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Original Article

Relationship between screen-time and motor skills in preschool children

DORIAN ROGOVIĆ[1], SANJA ŠALAJ[2], ZRINKA PUHARIĆ[3]
[1,2] Faculty of kinesiology Zagreb, University of Zagreb, CROATIA
[3] University of Applied Sciences Bjelovar, CROATIA

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Abstract
Introduction: Screen-time as the amount of time spent on screens per day. This is recognized by the World Health Organization (WHO) as a potential problem for cognitive and motor development of children. Study results suggest that prolonged screen-time can cause deterioration of social and emotional skills, poor sleep quality, obesity and poor development of language and speech skills. **Methods:** The aim of this article is to determine the correlation between screen-time and motor skills in a population of 262 preschool children aged 5 and 6 years. The children in the sample were divided into groups depending on how much time they spent in front of the screens. The primary measurement instrument used for the study was the "Bruininks-Oseretsky Test of Motor Proficiency-Second Edition" (BOT-2) test to assess motor skills and abilities for persons at age from 4 to 21 years. The time the child spends in front of the screens is determined by the "Netherlands physical activity questionnaire" **Results:** Parents stated through questionnaire that preschool children at that age spend 137,93 ± 71,16 minutes a day in front of screens, which is more than the recommended value of the World Health Organization (WHO). In this study children who spent more time in front of screens had worse results in BOT-2 motor test. It did not find a significant correlation between screen time and motor skills of children. Weak correlation was observed in manipulative abilities (dropping and catching the ball with both hands) and strength tests (knee push-ups and sit ups). **Discussion/Conclusions:** Children spend more time in front of screens than recommended by experts. Research shows that more time in front of screens can negatively affect cognitive and motor development. It would be advisable to perform a longitudinal study to determine the negative, and even possible positive consequences of screen-time development.
Keywords: **screen-time, cognitive development, physical activity**

Introduction

During childhood, adequate levels of physical activity are fundamental for the development of basic cognitive, motor and social skills, as well as musculoskeletal, cardiovascular, and metabolic health . It determinates and prevent childhood obesity and early metabolic risk factors (Kuznik et al, 2015; Moore et al, 2017) .Physical activity also have positive impact on academic achievement (Kantoma et al, 2015.).With technological developments in the 21st century, technical devices (television, computers, mobile phones) have become available to every household. Screen-time, defined as time spent in front of technical devices, is becoming a central component of the daily lives of young children and adolescents, and the most common form of sedentary lifestyle (Pate, Mitchell, Byun & Dowda, 2011). Along with advantages associated with access to information and fast communication, in recent years many studies associated screen exposure to health and psychological problems among infants, children, and adolescents (Lissak, 2018.).

The dangers of a sedentary lifestyle in front of technical devices and their impact on the human body from an early age have been recognized by the World Health Organization (WHO). "Sitting time in front of a screen" is described as time spent passively watching screen-based entertainment (WHO, 2019). Valid screen time limits for children and long-term consequences of excess screen time are topics of active research and debate in today's world.

In the last few years, a new term "glow kids" has been associated with this phenomenon, as experts in various fields of science have begun to address issues resulting from excessive time spent in front of screens (Kardaras, 2016; Puharić, Badrov & Puharić, 2020). When the computer or other screens are situated into childs room, its increases time spent in front of them (Puharić et al.2014). In 2017, the first national survey on screen exposure of preschool children (Đapić, Flander, Bagarić, 2020) was conducted in Croatia. Analyzed data showed that on average, 2 to 5 year olds spent 2 to 3 hours per day, and 6 to 7 year olds spent between 3 to 3.6 hours a day in front of screens.

Previous studies have largely been focused on examining negative impact (Hutton, Dudley, Horowitz-Kraus, DeWitt & Holland, 2019; Parent, Sanders & Forehand, 2016; Zimmerman & Christakis, 2005) and positive impact (Lieberman et al., 2017; Spence & Feng, 2010) of screen-time on cognitive development, social, and emotional skills. Studies show that young people who are active users and spend more than two hours on

Corresponding Author: ZRINKA PUHARIĆ, E-mail: zpuharic@vub.hr

social media are more likely to complain of mental health, including psychological disorders (anxiety and depression) (Sampasa-Kanyinga & Rosamund, 2015). There are a few studies that have investigated the relationship between screen-time and motor skills in children. Screen-time at the ages of 4, 5, and 7 years is not only negatively correlated with motor skills scores, but the analysis also revealed that time spent in front of screens at the age 4 years affected motor skills 3 years later, as the results in BOT-2 motor tests were even worse at the age of 7 years (Cadoret, Bigras, Lemay, Lehreri & Lemire, 2018).

Children (3 and 4 years old) who spend more time in front of the screen have a lower level of basic motor skills. Furthermore, children with a higher level of basic motor skills spend less time sitting, and more time in moderate and high-intensity physical activities (Webster, Martin & Staiano, 2019).

The problem that initiated this study is the sedentary lifestyle of children who spend more time in front of screens than recommended, and in addition, do not have enough physical activity. Such lifestyle can affect their development, have structural consequences on their brain as well as negatively affect their motor skills and abilities. Long-term consequences can be individual in the form of obesity, cardiovascular diseases, loss of interest, depression, social exclusion, but can also affect society as whole ((Hutton, Dudley, Horowitz-Kraus, DeWitt & Holland, 2019; Parent, Sanders & Forehand, 2016).

Methods

Participans

Participans are population of 262 preschool children aged 5 and 6 years and their parents who gave a written informed consent on the requirements, benefits, and risks of the study. The analysis of the questionnaire for screen-time and the results of motor skills testing yielded standardized values that were compared with the Croatian standardized values for this age group. The Commission for Scientific Work and Ethics of the Faculty of Kinesiology, University of Zagreb has issued an ethical approval for conducting this study.

Instruments

The primary instrument used for this study was the "Bruininks-Oseretsky Test of Motor Proficiency-Second Edition" (BOT-2) test to assess motor skills and abilities for ages 4 to 21 years (Bruininkis & Bruininkis, 2005). The test is used to assess motor development with an emphasis on fine motor skills, manual and physical coordination, strength and agility. Validity and reliability have been widely studied and confirmed (Deitz, Kartin & Kopp, 2007; Griffits, Toovey, Morgan and Spittle, 2018.).

A total of 14 tasks were used in this study (short form), which tested the following categories: fine motor skills - precision. For each task, there is a clear criterion for how to score and to reach a result by all tasks according to the scoring instructions. The total score was converted to standardized values by age and gender. The time the child spends in front of the screens is determined by the "Netherlands physical activity questionnaire" specifically, using part of the questionnaire that refers to the following questions: a) On average, how many hours a day did your child spend watching television (including video) during the previous 6 months? and b) On average, how many hours a day did your child spend playing computer games during the previous 6 months? ("including video" references to TV, smartphones cause mostly kids in that age are using parent's mobile phones) (Janz, Broffit &Levy, 2005).

Statistical analysis

Data were analyzed using Microsoft Excel and statistical package TIBCO Statistica v.13 (TIBCO Statistica Inc, OK, USA). Pearson correlation coefficient was used to determine the relationship between screen-time and the results obtained by the BOT-2 were used to determine the differences between children with different types of sedentary behavior. The level of statistical significance was set at $p < 0.05$. To perform an analysis of variance (ANOVA) children were divided into groups according to the screen-time duration:

Group 1: children who spend up to 60 minutes a day in front of a screen.
Group 2: children who spend 61 to 120 minutes a day in front of a screen.
Group 3: children who spend 121 to 180 minutes a day in front of a screen.
Group 4: children who spend 181 to 240 minutes a day in front of a screen.
Group 5: children who spend more than 240 minutes a day in front of a screen.

Results

Sample consisted of 262 children aged 5 and 6 years and their parents who had to fill questionnaire about daily screen-time in minutes in front of TV (mean=103.50±49.91 minutes), and daily screen-time playing computer games which included PC, tablet or mobile phone (mean=42.36±46.77 minutes) (Table 1).

Table 1. Mean values of screen-time

Variable	Mean ± SD
Screen-time TV	103.50 ± 49.91
Screen-time computer games (PC, consoles, mobile phones, tablets)	42.36 ± 46.77
Total Screen-time	137.93 ± 71.16

Table 2 shows the results of descriptive statistics (mean ± standard deviation (SD) of groups 1 to 5 according to the total standardized values of the BOT-2 test.

Table 2. Mean values of scores in BOT-2 by groups

Total sample (n=262)	Mean ± SD – Standardized score of BOT-2
Group 1 (n=44)	52.30 ± 7.56
Group 2 (n=105)	52.41 ± 8.99
Group 3 (n=72)	53.22 ± 6.76
Group 4 (n=26)	50.77 ± 8.17
Group 5 (n=15)	50.20 ± 8.97

Table 3 shows the correlation results (Pearson's correlation coefficient) of total screen-time, BOT-2 motor tests, total BOT-2 score, and standardized BOT-2 values.

Table 3. Pearson's correlation coefficient results of screen-time and BOT-2 results

Motor test	**Pearson correlation coefficient (r)**
Draw lines through winding paths	**0.02**
Paper folding	**-0.04**
Drawing a square	**0.11**
Drawing a star	**0.06**
Transfer of coins	**0.05**
Jumping in place- same side synchronized	**-0.04**
Taping with feet and toes - same side in sync	**0.04**
Walking forward along the line	**0.09**
Standing on one leg on a balance beam - eyes open	**0.09**
Jumps on one leg in place	**0.08**
Dropping and catching the ball with both hands	**0.19**
Dribbling the ball with changing hands alternately	**0.06**
Knee push-ups	**0.13**
Transition from lying to sitting	**0.16**
Total score of BOT-2 test	**0.11**
Standardized value of BOT-2 test	**-0.04**

In the total standardized values (by age and sex) in the BOT-2 test variance analysis (ANOVA) did not find a statistically significant difference between groups (p = 0.58), although there are visible numerical differences in average values in motor skills and abilities by groups of children who have different screen-time.
Pearson's correlation coefficient indicated significant correlation ($p < 0.05$) in the tests: a) Dropping and catching the ball with both hands (r = 0.19) b) Knee push-ups (r = 0.13) and c) Sit ups (r = 0.16).

As a correlation was found in the variable "dropping and catching the ball with both hands" analysis of variance (ANOVA) was made between the 5 groups of children of different levels of sedentary behavior to determine if there was a statistically significant difference between groups. Analysis of variance (ANOVA) showed a significant difference ($p < 0.05$)

Although the post-hoc Scheffe test did not show differences between individual pairs of groups, numerical differences are visible in the "Drop and grab ball test with both hands", with children who spend more time in front of screens having better results. In the variable "knee push-ups", no significant difference between the groups was found (p=0,37). Also, no significant difference between groups was found in the variable "sit ups" (p = 0.1). In the BOT-2 standard scores the analysis of variance (ANOVA) did not reveal a statistically significant difference between groups (p = 0.58), although there are visible numerical differences in average values in motor skills and abilities who spend different time in front of screens. Children who spend the most time in front of screens have, on average, lower motor skills scores.

The obtained values show that the worst results were achieved by group 4 and group 5, which spent 4 hours in front of screens.In this paper, the relation of screen-time and the motor abilities of children aged 5 and 6 years was investigated. A comparison between the groups was made according to the hours that the children spend in front of the screens daily. Parents stated through questionnaire that preschool children at that age spend 137,93 ± 71,16 minutes a day in front of screens, which is more than the recommended value of the World Health Organization (WHO). We did not find a significant correlation between screen time and motor skills of children. Weak correlation was observed in manipulative abilities (dropping and catching the ball with both hands) and strength tests (knee push-ups and sit ups).

Discussion

A study of the association between time spent on the iPad and motor skills (Axford, Joosten & Harris, 2018) demonstrated a significant impact of time spent on the iPad on motor coordination. On the other hand, study from Dadson et al. from 2020 (Dadson, Brown &Stagnitti, 2020) points to a negative correlation between the time children spend in front of screens on motor coordination. Given that there are not many studies dealing with this problem, it would be interesting for researchers to examine in more detail and accurately the possible effects of time children's screen-time and offer useful applications that encourage specific motor and other predispositions.

Compared to the results of this study, in a study conducted by Cadoret et al. in 2018, the results showed a weak negative correlation between the screen-time of children aged 4.5 and 7 years with the results of the BOT-2 test (4 years: r=-0.267; 5 years: r=-0.268; 7 years: r=0.246) (Cadoret, Bigras, Lemay, Lehrer & Lemire, 2018). Using BOT-2 test scores in this study (52.32±8.09) and study of Cadoret et al. (49.44±7.08), the respondents in our sample achieved better results in all groups than the results achieved by American children. Study conducted by Valtonen (Valtonen, Kyhala and Reunamo,2021.) show that boys spent three times more hours on recreational screen time during the schooldays and four times more during the weekend, compared to girls; an increase in sedentary behavior was associated with a decrease in physical activity.

Analysis of variance (ANOVA) between groups of children who spend different times in front of screens in children's motor skills and abilities did not yield a significant difference, but there are still some differences. Groups 4 and 5, in which children spend more than 4 hours in front of screens, perform worse than other groups. That is, groups 4 and 5 have a lower level of motor skills according to the results achieved.

Comparing the time children spend in front of screens with the study of Đapić et al. from 2020, children in Croatia spend on average more time than recommended by the World Health Organization (Đapić, Flander, Bagarić, 2020). One review study presented the impact of time spent in front of screens on children and adolescents (Stiglic, Wiener, 2019). The results of a review study showed that time spent in front of screens from an early age was associated with obesity in adulthood, with proposed mechanisms responsible for increasing energy intake (Marsh, Mhurchu &Maddison, 2013) and decreasing metabolic rate (Iannotti et al. 2009). Also, there is evidence in the study that screen-time is associated with adverse effects: irritability, low mood, poorer cognitive and socio-emotional development leading to poor educational achievements (Domingues-Montanari, 2017.). Although differences in motor skills of 5 and 6 years old are not significantly impacted, according to the results of this study, due to existence of some differences, there is a potential danger of a negative trend and we could expect worsening of scores as children grow up.

Conclusions

Furthermore, this research has some limitations. Data such as physical activity carried out by children in kindergarten (possible special sports activities) or in their free time were not included. Currently, there is limited number of studies in the world that have dealt with the impact of screen-time on motor skills, and there are no longitudinal studies that can prove whether and how harmful screen-time is, if exposure increases from year to year in human development from an early age. If the screens substitute physical activity for the children, the quality of life and health of the individual is reduced, and thus long-term productivity.

As the topic is still insufficiently studied, and there are no longitudinal studies with consequences, these are the results obtained on the population of children in three kindergartens in Zagreb. Therefore, it would be very useful to conduct a longitudinal ten-years study in Croatia on the same population to determine whether there is a relationship between time spent in front of screens with motor skills.

There is no conflict of interest.

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