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Original Article / *Özgün Makale*

The effects of screen time on balance in adolescents

Adolesanlarda ekran süresinin denge üzerindeki etkileri

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ABSTRACT

Objectives: This study aimed to investigate the effect of increased screen time during the coronavirus disease 2019 (COVID-19) pandemic on balance in children aged 14 to 18 years.

Patients and Methods: A total of 30 participants (16 females, 14 males; mean age: 15.3±1.3 years; range, 14 to 18 years) were included in the prospective study between March 2020 and December 2021. Videonystagmography and computerized dynamic posturography were applied and the Pediatric Berg Balance Scale (PBS) and Visual Analog Scale (VAS) were assessed in all participants. The participants were divided into three groups according to screen time, with 10 in each group: 4-6 h (Group 1), 6-8 h (Group 2), and >8 h (Group 3) per day.

Results: There was a significant difference between the three groups for somatosensory, visual, composite, VAS-imbalance scores ($p \leq 0.05$). While there was a significant difference for somatosensory and visual between Groups 1 and 3, there was a significant difference between all groups in composite scores ($p \leq 0.05$). There was a significant difference between the three groups for the vestibular score and PBS ($p \leq 0.05$). While there was a significant difference between Groups 1 and 3, as well as Groups 2 and 3 in vestibular scores, there was a significant difference between all groups in PBS scores ($p \leq 0.05$).

Conclusion: The increase in the time spent in front of the screen may negatively affect balance functions of children and adolescents.

Keywords: Children, COVID-19, balance, screen time, vestibular system.

ÖZ

Amaç: Bu çalışmada, 14-18 yaş arası çocuklarda koronavirüs hastalığı 2019 (COVID-19) salgını sırasında artan ekran süresinin denge üzerindeki etkisi araştırıldı.

Hastalar ve Yöntemler: Prospektif çalışmaya Mart 2020 - Aralık 2021 tarihleri arasında toplam 30 katılımcı (16 kadın, 14 erkek; ort. yaş: 15.3±1.3 yıl; dağılım, 14-18 yıl) dahil edildi. Tüm katılımcılarda videonistagmografi ve bilgisayarlı dinamik posturografi uygulandı ve Pediatrik Berg Denge Skalası (PBS) ve Görsel Analog Skala (VAS) değerlendirildi. Katılımcılar ekran sürelerine göre her grupta 10 katılımcı olacak şekilde üç gruba ayrıldı: günde 4-6 sa. (Grup 1), 6-8 sa. (Grup 2) ve >8 sa. (Grup 3).

Bulgular: Somatosensoriyel, görsel, kompozit, ve VAS-dengesizlik skorları açısından üç grup arasında anlamlı bir fark vardı ($p \leq 0.05$). Grup 1 ve 3 arasında somatosensoriyel ve görsel skor için anlamlı bir fark varken, kompozit skorlarda tüm gruplar arasında anlamlı bir fark vardı ($p \leq 0.05$). Vestibüler skor ve PBS için üç grup arasında anlamlı bir fark vardı ($p \leq 0.05$). Vestibüler skorlarda Grup 1 ile 3 ve Grup 2 ile 3 arasında anlamlı bir fark varken, PBS skorlarında tüm gruplar arasında anlamlı bir fark bulunmuştur ($p \leq 0.05$).

Sonuç: Ekran karşısında geçirilen sürenin artması çocuk ve ergenlerin denge fonksiyonlarını olumsuz etkileyebilir.

Anahtar sözcükler: Çocuklar, COVID-19, denge, ekran süresi, vestibüler sistem.

In March 2020, the World Health Organization declared the coronavirus disease 2019 (COVID-19) epidemic a global pandemic, resulting in millions of cases diagnosed in many countries and regions. Most countries have implemented a curfew policy, usually as a precaution to reduce the rate of COVID-19

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transmission. These quarantines have undoubtedly affected people's lives.[1] Ninety percent of students were physically disconnected from their schools, and this caused them to become more involved with technology. Personal communication devices have become vital for children and adolescents to interact with each other and access educational materials, which caused an increase in screen time.[2]

Screen time refers to the time spent in front of the screen, such as watching television, playing digital games, and spending time on social media. The increased screen time during the pandemic process caused sedentary activity.[2] Studies conducted before the COVID-19 pandemic show that with the increase in digitalization in recent years, the physical activity levels of children and adolescents have decreased, and their screen time has increased.[3] Studies after the beginning of the COVID-19 pandemic, on the other hand, show that physical activity levels of children and adolescents decreased, and their screen time increased compared to before the pandemic.[3,4] Excessive screen time was found to reduce physical activity, doing homework, playing games with friends, and spending time with family. In addition, excessive screen time has been shown to cause obesity, attention problems, sleep disorders, and issues at school.

A 2014 study revealed that children older than two years spend an average of 3 h a day in front of the screen, which was reported to be more than double the time spent in front of the screen for the same population in 1997.[3] In addition, a 2019 report by Common Sense Media reported that 8 to 12 year olds have a screen time of about 5 h a day, and 13 to 18 year olds has a screen time of more than 7 h a day.[4]

With the decrease in face-to-face interaction due to the pandemic, the use of technology by children and adolescents has increased dramatically. Before the pandemic, children of all ages spent an average of 3 h a day in front of the screen, now they spend about 6 h in front of the screen.[2] This dramatic increase in screen time raises concerns about its potentially damaging effects on children and is becoming a public health problem.

Social or emotional problems, such as obesity, poor general health, myopia, unhealthy weight gain, and low self-esteem, have occurred with the increase of screen time (smartphone, computer, tablet, television, and game consoles). Decreased physical activity, insufficient sleep, eating habits in front of the screen, anxiety, insomnia, increased perceived stress, low education level, and decreased overall quality of life have been common issues.[5,6] At the same time, we believe that balance problems will occur with the decrease in physical activity and increase in sleep problems.

In this study, we aimed to investigate the effect of digital technology use/screen time on balance, which may cause issues in children and adolescents aged 14 to 18 years. The study attempted to identify problems related to balance that children may experience, provide information and counseling to families about these problems, and produce rehabilitative solutions. We believe that this study will have the potential to inform public health policy and guidance regarding screen time and inform future research in this area.

PATIENTS AND METHODS

This prospective study involved data collected from the audiology unit of the ear-nose-throat department of the Ankara University Faculty of Health Science between March 2020 and December 2021. A total of 30 individuals (16 females, 14 males; mean age: 15.3±1.3 years; range, 14 to 18 years) were included in the study. The individuals were randomly selected from three different high school. The inclusion criteria were normal otoscopic findings (otolaryngology examination), having normal videonystagmography (VNG) results, and not having any diagnosed cognitive/neurological or otologic disease. The exclusion criteria were abnormal hearing and immittance metric measurements, any middle-ear pathology, such as otosclerosis, otitis media, or active ear discharge, being diagnosed with acoustic neuroma (monitored or treated), previous ear surgery or cranial surgery, any neuropsychiatric disease, having a neurological or orthopedic disease, and being diagnosed with benign paroxysmal positional vertigo, Meniere's disease, or vestibular neuritis.

The participants of this study had normal VNG and computerized dynamic posturography (CDP) findings. The Pediatric Berg Balance Scale (PBS) and Visual Analog Scale (VAS) were applied to all individuals. The screen time of the participants was asked of themselves and their relatives, and they were divided into three groups according to the screen time per day with the tablet, smartphone, and computer, with 10 participants in each group: 4 to 6 h (Group 1), 6 to 8 h (Group 2), and >8 h (Group 3).

Assessments

A patient evaluation form with demographic information and hearing loss was prepared by the authors. The form consists of 17 questions on age, sex, education level, hearing loss, the feeling of hum and fullness in the ear, hyperacusis, and the presence of balance issues. The forms were filled out by verbally questioning the participants.

Videonystagmography is one of the tests used to evaluate the vestibular system. It is a test based on recording eye movements created by visual or caloric stimulus with infrared video cameras by wearing glasses with a special recording apparatus without using VNG electrodes.[7]

The PBS is a version of the Berg Balance Scale (BBS) for children edited by Franjoine et al.[8] It consists of 14 parts, and each part is scored between 0 and 4. The highest score that can be obtained from the scale is 56. The PBS was rearranged in a functional order from easy to difficult to order the sections in the standard BBS. The time standards in the sections related to the continuity of the static posture have been reduced in accordance with the pediatric population, and the directions have been simplified.[8]

Visual Analog Scale was used to psychometrically evaluate the perception of imbalance/dizziness. Individuals were asked to give a score between 0 (I have no imbalance) and 10 (I have severe imbalance) for the severity of imbalance. On the VAS, the subjects were asked to mark the imbalance severity due to balance on a separate 10-cm line. As the measurement result advances from 0 to 10, the imbalance severity increases.

Computerized dynamic posturography is a quantitative test that aims to test the coordination of the visual and somatosensory system, as well as the balance (vestibular), various balance, and surface conditions encountered in daily life. The test device includes a moving platform on which the patient is standing, and a moving cabinet surrounds this platform (Figure 1). While the patient is standing on the platform with their eyes open or closed, they move the platform or the cabin to make it oscillate, and in this way, it is tested whether the patient can maintain balance in various situations. In the study, Neurocom Smart Balance Master system (Neurocom International Inc., Clackamas, OR, USA) CDP instrument was used, and the sensory organization test (SOT), one of the subtests of CDP, was applied. Computerized dynamic posturography determines the functional contributions of three systems: vestibular, visual, and proprioceptive inputs, central communication mechanisms, and musculoskeletal system outputs. It is a combination of three test protocols. The SOT is useful in investigating vestibular diseases. During Sensory organization test, the individual's balance adequacy is determined by evaluating vestibular, visual, and proprioceptive information for six different situations.[9]

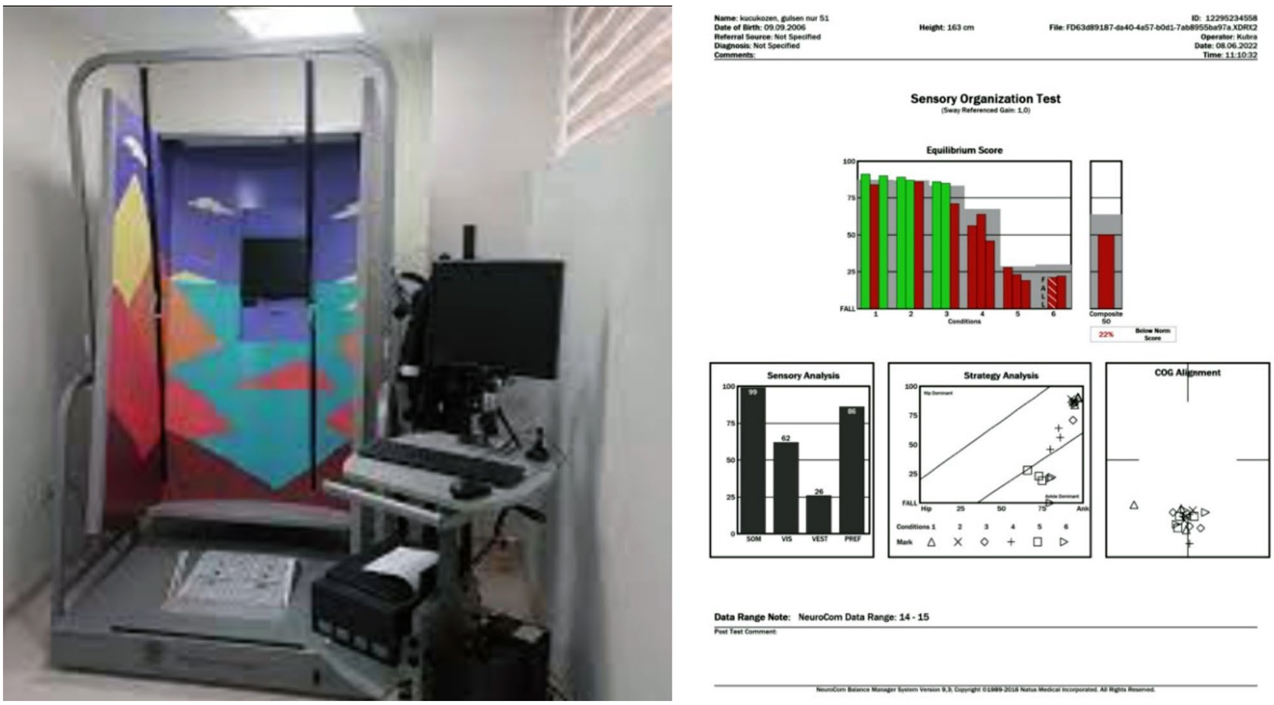

Figure 1. Computerized dynamic posturography and SOT results.
SOT: Sensory organization test.

Table 1
Demographic characteristics (n=34)

	n	Mean±SD	*p*
Screen time (daily average)	10	15.70±1.25	0.543
Group 1 (4-6 h)	10	15.10±1.28	
Group 2 (6-8 h)	10	15.20±1.31	
Group 3 (>8 h)	30	15.33±1.26	
Total			

SD: Standard deviation.

Statistical analysis

The sample size was calculated using the G*power version 3.1 software (Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany). The required sample size was determined as 30 participants, with 95% power (α=0.05 and effect size=0.90).

The data were assessed using the IBM SPSS version 26.0 software (IBM Corp., Armonk, NY, USA). Frequency (n) and percentage (%) were used for categorical data, and the mean ± standard deviation (SD)

Table 2
Comparison of CDP and VAS scores between groups

	Group 1	Group 2	Group 3	Total	
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	*p*
Somatosensory	98.207.56	90.60±9.87	79.60±10.95	89.46±12.06	0.001* (Groups 1-3)**
Visual	84.60±9.99	75.60±7.04	67.60±15.18	75.93±12.95	0.009* (Groups 1-3)**
Preference	97.80±16.31	95.00±17.13	82.80±19.84	91.86±18.43	0.155
Composite	73.60±5.48	64.00±5.55	48.60±6.68	62.06±11.93	0.001* (Groups 1-2, 2-3, 1-3)**
VAS/imbalance	3.80±1.39	3.40±1.26	6.00±1.33	4.40±1.73	0.001* (Groups 2-3, 1-3)**

CDP: Computerized dynamic posturography; VAS: Visual analog scale; SD: Standard deviation.

Table 3
Comparison of CDP and PBS results between groups

	Group 1	Group 2	Group 3			
	Mean±SD	Mean±SD	Mean±SD	IQR	Welch-Df	*p*
VEST	61.90±20.26	40.20±19.02	20.10±12.06	37.00	15.97	0.001*
PBS	68.00±10.70	48.80±3.29	42.20±4.15	9.25	26.15	0.001*

	Groups 1, 2, and 3		Mean difference	Lower bound	Upper bound	*p*
a) PBS	Group 1	Group 2	19.20	6.86	31.53	0.001*
	Group 1	Group 3	25.80	13.40	38.19	**0.00****
	Group 2	Group 3	6.60	1.25	11.94	0.003*
b) VEST	Group 1	Group 2	21.70	-6.13	49.53	0.070
	Group 1	Group 3	41.80	17.45	66.14	**0.00****
	Group 2	Group 3	20.10	-3.01	43.21	0.038*

CDP: Computerized dynamic posturography; SD: Standard deviation; IQR: Interquartile range; PBS: Berg balance scale; a) The effect of the change in PBS on the changes in Group 1, Group 2, and Group 3 scores; b) The effect of the change in vestibular scores on the changes in Group 1, Group 2, and Group 3 scores. Adjusted by multiple linear regression analysis; * p<0.05; ** p<0.01. Group 1 (4-6 h), Group 2 (6-8 h), Group 3 (>8 h) daily average.

or median (interquartile range) was used to express descriptive data. Whether the data fit the normal distribution was evaluated with histogram curves and bell curves. When comparing CDP scores, a paired samples t-test was used to compare normally distributed data. Student's t-test or the Mann-Whitney U test was used for two-group comparisons. For within-group variances, the paired t-test was used when the data were normally distributed, and the Wilcoxon signed-rank test was utilized when the data were nonnormally distributed. For between-group variances (number of groups >2), the one-way analysis of variance or the Kruskal-Wallis test was used when the data was normally or nonnormally distributed, respectively. A p-value <0.05 was considered statistically significant.

RESULTS

Demographic data of the participants is presented in Table 1. There was a significant difference between the three groups for somatosensory, visual, composite scores, VAS-imbalance ($p \leq 0.05$), and intergroup post hoc changes are displayed in Table 2. While there was a significant difference between somatosensory and visual scores in Group 1 and Group 3, there was a significant difference between all groups in composite scores ($p \leq 0.05$). There was a significant difference in VAS between Groups 2 and 3, as well as between Groups 1 and 3 ($p \leq 0.05$).

There was a significant difference between Groups 1, 2, and 3 for vestibular and PBS scores ($p \leq 0.05$, Table 3). Intergroup post hoc changes are shown in Table 3. While there was a significant difference between Groups 1 and 3, as well as Groups 2 and 3, in vestibular scores, there was a significant difference between all groups in PBS scores ($p \leq 0.05$, Table 3, Figure 2). The mean of daily screen time was found to be 6.66±2.02 h/day.

DISCUSSION

Screen time has become an important problem among children and adolescents under long-term mass quarantine, particularly with the beginning of the pandemic.[10,11] Despite the limited number of samples, the data we obtained from our study revealed the negative effects of quarantine during the COVID-19 pandemic on children and adolescents from a different perspective.

There are studies suggesting that children's screen time increased and reached nearly 6 h/day during the COVID-19 pandemic and that with the onset of the pandemic, children's daily screen time increased from approximately 3 h to 6 h.[2,12] In our study, it was found that the mean screen time was 6.66±2.02 h/day, consistent with the literature. In addition, it has been observed that children who are away from their social circles, schools, and hobbies during the quarantine spend most of their free time in front of the screen. It has been shown that this situation affects the immobility and inadequacy of physical activity in children and, consequently, the peripheral balance. One of the most striking findings of the study was that this situation became more dramatic with the differences in screen time. This study found that screen time and balance are negatively affected during the COVID-19 pandemic.

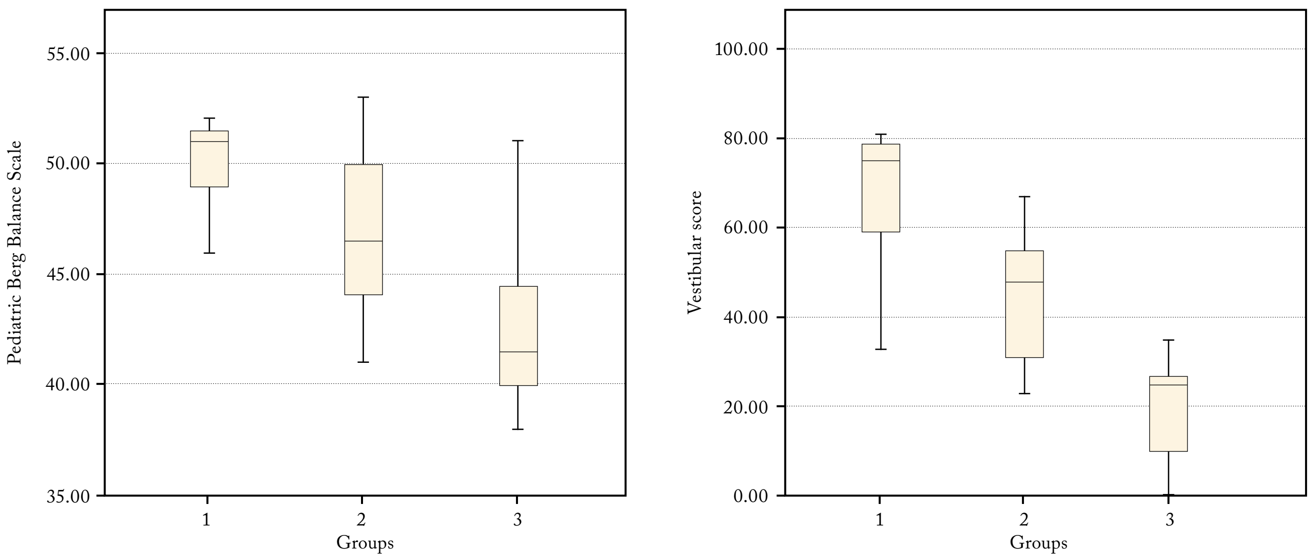

Figure 2. Pediatric Berg Balance Scale and vestibular score graphics.

In the USA, 8- to 12-year-old children have a screen time of about 5 h a day for entertainment, and 13- to 18-year-old children are subject to a screen more than 7 h a day. During the pandemic, with the decline of face-to-face interaction due to the pandemic, children's technology use has exceeded even these figures and almost doubled. This increase has raised concerns about the possible harmful effects of screen time on children.[2] It also caused screen time to replace physical activity and adequate sleep in children and adolescents.[2] This was demonstrated by the findings of our study, which negatively affected balance functions. There was a negative correlation between screen time and SOT, visual scores, and vestibular scores, showing the effect on balance. The decrease in physical activity, which is one of the factors that negatively affect peripheral balance, was associated with screen time.

Three sensory systems, namely visual, vestibular, and somatosensory, are involved in balance control. Information from these systems is integrated into the central nervous system and executed as a motor response. Disturbance in any of these systems can lead to an imbalance.[13] We evaluated the peripheral balance systems of children and adolescents with CDP. When we looked at the correlation with screen time, we saw that there was a negative correlation, and the peripheral balance scores were lower as the screen time increased somatosensory, vestibular, visual, and composite scores ($p \leq 0.05$). This showed that screen time negatively affects balance. In a similar study on children playing video games, it was investigated whether motion sickness developed after playing console video games in children who had no complaints before.[14] It was observed that motion sickness symptoms developed and balance was affected in these children who played video games for a long time. In addition, according to our results of the PBS questionnaire, in which the perceptual balance in children and adolescents were subjectively evaluated, worse scores were obtained with the increase in screen time. When imbalance was questioned according to the VAS, the complaints of imbalance were higher among the groups exposed to the screen for a longer time. A negative correlation between screen time and PBS scores and a positive correlation between screen time and VAS scores. In a similar study, it was emphasized that physical activity decreased with the increase in the time spent in front of the screen, which is one of the negativities brought by the pandemic.[2,3,5] We hypothesize that the decrease in physical activity and the increase in long-term immobility have negative effects on the musculoskeletal system, namely posture disorders, and the proprioceptive system, which is a part of balance.

Excessive screen time is associated with insufficient sleep in children and adolescents.[1] Considering these associations, the American Academy of Pediatrics recommends avoiding screens at least 1 h before bedtime. This practice can reduce sleep disturbances, given that sleep quality may be lower due to stressors or anxiety related to the COVID-19 pandemic.[3] Long-term social isolation and screen time can lead to an unhealthy lifestyle and increase the likelihood of adaptation problems after the COVID-19 pandemic.[10] Screen time is often viewed as a health issue for children and adolescents, as it is associated with sedentary behavior and screen snacking, which can increase risk factors for obesity and cardiovascular disease. However, there are no studies on balance.

It is crucial to monitor the duration, frequency, and content of personal communication device use to develop a healthy lifestyle in children and adolescents. The dramatic increase in the use of technological devices caused worrying consequences on the cognitive, physical, and emotional development of children and adolescents.[10] Whether it is for educational purposes, social interaction, or distraction and entertainment, this will be the result of extra screen exposure. We believe that population-based public health studies should draw more attention to the negative effects of this situation. In this sense, this study demonstrated that long-term exposure to the screen can cause balance problems over time. More research should be done on this issue to evaluate the effects and produce solutions.

This study has some limitations. First, the mean daily screen time of the children included the time reported by the families and the data obtained from the devices used (tablet, computer, TV, and mobile phone durations). Second, the small sample size of this study is insufficient to define the relationship between screen time and balance functions. Further studies with a larger sample involving reducing screen time and observing how it affects balance functions are needed. Finally, the findings of the study cannot be generalized to all children and adolescents since the participants were children of a certain region and age, and the study data were collected from a single centre.

In conclusion, based on the concerns about the negative consequences of children's unlimited and uncontrolled screen time, after determining the factors affecting screen time, better interventions and counseling information services can be developed for possible future pandemics. For example, with educational practices that increase physical activity, children can be motivated for a healthy lifestyle at home. In addition, based on the findings, since the balance functions are negatively affected by the increase in the time spent by children and adolescents in front of the screen, exercise programs, telehealth systems, and training packages could be produced. In addition, it can be said that effective strategies and intervention programs are needed for training on practices that reduce screen time. The parents and healthcare professionals share the responsibility of minimizing the damage of screen time on the physical and mental health of children. Experts should play an active role when necessary to help children cope with the physical and psychological problems arising from the sedentary life in front of the screen.

Ethics Committee Approval: The study protocol was approved by the Ankara Universıty, Faculty of Medicine, Human Research Ethics Committee (date: 10.03.2022, no: no: i03-120-22). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Patient Consent for Publication: A written informed consent was obtained from the patients and/or parents of the patients.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions: Created the study idea and design: Z.A.; Collected the data: K.B.B.; Carried out the analysis and interpretation: E.O.; Provided critical review: S.T.Y.

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