

Gender differences in Attitudes and Behaviors associated with Electromagnetic Radiation of Mobile Phones and Wireless Networks

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Abstract

The issue of gender differentiation has preoccupied researchers and led them to conduct studies covering many areas of interest. However, research on electromagnetic radiation from devices such as mobile phones and wireless networks is relatively limited. The purpose of the research was to investigate the attitudes and behaviors of young people regarding the electromagnetic radiation emitted by mobile phones and wireless networks, and whether they are related to their gender. The participants were 198 men and 421 women. The data was collected using a close ended questionnaire. The general conclusion of the research was that young people have a negative attitude towards the electromagnetic radiation emitted by mobile phones and wireless networks without any correlation with their gender. However, correlation was found with certain behaviors they follow to protect their health from it, especially when specialized knowledge was required.

Key words: attitudes, behaviors, electromagnetic radiation, students, gender, mobile phones, wireless networks

Introduction

Mobile phones and Gender differences in contemporary life

Mobile phones combined with the increase in the use of wireless technologies are the most important developments in Information and Communication Technologies (ICT). Smartphone technology 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). Young children use mobile phones mainly for entertainment and education. Teenagers and young adults also use them as a means of communicating with their peers. Finally, older people use them in e-commerce, e-government and for their information (Andone et al., 2016). It is obvious that all the new features offered by mobile phones and wireless technologies can influence people's attitudes and behavior as well as their usage patterns (Park et al., 2021).

Gender differences have always been an important factor whenever any pattern of behavior is studied in the social sciences. This provides very critical demographic information and ultimately helps researchers, educators and policy makers understand the issue in greater depth. An important part of the research focuses on the differences between genders in the field of Sciences (Barrow-Green et al., 2018; Chiu et al., 2018). The researchers argue that the different attitudes and perceptions of genders towards Sciences are directly related to the different experiences during school ages, as well as the different way in which they perceive the science of Physics. Like any other habit, there are significant gender differences in mobile

phone habits. There is considerable evidence that men and women have different patterns of Internet activities and preferences for mobile phone use (Taywade & Khubalkar, 2019).

Electromagnetic radiation and health

The extensive use of new technologies, especially mobile phones, has raised the awareness of researchers because problems have been identified in the physical, mental and social health of users (Shoukat, 2019). Users of new technologies are becoming interested in issues related to electromagnetic radiation, because devices such as mobile phones, laptops and wireless networks, emit electromagnetic waves in the radio frequency range (Mailankot et al., 2009). Human exposure to electromagnetic radiation has increased rapidly in recent years. The reasons are the development and use of wireless technology and the change in humans' social behavior (World Energy Council, 2016).

The World Health Organization (WHO) defines Health as the state of complete physical, mental and social well-being, characterizing it as a fundamental human right (WHO, 1946). The International Agency for Research on Cancer (2011) has classified electromagnetic radiation in the radio frequency range as possibly carcinogenic to humans (group 2B). Because it usually takes more than twenty years for a cancer to develop, the currently negative research findings do not clearly indicate the absence of risk (Magiera & Solecka, 2020). The absorption of energy from radiation can cause the molecules of the human body to vibrate, which leads to tissue heating. This absorption is determined by the Specific Absorption Rate (SAR). It is calculated as the energy absorbed by a certain mass of tissue, within a certain period of time and is measured in units of power per mass (W/kg) (International Commission on Non-Ionizing Radiation Protection, 2009). United States and European Union have set safety limits for the energy absorbed by the body from exposure to a cell phone (Varshney et al., 2018). Many researchers express strong concerns about the effects of long-term exposure to electromagnetic radiation from mobile phones on living organisms (Hu et al., 2021; Kesari et al., 2018; Magiera & Solecka, 2020; Sharma et al., 2020).

In addition, research has shown that electromagnetic radiation can also affect human cognitive functions (Brzozek, 2018). Other research focuses on the addictive side of specific technologies, which are particularly harmful to the mental health of users (Ayadi et al., 2021). We conclude that the extensive use of mobile phones can have a serious impact on people's physical, cognitive and social health.

Education in developing critical thinking for health decisions

The development of critical thinking contributes to the creation of active people and is one of the main goals of education, beyond the acquisition of knowledge (Albanese & Paturas, 2018). Students should be able to think critically and use their knowledge to make appropriate decisions about their personal health and safety. Adolescent risky behaviors are linked to their perceptions of risk and may remain in the form of habits throughout their lives (Martha & Griffet, 2007). Studies on teenagers' risk perceptions of mobile phones are very rare. However, some studies have shown that there are significant differences in relation to the individual's age, gender, and educational background (Kang & Jung, 2014).

Therefore, it is important to design effective teaching approaches aimed at acquiring scientific knowledge and developing critical thinking about electromagnetic radiation emitted by devices that people use every day. For their design, it is necessary to investigate the attitudes and behaviors of mobile and wireless users, because as previously mentioned the number of relevant studies is limited.

Research questions

The research questions of this study can be summarized as follows:

a) What is the attitude of respondents towards electromagnetic radiation in the radio frequency spectrum emitted by mobile phones and wireless networks in terms of its effects?

b) What are the respondents' behavior and practices regarding protection from the emitted electromagnetic radiation of these devices?

c) Is there any correlation between attitudes and behaviors of respondents, according their gender?

Methodology

A total of 198 (32%) men and 421 (68%) women participated to the study. The collection of quantitative data was carried out using a close ended questionnaire. The questionnaire and the data of this research are part of a larger research on electromagnetic radiation and pollution. Due to the size of the questionnaire, the limited time to complete it and the particular characteristics of the sample, after experts consensus, questions with binary answers (yes - no) were chosen, although Likert-type questionnaires are mainly used in research when examining attitudes (Joshi et al., 2015).

The validation and feasibility of the questionnaire was carried out in the pilot research. Three experts confirm the face validity and content validity of the research tool. The Kuder-Richardson Formula 20 (KR-20) coefficient was chosen to determine the internal consistency because our data was binary variables. The value of the KR-20 coefficient in this research was .722 and considered as acceptable (Foster, 2021; Glen, 2016).

The statistical processing and analysis of the data was based on the statistical program SPSS (Statistical Package for Social Sciences) version 21. Descriptive statistics were used and the appropriate tables and diagrams were created for the visual representation of the results with Microsoft Excel 2007. To inquiry the correlation of the answers with the variable "Gender" of the respondents, the statistical criterion χ^2 test (Pearson chi-square) was used with a significance level $\alpha=.05$ (Shih & Fay, 2017).

Results of Analysis

Attitudes questions

According to participants' responses to 1st question, "Do you think that the use of mobile phones causes biological effects in humans?" there wasn't any significant difference between answers of men and women (Figure 1).

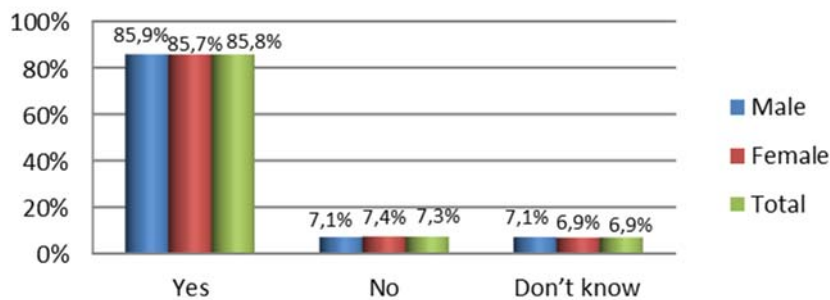


Figure 1: Participants' answers to 1st question: "Do you think that the use of mobile phones causes biological effects on humans?"

A Chi-Square Test of Independence was performed to assess the relationship between the answers of the 1st question and the gender of the participants. There wasn't a significant relationship between the variables, $\chi^2(2, N=619)=.023, p=.989>.05$ (Table1).

Table 1. Chi-Square Test of Independence between 1st question and participants' gender

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	,023 ^a	2	,989
Likelihood Ratio	,023	2	,989
Linear-by-Linear Association	,021	1	,884
N of Valid Cases	619		

a. 0 cells (0,0%) have expected count less than 5.

In 2nd question, "Do you think cell phone towers have biological effect on animals?" again there wasn't any significant difference between answers of men and women. Both believe that there is a risk in a high percentage (Figure 2).

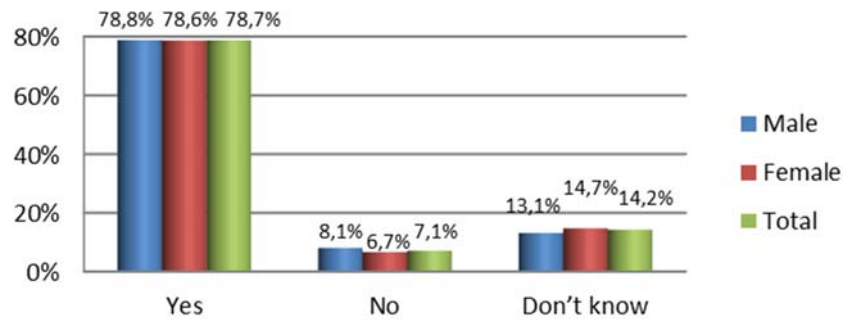


Figure 2: Participants' answers to 2nd question "Do you think cell phone towers have biological effect on animals?"

A Chi-Square Test of Independence was performed to assess the relationship between the answers of the 2nd question and the gender of the participants. There wasn't a significant relationship between the variables, $\chi^2(2, N=619)=.629, p=.730>.05$ (Table 2).

Table 2. Chi-Square Test of Independence between 2nd question and participants' gender

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	,629 ^a	2	,730
Likelihood Ratio	,624	2	,732
Linear-by-Linear Association	,591	1	,442
N of Valid Cases	619		

a. 0 cells (0,0%) have expected count less than 5.

In 3rd question, "Do you think that electromagnetic radiation can cause health problems in humans?" both men and women answered positively, with almost same percentages (Figure 3).

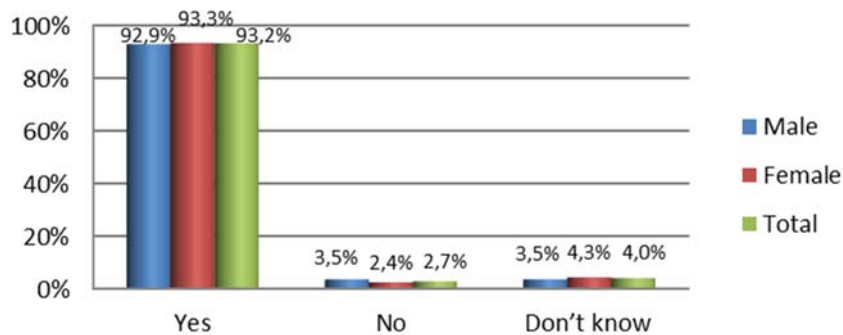


Figure 3: Participants' answers to 3rd question: "Do you think that electromagnetic radiation can cause health problems in humans?"

A Chi-Square Test of Independence was performed to assess the relationship between the answers of the 3th question and the gender of the participants. There wasn't a significant relationship between the variables, $\chi^2(2, N=619)=.845, p=.655>.05$ (Table 3).

Table 3. Chi-Square Test of Independence between 3rd question and participants' gender

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	,845 ^a	2	,655
Likelihood Ratio	,822	2	,663
Linear-by-Linear Association	,717	1	,397
N of Valid Cases	619		

a. 0 cells (0,0%) have expected count less than 5.

In 4th question, "Do you think that electromagnetic radiation is more dangerous for young children than adults?" 77,3% of men answered positively. Women answered positively in this question with a lower percentage (Figure 4).

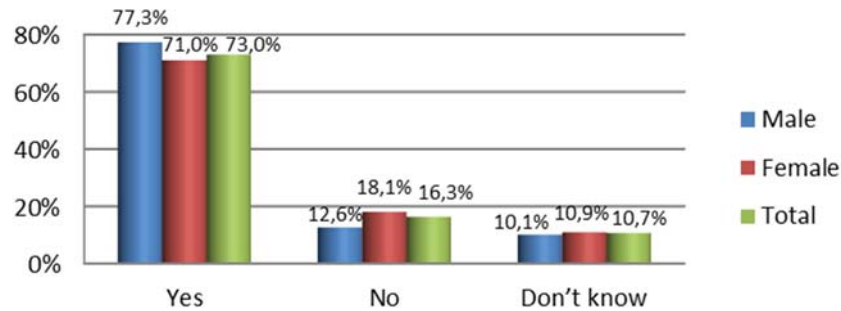


Figure 4: Participants' answers to 4th question: "Do you think electromagnetic radiation is more dangerous for young children than adults?"

A Chi-Square Test of Independence was performed to assess the relationship between the answers of the 4th question and the gender of the participants. There wasn't a significant relationship between the variables, $\chi^2(2, N=619)=3.237, p=.198>.05$ (Table 4).

Table 4. Chi-Square Test of Independence between 4th question and participants' gender

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3,237 ^a	2	,198
Likelihood Ratio	3,345	2	,188
Linear-by-Linear Association	1,067	1	,302
N of Valid Cases	619		

a. 0 cells (0,0%) have expected count less than 5.

Behaviors questions

In 5th question, "Would you install a mobile phone antenna on the roof of your house?" only 19.4% of respondents gave a positive answer. Both men and women answered in the negative, with almost same percentages (Figure 5).

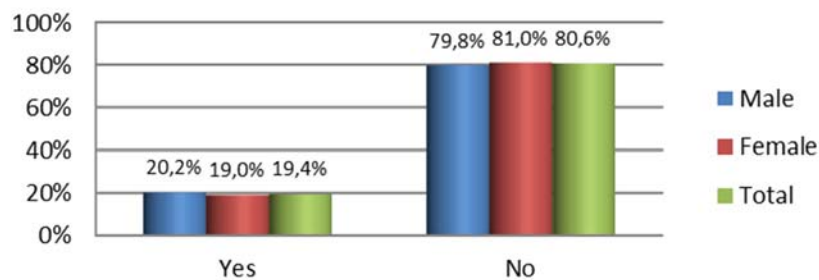


Figure 5: Participants' answers to 5th question "Would you install a mobile phone antenna on the roof of your home?"

A Chi-Square Test of Independence was performed to assess the relationship between the answers of the 5th question and the gender of the participants. There wasn't a significant relationship between the variables, $\chi^2(1, N=619)=.124, p=.725>.05$ (Table 5).

Table 5. Chi-Square Test of Independence between 5th question and participants' gender

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	,124 ^a	1	,725
Continuity Correction ^b	,059	1	,808
Likelihood Ratio	,123	1	,725
Linear-by-Linear Association	,124	1	,725
N of Valid Cases	619		

a. 0 cells (0,0%) have expected count less than 5. b. Computed only for a 2x2 table

In 6th question, "Would you prefer, within the boundaries of your area, to not have mobile phone antenna towers?" both men and women with almost same percentages of around 60% answered in this question in the negative (Figure 6).

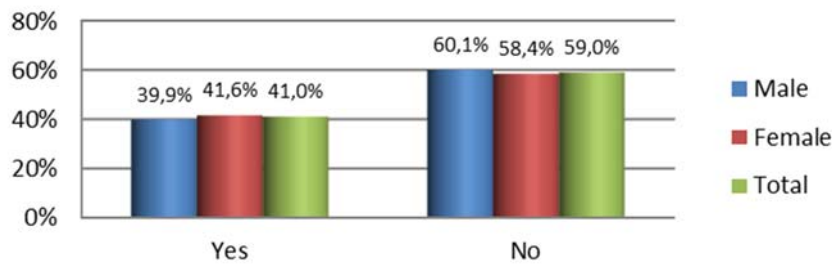


Figure 6: Participants' answers to 6th question "Would you prefer, within the boundaries of your area, to not have mobile phone antenna towers?"

A Chi-Square Test of Independence was performed to assess the relationship between the answers of the 6th question and the gender of the participants. There wasn't a significant relationship between the variables, $\chi^2(1, N=619)=.155, p=.694>.05$ (Table 6).

Table 6. Chi-Square Test of Independence between 6th question and participants' gender

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	,155 ^a	1	,694
Continuity Correction ^b	,094	1	,760
Likelihood Ratio	,155	1	,694
Linear-by-Linear Association	,155	1	,694
N of Valid Cases	619		

a. 0 cells (0,0%) have expected count less than 5. b. Computed only for a 2x2 table

In 7th question, "Would you rather not have wireless networks in university classrooms?" only 16.3% of respondents answered positively. Both men and women had almost same percentages of responses (Figure 7).

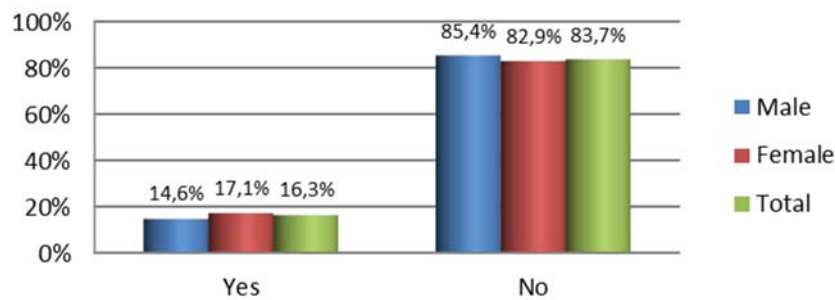


Figure 7: Participants' answers to 7th question "Would you rather not have wireless networks within the university (classrooms, laboratories)?"

A Chi-Square Test of Independence was performed to assess the relationship between the answers of the 7th question and the gender of the participants. There wasn't a significant relationship between the variables, $\chi^2(1, N=619)=.595, p=.441>.05$ (Table 7).

Table 7. Chi-Square Test of Independence between 7th question and participants' gender

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	,595 ^a	1	,441
Continuity Correction ^b	,428	1	,513
Likelihood Ratio	,604	1	,437
Linear-by-Linear Association	,594	1	,441
N of Valid Cases	619		

a. 0 cells (0,0%) have expected count less than 5. b. Computed only for a 2x2 table

In 8th question, "Is the rate of SAR of a mobile phone the main criterion for you when buying it?" a large difference was found in the answers of the respondents. The percentage of men's positive responses was 45.2%, while that of women was only 12.1% (Figure 8).

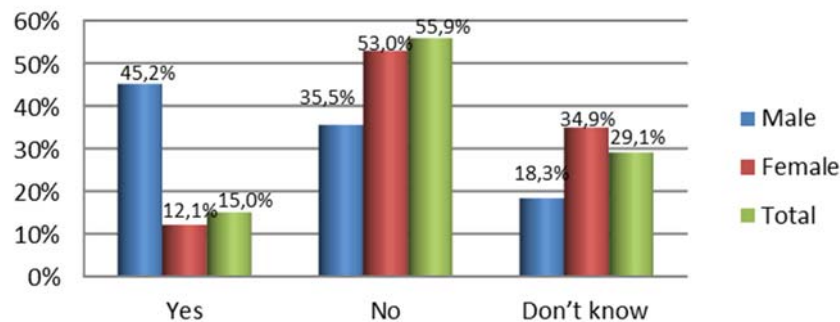


Figure 8: Participants' answers to 8th question "Is the rate of SAR of a mobile phone the main criterion for you when buying it?"

A Chi-Square Test of Independence was performed to assess the relationship between the answers of the 8th question and the gender of the participants. There was a significant relationship between the variables, $\chi^2(2, N=619)=24.862, p=.000<.05$ (Table 8).

Table 8. Chi-Square Test of Independence between 8th question and participants' gender

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	24,862 ^a	2	,000
Likelihood Ratio	26,043	2	,000
Linear-by-Linear Association	12,979	1	,000
N of Valid Cases	619		

a. 0 cells (0,0%) have expected count less than 5.

In 9th question, "Do you prefer to use wired network to connect your computer to the Internet at home?" a large difference was found again in the answers of the respondents. The percentage of men's positive responses was 58.6%, while that of women was 43% (Figure 9).

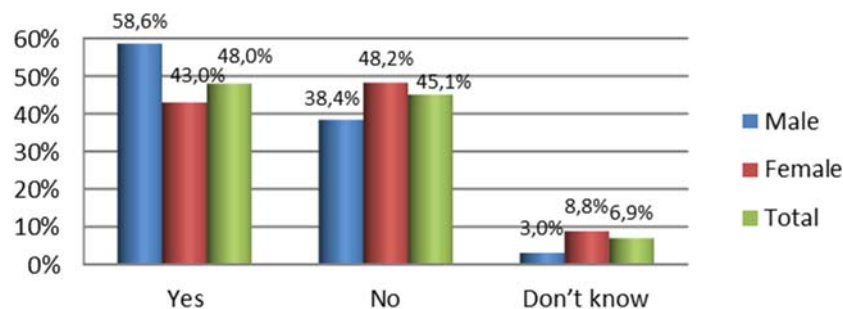


Figure 9: Participants' answers to 9th question "Do you prefer to use wired network to connect your computer to the Internet at home?"

A Chi-Square Test of Independence was performed to assess the relationship between the answers of the 9th question and the gender of the participants. There was a significant relationship between the variables, $\chi^2(2, N=619)=16.142, p=.000<.05$ (Table 9).

Table 9. Chi-Square Test of Independence between 9th question and participants' gender

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	16,142 ^a	2	,000
Likelihood Ratio	17,018	2	,000
Linear-by-Linear Association	,596	1	,440
N of Valid Cases	619		

a. 0 cells (0,0%) have expected count less than 5.

In 10th question, "Do you prefer to use wired headphones or speakerphone mode while talking on your mobile phone?" women scored the highest percentage of positive responses with 70.1%. The percentage of men who answered positively was a little lower with 64.6% (Figure 10).

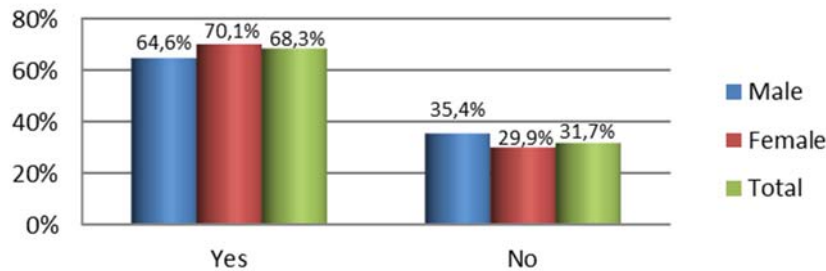


Figure 10: Participants' answers to 10th question "Do you prefer to use wired headphones or speakerphone mode while talking on your mobile phone?"

A Chi-Square Test of Independence was performed to assess the relationship between the answers of the 10th question and the gender of the participants. There wasn't a significant relationship between the variables, $\chi^2(1, N=619)=1.832, p=.176>.05$ (Table 10).

Table 10. Chi-Square Test of Independence between 10th question and participants' gender

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1,832 ^a	1	,176
Continuity Correction ^b	1,589	1	,207
Likelihood Ratio	1,814	1	,178
Linear-by-Linear Association	1,829	1	,176
N of Valid Cases	619		

a. 0 cells (0,0%) have expected count less than 5. b. Computed only for a 2x2 table

In 11th question "Do you prefer to talk on corded telephones instead of cordless?" both men and women scored almost the same percentages in their answers (Figure 11).

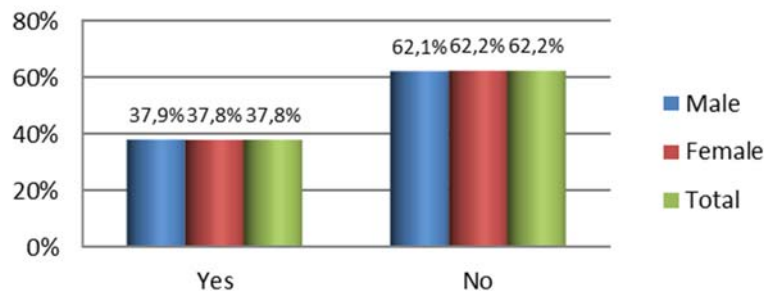


Figure 11: Participants' answers to 11th question "Do you prefer to talk on corded telephones instead of cordless?"

A Chi-Square Test of Independence was performed to assess the relationship between the answers of the 11th question and the gender of the participants. There wasn't a significant relationship between the variables, $\chi^2(1, N=619)=.001, p=.979>.05$ (Table 11).

Table 11. Chi-Square Test of Independence between 11th question and participants' gender

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	,001 ^a	1	,979
Continuity Correction ^b	,000	1	1,000
Likelihood Ratio	,001	1	,979
Linear-by-Linear Association	,001	1	,979
N of Valid Cases	619		

a. 0 cells (0,0%) have expected count less than 5. b. Computed only for a 2x2 table

In 12th question "When you don't use your home's WiFi network, do you turn off your router?" women scored the highest percentage of negative responses with 83.4% (Figure 12).

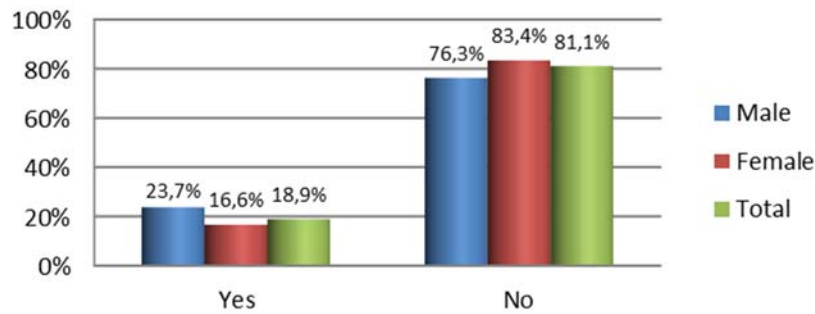


Figure 12: Participants' answers to 12th question "When you don't use your home's Wi-Fi network, do you turn off your router?"

A Chi-Square Test of Independence was performed to assess the relationship between the answers of the 12th question and the gender of the participants. There was a significant relationship between the variables, $\chi^2(1, N=619)=4.441, p=.035<.05$ (Table 12).

Table 12. Chi-Square Test of Independence between 12th question and participants' gender

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4,441 ^a	1	,035
Continuity Correction ^b	3,990	1	,046
Likelihood Ratio	4,314	1	,038
Linear-by-Linear Association	4,434	1	,035
N of Valid Cases	619		

a. 0 cells (0,0%) have expected count less than 5. b. Computed only for a 2x2 table

In 13th question "When you sleep do you turn off or set your mobile phone in 'flight mode'?" women scored the highest percentage of negative responses with 81.7% (Figure 13).

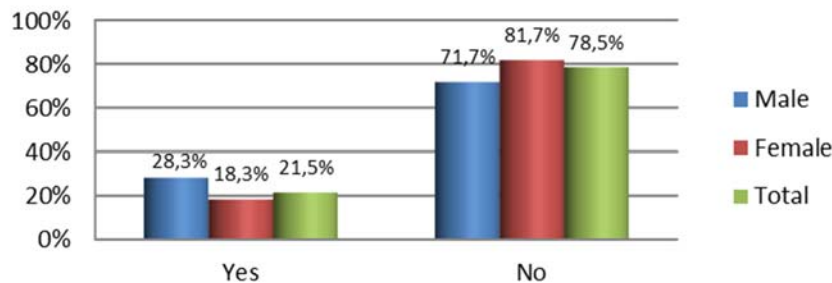


Figure 13: Participants' answers to 13th question "When you sleep do you turn off or set your mobile phone in 'flight mode'?"

A Chi-Square Test of Independence was performed to assess the relationship between the answers of the 13th question and the gender of the participants. There was a significant relationship between the variables, $\chi^2(1, N=619)=7.972, p=.005<.05$ (Table 13).

Table 13. Chi-Square Test of Independence between 13th question and participants' gender

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	7,972 ^a	1	,005
Continuity Correction ^b	7,390	1	,007
Likelihood Ratio	7,718	1	,005
Linear-by-Linear Association	7,959	1	,005
N of Valid Cases	619		

a. 0 cells (0,0%) have expected count less than 5. b. Computed only for a 2x2 table

In 14th question, "When you don't use your mobile phone, do you place it at a distance more than one meter from your body?" women scored the highest percentage of negative responses with 55.3% (Figure 14).

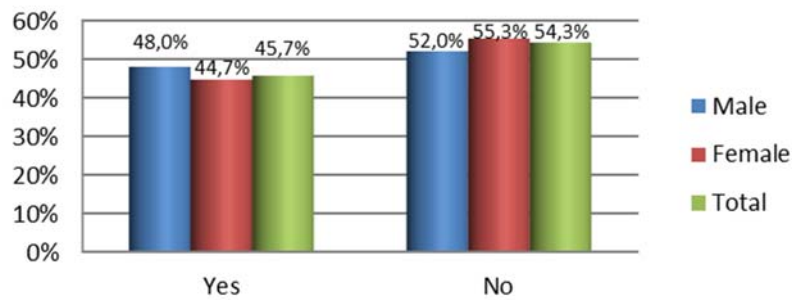


Figure 14: Participants' answers to 14th question "When you don't use your mobile phone, do you place it at a distance more than one meter from your body?"

A Chi-Square Test of Independence was performed to assess the relationship between the answers of the 14th question and the gender of the participants. There wasn't a significant relationship between the variables, $\chi^2(1, N=619)=.600, p=.439>.05$ (Table 14).

Table 14. Chi-Square Test of Independence between 14th question and participants' gender

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	,600 ^a	1	,439
Continuity Correction ^b	,473	1	,492
Likelihood Ratio	,599	1	,439
Linear-by-Linear Association	,599	1	,439
N of Valid Cases	619		

a. 0 cells (0,0%) have expected count less than 5. b. Computed only for a 2x2 table

In 15th question, "When you don't need internet, do you disconnect your Laptop or Tablet from WiFi?" men scored the highest percentage of negative responses with 71.2% (Figure 15).

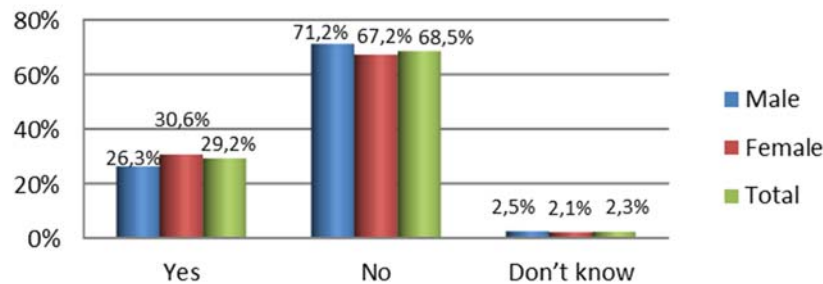


Figure 15: Participants' answers to 15th question "When you don't need internet, do you disconnect your Laptop or Tablet from WiFi?"

A Chi-Square Test of Independence was performed to assess the relationship between the answers of the 15th question and the gender of the participants. There wasn't a significant relationship between the variables, $\chi^2(2, N=619)=1.286, p=.526>.05$ (Table 15).

Table 15. Chi-Square Test of Independence between 15th question and participants' gender

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1,286 ^a	2	,526
Likelihood Ratio	1,299	2	,522
Linear-by-Linear Association	,649	1	,420
N of Valid Cases	619		

a. 1 cells (16,7%) have expected count less than 5.

Discussion - Conclusions

Starting the discussion by answering the research questions of the present study, it was found that the young people's attitude towards the electromagnetic radiation emitted by mobile phones is negative, and they consider it dangerous for living organisms. Other researchers have reached similar results (Muhayawi et al., 2012; Nasser et al., 2018). The percentages noted by the respondents are identical, regardless of gender, so no correlation of the attitudes with the gender of the respondents was found. Many times the content of science courses does not meet the interests of girls, which has the consequence of differentiating the knowledge of genders in the matter of science and technology (Barrow-Green et al., 2018; Chiu et al., 2018). However, the different knowledge and different interests between the genders do not seem to affect their attitude towards electromagnetic radiation. According to research, when the word radiation is used, readers automatically consider it as harmful regardless of its origin (Morales Lopez & Tuzon Marco, 2022). In addition, the internet, which is one of the main means of information for young people, has been found to use the term radiation incorrectly (Sesen & Ince, 2010).

Continuing with the next research question, found that the majority of the respondents don't follow behaviors of protection from the emitted electromagnetic radiation, despite the negative attitude they have towards it. The discrepancy between attitudes and behaviors has also been observed by other researchers (Bhattacharjee & Sanford, 2006; Lee et al., 2017). Correlations between behaviors and gender were mainly found in behaviors that required some specialized knowledge, such as wireless networks and SAR. It seems that the answers were influenced by the knowledge that the participants have acquired during their lives, which are differentiated by the interests of genders. In contrast, no correlations were found in questions that referred to simple behaviors such as corded phone use.

It is very difficult to identify the cause of the inconsistency between attitudes and behaviors. However, we can mention some factors. We start from the youth's need for constant communication, and the anxiety of loneliness (Khademian et al., 2020). In addition, there are many studies that report the phenomenon of young people's addiction to internet and mobile phones (Caponnetto et al., 2021; Kim et al., 2021). If we take these factors into account, we may understand the behaviors of young people, and why they are unable, for example, to turn off their mobile phone or wireless network, thus interrupting their continuous communication. Finally, we should mention that the possible serious effects of electromagnetic radiation are not immediate, since the development of a cancer takes several years. This affects attitude strength, and as a consequence the behaviors of young people. Something similar has been found with smoking attitudes and behaviors. While the health effects are known, they are not enough to stop it, since addiction, and the harmful effects after years, affect the attitude strength (Lee et al., 2017).

In conclusion, it is important to approach the issue of electromagnetic radiation from mobile phones and wireless networks with a preventive policy, because scientists haven't reached definitive conclusions regarding the health effects on living organisms. Further investigation is needed to search for the causes that lead young people to specific behaviors. The purpose of modern education is to empower students with the knowledge and train them for life, regardless of their gender, providing equal learning opportunities.

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