European Journal of Therapeutics https://doi.org/10.58600/eurjther.20232902-592.y

Original Research

The Impact of Using Technological Devices on Mental and Physical Health in Adolescents

[1] Istanbul Physical Medicine and Rehabilitation Training Hospital, Health Sciences University, Istanbul, Turkey

[2] Department of Physiotherapy and Rehabilitation, Faculty of Health Sciences, Istanbul University–Cerrahpasa, Istanbul, Turkey

[3] Public Health Department, Istanbul Medical Faculty, Istanbul University, Istanbul, Turkey

ABSTRACT

Objectives: In recent years, adolescents spend increasingly more time on technologic devices such as smartphones, televisions, computers, and tablets. The aim of the present study was to investigate the relationship between the usage of digital technology and health-related problems among adolescents.

Methods: A cross-sectional exploratory study was conducted by using a face-to-face survey administered to a sample of students studying at 4 randomly chosen public middle school and 4 randomly chosen public high school in the city of Istanbul. In this study recruited 1147 volunteer adolescents. All participants were answered a questionnaire regarding the demographic characteristics, technological devices useage patterns and health-related problems.

Results: Most of the adolescents had smartphones (99.4%) and the fewest had game consoles (18.2%). The rate of using television and smartphone for more than two hours a day among adolescents was 13.1% and 28.4%, respectively. A decrease in sleep duration, increase in falling asleep time, distraction, fatigue, eating disorders and psychological symptoms were significantly more present for individuals using smartphone more than two hours. A positive and very weak relationship was detected between the duration of smartphone use and neck (r=0.096; p=0.002), wrist (r=0.079; p=0.008) and shoulder (r=0.069; p=0.021) pain. Also, positive and very weak relationship was detected between the duration of computer use and upper back (r=0.102; p=0.001), lower back (r=0.078; p=0.011) and shoulder (r=0.069; p=0.041) pain.

Conclusion: This study showed the most widely used technological device among adolescents is smartphones and it was observed that the excessive use of this device among adolescents is more associated with many different health-related problems than other technological devices.

Keywords: technological devices; adolescents; adolescents health; screen time; musculoskeletal pain, health problems

INTRODUCTION

In the 21st century, increasingly popular digital technologies are the Internet of Things (IoT), artificial intelligence (AI), big data, blockchain technology and 5G telecommunications networks. These technologies are interconnected with each other and benefit human life. Digital technology devices take part in an important role in adolescents' social lives as well as entertainment. In recent years, both academics and the public have expressed concern about the rise of digital technology, focusing on smartphones and social media use [1]. It is observed that children start using technological devices at a very early age (during the kindergarten period) and the use of technological devices get more common by age. The transition to new digital technological devices has resulted in changes in device using habits. For example, in 1970s, children used to start watching television at the age of four, however, today they start to interact with digital technological devices when they are four months old [2]. Digital technology use is a general term that covers various devices, services, and types of use. Adolescents now spend more time on television, smartphones, tablets, and social media than they spend in school [3]. This became the most important activity for kids and adolescents while they are not sleeping. The largest growth in digital media usage has occurred when watching online videos, using social media, and browsing websites. Of these activities, both tweens (8- to 12-year-olds) and teens (13- to 18-year-olds) report that watching videos on YouTube is their favorite form of digital media activity, followed in order of preference by Snapchat, TikTok, Instagram, Discord, Facebook, Twitter, Pinterest, and Reddit. On average, teens spend close to an hour and a half a day on social media. In the context of daily interaction, most people in Malaysia use WhatsApp, Facebook, TikTok, Instagram, Zoom, and Hangout Meet. Facebook and WhatsApp applications have become the choice that dominates

How to cite: Doruk M, Mustafaoğlu R, Gül H (2023) The Impact of Using Technological Devices on Mental and Physical Health in Adolescents. Eur J Ther. 29(2):194-200. https://doi.org/10.58600/eurjther.20232902-592.y

Corresponding Author: Rüstem Mustafaoğlu **E-mail:** ahiska_1944@hotmail.com

Received: 17.04.2023 • **Accepted:** 21.05.2023 • **Published Online:** 22.05.2023

80% to 90% of social media usage among adolescents as these applications are able to speed up communication relationships and be able to reach other users at a time. Excessive use of digital technologic devices such as television, video games, and computers poses a danger on the body and mental health of kids and adolescents [4].

Effects of technological devices such as violence and aggression, sleep problems, fear, antisocial behaviours, eating disorders, obesity, attention problems and addiction are of particular concern to those who are interested [5-8]. In literature, more studies are found in recent years which indicates a relationship between the use of mobile technological devices (laptops, tablets) and musculoskeletal disorders among children and teenagers [9,10]. Using smartphones causes impaired joint position sense in flexion, decreased deep cervical flexors activity, and forward head posture [11]. A study conducted with children aged 6-17 has found that the risk of obesity is two times more for children who use technological devices for a long time and do less physical activity [12]. Despite the importance of sleep-in optimal adolescent health and development, sleep deficits are prevalent in this age group. In a study has shown that night-time use of at least one screen-based media devices, and specifically mobile phones or televisions, was associated with adverse sleep outcomes, particularly insufficient sleep duration, late midpoint of sleep, and poor sleep quality among adolescents [13]. A research conducted in Singapore, it was identified that headache is more common among smartphone users and as the daily talk time increases as minutes (>60 mins) and frequency of headache also increases which is considered as a dose-response relationship [14]. Studies report that spending a long time with mobile phones causes problems such as eye strain, eye irritation, blurred vision, rash, and diplopia [15, 16]. Moreover, excessive digital technologic device use might cause postural defects, musculoskeletal pain, anxiety, depression, and a decrease in proprioception [9, 17-19]. On the other hand, studies have shown that addiction to smartphones can be an obvious risk factor for poor academic performance [20, 21].

Considering the recent technological growth observed in Turkey and that concomitant to this fact, there has been an increase in access to these technologies, it is believed that today's adolescents are more exposed to these resources. It is important to determine the potential negative effects of technological device use on the mental and physical health of adolescents. To the knowledge of the authors, there are limited studies in the literature evaluating the use of technological devices, duration of use, preferences, and health-related problems among school-age students in Turkey. Therefore, the aim of this study is to examine the relationship between the use of digital technology and health-related problems in adolescents in Turkey.

METHODS

This was an epidemiological and cross-sectional study, which was conducted in the 2018-2019 academic year with the students studying at 4 randomly chosen public middle school and 4 randomly chosen public high school in the city of Istanbul, Turkey. According to data provided by Provincial Ministry of National Education there are 25 public middle schools and 32 public high schools in the city of Istanbul, Turkey. In the 2018-2019 academic year an estimated 65,048 adolescents were enrolled in these 57 public middle and high school. The sample size, estimated population was calculated as 1290 by using Epi-Info [22] program with a 95% confidence interval; sampling error of %3; estimated prevalence of 50%; sample loss of 20% and a two-fold design effect. Study inclusion criteria; attending one of the selected schools and age between 11 and 18 years. Students who do not have parental consent or parental consent form, do not use any technological device, have any known systemic disease, and fill the questionnaire insufficiently were excluded from the study. In each school, participant classes were chosen by a simple randomized sampling method. Two classes were chosen from each grade and 20±3 volunteer students were chosen from each class.

Data Collection

Data collection form was prepared by the researcher in the light of current literature and the form was finalized after performing pretest with 34 students. The form is divided into three parts; The first part of the data collection form aimed to assess socio-demographic characteristics of the participants such as age, gender, height, weight, body-mass index, type of education, type of school. In this study, ≥85 X <95 percentile BMI was considered as overweight and ≥95 percentile BMI was considered as obese [23]. The second part of the data collection form aimed to assess technological device usage habits (number of technological devices in the participants' house and time of daily use). The third part of the data collection form aimed to assess health-related symptoms such as sleep status, musculoskeletal pain, concentration, tiredness, stress, and nutrition [7, 9, 13]. The musculoskletal pain level of the participants was evaluated by the Numeric Pain Rating Scale. In this scale, the evaluation of pain level starts with 0 (no pain) and ends with 10 (severe pain) [24].

Data Analysis

Data analysis was performed using SPSS software version 21.0 (SPSS inc., Chicago, IL, USA). Shapiro-Wilk test was used to identify whether the data was normally distributed. The data obtained from the results of this test were found to be non-normally distributed and non-parametric tests were used for analysis. For statistical analysis, parameters were defined by average (mean), standard deviation (SD), frequency (n) and percentage (%) values. For comparing demographic and clinic characteristics of the groups, the Mann- Whitney U test was used for quantitative data and the Chi-Square test was used for qualitative data. Spearman Correlation test was used to analyze the relationship between the data obtained from the participants. Correlation values are rated as: r ≥ 0.81–1.0 is excellent; 0.61–0.80, very good; 0.41–0.60, good; 0.21–0.40, weak; and 0.00–0.20, very weak) [25]. In all tests, a p-value <0.05 was considered statistically significant.

RESULTS

At the end of the study, in total 1189 adolescents were included in the study. However, 42 individuals were excluded due to errors when completing the questionnaire and excluded from the

analysis. The final sample consisted of 1147 adolescents forms 572 public middle schools and 575 public high schools. The demographic characteristics are described in Table 1. Mean age and BMI of the participants was 13.5±2.3 years and 20.1±3.5 kg/m2, respectively. However, 52.1% of the participants were female. A statistically significant difference was found in every parameter except gender (p=0.409) in terms of the type of school (p=0.001).

It was found in the study rate of being overweight and obese was 19.9% among public middle school students and 13.5% among public high school students. By comparing in terms of the type of school, middle school students were found to be more overweight-obese than high school students (p=0.001) (Figure 1).

By investigating the technological devices that students have at home, it was found that smartphone (99.4%) and television (TV) (99.2%) were found the most and game consoles (18.2%) were found the least (Figure 2). Among participants 28.4% reported using smartphones for more than 2 hours on average per day, 13.1% of the individuals reported watching TV for more than 2 hours per day. In addition, 88.7% and 72.6% of the participants stated they do not use game consoles and tablets, respectively (Table 2).

The comparison of using different technological devices for more than two hours and various health-related problems is given in Table 3. A decrease in sleep duration, increase in falling asleep time, distraction, exhaustion, eating disorders and psychological symptoms were significantly more present for individuals using smartphones more than two hours (p<0.05). Psychological symptoms were significantly more present for individuals using computers for more than two hours compared to those using computers for less than two hours (p<0.05). Fatigue was significantly more present for individuals using game consoles for more than two hours compared to those using game consoles for less than two hours (p<0.05).

A positive and very weak relationship was detected between the duration of smartphone use and neck (r=0.096; p=0.002), wrist (r=0.079; p=0.008) and shoulder (r=0.069; p=0.021) pain. A positive and very weak relationship was detected between the duration of computer use and upper back (r=0.102; p=0.001), lower back (r=0.078; p=0.011) and shoulder (r=0.069; p=0.041) pain. A positive and very weak relationship was detected between the duration of watching television and neck (r=0.059; p=0.041) pain. A positive and very weak relationship was detected between the daily time of using all devices and all musculoskeletal pain complaints (p<0.05) (Table 4).

Table 1. Demographic characteristics of participants

		Total (n=1147) Mean±SD n (%)	Middle school (n=572) Mean±SD n (%)	High school (n=575) Mean±SD n (%)	p
Gender	**Male**	598 (52.1)	305 (53.3)	292 (50.9)	0.409[a]
	Female	549 (47.9)	267 (46.7)	282 (49.1)	
Age (years)		13.56±2.31	11.56±1.25	15.55±1.09	**0.001**[b]
Weight (kg)		52.33±14.05	44.78±12.04	59.87±11.67	**0.001**[b]
Height (cm)		160.30±12.75	152.07±10.95	168.38±8.53	**0.001**[b]
BMI (kg/m$^{2)}$)		20.10±3.56	19.15±3.61	21.06±3.25	**0.001**[b]
Duration of daily exposure to technological devices, hour		4.55±1.64	4.39±1.30	4.70±1.94	0.053[b]

BMI; body mass index
[a] Chi-square test, p<0.05
[b] Mann Whitney U-test, p<0.05

Table 2. Distribution of participants' average daily use time of technological devices

	Never used n (%)	<1 hour n (%)	1-2 hours n (%)	3-4 hours n (%)	>4 hours n (%)
Mobile phone	148 (13.0)	277 (24.4)	387 (34.1)	223 (19.6)	100 (8.8)
Computer	582 (52.0)	278 (24.8)	166 (14.8)	58 (5.2)	35 (3.1)
Television	206 (18.4)	402 (35.8)	367 (32.7)	112 (10.0)	35 (3.1)
Tablet	809 (72.6)	179 (16.1)	92 (8.3)	28 (2.5)	7 (0.6)
Game console	999 (88.7)	68 (6.0)	39 (3.5)	17 (1.5)	3 (0.3)

Table 3. Comparison of the use of technological devices over two hours and the presence of health problems

	Mobile phone %/p[a]	PC %/p[a]	TV %/p[a]	Tablet %/p[a]	Game console %/p[a]
Distractibility	**35.6/0.029**	25.8/0.263	29.2/0.632	37.1/0.437	20.0/0.279
Course activity	**56.8/0.001**	49.4/0.928	55.7/0.080	51.4/0.788	30.0/0.082
Sleep time	**57.5/0.001**	44.0/0.486	**34.6/0.001**	34.2/0.116	60.0/0.259
Sleep onset	**58.8/0.002**	55.9/0.391	59.1/0.053	60.0/0.316	60.0/0.448
Nutrition	**33.0/0.035**	46.2/0.093	33.5/0.286	38.2/0.965	40.0/0.835
Psychology	**41.6/0.001**	**48.3/0.018**	57.8/0.593	60.0/0.968	65.0/0.650
Failure of social activities	**15.4/0.001**	25.8/0.428	25.1/0.227	25.7/0.651	40.0/0.284
Fatigue	**6.8/0.005**	7.5/0.246	10.2/0.813	14.2/0.541	**30.0/0.006**

[a] Chi-square test; p<0.05

Table 4. The relationship between participants' duration of using technological devices and musculoskeletal pain complaints

Device usage	Upper Back		Lower Back		Neck		Hand		Wrist		Shoulder	
	r	p[c]	r	p[c]	r	p[c]	r	p[c]	r	p[c]	r	p[c]
Mobile phone, hour	0.057	0.051	0.043	0.141	0.096	**0.002**	0.056	0.052	0.079	**0.008**	0.069	**0.021**
Computer, hour	0.102	**0.001**	0.078	**0.011**	0.004	0.891	0.020	0.501	0.036	0.222	0.061	**0.041**
Television, hour	-0.018	0.552	0.009	0.773	0.059	**0.041**	0.029	0.335	0.023	0.444	-0.006	0.843
Tablet, hour	0.016	0.592	0.010	0.724	0.007	0.825	0.045	0.137	0.012	0.694	0.048	0.101
Game console, hour	-0.016	0.586	0.002	0.945	0.013	0.656	0.017	0.574	-0.003	0.916	-0.001	0.975
Total device usage, hour	0.093	**0.002**	0.094	**0.002**	0.109	**0.001**	0.088	**0.003**	0.114	**0.001**	0.101	**0.001**

[c] Spearman correlation; p<0.05

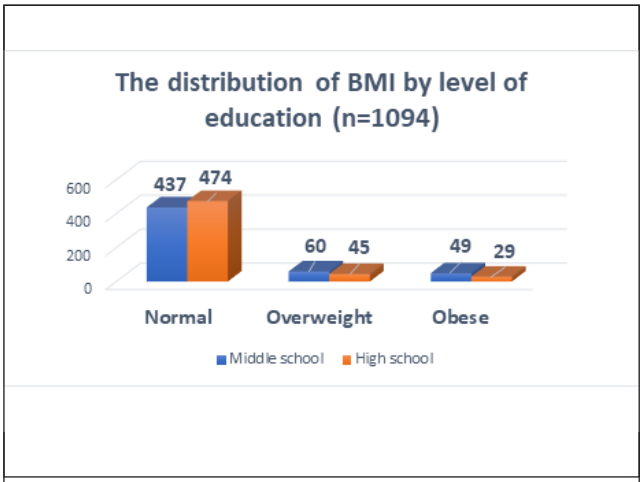

Figure 1. The distribution of participants BMI according to the educational level

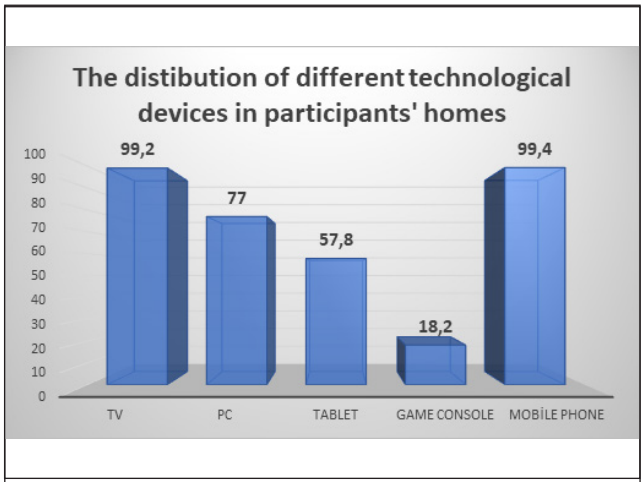

Figure 2. The distribution of different technological devices in participants' homes

DISCUSSION

As a result of the research, it was seen that the adolescents used smartphones the most and the game consoles the least. The rate of using television and smartphone for more than two hours a day among adolescents was 13.1% and 28.4%, respectively. A decrease in sleep duration, increase in falling asleep time, distraction, fatigue, eating disorders and psychological symptoms were more present for individuals using smartphone more than two hours. Moreover, there is an association between the smartphone use duration and presence of neck, shoulder, and wrist pain.

In the present study it is revealed that smartphone had the highest prevalence of use. Similar to recent large studies conducted in the Norway [7], United Kingdom [13], and Singapore [18] the smartphone was the most used device among the adolescents. Possible reasons for the high usage of smartphones included portability, convenience and multiple functions offered, such as ease of access to the internet, social media and messaging, and usage for daily functions. A study has proven that adolescents nowadays are more comfortable to interact through the Facebook than face to face. This is because the use of Facebook allows a person to interact with anyone around the world without being limited by time and geographical distance.

In literature investigating the effects of the use of digital technological devices on the musculoskeletal system of adolescents Harris et al. [26], states that there is a relationship between children's musculoskeletal complaints and using computer both at school and at home, musculoskeletal symptoms that start during youth due to the increased use of computers may cause an increase in discomfort and pain complaints during adulthood. A study conducted by Myrveit et al. [27], state that the teenagers who spend more time in front of the screen (console games, computer games, and other computer activities) experience more neck and shoulder pain. Moreover, it was stated in this study that the relationship between neck and shoulder pain and the time spent in front of the screen is partially related to depression. In another study Gustafsson et al. [28], reported that the greater amount of smartphone use was associated with a higher prevalence of musculoskeletal symptoms in neck/shoulders, upper back, arms and wrist/hand. Similarly in the Toh et al. [18] study, found that after adjusting for potential confounders, more hours/day of smartphone use was associated with increased risk of neck/shoulders, upper back, arms and wrist/hand discomfort to and visual symptoms. The results of our study are found to be in the same direction as literature. In another study, it was reported that, using smartphones causes impaired joint position sense in flexion, decreased deep and superficial cervical muscle activity, and forward head posture [11]. In the authors' opinion, smartphone users are unaware of their neck positions while using smartphones and learn an unhealthy flexion posture. This flexion posture has become a frequent and persistent habit among young individuals. The results of our study about the effects of daily total use of technological devices on pain complaints were different from the literature. Discomfort is likely associated with adolescent's unhealthy technological devices usage behaviours including frequent and long durations of devices use, adopting awkward postures because of inappropriate seating and furniture and workstation layout, inadequate forearm support during texting, gaming by keyboard and mouse use. However, the relationship between technological devices use and musculoskeletal symptoms is unknown, and prospective cohort or longitudinal studies are needed to provide more information on the nature of the relationship.

Besides, in our study, it was observed that the increase in fatigue status, psychological symptoms, neglecting house duties and eating disorders was significantly more frequent for the adolescents who use smartphones for more than two hours a day compared to those who use less than two hours a day. In a study conducted by Bickham et al. [29], it was reported that mobile phone use and television viewing were associated with depressive symptoms, while computer use, music listening, and video game play were unrelated. Nakamura et al. [30], it was found that frequency of breakfast decreased, duration of studying at home decreased, frequency of depression, anxiety and discomfort feelings increased for the children who play electronic games for more than one hour a day. It was also reported that, frequency of breakfast decreased and feeling of anxiety and discomfort increased for the children who watch television and using computer for more than one hour a day compared to those who watch less than one hour a day. As a result of the study, it was reported that multiple use of technological devices have a cumulative effect on subjective health. Orben et al. [31] found small negative between-person relations between social media use and life satisfaction in a large United Kingdom sample of adolescents over 7 years. In a sample of 1749 Australian adolescents, found overall low within-person relations between total screen time and depressive symptoms [32]. In literature, there are different results about the effects of technological devices on fatigue, neglecting house duties, psychological symptoms, and eating disorders. We believe that further study on this subject will be beneficial.

In the current study, it was found that the decrease in sleep duration and the increase in the duration of falling asleep was more frequent for the adolescents who use smartphone for more than two hours a day. Similarly, Parent et al. [33], reported that as the time spent in front of the screen increases, quality of sleep decreases, sleep duration decreases during puberty and sleep disorders occur in the group of age three. Hysing et al. [7], revealed that the extensive use of the technological devices was significantly and positively associated with sleep onset latency and sleep deficiency, with an inverse dose–response relationship between sleep duration and media use. Cain and Gradisar [34] reported that the frequency of use of a computer or electronic games is associated with longer falling asleep duration and shorter sleep duration. Possible mechanism might be in the compilation that technological device screens might increase physiological and mental stimulation which makes it difficult to fall asleep. It was also reported that the bright light of the television or computer screens might suppress the secretion of melatonin which might delay the onset of sleep. Similarly, Liu et al. [21], reported that excessive digital media use or screen time

may increase risk of sleep deprivation, sleep disturbance, mental and physical health problems, and daily functioning impairment.

Limitations and Recommendations

There is some limitation of the study. The first limitation is that the study only includes public school students. The fact that the participants were randomly selected from secondary and high school students studying in Bahçelievler district of Istanbul limits the generalizability of our results. Second, the reliability of the study is limited to the accuracy of the answers of the participants. Finally, the interpretation of the study results is based on the survey data and no objective evaluation method was used.

Nowadays, most digital activities can be accomplished with a single smartphone, and mobile phones will continue to increase in popularity and use. Adolescents should be advised to limit or reduce the time they spend on a mobile phone and take preventative measures against the harmful effects of screen time on sleep, mental health, and academic performance. So, parents need to take the efforts to guard, control and limit the screen time to avoid the risk of behaviour and psychological problems. Therefore, adolescents need more parental supported and direction as they gradually develop their own digital literacy skills. This is a valuable contribution to existing research in that significant increases in technological device use time may indicate that an adolescent health is deteriorating. Longitudinal research should be utilized to confirm our findings and provide evidence for directionality.

CONCLUSION

According to the results of our research, the increase in the time of using technological devices such as smartphones, computers, and television which have become indispensable parts of daily life for adolescents which is associated with various health problems. The smartphones were found to be the most used technological device among adolescents, and it was associated with various health problems such as decrease in sleep duration, increase in falling asleep duration, attention deficit, fatigue, eating disorders, psychological symptoms, neck, shoulder, and wrist pain. It is expected that the results of the study will contribute to raising awareness of the effects of intense technological device use on health.

Peer-review: Externally peer-reviewed.

Conflict of interest: The authors declare no conflict of interest.

Informed Consent: Informed consent was obtained from all patients participating in this study.

Funding: No funding

Author's Contributions: Conception: MD, RM, HG; Design: MD, RM, HG; Supervision: MD, RM, HG; Materials: MD; Data Collection and/or Processing: MD; Analysis and/or Interpretation: RM; Literature: RM; Review: MD, RM, HG; Writing: HG; Critical Review: HG.

Ethics Committee Approval: The study was approved by the was approved by the Istanbul University, Faculty of Medicine Clinical Research Ethics Committee (IRB:2018/1094, Approval Date; August 10, 2018).

REFERENCES

1- Dienlin T, Johannes N (2020) The impact of digital technology use on adolescent well-being. Dialogues Clin Neurosci.22(2):135. https://doi.org/10.31887/DCNS.2020.22.2/tdienlin

2- Kulakci-Altintas H (2020) Technological device use among 0–3 year old children and attitudes and behaviors of their parents towards technological devices. J Child Fam Stud. 29(1):55-61. https://doi.org/10.1007/s10826-019-01457-x

3- Radovic A, Badawy SM (2020) Technology use for adolescent health and wellness. Pediatrics.145(Supplement 2):S186-S94. https://doi.org/10.1542/peds.2019-2056G

4- Scherr S, Wang K (2021) Explaining the success of social media with gratification niches: Motivations behind daytime, nighttime, and active use of TikTok in China. Comput Human Behav. 124:106893. https://doi.org/10.1016/j.chb.2021.106893

5- Ayandele O, Popoola OA, Oladiji TO (2020) Addictive use of smartphone, depression and anxiety among female undergraduates in Nigeria: a cross-sectional study. J Health Res. 34.5: 443-453. https://doi.org/10.1108/JHR-10-2019-0225

6- Gustafsson M-L, Laaksonen C, Salanterä S, Löyttyniemi E, Aromaa M (2019) Associations between daytime sleepiness, psychological symptoms, headache, and abdominal pain in schoolchildren. J Sch Nurs.35(4):279-86. https://doi.org/10.1177/1059840518774394

7- Hysing M, Pallesen S, Stormark KM, Jakobsen R, Lundervold AJ, Sivertsen B (2015) Sleep and use of electronic devices in adolescence: results from a large population-based study. BMJ open. 5(1):e006748. https://doi.org/10.1136/bmjopen-2014-006748

8- Mei X, Zhou Q, Li X, Jing P, Wang X, Hu Z (2018) Sleep problems in excessive technology use among adolescent: a systemic review and meta-analysis. Sleep Sci Pract.2(1):1-10. https://doi.org/10.1186/s41606-018-0028-9

9- Straker L, Coleman J, Skoss R, Maslen B, Burgess-Limerick R, Pollock C (2008) A comparison of posture and muscle activity during tablet computer, desktop computer and paper use by young children. Ergonomics.51(4):540-55. https://doi.org/10.1080/00140130701711000

10- Silva GRR, Pitangui ACR, Xavier MKA, Correia-Júnior MAV, Araújo RCD (2016) Prevalence of musculoskeletal pain in adolescents and association with computer and videogame use. J Pediatr (Rio J). 92(2):188-96. https://doi.org/10.1016/j.jped.2015.06.006

11- Cetin H, Turkmen C, Bal GA, Tekerlek H, Bilgin S, Köse N (2022) Factors affecting the performance of the deep cervical flexors in young people using smartphones. Cranio. 25;1-9. https://doi.org/10.1080/08869634.2022.2078944

12- Sisson SB, Broyles ST, Baker BL, Katzmarzyk PT (2010) Screen time, physical activity, and overweight in US youth: National Survey of Children's Health 2003. J Adolesc Health. 47(3):309-11. https://doi.org/10.1016/j.jadohealth.2010.02.016

13- Mireku MO, Barker MM, Mutz J, Dumontheil I, Thomas MS, Röösli M, et al. (2019) Night-time screen-based media device use and adolescents' sleep and health-related quality of life. Environ Int.124:66-78. https://doi.org/10.1016/j.envint.2018.11.069

14- Chia S-E, Chia H-P, Tan J-S (2000) Prevalence of headache among handheld cellular telephone users in Singapore: a community study. Environ Health Perspect. 108(11):1059-62. https://doi.org/10.1289/ehp.001081059

15- Falkenberg HK, Johansen TR, Thorud HMS (2020) Headache, eyestrain, and musculoskeletal symptoms in relation to smartphone and tablet use in healthy adolescents. SJOVS. 13(2), 8–14. https://doi.org/10.5384/sjovs.vol13i2p8-14

16- Ichhpujani P, Singh RB, Foulsham W, Thakur S, Lamba AS (2019) Visual implications of digital device usage in school children: a cross-sectional study. BMC ophthalmology. 19(1):1-8. https://doi.org/10.1186/s12886-019-1082-5

17- Zirek E, Mustafaoglu R, Yasaci Z, Griffiths MD (2020) A systematic review of musculoskeletal disorders related to mobile phone usage. Musculoskelet Sci Pract. 49:102196. https://doi.org/10.1016/j.msksp.2020.102196

18- Toh SH, Coenen P, Howie EK, Mukherjee S, Mackey DA, Straker LM (2019) Mobile touch screen device use and associations with musculoskeletal symptoms and visual health in a nationally representative sample of Singaporean adolescents. Ergonomics. 62(6):778-93. https://doi.org/10.1080/00140139.2018.1562107

19- Straker L, Harris C, Joosten J, Howie EK (2018) Mobile technology dominates school children's IT use in an advantaged school community and is associated with musculoskeletal and visual symptoms. Ergonomics. 61(5):658-69. https://doi.org/10.1080/00140139.2017.1401671

20- Domoff S, Foley R, Ferkel R (2020) Addictive phone use and academic performance in adolescents. Hum Behav & Emerg Tech. 2:33–38. https://doi.org/10.1002/hbe2.171

21- Liu X, Luo Y, Liu ZZ, Yang Y, Liu J, Jia CX (2020) Prolonged Mobile Phone Use Is Associated with Poor Academic Performance in Adolescents. Cyberpsychol Behav Soc Netw. 23(5):303-311. https://doi.org/10.1089/cyber.2019.0591

22- Kamangar F, Islami F (2013) Sample size calculation for epidemiologic studies: principles and methods. Arch Iran Med. 16(5):295-300

23- Neyzi O, Bundak R, Gökçay G, Günöz H, Furman A, Darendeliler F, Baş F (2015) Reference Values for Weight, Height, Head Circumference, and Body Mass Index in Turkish Children. J Clin Res Pediatr Endocrinol. 7(4):280-293. https://doi.org/10.4274/jcrpe.2183

24- Kahl C, Cleland JA (2005) Visual analogue scale, numeric pain rating scale and the McGill pain Questionnaire: an overview of psychometric properties. Physical therapy reviews. 10(2):123-8. https://doi.org/10.1179/108331905X55776

25- Cohen J (1992) Statistical power analysis. Current directions in psychological science. 1(3):98-101. https://doi.org/10.1111/1467-8721.ep1076878

26- Harris C, Straker L, Pollock C, Smith A (2015) Children, computer exposure and musculoskeletal outcomes: the development of pathway models for school and home computer-related musculoskeletal outcomes. Ergonomics. 58(10):1611-23. https://doi.org/10.1080/00140139.2015.1035762

27- Myrtveit SM, Sivertsen B, Skogen JC, Frostholm L, Stormark KM, Hysing M (2014) Adolescent neck and shoulder pain—the association with depression, physical activity, screen-based activities, and use of health care services. J Adolesc Health. 55(3):366-372. https://doi.org/10.1016/j.jadohealth.2014.02.016

28- Gustafsson E, Coenen P, Campbell A, Straker L (2018) Texting with touchscreen and keypad phones-A comparison of thumb kinematics, upper limb muscle activity, exertion, discomfort, and performance. Appl Ergon. 70:232-239. https://doi.org/10.1016/j.apergo.2018.03.003

29- Bickham DS, Hswen Y, Rich M (2015) Media use and depression: exposure, household rules, and symptoms among young adolescents in the USA. Int J Public Health. 60(2):147-155. https://doi.org/10.1007/s00038-014-0647-6

30- Nakamura H, Ohara K, Kouda K, Fujita Y, Mase T, Miyawaki C, et al. (2012) Combined influence of media use on subjective health in elementary school children in Japan: a population-based study. BMC Public Health. 12:432. https://doi.org/10.1186/1471-2458-12-432

31- Orben A, Dienlin T, Przybylski AK (2019) Social media's enduring effect on adolescent life satisfaction. Proc Natl Acad Sci. 21;116(21):10226-10228. https://doi.org/10.1073/pnas.1902058116

32- Houghton S, Lawrence D, Hunter SC, Rosenberg M, Zadow C, Wood L, et al. (2018) Reciprocal relationships between trajectories of depressive symptoms and screen media use during adolescence. J Youth Adolesc. 47(11):2453-2467. https://doi.org/10.1007/s10964-018-0901-y

33- Parent J, Sanders W, Forehand R (2016) Youth screen time and behavioral health problems: The role of sleep duration and disturbances. Journal of developmental and behavioral pediatrics: J Dev Behav Pediatr. 37(4):277-284. https://doi.org/10.1097/DBP.0000000000000272

34- Cain N, Gradisar M (2010) Electronic media use and sleep in school-aged children and adolescents: A review. Sleep Med. 11(8):735-742. https://doi.org/10.1016/j.sleep.2010.02.006