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Research Article

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Research for self-reported health problems after excessive talking time on mobile phones among university students

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ABSTRACT

The devices that people use every day, such as mobile phones and wireless networks, emit electromagnetic waves in the radio frequency range. The widespread use of these devices, as well as the change in people's social behavior, have dramatically increased their exposure to electromagnetic radiation. Due to the rapid increase of young people users, public health officials and the scientific community are showing particular interest in the possible effects of electromagnetic radiation on human health. Many researchers express strong concerns about the effects of exposure to electromagnetic radiation, as it can have a serious impact on physical, cognitive, and social health. This study focused on self-reported health problems after excessive talking time on mobile phones of 619 (n=619) University students of both genders, in the age group of 18-24 years were randomly selected. The data was collected using a close-ended questionnaire. Headache was found to be the most frequently reported symptom (69%) followed by pressure in the head (38.8%). In most self-reported health problems no correlation was found between the genders. Female students tend to talk more on their mobile phones, and it was found that this extensive use was associated with the declaration of more self-reported health problems. The results of this study do not leave us any room for complacency, especially when we talk about health issues, and continuous research is needed to protect people's health. In addition, modern education should provide the necessary knowledge to students, but also take care of the development of the critical thinking of future citizens, so that they can make the most appropriate decisions for their health.

Keywords: electromagnetic radiation, health problems, mobile phones, university students, gender

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INTRODUCTION

Wireless Technologies in Modern Life

Electromagnetic fields are everywhere in our environment and come from either natural or man-made sources. Sunlight, the earth's electromagnetic field, lightning, the heartbeat, and the human nervous system are natural sources of electromagnetic fields. Artificial sources include household electrical appliances, power lines, radio and television stations, mobile phone base stations, radars, etc. During the 20th century, environmental exposure to man-made sources of electromagnetic radiation increased rapidly. The main causes of this increase are the demand for electricity, the development of wireless technology and its applications, and the change in people's social behavior (Vecchia, 2007; Wen & Huang, 2017; Wu et al., 2022).

Mobile phones combined with the increase in the use of wireless technologies are the most important developments in information and communication technologies in recent years (Dixit et al., 2010). Smartphones and their constant connection to the internet have led to a huge increase in the number of users of all age groups (Piper et al., 2019; Taylor & Silver, 2019). Young children use smartphones mainly for entertainment. Teenagers and young adults use them to communicate and in education. Finally, the elderly use them in e-commerce, e-government, and for their information (Busch et al., 2021; Dresselhaus & Shrode, 2012; Finch et al., 2021; Wang et al., 2011; Zhou et al., 2014). It is evident, that all the new features offered by mobile phones and wireless technologies can influence people's behavior (Kumar & Sriram, 2018; Park et al., 2021). The widespread use of these devices, as well as the change in people's social behavior, have dramatically increased their exposure to artificial sources of electromagnetic radiation (Han & Yi, 2018; World Energy Council, 2016). Users of these devices are beginning to show an interest in emitted radiation mainly by searching the internet for information about its dangers (Busby, 2020; Neumann, 2014).

Electromagnetic Radiation of Wireless Technologies

The devices that people use every day, such as laptops, tablets, mobile phones, and wireless networks, emit electromagnetic waves in the area of radio frequencies (Mailankot et al., 2009; Mortazavi et al., 2014). All electromagnetic waves propagate at the speed of light and carry momentum and energy from a source to a receiver. In 1887 *Hertz* produced and detected electromagnetic waves at radio frequencies. The

energy or otherwise energy flow rate is described by the *Poynting* vector and describes the energy flow rate, i.e. the energy per unit time, or otherwise the power, through a unit surface that is perpendicular to the direction of wave propagation. The unit of measurement is W/m^2 (power per unit area) (Beckers et al.,2017; Saslow, 2002; Tang & Resurreccion, 2009).

Absorption of energy from radio frequency fields can cause molecules to vibrate, which in turn leads to the heating of body tissues. This absorption is determined by a physical quantity known as the specific absorption rate, with a unit of watts per kilogram of mass (W/kg). The quantity-specific absorption rate (SAR) is calculated from the square of the (instantaneous) intensity of the electric field E in the tissue: $SAR=(\sigma |E|^2)/\rho$, where σ and ρ are the conductivity (in Siemens per meter, S/m) and the density (kg/m^3) of the tissue (International Commission on non-Ionizing Radiation Protection, 2009; McKinlay et al., 2004).

SAR provides a measure of the absorbed energy, from a radio frequency signal, per mass of body tissue, and is often used as a proxy for the amount of heating or increase in body temperature. It may refer to a small spot of body tissue, but it is more common to estimate an average value over time and space. Whole-body SAR is derived from the average amount in all body tissues, while localized SAR is calculated for a specific organ. The time-averaged value is related to the thermal consideration since the probability of heating from the exposure of a particular tissue depends on the rate of energy input, relative to the rate of its diffusion into the surrounding tissues (Fakhri et al., 2016; Kokabi & Davoodi, 2019).

Guidelines for limiting human exposure to radio frequencies are based on protecting them from the effects that may occur due to tissue temperature increases beyond acceptable limits. The limits for the retina, brain, and spinal cord are up to 38 °C, for the neck and trunk up to 39 °C and for the extremities up to 40 °C (McDonald, 2004). An increase in body temperature of 1 °C corresponds to a whole-body EEA of about 4 W/kg. The main factors affecting it are the heat diffusion distance in the biological tissue and the penetration depth of the electromagnetic wave (Hirata et al., 2009). Temperature increases approaching 1 °C are likely to affect several biological processes. The rate of increase in temperature is also important in inducing a change in a physiological function (Behari & Nirala, 2013; International Agency for Research on Cancer, 2011).

Effects of Radio Frequency Radiation on Human Health

The increasing use of wireless networks has raised many concerns about their impact on human health. Most of the concerns are about the use of mobile phones. This is because the transmit power of cellular phones is significantly higher than that of wireless systems such as wireless local area networks and personal area networks. Unlike these two types of wireless networks, mobile phones are used at a much shorter distance from the human brain and emit radiation throughout the phone call (Gandhi et al., 2012).

Biological effects that occur as a result of heating are called thermal effects, while those that occur through mechanisms other than heating are called non-thermal effects. The basic principle that applies to any biophysical interaction is that biological systems are subject to random variation in electric and magnetic fields, known as thermal noise. Therefore, for a system to be considered responsive to an applied RF field, the magnitude of the induced fields in the system should be larger than the corresponding random pre-existing fields (Challis, 2005; Wainwright, 2003).

Electric currents circulate in the human body, which is necessary for the body's normal functions. Tissues contain 70% water, the molecules of which are like electric dipoles (Mentre, 2012). The penetration of an electromagnetic field into the body and its interaction with the dipoles of water can cause long-term complications. The absorption of electromagnetic radiation by the human body depends not only on the intensity but also on the frequency of the radiation. High-frequency electromagnetic radiation is absorbed near the skin, while lower-frequency radiation penetrates deeper into the body. The effects, whatever they are, depending on the intensity of the radiation, on the time an organism is exposed to it, and also on its distance from the source of the radiation. The effects of non-ionizing electromagnetic radiation can be divided into thermal and non-thermal (Behari & Nirala, 2013; Pegios et al., 2022; Singh et al., 2018).

The thermal effects on humans mainly come from electromagnetic radiation, as it penetrates the body at a relatively shallow depth, is absorbed, and causes the movement of molecules which then, with friction and impacts, cause an increase in tissue temperature. Thermal effects occur for frequencies above 100 kHz and damage is caused if the body's thermoregulatory mechanism fails to maintain a normal temperature. For the temperature increase to be observable, the power density of the electromagnetic radiation must be very high ($1 mW/cm^2$) or the whole-body average energy absorption rate (SAR) must be above 5 W/kg. When the amounts of heat generated are relatively small, thermoregulatory mechanisms can sequester this heat, maintaining a constant physiological body temperature (Behari & Nirala, 2013; Martínez-Búrdalo et al., 2004; Sheppard et al., 2008).

The impact of electromagnetic radiation on biological material also has non-thermal effects, which are located in the biological action of the radiation on the functioning of the components of the cell. The exact mechanism by which it works is not known. They probably affect the flow of calcium across the cell membrane, meaning that they either facilitate the growth of existing cancers for other reasons or reduce the ability of cells to resist cancer formation. These non-thermal effects are also considered the most important from a medical point of view and are not covered by the established safety limits, because they are not directly measurable with a scientific instrument. This biophysical mechanism is defined as non-thermal if the interaction of the electromagnetic field with living material leads to specific effects that do not occur through the heating process (Glaser, 2005; Mai et al., 2020; Szasz et al., 2016). Non-thermal effects can be defined as biological effects resulting from a change in body temperature that is either less than 1°C or less than measurable or in the region of thermal noise (Scientific Committee on Emerging and Newly Identified Health Risks, 2015).

Prolonged exposure to radiofrequency radiation from mobile phones, cordless phones, cell towers, Wi-Fi wireless networks, and other wireless technologies have been linked to physical symptoms, including headache, fatigue, insomnia, dizziness, changes in brain activity, and impairments in concentration and memory (Chu et al., 2011; Farashi et al., 2022; Jacob, 2020). Scientists report that these effects can occur with even minimal levels of exposure if they occur daily. Children, in particular, are more vulnerable to being harmed by environmental exposures. World Health Organization (WHO) defines health as the state of complete physical, mental and social well-being

characterizing it as a fundamental human right (Huber et al., 2011; WHO, 1946). Public health officials and the scientific community show particular interest in the possible effects of electromagnetic radiation on the health of children and adolescents (Shinde & Patel, 2014). The International Agency for Research on Cancer (2011) has classified electromagnetic radiation in the radio frequency range as a group 2B carcinogen, possibly carcinogenic to humans. Because cancer usually takes more than 20 years to develop, the currently negative research findings do not clearly indicate the absence of risk. In addition, today's children and teenagers start using mobile phones and wireless technologies at a much younger age than today's adults, whose bodies are still growing (International Agency for Research on Cancer, 2011; Magiera & Solecka, 2020; Pendse & Zagade, 2014).

Research Questions

The widespread use of mobile phones, especially by university students, who are characterized as heavy users (Kim et al., 2021; Loleska & Pop-Jordanova, 2021), the inconclusive verdict from the scientific community on the danger, or not, of electromagnetic radiation in the radio frequency range, and the growing interest of users, especially after the advent of the new 5G technology of mobile networks to the general public, led us to write this paper (Hannan et al., 2022). The research questions of this study can be summarized as follows:

1. What symptoms do the respondents seem to experience after extensive talking on the mobile phone according to their statements?
2. Is there a correlation between the appearance of symptoms with the gender of the university students?
3. Is there a correlation in symptom reporting, according to their mobile phone talk time?

METHODOLOGY

Participants

A total of 619 university students, aged 18-24 took part in the survey. The students who participated in the research were from seven different departments of the university. 94.6% of students had used a mobile phone for more than 3 years, 5.2% for two years, and only 0.2% stated that they had used a mobile phone for less than a year or do not use it at all.

Research Tool

The collection of quantitative data was carried out using a close-ended questionnaire. The research tool was created after first understanding the special characteristics of the respondents and the selection of the questions were made after a literature review of research related to the topic. The questionnaire and data in this research study are part of a larger study into electromagnetic radiation and pollution emitted by mobile phones and wireless networks (Gavrilas, 2017).

The questionnaire was designed to explore four topic areas, which included knowledge, attitudes, behaviors, and symptom statements. The feasibility and validation of the questionnaire were carried out after conducting a pilot study, with the distribution of the questionnaire to thirty randomly selected university students of different genders. Confirmation of the face validity and content validity of the research instrument was done by three experts on the subject being discussed in the research. After all the suggested corrections were made, the questionnaire took its final form and was distributed to collect all the research data (Gavrilas et al., 2022a).

Because our data are binary variables, to determine the internal consistency of the instrument, the Kuder-Richardson formula 20 (KR-20) coefficient was chosen, which is a derivative of Cronbach's alpha (Foster, 2021), with a value for the entire survey questionnaire to be 0.722. The values of the KR-20 coefficient range from 0 to 1, where 0 defines no reliability and 1 that the research instrument is completely reliable (Klein & Dabney, 2013). Values above 0.5 are considered acceptable. At this point, we should mention that only the results of the questions related to the research questions of this study are presented and analyzed, and not the results of all the questions of the questionnaire (Gavrilas et al., 2022a).

Data Collection

The research data were collected, after the distribution of the questionnaires in paper form, before the start of teaching the University courses. There had been prior consultation with the professor, in order to provide the required time to the students, which was about fifteen minutes. Before the distribution of the questionnaires, introductory information was given by the researchers, for the purposes of the research, the use of the data, the anonymity of the questionnaires, and the necessary instructions were given for completing them. After the end of the time, the questionnaires were collected again, so that their answers were digitized, for data analysis.

Data Analysis

The statistical processing and analysis of the data were based on the statistical program SPSS (statistical package for social sciences) version 21. Descriptive statistics were used, while for the visual representation of the results appropriate tables and diagrams were created with Microsoft Excel. To investigate the correlation of the answers with the variable "*Gender*" of the respondents, the statistical test χ^2 (Pearson Chi-square) was used with a significance level of α=.05 (Gavrilas et al., 2022b; Shih & Fay, 2017).

RESULTS OF ANALYSIS

Talk Time on Mobile Phone Per Day by Gender

According to the results of the question, "*About how much time do you spend talking on your mobile phone every day?*", it was found that majority of men talk for 15 to 30 minutes every day with a rate of 41.4%, while women with a rate of 53.4% for more than 30 minutes (**Figure 1**).

A Chi-square test of independence was performed to assess the relationship between the answers to the previous question and the gender of the participants. There was a significant relationship between the variables, $\chi^2(3, n=619)=26.892$, $p=.000<.05$.

Self-Reporting Symptoms After Talking on the Mobile Phone

According to **Figure 2**, 87.6% of the respondents stated that they had at least one symptom after excessively talking on their mobile phones. Only 12.4% of university students said they did not feel any symptoms. In more detail, most respondents (26.7%) stated that they had at least two symptoms, while 23.9% of respondents felt one symptom.

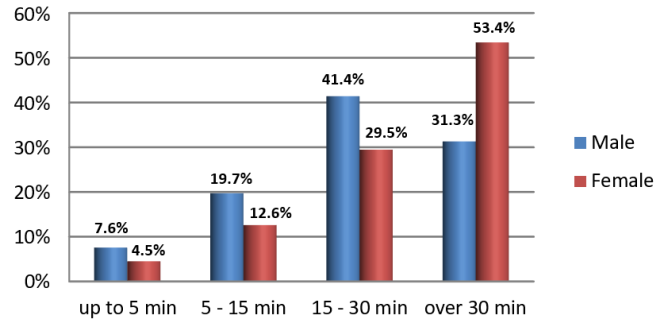


Figure 1. Answers of respondents by gender to the question "*About how much time do you spend talking on your mobile phone daily?*" (Source: Authors' own elaboration)

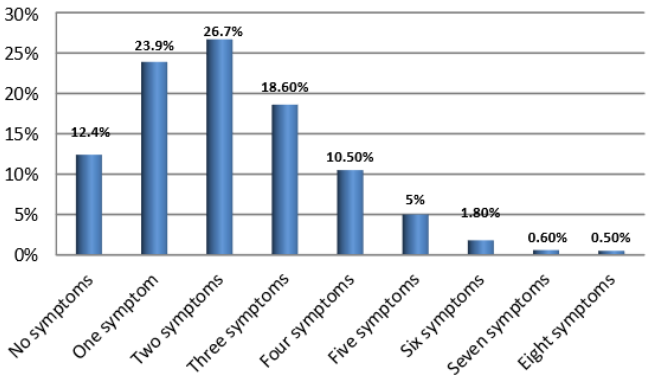


Figure 2. Number of symptoms reported by university students (Source: Authors' own elaboration)

Detailed Presentation of Each Symptom According to University Students' Self-Reports

According to participants' responses to the question, "*Do you find it difficult to sleep after talking too much on your mobile phone?*" men seem to show this symptom more often than women, with a rate of 29.6%. A Chi-square test of independence was performed to assess the relationship between the answers to the previous question and the gender of the participants. There was not a significant relationship between the variables, χ^2 (1, n=619)=.410, p=.522>.05 (**Table 1**).

On the next question, "*Do you feel a headache after talking too much on your mobile phone?*", 69% of the respondents stated that they feel this symptom. Women seem to have it more often than men with a rate of 73.9%. A Chi-square test of independence was performed to assess the relationship between the answers and the gender of the participants, showing that there was a significant relationship between the variables, χ^2 (1, n=619)=14.706, p=.000<.05 (**Table 1**).

To the third question, "*Do you feel pressure in your head after talking too much on your mobile phone?*", 38.8% of the respondents stated that they feel this symptom. The correlation test shows that there was not a significant relationship between the variables, χ^2 (1, n=619)=.002, p=.967>.05 (**Table 1**).

According to participants' responses to the question, "*Do you feel sleepy after talking too much on your mobile phone?*", 7.6% of respondents stated that they feel this symptom. The correlation test shows that there was not a significant relationship between the variables, χ^2 (1, n=619)=.113, p=.737>.05 (**Table 1**).

The next question said, "*Do you feel nervous after talking too much on your mobile phone?*", 17.9% of respondents said that they feel this symptom. There was not a significant relationship between the variables, with χ^2 (1, n=619)=1.530, p=.216>.05 (**Table 1**).

The sixth question asks, "*Do you feel anxious after talking too much on your mobile phone?*", 9.5% of respondents said that they feel this symptom. There was not a significant relationship between the variables, χ^2 (1, n=619)=.390, p=.532>.05 (**Table 1**).

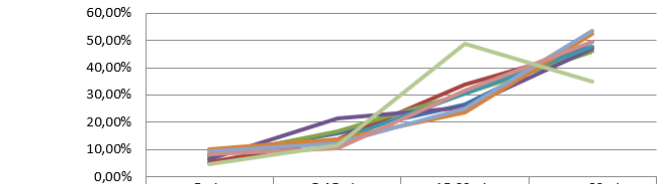
According to participants' responses to the question, "*Do you feel difficulty concentrating after talking too much on your mobile phone?*", 24.1% of them stated that they feel this symptom. There was not a significant relationship between the variables, χ^2 (1, n=619)=.018, p=.894>.05 (**Table 1**).

Moving on to the next question, "*Do you feel dizzy after talking too much on your mobile phone?*", 25% of the respondents stated that they feel

Table 1. Participant's answers by gender & Chi-square tests results

Question	Answer	Male	Female	Average	χ^2test p-value
"Do you feel difficulty falling asleep after talking too much on your mobile phone?"	Yes	29.6%	20.9%	20.2%	.522
	No	81.3%	79.1%	79.8%	
"Do you feel a headache after talking too much on your mobile phone?"	Yes	58.6%	73.9%	69.0%	.000*
	No	41.4%	26.1%	31.0%	
"Do you feel pressure in your head after talking too much on your mobile phone?"	Yes	38.9%	38.7%	38.8%	.967
	No	61.1%	61.3%	61.2%	
"Do you feel sleepy after talking too much on your mobile phone?"	Yes	7.1%	7.8%	7.6%	.737
	No	92.9%	92.2%	92.4%	
"Do you feel nervous after talking too much on your mobile phone?"	Yes	15.2%	19.2%	17.9%	.216
	No	84.8%	80.8%	82.1%	
"Do you feel anxious after talking too much on your mobile phone?"	Yes	10.6%	9.0%	9.5%	.532
	No	89.4%	91.0%	90.5%	
"Do you feel difficulty concentrating after talking too much on your mobile phone?"	Yes	23.7%	24.2%	24.1%	.894
	No	76.3%	75.8%	75.9%	
"Do you feel dizzy after talking too much on your mobile phone?"	Yes	22.2%	26.4%	25.0%	.267
	No	77.8%	73.6%	75.0%	
"Do you feel any other symptom than talking too much on your mobile phone?"	Yes	11.1%	5.0%	6.9%	.005*
	No	88.9%	95.0%	93.1%	
"Do not you feel any symptoms after taking too much on your mobile phone?"	Yes	18.2%	9.7%	12.4%	.003*
	No	81.8%	90.3%	87.6%	

Note. Pearson Chi-square; *Correlation is significant at 0.05 level; Sig. (2-tailed); & p<.05



	5min	5-15min	15-30min	over 30min
sleeplessness	8,00%	16,00%	26,40%	49,60%
headache	5,20%	13,80%	33,70%	47,30%
pressure	7,10%	16,70%	30,40%	45,80%
sleepiness	6,40%	21,30%	25,50%	46,80%
nervousness	8,10%	13,50%	30,60%	47,70%
worry	10,20%	13,60%	23,70%	52,50%
distraction	9,20%	12,10%	25,20%	53,50%
dizziness	8,40%	10,30%	31,60%	49,70%
other symptom	4,70%	11,60%	48,80%	34,90%

Figure 3. Statements of positive symptoms concerning mobile phone talk time (Source: Authors' own elaboration)

this symptom. Chi-square test of independence shows that there was not a significant relationship between the variables, χ^2 (1, n=619)=1.232, p=.267>.05 (**Table 1**).

As we found in the question, "*Do you feel any other symptom after talking too much on your mobile phone?*", only 6,9% of the respondents stated that they feel something else. According to the Chi-square test, there was a significant relationship between the answer and the gender of the university students, χ^2 (1, N=619) =7.810, p=.005<.05 (**Table 1**).

Finally, on to the last question, "*Do not you feel any symptoms after talking too much on your mobile phone?*", only 12.4% of the respondents stated that they do not feel anything. According to the Chi-square test of independence, there was a significant relationship between the answer and the gender of the university students, χ^2 (1, n=619)=8.814, p=.003<.05 (**Table 1**).

Statements of Positive Symptoms Concerning Mobile Phone Talk Time

Continuing the presentation of the research data analysis, **Figure 3** shows only the statement of positive symptoms in relation to the talk time, as reported by the university students. It was found that the proportion of those experiencing any symptom increased as talking time on the mobile phone increased. In addition, we can observe that in most queries, there is an almost proportional increase concerning the talking time on the mobile phone.

DISCUSSION

We will start the discussion by answering, at the same time, the research questions of the survey. The rates of positive symptom declarations can be characterized as particularly high. All the participants in the research, regardless of their gender, declared at a rate of 87.6% that they felt a symptom after excessively talking on their mobile phones. As we mentioned in the introduction of this research, electromagnetic radiation can affect human tissues. Studies of the harmful effects have been conducted by scientists around the world, finding similar results (Chu et al., 2011; Farashi et al., 2022; Hu et al., 2021; Sharma et al., 2020). The most reported symptom in the survey was a headache. The same symptom has been recorded again with a particularly high rate in previous research (Acharya et al., 2013; Bidabadi et al., 2015; Chiu et al., 2015; Chu et al., 2011; Demir & Sumer, 2019; Noaman, 2018; Szyjkowska et al., 2014; Wang et al., 2017). The next most common symptom that respondents seem to experience is pressure in the head.

No correlations were observed between the reported symptoms and the gender of the respondents, except for headaches. 73.9% of women felt this symptom compared to 58.6% of men. Mishra and Tiwari (2014) also found such a difference and attributed it, to the different duration of mobile phone use by the genders (Mishra & Tiwari, 2014). That is, the more someone uses their mobile phone, the more symptoms they are likely to have since they will be exposed to electromagnetic radiation for more time (Gomez-Perretta et al., 2013; Wang et al., 2017). This finding agrees with the present research, since women, as they stated, spend more time talking on their mobile phones than men. In addition, it was found that there is an almost proportional increase between positive symptom reports and talking time.

Suppose we now study the results in relation to the science of physics and medical physics, as we mentioned in the introduction. In that case, some symptoms have a scientific basis, such as a headache or pressure in the head due to the heating of tissues by electromagnetic radiation (Hirata et al., 2009; International Agency for Research on Cancer, 2011). However, we should be concerned about the causes of some other symptoms and whether they are due to the electromagnetic radiation emitted by mobile phones. For example, the feeling of restlessness, or insomnia reported as symptoms by the students, may not be caused by the electromagnetic radiation, but by the content of the discussion, which may affect the users psychosomatically. We should consider that many studies have found that the extensive use of mobile phones significantly affects the psychology of the user, because of the applications, digital games, and social media applications that smartphones have (Kim et al., 2021; Khademian et al., 2020).

Of course, whatever the cause of the symptoms, once the user's health is negatively affected, we should be concerned about the behavior of the users toward these devices. Young people are characterized as heavy users of mobile phones, to an addiction level (Kim et al., 2021; Loleska & Pop-Jordanova, 2021). Still, despite their negative views of electromagnetic radiation, it does not seem to affect their behaviors toward these devices (Gavrilas et al., 2022a).

From an educational point of view, students should be informed about electromagnetic radiation, as it is often confused with radioactivity (Burcin & Ince, 2010). In addition, they should be informed through appropriately designed study programs on the correct use of new technologies, especially smartphones, to protect themselves and their health as much as possible. That is, they should acquire from an early age, such as health education, to minimize talking time directly with the device near their head, use wired or Bluetooth headphones, and place their mobile phone away from their body when not in use, as suggested by scientists (International Commission on non-Ionizing Radiation Protection, 2009). They should, by thinking critically, decide what is best for themselves and their health, and make appropriate decisions, in choosing a mobile device, for example, in terms of its SAR, how to use it, and the duration of use.

Closing the discussion, we should also be concerned about the SAR limits of the devices enacted and implemented today. All these years of research on the symptoms of users and the ever-increasing use of mobile phones, not just for talking, by ever younger users (Taylor & Silver, 2019), perhaps should put the current SAR limits under discussion and reconsideration so that they are set even lower since the technology also advances and will be able to apply them.

CONCLUSIONS

In conclusion, it would be essential to approach the issue of electromagnetic radiation from mobile phones with a precautionary policy until researchers reach definitive conclusions about its effects on living organisms. Despite the limitations, the results of the studies leave us no room for complacency, especially when we talk about health issues. And the slightest indication that our health may be at risk, as defined by WHO, must be the subject of reflection and continuous research. In addition, modern education should provide the necessary knowledge to students but also take care of the development of the critical thinking of future citizens so that they can make the most appropriate decisions for their health (Albanese & Paturas, 2018; Liu et al., 2021; Marin & Halpern, 2011).

Future Directions

Based on the above discussion and conclusions, some directions are proposed for further research, regarding the issue of electromagnetic radiation of mobile phones. In summary, the proposals are, as follows:

1. Continuous recording of mobile phone health effects (physical, mental, and social) after long hours of daily use by young children.
2. Development of health education programs to inform the behaviors of protection from sources of electromagnetic radiation and environmental education programs aimed at informing students about electromagnetic pollution.
3. Design and development of communication technologies to minimize the emitted electromagnetic radiation.

Limitations

The generalizability of the findings of this research can be considered limited because of the participants' self-reports which may contain some bias. Also, the sample was from a single area and the same educational level.

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Ethics declaration: Authors declared that the research did not need any ethical approvals or written consent since a) the survey questionnaire was anonymous; b) the research participants were adults; c) any participant, after being informed by the researchers, before the distribution of the questionnaires, did not want to participate, declared it verbally and did not participate; d) any participant during the research who wanted to stop participating, declared it verbally and stopped participating. Participation in the research was anonymous and voluntary.

Declaration of interest: Authors declare no competing interest.

Data availability: Data generated or analyzed during this study are available from the authors on request.

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