

Original Research Article

The effect of technology on the occurrence of musculoskeletal disorders in students of high school in Greece

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ABSTRACT

Background: There has been a rise in the proliferation of technological devices across the globe. Many children use electronic devices from the age of 3 years old, especially mobile phones. The prolonged use of electronic devices has led to a distortion of body posture, leading to musculoskeletal disorders, including neck, thoracic, and back pain, and tendonitis of the upper extremities, primarily when using one hand.

Methods: To prove the positive correlation between technology and musculoskeletal disorders and to answer the above questions, an online questionnaire was distributed to 120 students of high school from all over Greece. The questionnaire comprises questions from two standardized questionnaires, the internet addiction test (IAT) and the Nordic musculoskeletal questionnaire (NQS). In addition, respondents completed a medical history and supplementary questions about their physical condition and their attitudes when using electronic devices.

Results: The results show that there is a positive correlation between long-term use of electronic devices and the occurrence of musculoskeletal problems in all parts of the body (neck, chest, lower back, hip, and lower extremities), as well as students who chose the wrong postures, had much more symptoms in contrast to the students who chose the positions with the greatest alignment. Finally, physical activity decreased significantly as the respondents' hours of using electronic devices increased.

Conclusions: Uncontrolled use of electronic devices can be a factor in the onset of symptoms, but adopting correct posture while using the devices and the good physical condition of the students would significantly reduce pain.

Keywords: Electronic device, Technology, Addiction, Musculoskeletal pain

INTRODUCTION

There have been advances in information and communication technology, especially in the last decade. Electronic media such as computers, mobile phones, and tablets, among others, have become integrated into the lives of users. Most people are using mobile phones as it has evolved from just communication device to multifunctional device capable of handling functions like a computer.¹

Technology is found in different facets of life, including, fun, education, and communication. The acquisition of smart devices is now possible as there is a wide variety in the price of devices. Are addressed to all age groups, even to people who face some difficulties such as mental retardation, disability, and learning difficulties.¹

Although the use of technology and especially mobile phones has proven to be a better and more effective way of communication between friends and professionals,

their excessive use can bring the exact opposite results to user, as behavioral disorders, low school performance, reduced cognitive functions depression, and anxiety.¹

Another major disadvantage of the frequent use of electronic devices is the occurrence of musculoskeletal disorders in minors. Prolonged and long-term use of the devices, especially in combination with incorrect posture, are factors in the development of musculoskeletal disorders, including cervical syndrome, back pain, and tendonitis of the upper extremities.²

Generally, the typical body posture adopted by individuals when using smart devices is to grasp it with one or both hands and place it below eye level. Using a device in such a posture forces one to assume an uncomfortable posture, such as bending the head forward and down, increased chest kyphosis, increased lumbar lordosis, and back call of the pelvis, where they are usually maintained for a long time.³ As a result of the above posture is the appearance of pain in the cervical spine but also in other areas of the body.⁴

Also, another negative achievement of the frequent use of electronic devices is the removal of young people from physical activity. While smart devices enable people to exercise through various applications, their ability to send messages and update social networking sites, is gaining traction and thus promoting sedentary life. Abstinence from physical activity is associated with the development of multiple problems in the appearance and health of individuals, such as reduced muscle mass, increased body fat, low cardiorespiratory capacity, and increased risk of metabolic diseases.⁵

According to the world health organization, a person aged 5-17 needs to work out daily for about sixty minutes, which is not the case when students spend more than three hours online on average with those who state that they use less than seventy minutes.¹⁰

Objectives

The purpose of this study is initially to prove that the long-term use of electronic devices can negatively affect the occurrence of musculoskeletal disorders in students at high school. Secondly, to determine whether long-term use of electronic devices in combination with adopting wrong positions can create discomfort in musculoskeletal system. Also, a hypothesis was whether students who have low physical activity had more musculoskeletal problems and the last hypothesis was whether technology is a cause for the decline of physical activity in students.

METHODS

A researcher led the research in the context of her master's thesis in the master's study program of the physical therapy department of the international Hellenic university. The study was conducted online over a one-

week period, the first week of February 2022. The questionnaires were randomly distributed to high school students throughout the Greek territory in order to have a representative sample from different regions. The students answered a questionnaire that included questions about participants' height, weight, age, and place of residence. Then, the students completed a medical history and answered questions from two standard questionnaires the IAT, which examines students' dependence on the internet, and the NQS. These questionnaires examined the onset of symptoms from the musculoskeletal system. In addition, the questionnaire contained questions about the usual postures that students adopt while using the devices. In particular, pictures were given in the upright, sitting, and lying positions. Respondents had to choose which image represents them in the specific positions. Besides the electronic device, the students answered questions about their physical condition. Finally, they were asked to answer those who reported pain and what treatment they received, i.e., whether they visited their doctor, used medication, and received physical therapy.

Google Forms was used to create the questionnaire, which was shared online. A sample of 12 students was collected from all over Greece. Criteria for participation in the research were competent students without psychiatric disorders who attended the high school, while the exclusion criteria were students who have undergone surgery on the musculoskeletal system.

For the statistical analysis of the responses collected the SPSS statistical package, version 25 was used. In the analysis of nominal scale questions statistical tables of frequencies and relative frequencies were used (frequency, percent), bar charts and pie charts for graphical representation of findings. In interval questions (e.g., weight) measures of position and dispersion as well as frequency histograms were used. Incomplete responses were coded as "99". Sample prices available appear as "valid" while the incomplete ones as "missing".

This research was audited, approved, and licensed by the bioethics and ethics committee of the International Hellenic university with protocol number XX and registered to clinical trials with NCTXXXXXX.

Reliability of the questionnaire

Before distributing questionnaire, it was deemed necessary to check its reliability. For this reason, in the first phase the questionnaire was answered by 20 students and after one week it was answered again to check its reliability. Absolute identification, repeatability and stability of responses were found, which makes the questionnaire 100% reliable.

According to Table below, results show high percentages of reliability and validity as in answers of sample, absolute identification, repeatability, and stability of the answers made the questionnaire almost 100% reliable.

Table 1: Test- retest reliability.

Questionnaire							
Assessor	Mean	95% confidence interval for mean		Variance	SD	Minimum	Maximum
		Lower bound	Upper bound				
1 st day	30.4500	27.9360	32.9640	61.792	7.86081	19.00	49.00
3 rd day	30.0500	27.6678	32.4322	55.485	7.44880	19.00	49.00

Table 2: Confidence interval.

Questionnaire	Intra-class correlation	95% confidence interval	
		Lower bound	Upper bound
	0.991	0.981	0.996

RESULTS

Sample characteristics

The 37.5 percentages of the participants who answered the questionnaire were boys and 62.5 percentages were girls, the average age of the students was 16 years, 34.2 percentages of the participants were in the first grade of high school, and 65.8 percentages were in the second grade. The average value of height was 1.69 m while the mean weight was 62.79 kg. The 5% suffered from a chronic disease while 8.3 percentages of them took some medicine (Table 3).

Correlation of long-term use of electronic devices in the occurrence of musculoskeletal disorders in students

Based on the sample responses regarding the hours of use of electronic devices, only one student used the mobile phone for less than an hour, 22.5 percentages used at least four hours, 16.7 percentages used 1-2 hours, 34.2 percentages did use 2-3 hours. Finally, 25.8 percentages used a mobile phone for 3-4 hours. The main reason for using the participants' devices was the conversations.

The tables below show that students who used electronic devices for less than an hour had significantly lower rates of pain in all parts of the body. More specifically, as Table 4 shows, the positive responses for cervical discomfort were much higher in the students who used the electronic device for four hours or more. A percentage that reached 39.1 percentages in contrast to

those who consumed 1-2 hours on the internet, which was only 10.9%. According to Table 5 people who used for less than 1-2 hours reported a very small percentage of pain instead of those who reported using smart devices for more than four hours. Finally, the percentages in Figure 4 are remarkably lower as those who reported low back pain while using the electronic device for less than an hour were only 1.9 percentages. In contrast, those who used it for more than four hours reached 33.3 percentages.

Table 3: Characteristics of the sample.

Features	Frequency (%)
Sex	
Female	62.5
Male	37.5
Age (Years)	
Average	16
Attendance class	
A' high school	34.2
B' high school	65.8
Height (m)	
Average	1.69
Weight (kg)	
Average	62.79
Underlying diseases	
Yes	5
No	95
Medication	
Yes	8.3
No	91.7

Table 4: Sample rates of neck pain depending on the hours of use of the electronic devices.

Variables		Hours of use of electronic appliances (Hours) (%)					Total (%)
		<1	>4	1-2	2-3	3-4	
Have you ever had pain in the last 12 months in the neck?	Yes	2.2	39.1	10.9	30.4	17.4	100
	No		12.2	20.3	36.5	31.1	100

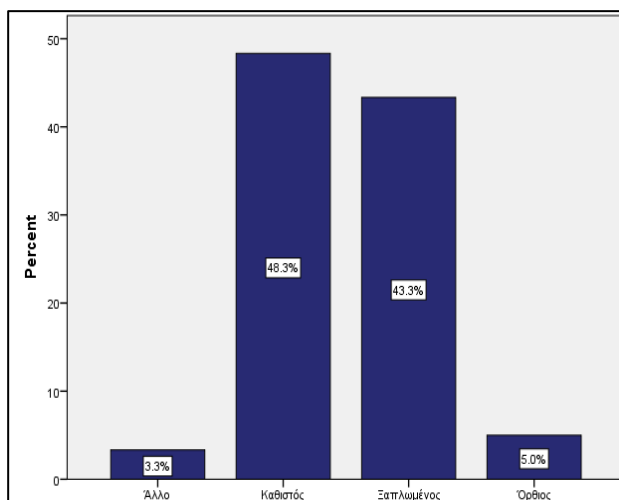
Table 5: Percentages of sample of pain depending on the hours of use of electronic devices.

Variables		Hours of use of electronic device (Hours) (%)					Total
		<1	>4	1-2	2-3	3-4	
Have you ever had pain in the last 12 months in the shoulder blades?	Yes	2.8	27.8	8.3	41.7	19.4	100
	No		20.2	20.2	31	28.6	100
Have you ever had pain in the last 12 months in the hip?	Yes		58.3		33.3	8.3	100
	No	0.9	18.5	18.5	34.3	27.8	100
Have you ever had pain in the last 12 months in knees?	Yes		36.8	13.2	28.9	21.1	100
	No	1.2	15.9	18.3	36.6	28	100
Have you ever had pain in the last 12 months in fingers?	Yes		21.4		50	28.6	100
	No	0.9	22.6	18.9	32.1	25.5	100
Have you ever had pain in the last 12 months in the upper back (chest)?	Yes		37.5	12.5	37.5	12.5	100
	No	1.0	20.2	17.3	33.7	27.9	100
Have you ever had pain in last 12 months in lower back?	Yes	1.9	33.3	13	31.5	20.4	100
	No		13.6	19.7	36.4	30.3	100
Have you ever had pain in the last 12 months in elbows?	Yes		60		40		100
	No	0.9	20.9	17.4	33.9	27	100

Combination of incorrect posture and long use of electronic devices as a cause of musculoskeletal disorders

A common mistake made by most people in all positions is excessive neck flexion, increased chest kyphosis, increased lumbar lordosis, lack of forearm support, and the use of a single thumb for writing messages.¹⁰

Adopting the specific posture standards, it was expected that the people in the sitting, standing, and lying position one or more characteristics of the specific posture would have more musculoskeletal problems. For this reason, they were given images with incorrect and correct positions in sitting, standing, and lying down and had to choose which ones to adopt most of the day. According to the students' answers, as shown in Figure 1, 48.3% during use of the mobile phone and spend most of the day in a sitting position while 43.3% are lying down, and the minority of students with 5% are standing.

**Figure 1: Stop using a device most of the day.**

In all the answers given by the students, the percentages of pain in the students who chose the image with the wrong position were impressively higher than those who chose the image with the correct position. More specifically, two images were given to the students in the upright position. Similar images were given in the sitting position as in the first choice, the person had a correct alignment without straining the parts of the spine, which did not represent the second image as there were loads on the above degrees of the spine due to the uncomfortable position that the person had adopted. More specifically, out of all the students who stated that they had neck pain in the last 12 months, 89.1% chose option 1 for the upright position, i.e., the wrong position, and 10.9%, option 2, the correct position. For the sitting position, only 10.9% who declared pain chose the image with the correct alignment instead of 89.1% who chose the one with the least alignment. The responses of students who reported shoulder pain are about the same percentages as 83.3% had chosen the image in the upright position with the wrong posture while 16.7% reported shoulder pain had chosen the right position. As expected, students who adopted the position with the least alignment had the highest rates of pain and in the rest parts of the body whether in the sitting or upright position.

People who experience pain in the cervical and lumbar spine have low receptive acidity, i.e., they do not realize that the posture they have adopted is wrong, as a result of which they do not modify it, and consequently, pain episodes occur.^{13,14} Also, people with recurrent episodes of pain, especially in the lumbar spine, seem to adopt a wrong posture pattern which activates the torso muscles with a different pattern which reduces its mobility increases its stiffness and instability, resulting in increased episodes of back pain.¹²

Numerous studies have shown that the main intervention of therapists to reduce chronic pain is to modify the

posture of individuals and improve orthostatic control as it seems that a large percentage of pain is due to poor posture and poor orthostatic control.¹¹

Regarding the lying position, the students had four options to state which one represents the best in the specific position. The first option depicted the person in the bed who had a pillow in the chest, no support in the back, a large bend in the cervical region, and the mobile enough below eye level. In the second option, there was a perfect alignment of the body in the supine position, support of the neck and chest, support of the forearms, and use of the mobile phone at eye level, in the third option was depicted in the lateral position with a small cervical tilt forward, thoracic kyphosis and the cell phone just below eye level. In contrast, the fourth and last option was depicted in the prone position with elbow support and torso overextension. In the responses of students who reported neck pain in the last twelve months, 30.4% chose option 1, 6.5% option 2, 50% option 3, and 13% option 4 for students who reported pain in the last 12 months. Twelve months on the shoulder for the position when lying down 25% chose option 1, 5.6% option 2, 50% option 3, and 19.4% option 4, similar are the rates of pain in the elbow, fingers, and chest. Generally, in all the answers given by the students, it seemed that those who had chosen image two, that is, the one with the largest alignment, had the lowest percentages of pain, the third choice, has the highest percentages of pain, immediately after the image with most symptoms were option one and finally option four.

The existence of views on negative association between pain and poor posture does not seem to exist as several studies have shown that improving posture prevented the onset of musculoskeletal pain while also reducing its further deterioration.¹¹ However, changing the usual posture patterns requires the individual to be aware that he/she is adopting the wrong posture to participate in the change of the specific pattern, which is difficult outside the laboratory.¹¹ Continuous exercise and attention by the individual to maintain muscle strength in the desired posture is very important as it may not eliminate the symptoms but can certainly reduce them.¹⁵

Correlation between low physical condition and long use of electronic devices

The third and final question of the present study is the association of long-term use of electronic devices with low physical activity. According to the students' answers, 51.7% do not exercise. Of those who stated that they exercise, in terms of exercise hours as shown in Figure 2, 70.8% exercise daily for less than an hour while two 25.8% of the participants exercise for three hours. The minority, with a percentage of 3.3%, exercises for more than 3 hours daily. Most participants (75%) do not seem to neglect their physical activity to surf the internet, but 25% of the sample has the opposite habit (Figure 3).

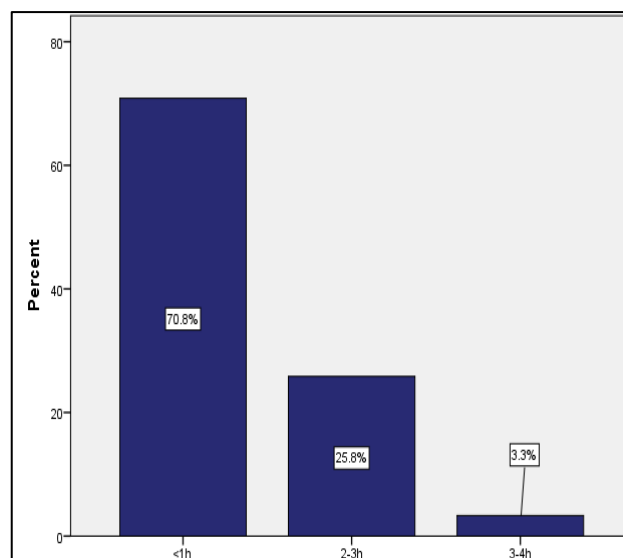


Figure 2: Hours of exercise per day.

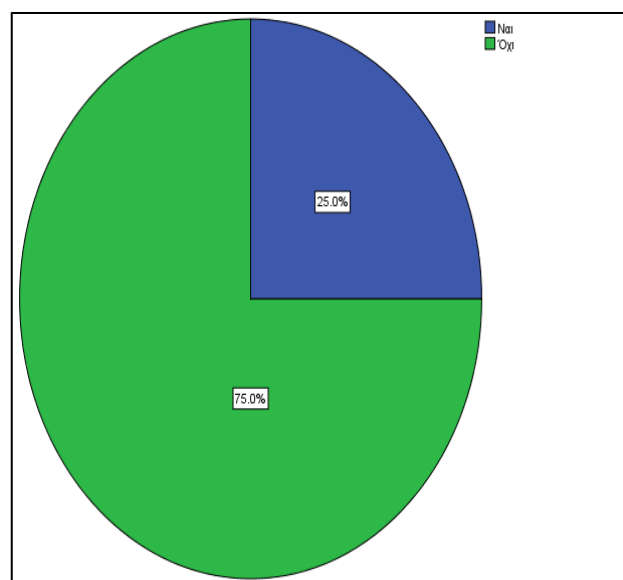


Figure 3: Percentage of students who neglect exercise to surf the web.

As shown in Figure 4, as the hours of use of electronic devices increase, the percentages of people who stated that they participated in a sport also decrease. More specifically, of the students who used electronic devices for 1-2 hours, 60% did some sport, then when the hours increased to 2-3 then the percentage who declared a sport decreased to 43.9% the participation rates in sports decreased to a greater extent while the hours increased even more to 3-4 as 41.9% declared participation in a sport, finally, there is a slight increase in the percentage of students who play sports while the hours of use of electronic devices increased by more than four. Although the percentage of people who play sports is already low, the long hours of using electronic devices seem to reduce physical activity levels in underage students further.

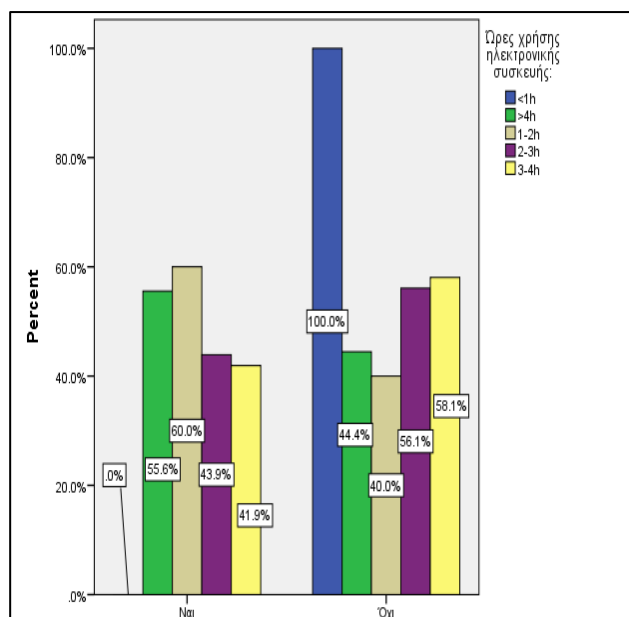


Figure 4: Hours of use of electronic device and participation in sports.

Treatment of pain of students who reported symptoms in the musculoskeletal system

Of the students who reported pain in the musculoskeletal system from the total of valid answers, 33.3% sought medical help to treat pain while 27.3% consumed some medication to treat pain.

The 9.2% have already had physiotherapy while 63.2% of participants said they were willing to do physical therapies to reduce pain.

Finally, 65.8% of respondents know the benefits of physiotherapy in both therapy and consulting ergonomics.

DISCUSSION

The present study confirms that the long duration of use of smart devices is a factor in the occurrence of pain in young A&B high school students compared to those who made limited use of electronic devices. According to the results, it is understood that the percentages of students who reported pain while using the devices for more than four hours are significantly higher compared to those who used the electronic devices for less than an hour.

The results of another survey of a sample of one hundred and fifty people confirm the crucial role of long-term use of electronic devices, people aged seventeen and over who worked in an office that used computers, mobile phones, and the internet for more than three hours were asked to respond in a questionnaire regarding symptoms in various parts of the body. Responses from employees who used for more than six hours were common as they all experienced discomfort in the neck, wrists, shoulders,

and headaches, which did not occur in those who used for less than six hours.¹⁶ Another study of a sample of 120 students and staff found that people who used smart devices for more than four hours a day had high rates of musculoskeletal pain, carpal tunnel syndrome, computer syndrome, and vision problems.¹⁷

However, there was a negative record of the main question of the investigation and the cases that were conducted before the investigation. More specifically, the first case concerned whether incorrect postures, i.e., positions with excessive head flexion, excessive chest kyphosis, and lumbar lordosis, are a factor of aggravation and cause of pain. As can be seen from the students' responses, those who chose those attitudes with the least alignment also had the most symptoms compared to those who stated that they took a more neutral position, which should be pointed out to young students to prevent symptoms.

The second and final hypothesis was whether technology was a factor in reducing physical activity, that is, whether students who reported spending many hours online reported a low level of physical activity. In general, the participation rates of students in sports activities were already limited, and the hours of exercise were less than an hour. So, the second hypothesis came out positive in part as initially there was a significant drop in participants as the hours of use of electronic devices increased, but there was an unexpected increase in the percentage of athletes while they used electronic devices for more than four hours.

The percentages of students who sought medical treatment for pain are impressively high. On the positive side, a large percentage of students, reaching 65.8%, are aware of the therapeutic effects of physiotherapy and the benefits it offers in counseling ergonomics.

The use of technology, the Internet, and consequently electronic devices will increase even more while at the same time, the average age of users will decrease. In the last decade, the percentage of people suffering has increased by 25% worldwide from musculoskeletal disorders, while 2% is associated with poor ergonomics.¹⁷

The limited-time of use of electronic devices is a very important factor in reducing the appearance of symptoms from the musculoskeletal system as it seems that when the person uses it for less than sixty minutes, the tissues and surrounding structures do not "deform" while also when the person adopts the right attitude, i.e. a neutral position of the members then there is no overloading of the structures which prevents the occurrence of symptoms.

Limitations

The limitations of this study include the number of the sample if we consider the total number of high school

students in Greece. Another limitation can be considered how accurate was the completion of the questionnaires by the students due to their young age and whether the supervision of an adult caregiver should be considered mandatory.

CONCLUSION

In conclusion, the findings of the study are positive, that is, the long-term use of electronic devices is a factor in the appearance of musculoskeletal pain, as people who use smart devices for more than three hours had higher rates of pain compared to students who stated that they used it for less than two hours. Also, a cornerstone is an attitude adopted by the person during the use of electronic devices both in the sitting, the upright, and in the lying position, the people who chose the position with the least alignment were those who reported the most symptoms,

Finally, the level of sports of the students was at quite low levels as the above tables showed, as the hours of use of the devices increased, the percentage that stated that they were exercising decreased, which confirms the positive correlation between long hours of mobile phone use and low physical condition.

Recommendations

Students are initially advised to use electronic devices for less than two hours a day. It is also important to point out to students the correct posture while using electronic devices. The first ergonomic advice concerns the reduction of the bending of the head downwards and the excessive kyphosis of the thoracic degree, the device should always be placed at eye level, the shoulders should not be "rounded" forward, there should be support in the lumbar region and their forearms, use both hands, also use both thumbs while typing a message and take frequent breaks.

In addition, students should understand the contribution of exercise and its role in preventing and rehabilitating injuries. Research shows that the better a person's muscular system, the more resistant to stress and injury.⁸ In conclusion, actions should be taken to promote the advantages of physical exercise and point out the disadvantages of abstinence from it.

In general, the correlation between the long-term use of electronic devices and the occurrence of musculoskeletal disorders has been extensively researched in the adult population. There is generally a wealth of research and literature on the negative effects on the musculoskeletal system.⁴

Finally, in terms of research, it would be useful to collect a larger sample of students and more age ranges in future research.

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