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ORIGINAL ARTICLE

Investigation of the Relationship Between Technology Addiction and Posture, Balance, and Muscle Strength in Preschool Children

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Main Points

- Technology use in preschool children is moderate.
- Problematic technology use can lead to postural distortions in children.
- Increased problematic technology use is associated with decreased balance function in children.
- Contrary to expectations in the literature, a positive relationship has been found between technology addiction and muscle strength in preschool children.

Abstract

The aim of this study was to examine the relationship between technology addiction and posture, balance, and muscle strength in preschool children. Fifty-six children (26 boys and 30 girls) between the ages of 4 and 6 participated in this study. Technology addiction of the children participating in the study was evaluated with the Problematic Technology Use Scale for Young Children (PTUS-YC), muscle strength was evaluated with the Lafayette Manual Muscle Testing Device, balance was evaluated with the Y Balance Test, and posture was evaluated with the New York Posture Analysis. A moderate negative correlation was found between PTUS-YC and NYPA scores ($r = -.540$, $p < .01$). Additionally, a moderate negative correlation was found between PTUS-YC and the YBT ($r = -.318$, $p < .017$). When the relationship between PTUS-YC and muscle strength was examined, a moderate positive correlation was found between the right and left hip extensors and the left knee flexors (right: $r = .318$, $p < .017$; left hip: $r = .381$, $p < .004$; left knee: $r = 0.324$, $p < .015$). In conclusion, an increase in problematic technology use in preschool-aged children is associated with an increase in balance and posture disorders. Therefore, suggestions to reduce the level of problematic technology use may be effective in the development of balance and posture.

Keywords: addiction, balance, muscle strength, posture, preschool children

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Introduction

In Türkiye, 55.6% of children aged 6 – 15, who constitute a significant part of the population, use computers, 82.7% use the internet and 64.4% use mobile phones (TÜİK, 2021). It is observed that the age at which preschool children start using technological devices drops to 2.21 years, and 72.4% of children aged 5 – 6 use computers/tablets for 2 – 3 hours a day (Yengil et al., 2019; Özkan, 2017).

With the widespread use of technological devices, it is observed that technology addiction is also increasing. Technology addiction is when the use of technological devices becomes uncontrollable. Unlike classical substance addiction, the cause of addiction in technology addiction is the needs such as information, interaction and entertainment provided by technological devices. These needs increase the individual's tendency to use technology repeatedly (Küçükvardar & Tingöy, 2018). At the same

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time, technology addiction can be defined as the emergence of an uncontrollable interest and desire behavior toward technology-related stimuli. This behavior manifests itself with symptoms such as an intense desire to use technology, anxiety about staying away from technology, and the negative impact of technology use on other activities in life (Arısoy, 2009). Technology addiction is a comprehensive expression that indicates that intense desire to use technological devices such as smartphones, computers, and game systems can lead to physical, psychological, and social problems (Hosokawa & Katsura, 2018).

Posture is the combination of positions taken by the joints in each movement of the body, defining the relationships of body parts with each other and with the body's gravitational line (Kendall et al., 2005). Preserving and maintaining postures is achieved by statically and dynamically working various muscle groups of the body.

A good posture provides maximum efficiency in the body by consuming the least amount of energy in terms of physiological and biomechanical aspects (Otman & Köse, 2013). Saarni et al. (2008) showed that spinal asymmetry due to school furniture may be a common risk factor in children (Saarni et al., 2008). Geldhof et al. (2008) found that prolonged static kyphotic sitting was common in children in the classroom and 50% had significant asymmetry (Geldhof et al., 2008). Although posture disorders can occur at any age, they are more common in childhood and adolescence. This is because the body grows and develops rapidly during this period. This rapid development process can make it difficult for muscles and bones to develop harmoniously and can lead to posture disorders. Factors such as genetic factors, physical activity, habits, family environment, television, and spending long periods of time on the computer play a role in the formation of posture disorders (Kosinac, 2011).

Balance is achieved by the coordinated work of the vestibular, visual and proprioceptive systems, together with the processing of environmental data. Static and dynamic balance is the ability to keep the body's center of gravity above the support surface. Static balance is achieved while standing on a stationary surface, while dynamic balance is achieved on a moving surface or while in motion (Shamsabad, 2015). Balance development begins with babies learning to stand and walk and improves significantly with conscious movement control in preschool and school age. During this period, the integration of information from the visual, vestibular, and proprioceptive systems and the selection of appropriate muscles to keep the body center of mass in the appropriate position are critical in maintaining body balance. However, at this age, children begin to sit more and move less. This may cause balance development to slow down or deteriorate (Shickedanz, 2001). Research over the last decade has shown that home media environment is associated with childhood obesity (Kininmonth et al., 2021). Long periods of time spent in front of screens lead to lack of physical activity and consumption of high-calorie foods, increasing the risk of overweight/obesity. Obesity leads to negative consequences such as balance and gait disorders, functional decline, and a higher risk of falling (Pataky et al., 2013).

The motor development process is very important for the healthy growth and development of children (Clark & Whitall, 1989). Nowadays, with the widespread use of computers, the incidence of musculoskeletal system problems in children is increasing. This situation occurs due to posture disorders and repetitive movements caused by computer use. Yel and Korhan's (2015) study found that the increase in tablet and computer use caused problems in children's musculoskeletal systems (Yel & Korhan, 2015). In the study of Harris and Straker, it was reported that the increase in the use of digital technology in the home and school environment was associated with an increase in musculoskeletal system problems in children (Harris et al., 2015). These studies show that children's risk of problems such as neck, shoulder, waist and back pain may increase due to technology use.

Research shows that the use of technology can cause posture disorders, balance problems, decrease in muscle strength, and delay in motor skills in children. These effects increase in parallel with the increase in technology use. When the literature is examined, it is noteworthy that there are insufficient studies on the effect of technology addiction on posture in 4- to 6-year-old preschool children. Additionally, postural disorders that may be caused by technology addiction have not been found to be associated with balance and muscle strength in children. In this context, this study aimed to examine the relationship between technology addiction and posture, balance and muscle strength in preschool children.

Material and Methods

Study Design and Participants

The research is an observational cross-sectional study conducted with children at Karabuk University Demir Children's Kindergarten in Türkiye between March 2023 and June 2023. A total of 56 children participated in this study. Children between the ages of 4 and 6 were included in the study. Children whose parents did not allow participation, children with neurodevelopmental or neuromotor disabilities, physical or mental disabilities, and children with orthopedic or metabolic problems were not included in the study. Ethics committee approval was received Karabuk University Ethics Committee (28 March 2023, no. 2023/1321). Parental consent was obtained following verbal explanation of the research objectives and procedures. A written informed consent form was secured from all participating parents. Demographic data of the enrolled children were systematically collected and documented. Then, the duration and frequency of technological device use were measured with the Problematic Technology Use Scale for Young Children (PTSC-YC), muscle strength with the Manual Muscle Testing Device, balance function with the Y Balance Test, and posture with New York Posture Analysis. To increase the reliability and accuracy of the study, all measurements and suitability assessments were performed by the same researcher. Submitted to ClinicalTrials number: NCT05869175.

Outcome Measures

Demographic İnformation

Age, gender, height (cm), body weight (kg), and body mass index (BMI) were collected from study participants using a questionnaire and recorded on the evaluation form.

Problematic Technology Use Scale for Young Children (PTUS-YC)

It is a 5-point Likert type scale developed by Konca et al., which aims to determine students' technology addiction levels. There are 26 items in the scale. Scale items are evaluated on a Likert scale between 1 and 5. The scale consists of four sub-dimensions. Continuity of Use sub-dimension, with items numbered 1-2-3-4-15-19-21-22; Resistance to Control subscale, with items numbered 11-14-23-24-25-26; Impact on Development sub-dimension, with items numbered 12-16-17-18-20; The Deprivation-Escape subscale is measured by items numbered 5-6-7-8-9-10-13. The minimum score from the scale is 26 points and the maximum score can be 130 points. High scores indicate high technology addiction (Konca et al., 2022).

New York Posture Scale

The New York Posture Scale (NYPS) applies a quantitative approach to assess the correct and misalignment of various body parts for a person in anatomical position. Published in 1958, the NYPS contains a set of three figure drawings for each of 13 parts of body alignment that contribute to overall postural alignment. 13 body alignment sections; Includes rear views of the head, shoulders, spine, hips, feet, and arches; and lateral (left side) views of the neck, chest, shoulders, upper back, torso, abdomen, and lower back. Brief verbal descriptions are provided to indicate the visual cues that will be used as criteria in determining the score. This method is scored between 13 and 65 in total, with ratings of 5 (best), 3 (poor posture) and 1 (very poor posture). The participant's total score is then classified as "poor" (≤19 points), "poor" (20 – 29 points), "fair" (30 – 39 points), "good" (40 – 44 points), or "very good" (≥45 points) (McRoberts et al., 2013).

Y Balance Test

Y Balance Test platform was used to evaluate the dynamic balance of individuals. Before starting the test, the leg lengths of the individuals were measured using the bilateral anterior superior iliac point and the distal part of the medial malleolus as references. The measurement was made barefoot and from three directions: anterior, posterolateral and posteromedial. Individuals were asked to stand at the point of intersection of 3 measuring tapes fixed to the ground at 135° angles (135 × 135 × 90). At the midpoint of the test apparatus, the farthest distance that the individual standing on one leg could reach with his toe tip in the anterior, posteromedial and posterolateral directions with his other foot was measured. The test was repeated three times for each direction and the average value was recorded in centimeters (Haksever et al., 2017).

Muscle Strength

Isometric muscle strength was assessed using a hand dynamometer (Hand-Held Dynamometer, Lafayette Manual Muscle Tester, Model 01163, Lafayette Instrument Company, Sagamore Parkway North Lafayette, USA). Hand dynamometry (HHD) is a reliable and valid method to measure muscle force or torque in adults and children. Measurements were taken in kilograms. Standard positions were used to avoid compensations during testing. After the tests were explained to the children clearly, they were repeated twice with a 15-second rest interval between trials to prevent fatigue. Isometric muscle strength values of trunk extensors and flexors, bilateral hip flexors, abductors, adductors, extensors, knee extensors and flexors of all individuals were recorded three times with device resistance and averaged (Beenakker et al., 2001).

Statistical Analysis

The number of individuals participating in the study was calculated as 57 people with G*power (3.1.9.2) with 95% power and α = .05 margin of error. SPSS 21.0 statistical software package (IBM SPSS Corp.; Armonk, NY, USA) was used to analyze data in this study. The data was evaluated for normality using the Shapiro – Wilk test. Categorical variables were presented as frequency (N) and percentage. For quantitative data, the mean, standard deviation, median, and minimum – maximum values were reported. Pearson correlation analysis was utilized to evaluate the relationships between normally distributed variables, while Spearman correlation analysis was utilized to evaluate the relationships between non-normally distributed variables. A correlation coefficient greater than .90 indicates an excellent relationship, and a correlation coefficient of .30 or less indicates a very poor relationship. Intercorrelation coefficients can be classified as moderate (0.70 – 0.51) or weak (0.50 – 0.31). A p value < .05 was considered statistically significant (Schober et al., 2018).

Results

Demographic Data

Fifty six children were included in this study. Demographic data on the children are presented in Table 1. The average age of the children was 5.05 ± 0.70 years (4 – 6 years old), 53.6% were girls and 46.4% were boys.

The children's right and left Y Balance Test averages were found to be 54.09 ± 12.28 cm and 54.86 ± 12.77 cm, respectively. The total Y Balance Test average was calculated as 54.48 ± 12.06 cm. The mean value of the Children's New York Posture Analysis was found to be 36.70 ± 9.13, and the mean value of the Problematic Technology Use Scale for Children was 56.21 ± 12.60. The distribution of features related to YDBT, NYBS, and PTUS-YC is shown in Table 2. The muscle strength measurement results of the children are presented in Table 3.

It was found that there was a significant negative correlation between problematic technology use and the New York Posture Assessment Scale and Y Balance Test. Additionally, there was a moderate relationship between problematic technology use and the New York Posture Scale ($r = -.540$, $p < .01$), Y Balance Test between total right and weak severity ($r = -.227$, $p < .039$), Y Balance Test between total left and total left. A weak correlation was found ($r = -.295$, $p < .027$) and a moderate correlation was found with the Y Balance Test total ($r = -.318$, $p < .017$) (Table 4).

Table 1.
Demographic and Anthropometric Data Results of the Children

Variables	n	Mean ± SD	Median (Minimum – Maximum)
Age (years)	56	5.05 ± 0.70	4 – 6
Height (cm)	56	114.26 ± 6.63	103 – 130
Weight (kg)	56	20.86 ± 3.55	14.20 – 28.10
BMI (kg/m²)	56	15.90 ± 1.69	11.32 – 20.73

Note: BMI = Body mass index.

Table 2.
Y Balance Test, New York Posture Analysis and Problematic Technology Use Scale for Young Children Results of the Children

Variables	*n*	Mean ± SD	Median (Minimum – Maximum)
Total Y Balance Test—Right (cm)	56	54.09 ± 12.28	24.58 – 81.15
Total Y Balance Test—Left (cm)	56	54.86 ± 12.77	26.58 – 85.17
Total Y Balance Test (cm)	56	54.48 ± 12.06	25.58 – 79.37
New York Posture Scale (13 – 65)	56	36.70 ± 9.13	19 – 57
PTUS-YC (26 – 130)	56	56.21 ± 12.60	29 – 86

Note: PTUS-YC = Problematic Technology Use Scale for Young Children.

It was found that there was a significant positive correlation between problematic technology use and muscle strength. Additionally, there was a moderate positive correlation between problematic technology use and right hip extensors ($r = .318$, $p < .017$), positive moderate intensity with left hip extensors ($r = .381$, $p < .004$), weak positive intensity with left hip adductors ($r = .281$, $p < .036$), moderate positive intensity with left knee flexors ($r = .324$, $p < .015$) relationship was determined (Table 5).

Discussion

The present study revealed a significant inverse relationship between technology usage and posture measures, indicating that increased technology engagement was associated with poorer postural outcomes among preschoolers. Additionally, an increase in technology addiction was associated with a decrease in balance

Table 3.
Muscle Strength Results of the Children

Variables		Mean ± SD (*n* = 56)	Median (Minimum – Maximum) (*n* = 56)
Muscle Strength (kg)			
Hip flexors	Right (kg)	60.18 ± 13.57	28.60 – 101
	Left (kg)	62.61 ± 16.62	28.60 – 101
Hip extensors	Right (kg)	63.50 ± 14.44	28.60 – 101
	Left (kg)	64.09 ± 17.07	26.40 – 116
Hip abductors	Right (kg)	61.68 ± 11.73	28.60 – 88
	Left (kg)	59.88 ± 13.40	35.20 – 96.80
Hip adductors	Right (kg)	60.51 ± 14.44	24.20 – 110
	Left (kg)	59.74 ± 14.68	28.60 – 103
Knee flexors	Right (kg)	60.43 ± 13.14	28.60 – 92.40
	Left (kg)	60.31 ± 15.62	28.60 – 90.20
Knee extensors	Right (kg)	62.70 ± 12.59	35.20 – 88
	Left (kg)	63.38 ± 11.32	41.80 – 88.20

Table 4.
Relationship between Problematic Technology Use Scale for Young Children and NYPS, YBT

Variables		PTUS-YC
NYPS	*r*	-.540**
	p	.000 <.01
YBT total right	*r*	-.227*
	p	.039
YBT total left	*r*	-.295*
	p	.027
YBT total	*r*	-.318*
	p	.017

Note: NYPS = New York Posture Scale; PTUS-YC = Problematic Technology Use Scale for Young Children; YBT=Y Balance Test.
*Correlation is significant at the .01 level (Spearman correlation test).
**Correlation is significant at the .5 level (Spearman correlation test).

Table 5.
Relationship between Problematic Technology Use Scale for Young Children and Muscle Strength

Variables			PTUS-YC
Hip flexors	Right	*r*	.170
		p	.211
	Left	*r*	.243
		p	.071
Hip extensors	Right	*r*	.318*
		p	.017
	Left	*r*	.381**
		p	.004
Hip abductors	Right	*r*	.167
		p	.218
	Left	*r*	.194
		p	.153
Hip adductors	Right	*r*	.123
		p	.368
	Left	*r*	.281*
		p	.036
Knee flexors	Right	*r*	.227
		p	.093
	Left	*r*	.324*
		p	.015
Knee extensors	Right	*r*	.182
		p	.178
	Left	*r*	.151
		p –	.266

Note: PTUS-YC = Problematic Technology Use Scale for Young Children.
*Correlation is significant at the .01 level (Spearman correlation test).
**Correlation is significant at the .5 level (Spearman correlation test).

functions. However a positive relationship was observed between technology addiction and muscle strength.

In recent years, the age at which preschool children start using technological devices has been decreasing. According to a study, the average age of preschool children accessing any of the technological devices such as television, tablet, Internet, or mobile phone was found to be 2.21 ± 0.97 years (Yengil et al., 2019). Similarly, this research shows that preschool children's exposure to technological devices begins at a very early age. It has been determined that the duration of technological device use of preschool children is quite high. Özkan (2017) found in his study that 72.4% of children aged 5 – 6 spend 2 – 3 hours a day with computers/tablets; Aral and Keskin (2018) determined that 44.8% of children in the 0 – 6 age group use mobile phones, 43.1% use tablets, and 21% use computers (Özkan, 2017; Aral & Keskin 2018). These studies show that preschool children use technological devices for an average of 2 – 3 hours a day. Therefore, children face technology use problems. In this study, the mean value of the Problematic Technology Use Scale of children aged 4 – 6 was determined as 56.21 ± 12.60. This result shows that the level of problematic technology use of children is at a medium level. The findings of our study indicate that the prevalence of problematic technology use among children exhibits considerable variability This situation is affected by factors such as the duration of children's exposure to technological devices, the content of the devices and parental attitudes.

Nowadays, the restriction of children's movement areas and the decrease in open play areas pose a serious threat to children's health. With developing technology, children mostly live in closed areas and spend time with technological play materials. As a result of this situation, various body posture disorders, inactivity, weight gain, and changes especially in muscle and bone tissues are observed in children (Draper et al., 2012). A study published in the Children's World National Report in South Africa revealed that a substantial proportion of children engage in sedentary behaviors. The findings indicate that 69.8% of 10-year-olds and 71.6% of 12-year-olds engage in television viewing or music listening on a daily basis. Additionally, 40% of 10-year-olds and 35.6% of 12-year-olds utilize computers daily. These results suggest a concerning prevalence of sedentary behaviors among children (Sevahl et al., 2014). A failure to provide children with ergonomically designed workspaces and seating arrangements can lead to the inevitable development of postural abnormalities and associated musculoskeletal system disorders. In a study, it was stated that the average time spent by children between the ages of 8 and 15 in front of TV and computer is 2 hours a day. This period increases with age. The proportion of children in the 15-year-old group who spend more than 3 hours a day in front of the computer is 20.4%. These students are mostly male students. Research has found that 70% of children have at least one poor posture. It has also been found that there is a relationship between the time spent on the computer and posture disorders (Kratěnová et al., 2007). In the light of these data, it can be said that children's sedentary behavior and increased time spent in front of the computer play an important role in the development of posture disorders. In our study, it was found that there was a moderate negative relationship between the problematic technology use of children aged 4-6 and their posture. As the level of children's problematic technology use increases, their posture scores decrease. This result shows that problematic technology use may cause deterioration in children's posture. This relationship supports the hypothesis that problematic technology use may reduce physical activity in children, leading to posture disorders.

With the spread of technology, children have begun to perform many activities such as playing games, studying and socializing through technological devices. This situation significantly reduces children's physical activity levels (Günay et al., 2018). In a study conducted by Cox et al. (2012) on preschool children aged 2 – 6, it was reported that excessive television watching caused a decrease in physical activity levels and a significant increase in BMI levels (Cox et al., 2012). A study investigating the associations between anthropometric measures, postural balance, and motor skills in healthy preschoolers aged 3-4 years revealed a significant correlation between balance skills and height and BMI. However, no significant association was observed between balance skills and motor skills. These findings suggest that balance abilities in healthy preschoolers aged 3 – 4 are primarily influenced by their physical growth parameters rather than their motor skill development (Singh et al., 2015). A study by Ku et al. found that overweight youth performed worse on both static and dynamic balance tests than normal weight youth (Ku et al., 2012). This shows that overweight young people have a higher risk of falling. In this study, it was determined that the increase in problematic technology use was associated with a decrease in balance functions in children. Therefore, balance technology addiction may have a negative impact on balance skills. The spread of technology causes individuals to become more dependent on technological devices in their daily lives. This may lead to decreased physical activity and, as a result, weight gain. Weight gain is a factor that can cause balance problems (Singh et al., 2015). Therefore, in order to reduce the negative effects of the widespread use of technology, individuals need to increase their physical activity levels and adopt a healthy diet.

The relationship between technology addiction and musculoskeletal system problems is a subject that is increasingly researched with the widespread use of technology. Studies show that technology addiction is associated with musculoskeletal system problems in the upper extremities such as neck, upper back, shoulder, hand, and thumb (Straker et al. 2015; Woo et al., 2016). Studies conducted in recent years show that technology addiction may also be associated with musculoskeletal problems in other parts of the body. For example, one study showed that there is a relationship between children's and adolescents' daily use of desktop and laptop computers for an average of 4 – 7 hours per day and discomfort in the lower back, upper arm, thigh, lower leg, hip, and knee areas (İnal & Arslan, 2021). Although musculoskeletal problems have been generally evaluated in studies conducted on technology users, the relationship between body parts and problems has not been examined in detail. Our study is the first to examine the relationship between technology addiction and muscle strength. As a result of the children's muscle strength tests, it was seen that the average strength values in all muscle groups were within normal limits. However, a moderate positive relationship was found with the level of problematic technology use in some muscle groups (right hip extensors, left hip extensors, left hip adductors, left knee flexors). The relationship between technology addiction and muscle strength was found to be a positive relationship, contrary to expectations in the literature. This finding may have occurred due to the fact that children are in a developmental age and stay in a sitting position for a long time, causing the muscles to shorten and increase their strength, or it may have arisen due to the study with a limited sample.

Limitations and Directions/Suggestions for Future Research

The research is constrained by several limitations. Longer-term follow-up studies should be conducted to better understand the disorders resulting from problematic technology use in preschool children. This will allow research into the long-term effects of problematic technology use. Another limitation of the study is that its findings are correlational. This means that the effects of problematic technology use on posture, balance and muscle strength cannot be causally explained.

This research examined the problematic technology use level of children aged 4 – 6 and its relationship with posture, balance and muscle strength. As a result of the research, it was found that the level of problematic technology use of children was at a medium level. It has been found that problematic technology use may cause posture and balance disorders in children. This relationship supports the hypothesis that problematic technology use may reduce physical activity in children. The relationship between technology addiction and muscle strength is complex. Contrary to expectations in the literature, a moderate positive relationship was found between the level of problematic technology use in some muscle groups. The reason for this finding is not yet fully understood. In conclusion, the findings of this study indicate that problematic technology use may have negative effects on children's physical development. Therefore, children's technology use should be closely monitored and precautions should be taken to prevent problematic technology use. Awareness should be increased about parental attitudes and guidance regarding children's use of technology. Parents should be informed about the importance of limiting their children's use of technology and encouraging physical activity. Measures should be taken to prevent and reduce problematic technology use by children aged 4 – 6. These measures may include awareness raising activities for parents and educators, limiting technology use and encouraging physical activity.

Ethics Committee Approval: This study was approved by Ethics Committee of Karabuk University (approval number: 1321; date: March 28, 2023).

Informed Consent: Written informed consent was obtained from the parents of the participants who agreed to take part in the study.

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