

# The impact of using multimedia technologies on the cervical spine among young adults – preliminary studies\*

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## ABSTRACT

**Introduction:** The Internet and access to electronic devices seem to be the necessities of the modern daily life. The aim of this study was to assess the amount of time spent daily in front of a mobile phone and computer/laptop, the body posture while using these devices, and the occurrence of pain during usage.

**Materials and methods:** The study group consisted of first-year students of engineering and IT at 2 universities in Kielce. The research was carried out using the self-constructed questionnaire technique. The questionnaire was divided into 3 parts: I. personal data; II. mobile phone use; III. desktop computer/laptop use. The survey concerned mainly the amount of time spent in front of electronic devices, posture, as well as the scale of pain while using the above-mentioned devices.

**Results:** The study involved 135 people (96 men – 71% and 39 women – 29%) aged 19–30 years ( $\pm 21$  years). The use of electronic

devices up to about 3 h a day was the most frequent response – 56% of all responses for a mobile phone uses and 62% for a computer/laptop use. The percentage of people who devoted more than 5 h a day to mobile phones as well as using computers over 6 h a day was 4%. The analysis showed that when using the electronic devices, pain was reported for almost every area of the body. Body position while standing and sitting was described in various variants of answers indicated by respondents when using electronic devices.

**Conclusions:** The implementation of correct health-related habits regarding the adoption of the correct body position from an early age results in avoiding pain in the future. Spending too much time on the computer or mobile phone contributes to the occurrence of pain in the study group.

**Keywords:** multimedia technology; cervical spine; mobile phones; computers; text neck syndrome; Internet; addiction.

## INTRODUCTION

The ongoing era of digitalization enables to develop information and computer technology that allows people to connect with the whole world without any barriers. Nowadays, the Internet and access to electronic devices are the inextricable parts of the daily life [1, 2, 3]. The greatest invention of all time was the 1st computer ENIAC which means “Electronic, Numeric Integrator and Computer” that was presented in February 1946 [4]. The 2nd device – a prototype of the Motorola DynaTAC mobile phone from 1973 revolutionized the market of modern gadgets [5]. The 1st website and IT system called CERN was distributed in 1991. Its founder was the British scientist Tim Beners-Lee [6, 7]. In December 1992, the 1st SMS, containing the words “Merry Christmas”, was sent by Neil Papworth [8]. ICQ, the 1st instant messaging application, was established in 1996. Similar applications evolved at a rapid pace and gave rise to more extensive tools and services, e.g., Facebook, Skype, Viber [9, 10].

Technologies, devices, the Internet, and computer games are an integral part of today’s culture. Despite a positive impact of digitalization and quick access to information, the modern world of technology has affected the lives of individuals on the

social level (isolation, depression, family or school environment), physical level (pain, SMS neck) and mental level (addiction to computer games or the Internet, cyberbullying). Furthermore, the real world is increasingly replaced by a virtual environment where users spend more and more time in front of their screens [11, 12, 13, 14, 15, 16, 17, 18].

Modern phones have replaced many devices, e.g. watch, camera, digital camera, radio and even wallet. However, our reliance on phones in daily life has certain disadvantages as described in a report issued by the California Department of Public Health in 2017. Portable devices generate electromagnetic fields, which can be one of the factors that lead to brain tumors. Some studies have shown that excessive mobile phones and computers use may lead to a number of symptoms, such as headaches of varying frequency, fatigue, insomnia, poor concentration, and memory loss [19, 20].

People who use electronic devices on a daily basis tend to slouch and lean their bodies forward. It is believed that the phenomenon called either tech neck or smartphone face developed over the years and the effects have only been noticed recently [21]. It should be emphasized that keeping the cervical spine in the wrong position causes serious problems with maintaining the proper body posture. Muscles, nerves and joints run through the cervical spine, which under pressure

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cause irritation, and in the final stage lead to various types of pain, including neck pain, upper back and shoulder pain, muscle stiffness as well as tingling and burning sensation around arms. Furthermore, prolonged awkward body position can contribute to the deviation of the spine [21, 22, 23].

The use of computers and mobile phones to perform various daily activities intensifies the likelihood of risk in relation to musculoskeletal disorders of the cervical spine and upper parts of the human body. The placement of the screen, the desk, chair palm rests, and the way we hold our phones all have a significant impact on our posture. Lack of correct work ergonomics can lead to chronic health issues. One of the main problems is the downward inclination of the cervical spine, which may lead to severe back pains and other conditions [24, 25].

The key element is an ergonomic chair, which should have adjustable armrests and seat height so that the knee bends at 90°. A profiled orthopedic lumbar support or appropriate footrests may be considered as additional equipment. Certain rules should be followed while choosing a desk: the dimensions of the desk should be adjusted to body height and the amount of space for legs should be taken into consideration. Additionally, the desk should be both wide and long, so that peripheral devices fit easily on it [26]. Resting forearms on a desk or armrests can reduce pain [27].

It is necessary to set the height of the monitor so that the top edge – not the middle – of the screen is in line with your eyes, while the distance between it and a person is 40–65 cm [28], or max. 75 cm according to some sources [29]. An equally important aspect is the ergonomic (gel) wrist rests that increase the comfort of desk work [28]. However, no less important is adequate lighting, which should consist of general light (e.g. hanging lamp) as well as the light focused on the keyboard (e.g. office lamp), an arrangement that helps avoid eye strain [30].

The occurrence of text neck syndrome can be reduced by the use of preventive exercises. However, it seems that various ways to improve body posture should be included in mass educational programs. Hours spent daily in front of a computer or a smartphone have a huge impact on human life, emotions and health. If the pain in the cervical spine persists or intensifies, a physiotherapist should be consulted to choose the appropriate exercises intended to eliminate the problem [31, 32].

The aim of this study was to assess the amount of time spent daily in front of a mobile phone and computer/laptop, the body posture while using these devices, and the occurrence of pain during usage.

## MATERIALS AND METHODS

The study was conducted in 2018–2019. The test group included first-year students of engineering and IT from 2 universities in Kielce. One hundred and thirty-five people between the ages of 19–30 were involved in the study, including 96 men – 71% and 39 women – 29%. The average age was 21 years. The research was carried out using the self-constructed questionnaire technique.

It contained 33 questions. The questionnaire was divided into 3 parts: I. personal data; II. mobile phone use; III. desktop computer/laptop use. The survey concerned mainly the amount of time spent in front of electronic devices, posture, as well as the scale of pain while using the aforementioned devices.

The following body postures were defined as correct for using a mobile phone:

1. While standing:
  - holding mobile phone 25–35 cm away from the face,
  - the head is located in the extension axis of the torso,
  - keeping torso erect,
  - standing position with legs and knees straight.
2. While sitting:
  - holding mobile phone 25–35 cm away from the face,
  - the head is located in the extension axis of the torso,
  - sitting with support (special roller) in the lumbar spine,
  - legs bent at a 90° angle at the knee or a 120° angle and feet flat on the floor.

The following body postures were defined as incorrect for using a mobile phone:

1. While standing:
  - holding mobile phone 25–35 cm away from the face, 36–50 cm from the face, 51–65 cm from the face,
  - bending the head forward, head bending sideways, forward head posture,
  - the forward shoulder posture, one of the shoulders is higher than the other, forward bending of the torso,
  - standing position with one leg extended.
2. While sitting:
  - holding mobile phone 24 cm away from face, 36–50 cm from the face, 51–65 cm from the face,
  - supporting the chin by the hand, bending the head forward, head bending sideways, forward head posture,
  - extending the shoulders forward, one of the shoulders is higher than the other, forward bending of the torso, convex back, concave back,
  - sitting cross-legged, legs outstretched, legs curled under the chair, leg-crossing, pulling knees to chest.

Correct body posture while using a computer or laptop has been assumed – while sitting:

- the head is in the extension axis of the torso,
- sitting with support (special roller) in the lumbar spine,
- elbows based on a desk or armrests,
- wrist support with gel pad,
- legs bent at a 90° angle at the knee or a 120° angle and feet flat on the floor.

Poor body posture while using a computer or laptop – while sitting:

- supporting the chin by the hand, bending the head forward, head bending sideways, forward head posture,
- extending the shoulders forward, one of the shoulders is higher than the other, forward bending of the torso, convex back, concave back,
- forearms raised in the air, a loss of elbow support,
- a loss of wrist support, typing “from above”,

– sitting cross-legged, Turkish sitting position, legs outstretched, legs curled under the chair, leg-crossing, pulling knees to chest.

The course of the research procedure was as follows:

1. The people surveyed were informed about the study details.
2. Each participant has given written consent to take part in them.
3. The respondents completed a questionnaire on the amount of time, experienced pain and body postures when using multimedia devices.

A common database was created and analyzed on the basis of the obtained statistical values. When assessing the collected data based on variables, descriptive statistics were used, including arithmetic average. The Pearson’s  $\chi^2$  test of independence was used to carry out activities. Interpretation of calculations was developed in the form of percentage results. The performed analysis was performed using the Statistica 13 software. Statistical significance was assumed at  $p < 0.05$ .

It is recognized that posture, head reclination and shoulder protraction are influenced by many factors other than the use of phones or laptops, however, this research paper focuses on the fields of study in which students have the greatest contact with electronic devices. Preliminary results of the study are presented in this research paper.

## RESULTS

One hundred and thirty-five people (96 men – 71% and 39 women – 29%) were involved in the study in the age group 19–30 years ( $\pm 21$  years). The average age was 21 years.

The amount of time spent in front of the screen of a mobile phone and a desktop computer/laptop was analyzed by gender. It was observed that most of the respondents used electronic devices for less than 3 h and 3–4 h (Tab. 1, 2). The use of electronic devices up to about 3 h a day – 56% from a telephone, while 62% from a computer/laptop was the most frequently mentioned response of respondents. The percentage of people who devoted more than 5 h a day to mobile phones as well as using computers over 6 h a day was 4%.

TABLE 1. The amount of time spent using the mobile phone, by gender

Sex	Time				Total
	<3 h	3–4 h	4–5 h	>5 h	
Woman	22	11	4	2	39
Man	54	27	12	3	96
Total	76	38	16	5	135

The occurrence of pain during the use of mobile phones and computers/laptops without gender was examined. The analysis showed that when using the aforementioned devices, pain occurs in almost every area of the body (Tab. 3, 4). It is said that prolonged use of electronic devices often results in chronic pain.

TABLE 2. The amount of time spent using the computer and/or laptop, by gender

Sex	Time				Total
	<3 h	3–4 h	4–5 h	>5 h	
Woman	28	3	5	3	39
Man	56	26	11	3	96
Total	84	29	16	6	135

TABLE 3. The occurrence of pain when using mobile phones (both genders)

Pain	p
Headache	0.0002
Eye pain	0.0000
Cervical pain	0.0000
Shoulder pain	0.0004
Thoracic spine pain	0.0105
Lumbar spine pain	0.0019
Forearm pain	0.0031
Wrist pain	0.0020
Finger pain	0.3254

TABLE 4. The occurrence of pain when using a personal computer or laptop (both genders)

Pain	p
Headache	0.0731
Eye pain	0.1285
Cervical pain	0.0003
Shoulder pain	0.0001
Thoracic spine pain	0.0169
Lumbar spine pain	0.0348
Forearm pain	0.0000
Wrist pain	0.0000
Finger pain	0.0052
Hip pain	0.3611
Knee pain	0.0046
Foot pain	0.0313

The impact of improper body posture when using a smart-phone while standing may affect the upper parts of the torso. Moreover, it most often causes pain in the thoracic, lumbar and cervical spine, as well as shoulder and forearm pain. The respondents complained of pain occurring in the same areas when using the computer or laptop for too long. Most frequently, the respondents complained of lumbar spine pain and hip pain; however, the problem of knee pain was also mentioned.

In addition, students were examined in terms of the most frequently used body positions when using mobile phones and computers/laptops (Tab. 5, 6, 7). For the measurements, the body positions were divided into standing and sitting.

While using smartphones, the right distance of 25–35 cm from the face is a very important factor. In a standing position, the respondents set the phone correctly (39%) while the other people either kept the phone too close (39%) or too far (22%). The respondents bowed (37%) or extended their heads forward (33%), so their body posture was not correct and at the same time they leaned their torso forward (39%). Only 30% of people kept their heads in the extension axis of the torso and 33% kept their bodies straight. Similar results were collected for a sitting posture. Respondents, despite keeping mobile phones at an appropriate distance (41%), tilted their head forward (36%). Moreover, most people used a lumbar support (30%).

The respondents browsing a mobile phone in a standing posture in 39% tended to hold the smartphone up to 24 cm from their face, 37% tilted the head forward, 39% tilted the torso forward, 69% stood with legs and knees straight. However, when sitting, 41% kept their device at a distance of 25–35 cm from the face, 36% tilted the head forward, 18% assumed a kyphotic posture (a convex back), 53% bent their knees to a right angle or obtuse angle, as well as put their feet flat on the floor.

In addition, the sitting posture in front of the computer was different from the positions assumed when using the telephone. In order to eliminate pain the correct body posture is desirable. The most common position when using a computer or laptop was associated with bending their head forward significantly (37%), was using a special roller to support the lumbar spine (26%), was leaning the elbows on the top table or armrests (70%), did not have a mouse pad (53%), was bending their knee sat a 90° angle or 120° angle as well as putting feet flat on the floor (50%).

## DISCUSSION

According to one study, about 560 billion SMSes are sent worldwide every month [33]. As many as 77% of the society around the world communicate using mobile phones [34]. It is estimated that the amount of time spent in front of the smartphone screen is more than 4 h/day among 58% of men and 52% of women [25], while for the computer screen these figures are less than 2 h/day – 28%, 2–4 h/day – 35%, while over 4 h/day – 37% [35]. Studies on the weekly use show that about 91% of the total number of respondents, including about 52% of adolescents, use it for up to 7 h a week. Moreover, about 4.5% use these devices for more than 21 h a week [25].

In our research the available data analysis showed that as many as 56% of respondents used a mobile phone up to 3 h/day, the others used it between 3–4 h – 28%, 4–5 h – 12%, over 5 h – 4%. The statistics on the amount of time while using personal computers and laptops were similar. Most of the respondents (62%) use the above-mentioned devices for up to 3 h/day, the next group of people spending 3–4 h in front of the screen was 21%. In the case of using a computer and laptop for 4–5 h and over 5 h, the same results were obtained as for people using a mobile phone – 12% and 4%, respectively.

In the literature it has been described how the weight of the head on the spine increases when bending the neck at varying degrees. The weight can vary between 0° (most desirable 4.5–5.5 kg) and 60° (critical value 27 kg) [36, 37]. This applies especially to those who use mobile phones as well as computers in an uncomfortable position. This posture is distinguished by a pronounced flexion of the cervical spine (when using smartphones) or protruding the jaw forward (when the user is in front of a laptop or computer screen) [21].

TABLE 5. Body position while using a mobile phone (standing position)

Body position	Eyes		Head/Neck		Shoulders/Torso		Legs/Feet					
	n	%	n	%	n	%	n	%				
Standing position	holding a mobile phone at a distance of up to 24 cm from the face	53	39	tilting/bowing the head forward	50	37	movement of the shoulders forward	36	27	standing position with one leg extended forward	42	31
	holding a mobile phone at a distance of up to 25–35 cm from the face	52	39	bending the head to both sides	0	0	one shoulder is placed higher than the other	3	1			
	holding a mobile phone at a distance of up to 36–50 cm from the face	30	22	put the head forward	45	33	forward tilt of the torso	52	39	standing position with straight legs in the lap	93	69
	holding a mobile phone at a distance of up to 51–65 cm from the face	0	0	the head is in the extension of the torso axis	40	30	torso straight	44	33			
<b>Total</b>	<b>135</b>	<b>100</b>	<b>135</b>	<b>100</b>	<b>135</b>	<b>100</b>	<b>135</b>	<b>100</b>	<b>135</b>	<b>100</b>		

**TABLE 6. Body position while using a mobile phone (sitting position)**

Body position	Eyes	n	%	Head/Neck	n	%	Shoulders/Torso	n	%	Legs/Feet	n	%	
Sitting position	holding a mobile phone at a distance of up to 24 cm from the face	48	36	supporting the head with hand	24	18	movement of the shoulders forward	15	11	cross-legged sitting	6	4	
				tilting the head forward	48	36	one shoulder is placed higher than the other	17	13	legs stretched out in front of person	18	13	
	holding a mobile phone at a distance of up to 25–35 cm from the face	55	41	bending the head to both sides	29	21	forward tilt of the torso	17	13	legs tucked under the chair	15	11	
							torso upright	22	16	legs bent at the knees at a right 90° or obtuse 120° and feet flat on the floor	71	53	
	holding a mobile phone at a distance of up to 36–50 cm from the face	32	24	put the head forward	33	24	kyphotic spine position	24	18	crossing the legs	22	16	
							lordotic spine position	0	0				
	holding mobile phone at a distance of up to 51–65 cm from the face	0	0	the head is in the extension of the torso axis	1	1	a seat with support (a special roller) in the lumbar spine	40	30	pulling knees up to the chest	1	1	
	<b>Total</b>		135	100		135	100		135	100		135	100

**TABLE 7. Body position while using a computer or laptop (sitting position)**

Body position	Head/Neck	n	%	Shoulders/Torso	n	%	Elbows	n	%	Wrists/Hands/Fingers	n	%	Legs/Feet	n	%	
Sitting position	supporting the head with hand	26	19	movement of the shoulders forward	20	15	elbows/forearms raised in the air, no elbow support	41	30	using pads, e.g. gel pads to support the wrists	63	47	cross-legged sitting	10	7	
				tilting the head forward	37	27							one shoulder is placed higher than the other	23	17	legs stretched out in front of person
	bending the head to both sides	0	0	forward tilt of the torso	18	13							legs tucked under the chair	17	13	
				torso upright	13	10	legs bent at the knees at a right 90° or obtuse 120° and feet flat on the floor	68	50							
	put/bend head forward	49	37	kyphotic spine position	26	19	elbows resting on the table top or armrests	94	70	no wrist support when typing	72	53	crossing the legs	31	23	
				lordotic spine position	0	0							pulling knees up to the chest	4	3	
	the head is in the extension of the torso axis	23	17	a seat with support (a special roller) in the lumbar spine	35	26										
	<b>Total</b>		135	100		135	100		135	100		135	100		135	100



The neck position when using electronic devices is associated with an increased incidence of pain and is primarily determined by mental, physical and social well-being as well as gender and the proper position of the body [35, 38]. Neck pain is also experienced during childhood and adolescence. The problem of estimating the number of occurrences of symptoms is under discussion because the level of the initial pain episode is high among young adults. Over the years, the symptoms systematically get worse [23, 39, 40, 41, 42]. It has been estimated that office workers and people who constantly use electronic devices are the most frequent group of people exposed to neck pain (from about 10% to 21%) [23]. Other studies also point to unpleasant sensations in the same part of the body in 20% of adolescents [43]. Gustafsson et al. demonstrated that women using mobile phones more often experienced neck pain (47%) and upper body pain (29%) than men (23% and 21%, respectively) [35]. The long-term impact of poor posture (continuous bending forward) can lead to nerve compression that causes headaches, and pain in the wrists or fingers.

In this research, the most frequent symptom related to smartphone among the respondents of the survey was a pain in the wrists – 42%. Other painful areas include shoulders – 33%, cervical spine and eyes – 31% each, fingers – 27%. Similarly, respondents were asked to indicate the location of pain experienced when using a computer or laptop. The results are presented as follows: wrists – 43%, cervical spine – 42%, shoulders – 41%, eyes – 32%, forearms – 31%, thoracic spine – 27%, fingers and hips – 23% each, head and lumbar spine – 21% each, knees – 20%, and feet – 17%.

In order to prevent text neck pain, it is recommended to hold electronic devices at eye level as well as maintain a proper posture while sitting at the desk [28]. Studies conducted by scientists from Australia have shown that small changes of a few degrees in body position (2%) and pain may result mainly from the excessive use of a computer or laptop [25]. Researchers who study the users of multimedia devices have stated that the vast majority of people (about 62%) experience pain in the upper parts of the body (neck and shoulders) [22].

Growing up while using electronic devices to learn habits has a huge impact on body position. Our analysis shows that the respondents assume different positions when using mobile phones in a sitting and standing position, and computers/laptops in a sitting position. People using mobile phones in a standing position held them too close to their face – up to 24 cm (39%, 53 people), put/bend the head forward (39%, 50 people), had a forward tilt of the torso (39%, 52 people) and standing position with straight legs in the lap (69%, 93 people). The respondents showed better posture when using a mobile phone in a sitting position. As many as 41% (55 people) of the respondents held the phone at a good distance from the face, but still most of them tilted head forward 36% (48 people). The respondents used seats with support (a special roller) in the lumbar spine 30% (40 people) and correctly positioned legs bent at the knees at a right 90° or obtuse 120° and feet flat on the floor 53% (71 people). When using a personal computer or laptop in a sitting position, the respondents put/

bend head forward 37% (49 people). The advantage was that the respondent used a seat with support (a special roller) in the area of the lumbar spine 26% (35 people), held elbows resting on the table top or armrests 70% (94%) and held legs bent at the knees at a right 90° or obtuse 120° and feet flat on the floor 50% (68 people). Most of the respondents did not have support for the wrists 47% (63 people).

For people using mobile phones for an extended time, it is suggested to hold the device with 2 hands to provide a more comfortable position, e.g. when writing a message. Using both thumbs reduces the feeling of discomfort in the cervical spine. The experts emphasize that forearm support can help to avoid tilting the head down [27, 37]. Our results are similar to the results of several studies. In Korea, 38% of respondents in the age group between 28–30 experienced neck and upper body pain, while 33% had cervical problems. Monitoring of medical staff in terms of health problems showed that 26% had problem with the cervical spine as well as thumbs and they also suffered from sleep disorders or anxiety [15, 44, 45].

It is important that the better and proper postural habits a person acquires in the period of adolescence and will use appropriate facilities to facilitate the use of electronic devices, the greater the likelihood of reducing pain in the future.

## CONCLUSIONS

The implementation of correct health-related habits regarding the adoption of the correct body position from an early age results in avoiding pain in the future.

The extended use of a computer or mobile phone contributed to the occurrence of pain in the study group.

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