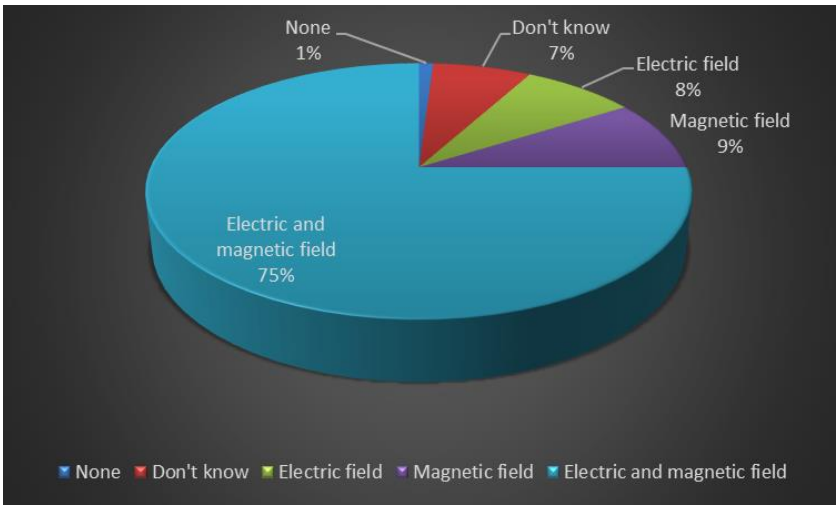

Figure 4. *Participants' "What happens when appliances at home are working?" distribution of answers to the question*

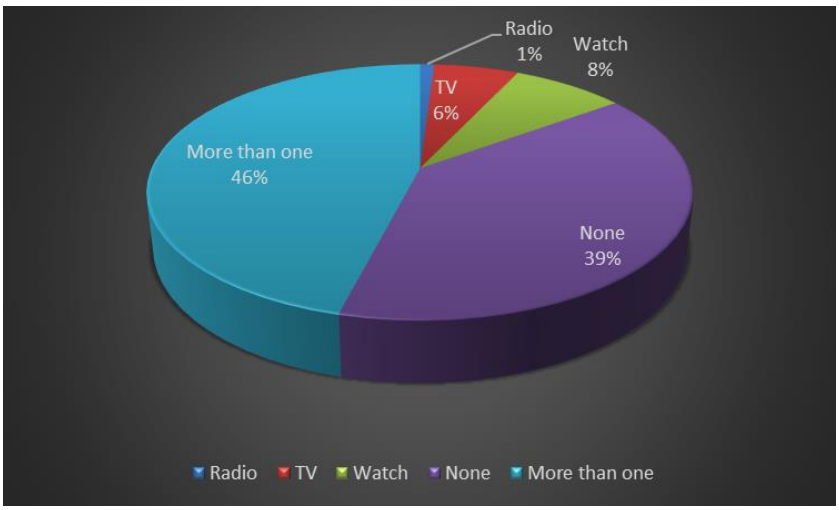

Figure 5. *Percentage of electrical devices in the bedrooms of the participants*

56.4% of the students stated that they spend 1-8 hours a day, 14% 8-12 hours a day, and 12% more than 12 hours a day in front of electrical devices such as computers, TVs and radios. In addition, 42% of these students spend 1-3 hours a day, 21% spend 3-8 hours, and 3% spend more than 8 hours a day just in front of the computer (Figure 6). While 61% of our students do not play computer games, 23% play computer games for a few hours every week, 9% for a few hours every day and 7% for more than 3 hours every day. While 35% of the students stated that they never used a hair dryer, 36% stated that they used a hair dryer at least twice a week, 22% at least 7 times a week, and 7.2% more than 7 times a week. The duration of using the hair dryer was 5 minutes or less in 36% of the students, between 5 and 10 minutes in 24% and more than 10 minutes in 7% of the students.

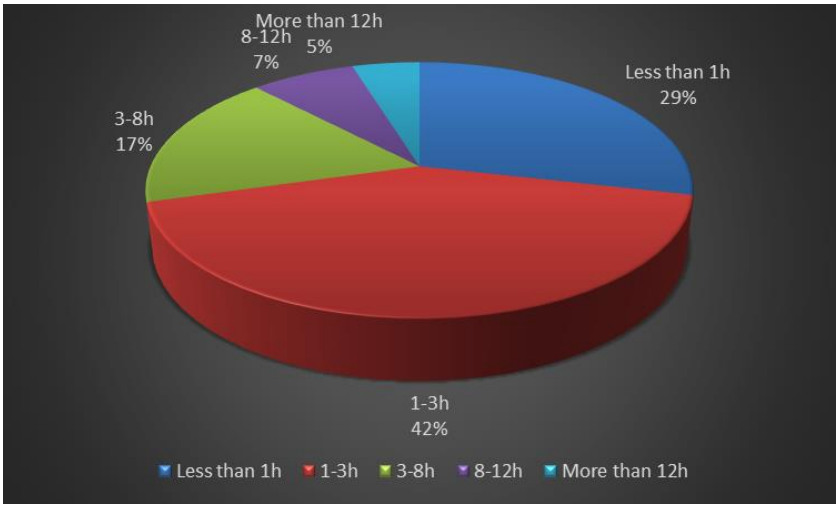

Figure 6. *Percentages of time spent in front of the computer*

While 64% of the students stated that they did not know how close they lived to the high voltage lines, 5% of them stated that they lived closer than 20m, 11% of them 20-100m away, and 22% more than 100m away (Figure 7). Similarly, 59% of the students stated that they did not know the distance of their houses to the transformers, while 7% reported that they were closer than 20m, 17% were 20 -100m away, and 18% were more than 100m away. 91% of the students stated that high voltage lines are associated with cancer.

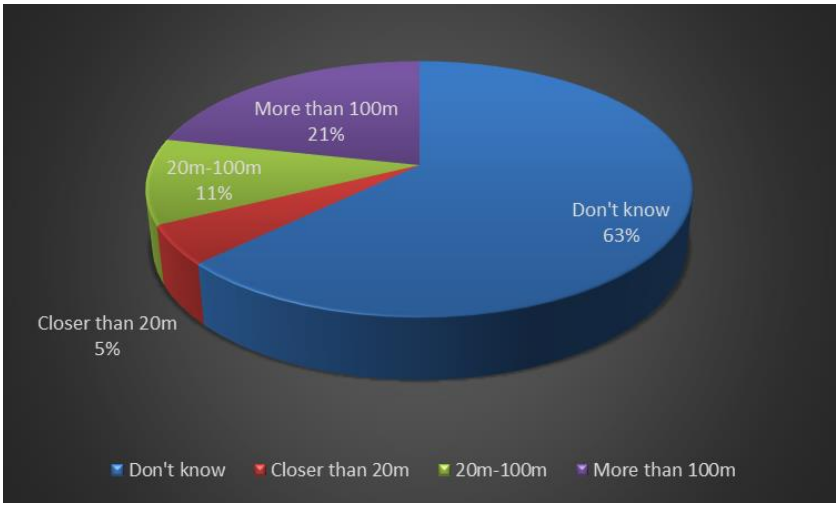

Figure 7. *Distribution of students' answers to the question of how far they live from the high voltage line*

4. CONCLUSION

Today, with the advancement of technology, there is an increasing demand for novel devices. EMF is created by several systems such that base stations, high voltage lines, radio/television broadcasts, wifi systems, etc. The signal strength and distance of electrical devices signify the intensity of EMFs. There is no information that ELF-EMF and RF-MF, which are non-ionizing radiation, directly damage DNA or cells (National Cancer Institute, 2019). However, although there is evidence that ELF-EMF has a negative effect on human health, the fact that the mechanism of action on living things has not been clearly revealed makes the results of laboratory studies open to discussion (Repacholi., 2012).

As seen in Figure 1 in Aydın Adnan Menderes University Central Campus, the magnetic field and electric field strength values measured from different points were found below the limit values. The magnetic field values measured under and around the energy transmission lines passing through the northern border of the campus were also within the ICNIRP limit values, and the distance of the power transmission lines (at least 25 m) from the settlements is important in reducing the possible effects. Similarly, the magnetic field values

measured around the transformers are within normal limits, and since the transformers are at least 10 meters away from the buildings, the degree of the possible impact on human health is significantly reduced. Therefore, Aydın Adnan Menderes University can be considered a relatively safe area since electromagnetic field exposure values are within the ICNIRP safe limit values.

As a result of the survey application, it is understood that our students are conscious to a certain extent about what ELF-EMF is and its effects, but they do not pay attention to protect themselves against the possible effects of ELF-EMF. According to the "precautionary principle" determined by the World Health Organization, since it is not yet known exactly what kind of problems it may cause in the future, the severity of ELF-EMF should be kept as low as possible. Therefore, it is necessary to develop behavioral awareness and attitude for students who will work in the field of health when they graduate from the university, to protect themselves against the effects of ELF-EMF. Health personnel who implement the measures to protect against the effects of ELF-EMF can play a role in raising the awareness of society against ELF-EMF appropriately.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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