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Original Article

The Association of Screen Time with Isometric Back and Leg Muscle Strength in School-aged Children

Okul Çağı Çocuklarda Ekran Süresinin İzometrik Sırt ve Bacak Kas Gücü ile İlişkisi

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ABSTRACT

Objective: Long recreational screen time affects many aspects of children's health. We aimed to assess the association of screen time with isometric back and leg muscle strength in school-aged children.

Method: Healthy children aged between 7-11 years were enrolled in this study. Gender of the children, their weight, and height at enrollment were recorded. A research assistant surveyed the parents of each child with face-to-face interview technique in order to analyse child's screen-viewing behavior. Children participating in the study were divided into 2 groups according to their average daily screen time (group 1: ≤ 2 hours, group 2: >2 hours). The children in Groups 1 and 2 were also divided into subgroups according to their body mass index (BMI) percentiles. The back and leg muscle strength were measured by using isometric back-leg strength dynamometer. The demographic characteristics, BMI Z-scores and the back and leg muscle strength of the children in groups were compared statistically.

Results: A total of 307 children including 103 boys (33.6%) and 204 girls (66.4%) were enrolled in the study. There were 204 (66.4%) and 103 (33.6%) children in groups 1 and 2, respectively. There was no statistically significant difference between the two groups in terms of back and leg muscle strength. The BMI Z-score of children positively correlated with their back and leg muscle strength, respectively.

Conclusion: This study could not find an association between screen time and both back and leg muscle strength of children. There is a need for further studies to analyse the effects of other confounding factors such as physical activity, sedentary behaviors, sleep duration and quality, sociodemographic factors and seasonal influence in associaton with screen time in muscle strength outcome measures in children.

Keywords: Child, dynamometer, muscle strength, screen time

ÖZ

Amaç: Sağlıklı okul çağındaki çocuklarda ekran süresinin izometrik sırt ve bacak kas gücü ile ilişkisini değerlendirmeyi amaçladık.

Yöntem: Çocukların ekran izleme sürelerini analiz etmek için bir araştırma görevlisi her çocuğun ebeveyniyle yüz yüze görüşme tekniğiyle anket yaptı. Araştırmaya katılan çocuklar ortalama günlük ekran sürelerine göre 2 gruba ayrıldı (grup 1: ≤2 saat/gün, grup 2: >2 saat/gün). Grup 1 ve grup 2'deki çocuklar da vücut kitle indeksi (VKİ) persentillerine göre alt gruplara ayrıldı. Sırt ve bacak kas kuvvetleri izometrik sırt-bacak kuvveti dinamometresi kullanılarak ölçüldü. Gruplardaki çocukların demografik özellikleri, VKİ Z-skorları ve izometrik sırt ve bacak kas güçleri istatistiksel olarak karşılaştırıldı.

Bulgular: Çalışmaya toplam 307 çocuk alındı. Grup 1 ve grup 2'de sırasıyla 204 (%66,4) ve 103 (%33,6) çocuk vardı. Sırasıyla izometrik sırt ve bacak kas kuvvetleri açısından iki grup arasında istatistiksel olarak anlamlı bir fark yoktu. Çocukların VKİ Z-skoru, sırasıyla izometrik sırt ve bacak kas güçleri ile pozitif korelasyon gösterdi.

Sonuç: Bu çalışmada sırasıyla çocukların ekran başında geçirilen süre ile izometrik sırt ve bacak kas güçleri arasında bir ilişki bulunamamıştır. Fiziksel aktivite, sedanter davranışlar, uyku süresi ve kalitesi, sosyodemografik faktörler ve ekran süresi ile ilişkili mevsimsel etki gibi diğer karıştırıcı faktörlerin çocuklarda kas gücü sonuçları üzerindeki etkilerini analiz etmek için daha ileri çalışmalara ihtiyaç vardır.

Anahtar kelimeler: Çocuk, dinamometre, kas gücü, ekran süresi

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INTRODUCTION

Increased levels of physical activity and fitness during childhood and adolescence are associated with reduced risk of many diseases in adulthood such as cardiovascular disease, diabetes, selected cancers, musculoskeletal conditions and depression[1]. Physical exercise strongly modifies metabolic potential, morphology, and physiology of skeletal muscles. Regular physical activity leads to mitochondrial biogenesis, fast-to-slow fiber transformation, expansion of the muscle capillary bed, changes in substrate metabolism, an increase in the size of muscle fibers and muscle strength[2].

Long recretional time spent in front of TV and computer screen is a reason of failure to comply with recommendations on effective time spent with daily physical activities, thus muscle strength development[3]. The American Academy of Pediatrics (AAP) recommends limiting children's screen time in order to promote developmental, psychosocial and physical health[4]. There are few studies in the literature examining the effects of screen time on muscle strength in children[5,6]. In this study, the relationship between screen time and muscle strength in healthy primary school-aged children was evaluated.

MATERIALS and METHODS

Healthy children aged between 7-11 years were enrolled in this study. This study was approved by the Ankara Keçiören Training and Research Hospital Clinical Research Ethics Committee (decision no: 1284, date: 11.01.2017), and all participants and at least one parent gave his/her informed consent. Children who had malignant, infectious, inflammatory, endocrinological, neurological and/or muscular disease and/or growth retardation, and/or attended any sport program in the last 6 months were excluded. The sociodemographic characteristics of the children were recorded. A research assistant surveyed the parents of each child with face-to-face interview technique in order to analyse child's screen-viewing behavior. Children participating in the study were divided into 2 groups according to their average daily screen time (group 1: ≤2 hours, and group 2: >2 hours). The children in groups 1 and 2 were also divided into subgroups according to their body mass index (BMI) percentiles (A: normal, BMI=5p-<85p; B: overweight, BMI=85p-<95p and obese, BMI≥95p BMI=5p-<85p; B: overweight, BMI=85p-<95p and obese, BMI≥95p) [7]. BMI was calculated using the formula: body weight (kg)/ height^2 (m^2)[8]. The AAP recommends creation and implementation of a family media use plan. The 2-hour limit for daily screen time was determined according to AAP recommendations for children aged ≥6 years[4].

The measurements of muscular strength was carried out after each child rested for 30 minutes after feeding. The back and leg muscle (extensors of the knees and back) strengths of the children were measured using an isometric back-leg strength dynamometer (Baseline© back-leg-chest dynamometer Fabrication Enterprises, NY, USA). In order to measure back muscle strength, after a period of warm-up time the child pulled the dynamometer bar vertically upwards exerting his/her maximum force in the position of standing, knees tense, placing his/her feet on the dynamometer stand, arms tense, straight back and body slightly bent forward[9]. For leg muscle strength, after a period of warm-up time, the child pulled the dynamometer bar vertically upwards exerting his/her maximum force in the position of standing, knees twisted, placing his feet on the dynamometer stand, arms tense, straight back and body slightly bent forward[9]. After repeating this set of exercises for 3 times, the best values for back and leg muscle strength obtained were recorded. Back and leg muscle strength were measured in pounds, and pounds were converted to kilograms by multiplying the value by a coefficient of 0.45.

Statistical Analysis

In the study descriptive statistics for categorical variables were reported as numbers, percentages, and pie charts. Statistics for continuous variables were reported with mean, standard deviation, median, minimum and maximum values. Chi-square test was performed to compare categorical variables. The relationship between categorical and continuous variables was examined by box plot and line plot graphs. In accordance with the distribution assumptions, the differences between the groups were examined with the Mann-Whitney U test. The effect of one or more continuous variables on another continuous variable was examined with simple linear regression and multiple linear regression methods. The effect of a continuous variable on a categorical variable was analyzed using the Logistic Regression method. IBM SPSS Statistics 22 was used for statistical analysis. A value of $p<0.05$ was considered statistically significant.

RESULTS

A total of 307 children including 103 boys (33.6%) and 204 girls (66.4%), (age range: 6 yr + 8 mos - 8 yr + 8 mos)

were included in the study. The mean ages of the male and female children enrolled in the study were 9 yr + 6 mos and 1 yr + 5 mos, respectively. According to CDC 2000 growth reference chart[7] respective number of patients were underweight (n=11; 3.58%), healthy weight (n=179; 58.3%), overweight (n=52; 16.9%) and obese (n=65; 21.1%). Daily screen time was more than 2 hours in group 1 (n=204; 66.4%) and ≤2 hours in group 2 (n=103; 33.6%) (Table 1). There were 28 (27.1%) boys and 75 (72.8%) girls in group 1 and 75 (36.7%) boys and 129 (63.2%) girls in group 2. The mean ages in groups 1, and 2 were 9 yr + 7 mos, and 9 yr +6 mos, respectively. Eight (2.6%) children did not spend time in front of the screen, while average daily screen time was 1-2 hours/day in 142 (46.3%), 3-4 hours in 125 (40.7%), 5-6 hours in 28 (9.1%) and >6 hours/in 4 (1.3%) children, in weekdays. On weekends, 3 (1%) children did not spend time in front of the screen, while average daily screen time was 1-2 hours in 117 (37.1%), 3-4 hours in 144 (46.9%), 5-6 hours in 39 (12.7%) and >6 hours in 4 (1.3%) children.

The average daily screen time of boys (3.1±1.4 hours; range: 0.7-7 hours) and girls (2.7±1.2 hours; range: 0-7 hours) were recorded. A statistically significant difference was found between boys and girls in terms of daily screen time (p=0.018).

Back muscle strength (n=307), both back, and leg muscle strength (n=114) were measured in indicated number of children.

The mean back muscle strength of 307 children was 33.29±13.23 kg (range: 6.75-72 kg). It was 35.82 kg ±14.99 kg (range: 6.75-72 kg) in group 1 (n=103) and 34.1 kg ±13.78 kg (range: 9-72 kg) in group 2 (n=204). There was no statistically significant difference between groups in terms of back muscle strength (p=0.273) (Table 1).

The mean back muscle strength was 31.02±11.41 kg (range: 9-54 kg) in girls and 37.81±15.33 kg (range: 6.75-72 kg) in boys. A statistically significant difference was found between girls and boys in terms of back muscle strength (p<0.001) (Table 2).

The mean leg muscle strength of 114 children was 34.91 kg ±14.84 kg (range: 9-72 kg). It was 34.84 kg ±14.64 kg (range: 9-72 kg) in group 1 (n=47) and 34.26 kg ±15.06 kg (range: 9-72 kg) in group 2 (n=67). There was no statistically significant difference between groups in terms of leg muscle strength (p=0.577) (Table 1).

The mean leg muscle strength of girls (n=76) and boys (n=38) were 31.13±12.33 kg (range: 9-72) and 42.48±16.6 kg (range: 9-72), respectively. A statistically significant difference was found between girls and boys in terms of leg muscle strength (p<0.001) (Table 2).

Statistically significant positive correlations were found between the back and leg muscle strength of children, their ages and BMI Z-scores (group 1-age: p<0.001, r=0.56; group 2-age: p<0.001 r=0.52 and group 1-BMI: p<0.001 r=0.41; Group 2-BMI: p<0.001, r=0.46) (Graphic 1, 2). There was no correlation between children's back and leg muscle strength and maternal age, paternal age, maternal educational level, paternal educational

Table 1. Back and leg muscle strength of children grouped according to their average daily screen time (group 1: ≤2 hours, group 2: >2 hours)

Groups	N	Mean back muscle strength (kg)	Range (kg)	p-value
Group 1	103	35.82 kg ±14.99	6.75-72	0.273
Group 2	204	34.1 kg ±13.78	9-72	
		Mean leg muscle strength (kg)	**Range (kg)**	**p-value**
Group 1	47	34.84 kg ±14.64	9-72	0.577
Group 2	67	34.26 kg ±15.06	9-72	

N: number

Table 2. Back muscle strength and leg muscle strength of girls and boys

Gender	N	Mean back muscle strength (kg)	Range (kg)	p-value
Girls	204	31.02±11.41	9-54	<0.001
Boys	103	37.81±15.33	6.75-72	
		Mean leg muscle strength (kg)	**Range (kg)**	**p-value**
Girls	76	31.13±12.33	9-72	<0.001
Boys	38	42.48±16.64	9-72	

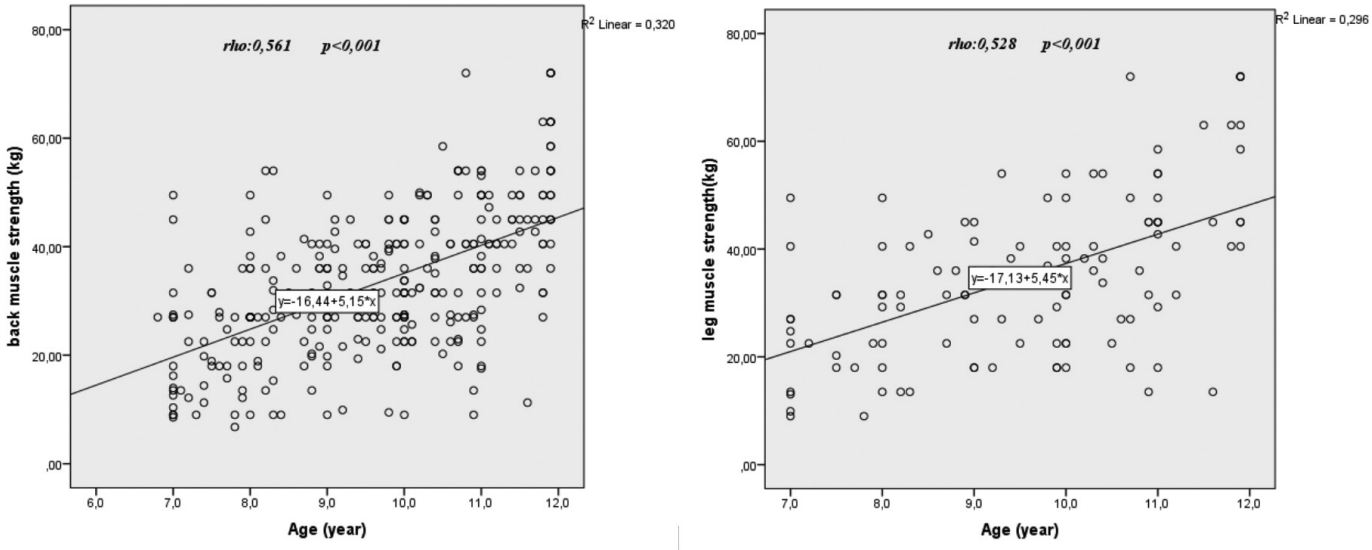
N: number

level, monthly income, maternal employment status and presence of a sibling. One year increase in age caused an increase of 4,539 kg in back, and 9,426 kg in leg muscle strength. Also, one unit increase in BMI caused an increase of 0.829 kg in back and of 3,205 kg in leg muscle strength.

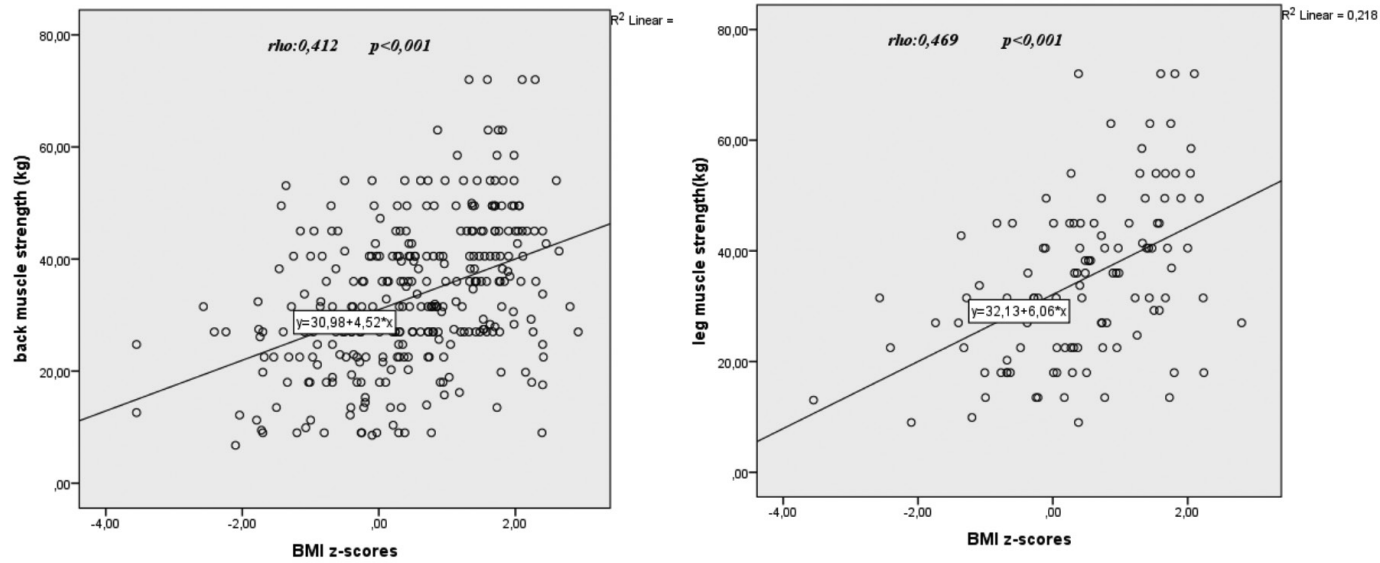
When back and leg muscle strengths were adjusted according to BMI Z-scores, neither back nor leg muscle strength significantly differed among patients in groups 1 and 2.

DISCUSSION

Adequate muscle mass and muscle strength are considered as reliable measures of overall health[10]. Development of muscular strength in children depends on age, height, gender, sexual maturation, genetic background, neuromuscular integrity, physical activity level, BMI and limb dominance[11]. Long recreational time spent in front of TV and computer screens often while sitting or lying down limit the time spent for daily physical activity and may lead a decrease in muscle



Graphic 1. Correlation between age and back and leg muscle strength of children



Graphic 2. Correlation between BMI Z-scores and back and leg muscle strength of children

BMI: Body mass index

mass, isometric muscle strength and bone density[12]. However, there are few studies investigating the effect of screen time on muscle strength of children and adolescents[6,12,13]. Ours is one of few studies analysing association between school-age children's muscle strength and screen time.

The AAP recommends imposing restrictions on types of media platforms used, and hours of media used per day for children aged 6 years or older to ensure that screen time does not displace sleeping, playing, conversation and physical activities[4]. Studies have shown that children and adolescents are more likely to spend more time in sedentary activities such as watching television and playing computer games[14]. Many studies found a significant negative association between screen time and physical activity in children and adolescents[15-17]. In a cross-sectional study including 606 adolescents, screen time was found to be inversely associated with isometric trunk muscle strength independent of lifestyle, sociodemographic factors, cardiorespiratory fitness and waist circumference[18]. In our study, no statistically significant difference was found between children spending >2 or ≤2 hours a day in front of the screen in terms of back and leg muscle strength. This finding might be due to engagement of children in physical activity during screen was on, that was not reported by the parents during face-to-face interviews or on the contrary due to lack of physical activity during the daytime among most of children enrolled in the study. Its effect on muscle strength might have been revealed when more children with excessive screen time had been involved in the study, but limited number of children with a daily screen time of >6 hours were enrolled in this study. The average daily screen time of boys was significantly longer than girls. This finding is consistent with previous studies reporting that boys are spending substantially more time in front of TVs, and computer monitors than girls both during the weekdays and at the weekend[19].

Strength of the back and leg muscles of girls was significantly lower than boys. Nevertheless, when strength of the back, and leg muscles were adjusted for BMI-Z-score, the gender difference in muscle strength was not statistically significant. Muscle strength appears to increase in both boys and girls until about the age of 14 years where it begins to plateau in girls and a spurt in muscular strength is evident in boys[20]. Hormonal differences during puberty are responsible for a gradual increase in the strenght development of boys which is maintained at approximately the same rate in the strength development of girls seen during their preadolescent years[21]. The lack of difference between girls and boys in terms of muscle strength can be explained by the fact that the majority of children included in the study were in the prepubertal stage, where the muscle strength of girls and boys is essentially equal.

Muscle size and muscle strength increase throughout preadolescence and adolescence due to changes in muscle mass and muscle fiber size. Gender, individual body size, growth, maturity and motor competence and level of physical activity effect muscular strength[22,23]. As expected, back, and leg muscle strength positively correlated with age ($p<0.001$, rho:0.561 and $p<0.001$ rho:0.528, respectively) in children enrolled in this study and in fact, gender effect on back and leg muscle strength was not remarkable in children with normal BMI.

The relationship between media exposure and obesity has been widely studied[24,25]. A meta-analysis reviewing the results from 16 studies examining the relationship between screen time and overweight/obesity in children has shown that daily screen time of ≥2 hours was likely to be associated with greater risk of overweight/obesity than daily screen time of <2 hours[25]. The possible mechanisms to explain the effects of screen media exposure on obesity include displacing physical activity, increasing energy intake and reducing sleep[24]. The previous studies have shown that children with high BMI values have greater absolute measures of grip strength and leg extension power, but have lower core and upper body strength when compared to children with lower BMI[26]. Obese individuals have reduced maximum muscle strength relative to body mass in their anti-gravity muscles compared to non-obese persons. High levels of adiposity may impair agonist muscle activation in the adolescents[27]. In our study, a positive correlation was found between BMI values and both back, and leg muscle strength. Nevertheless, in our study, when back and leg muscle strength were adjusted according to BMI Z-scores, longer screen time apparently had not any significant negative effect on muscle strength.

Study Limitations

The relatively scarce number of children enrolled in this study may be considered as one limitation of our study. Besides, the information on screen time, screen-based sedentary behaviors and daily physical activity were gathered from the self-reports of the study participants which could lead a bias in interpretation of

the results. Furthermore we did not query school-related screen (video game/computer/TV) use which could likely underestimate the total amount of screen time of children. In fact, we did not analyse jump performance signifying the action of passive and active components of lower limb muscles and the motor performance tasks like throwing which are used as indicators of specific aspects of muscular strength in children[28].

CONCLUSION

This study could not find an association between screen time and back and leg muscle strength measurements of children, respectively. We suggest that only the screen time per se may not have substantial effect on muscle strength outcomes. There is a need for further studies to analyse the effects of other confounding factors such as physical activity, sedentary behaviors, sleep duration and quality, sociodemographic factors and seasonal influence in association with screen time on outcome measures of muscle strength.

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Ethics

Ethics Committee Approval: This study was approved by the Ankara Keçiören Training and Research Hospital Clinical Research Ethics Committee (decision no: 1284, date: 11.01.2017).

Informed Consent: All participants and at least one parent gave his/her informed consent.

Peer-review: Externally and internally peer reviewed.

Author Contributions

Concept: S.A.O., A.Ç.T., D.Y., Design: S.A.O., I.Z., Data Collection or Processing: S.A.O., Analysis or Interpretation: S.A.O., A.Ç.T., A.Y., D.Y., S.G., Literature Search: S.A.O., A.Ç.T., Writing: S.A.O., A.Ç.T.

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