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EXPLORING THE RELATIONSHIP BETWEEN ONLINE GAMING ADDICTION, CORE MUSCLE ENDURANCE, AND REACTION TIME IN ADOLESCENTS

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Abstract

Objective: It was aimed to investigate the relationship between online gaming addiction, core muscle endurance, and reaction time in adolescents.

Methods: The study was designed as a descriptive-correlational study and was conducted with 67 adolescents who play online games daily. The Online Gaming Addiction Scale, core muscle endurance tests, and hand and foot reaction time tests were performed.

Results: The overall score of the Online Gaming Addiction Scale was 64.79±17.38, which corresponds as moderate negative reflections on the individual's life. A statistically significant difference was observed in online gaming addiction (p<0.001) and hand reaction time (p=0.004) according to the daily time allocated to video games. There was a negative correlation between the score of Online Gaming Addiction Scale and the hand reaction time test (r=-0.588; p<0.001) and the trunk extension test (r= -0.335; p=0.006) of the core muscle endurance tests.

Conclusion: It was observed that the hand reaction time performance of adolescents was significantly impacted by the time spent in online games. Besides that, online gaming addiction may have a detrimental impact on adolescents' core muscle endurance.

Keywords: *Adolescent, core muscle endurance, reaction time, video games*.

Introduction

With the increasing use of smartphones, tablets, and laptops, online video games are replacing play, socialization, and physical activity, leading to a largely sedentary lifestyle, particularly in children and adolescents. Prolonged inactivity and poor posture while playing video games can lead to various posture, musculoskeletal, and cardiovascular issues.[1-3]

Reaction time is defined as the time from the arrival of a sudden and unpredictable signal to the response to this signal and is one of the important indicators of central and peripheral nervous system and muscle performance.[4,5] There are studies showing that physical activity shortens reaction time in adults. Higher muscle strength and physical activity have been associated with faster reaction time.[6]

The core muscles act to move the trunk, transfer loads between the upper and lower extremities and are responsible for proper load balance within the vertebral column, pelvis, and kinetic chain.[7] Reduced core muscular strength and endurance may result in overstress on the spinal structures. In this case, pain may occur in other structures of the body and decrease functional performance.[8]

Numerous articles have emphasized the negative aspects of gaming over the past few decades, however, some studies have also encouraged that playing useful video games should be supported and developed. According to recent studies, playing video games improves one's ability to perceive cues in the visual field, speeds up and improves the performance of surgeons performing laparoscopic procedures, and helps athletes' motor coordination.[9-11]

There are a range of terms to describe internet gaming disorder.[12,13] "Online gaming addiction" was not used as a diagnostic term in this study. It was not encountered any study in the literature examining the relationship between online gaming addiction, reaction time, and core muscular endurance in adolescents. Since there is no available data in the literature up to now, the current study was planned to explore the relationship between online gaming addiction, core muscle endurance, and reaction time in adolescents. Hence, it was hypothesized that there would be a correlation between online gaming addiction, core muscular endurance, and reaction time in adolescents.

Methods

Study Design

This study, which was designed as a descriptive-correlative study, included a total of 67 adolescents (51 male and 16 female) between the ages of 11-17 who play online games at various frequencies. It was conducted in adherence to the Declaration of Helsinki and the protocol was approved by the Bezmialem Vakif University Non-Interventional Clinical Research Ethics Committee (26.07.2023-116593).

All testing procedures were carried out at Bezmialem Vakif University, Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation. Written informed consent was signed by all adolescents and their parents. The inclusion criteria were being between the ages of 10 and 18 and playing online games daily, while musculoskeletal, neurological, orthopedic, or intellectual disabilities that may prevent performing the tests within the study were accepted as exclusion criteria.

In data collection, after the information was recorded with the "Personal Information Form," each adolescent was questioned with the "Online Gaming Addiction Scale." Then, core muscle endurance tests and ruler drop tests for dominant hand and foot were applied to the participants. With the "Personal Information Form" created by the researcher, information about the adolescents' age, gender, height, weight, body mass index, average daily time spent on online gaming, average length of time since online gaming, and physical exercise frequency were recorded. Before performing the tests, the therapist clearly demonstrated the tests until the subjects understood them in detail. The tests were performed on the same day with a 15-min interval between tests.

Measures

Online Gaming Addiction Scale

This five-point Likert-type scale consists of 21 items that range from strongly disagree to strongly agree. The items in the scale inquire about the sense of in-game achievement of online gamers, on how much an individual's life is disrupted due to online gaming, and whether online gamers earn income from gaming.

The obtained score indicates the magnitude of the negative impact of online games on the player's life. If the player's score is between 21 and 42, it can be interpreted as "playing online games has no negative reflections on the individual's life," between 43 and 63 as "playing online games has low negative reflections on the individual's life," between 64 and 84 as "playing online games has moderate negative reflections on the individual's life," and between 85 and 105 as "playing online games has high negative reflections on the individual's life".[14]

Core Muscle Endurance Tests

Trunk flexion, trunk extension, side bridge, and prone bridge tests developed by McGill were performed.[15]

Trunk flexion test: The participant sat on the mat with the upper body at a 60° angle from the floor. Both knees and hips were flexed 90°, the hands were placed on the opposite shoulder, and the feet were supported by the evaluater. The adolescent was asked to maintain the posture for as long as possible. The time remaining in the position without breaking the position was recorded in seconds.

Trunk extension test: The participant was placed with the inguinal region at the edge of the table. The lower extremities were extended, the ankles were fixed, and the arms were positioned next to the body. The test was terminated when the horizontal position couldn't be maintained (maximum 240 seconds).

Side plank test: The participant was placed in a side-lying position with the lower extremities extended and the upper foot placed in front of the lower foot. Elevation was performed on the forearm and ankle until the trunk and pelvis became parallel. The time spent keeping the body in a straight line was recorded in seconds. Measurements were performed bilaterally.

Horizantal plank test: The participant was placed in the push-up position with shoulders and elbows in 90° flexion. The time spent keeping the body on their feet and forearms in a straight line was recorded in seconds.

Hand Reaction Time Test

After determining the dominant hand[16], a ruler drop test was performed with this hand to measure the hand reaction time. The participant sat on a chair with the forearm and hand relaxed on the table. The tops of the index finger and thumb, positioned on the edge of the table, were parallel to each

other. The therapist kept the ruler just over the thumb and index finger of the participant and asked the participant to look directly at the center point of the ruler. The participant was asked to catch the ruler when the ruler was released. Then the reading on the top edge of the thumb where the participant caught the ruler was recorded. After five trials had been performed, the test was repeated two more times, and the average value of these two readings was used in the assessment. The data measured in cm on the ruler was converted to reaction time according to the algorithm to calculate the reaction speed [(t = Sqrt(2d/a), t = reaction time, d = distance travelled by the ruler, a (gravitational constant) = 9.81 m/s^2)].[17,18]

Foot Reaction Time Test

The dominant leg was determined from the preferred kicking of the ball[19], and a ruler drop test was performed with this foot for measuring the foot reaction time. The participant sat against the wall with the toe 2.5 cm and the heel 5 cm away from the wall. The therapist kept the ruler on the wall just over the toe and asked the participant to look directly at the center point of the ruler. The participant was asked to catch the falling ruler with the toe of the foot pressed against the wall. After five trials had been performed, the test was repeated two more times, and the average value of these two readings was used in the assessment. The data measured in cm on the ruler was converted to reaction time according to the algorithm to calculate the reaction speed [(t = Sqrt(2d/a), t = reaction time, d = distance travelled by the ruler, a (gravitational constant) = 9.81 m/s2)].[17,18]

Statistical Analyses

The G-Power 3.1 (Universitat Kiel, Germany) program was used to determine the sample size. The sample was calculated with 80% power (one-tailed; α=0.05) by accepting the correlation coefficient (r=0.3), and a total of 67 participants were required to be included in the study.

Data was analyzed by using the IBM SPSS version 26.0 software (IBM Corp., Armonk, NY, USA). The Kolmogorov-Smirnov test was used for analyzing the normality of the distribution of data. Qualitative data was presented as number (n) and percentage (%), while quantitative data were presented as mean (m) and standard deviation (SD).

Categorical variables were analyzed with the χ2-test. A t-test was used to compare the differences between male and female participants, and a one-way ANOVA test was used to compare the test parameters according to daily time allocated to video games. The relationship between online gaming addiction, reaction time, and core muscle endurance was evaluated by the Pearson correlation coefficient. The statistical significance value was accepted as p<0.05.

Results

A total of 67 adolescents with a mean age of 13.87±1.62 years participated in the study. The rate of male adolescents (76.12%, n=51) was higher than that of female adolescents (23.88%, n=16). According to gender, height (p=0.003), weight (p=0.005), daily time allocated to video games (p=0.036), and length of time since online gaming (p=0.022) were significantly higher in male adolescents; no significant difference was observed in age, body mass index, or weekly physical exercise frequency (p>0.05) (Table 1).

While there was a statistically significant difference in online gaming addiction (p<0.001) and hand reaction time (p=0.004) according to the daily time allocated to video games, there was no significant difference in the core muscle endurance tests or foot reaction time test (p>0.05) (Table 2). According to Tukey's post hoc analysis, the online gamers who play for more than two hours have better hand reaction time than the players who play for less than one hour.

Table 1. Comparison of the descriptive characteristics of the adolescents according to gender

Variables		Male (n=51) Mean±Sd	Female (n=16) Mean±Sd	*p*
Age (years)		13.92±1.70	13.74±1.45	**0.685
Height (cm)		159.75±8.20	152.88±7.01	****0.003**
Weight (kg)		58.82±8.24	51.11±8.23	****0.005**
BMI (kg/m^2)		23.04±2.71	21.76±2.91	**0.131
		n(%)	**n(%)**	
Daily time allocated to video games	Less than 1 hour	6 (11.76)	8 (50.0)	***0.036**
	1-2 hours	22 (43.14)	6 (37.50)	
	More than 2 hours	20 (39.22)	5 (31.25)	
Length of time since online gaming	< 5 years	13 (25.49)	9 (56.25)	***0.022**
	≥ 5 years	38 (74.51)	7 (43.75)	
Weekly physical exercise frequency	None	27 (52.94)	10 (62.50)	*0.722
	1-3 times a week	9 (17.65)	2 (12.50)	
	4-6 times a week	8 (15.69)	5 (31.25)	
	Everyday in a week	4 (7.84)	2 (12.5)	

BMI: Body mass index. m: mean; Sd: Standard deviation; n: number; %: percentage; *χ2-test; **Independent t-test; p<0.05.

Table 3 shows the correlation between the online gaming addiction, reaction time, and core muscle endurance of the adolescents. No correlation was found between online gaming addiction and foot reaction time test, trunk flexion, side bridge, and prone bridge tests; however, there was a negative correlation with the hand reaction test (r=−0.588; p<0.001) and trunk extension test (r=−0.335; p=0.006).

No statistically significant relationship was observed between physical exercise frequency and online gaming addiction, and no statistically significant difference was observed between online gaming addiction and core muscle endurance tests according to physical exercise frequency (p>0.05). Also, no statistically significant difference was observed in core muscle endurance tests or reaction time tests according to the length of time since online gaming (p>0.05).

Table 2: Comparison of online gaming addiction, hand reaction time, and foot reaction time of the adolescents according to daily time allocated to video games

Daily-time allocated to video games	n	%	Online gaming addiction m±Sd	*p	Hand reaction time m±Sd	*p	Foot reaction time m±Sd	*p
< 1 hour	14	20.90	42.29±6.91		0.14±0.02		0.14±0.02	
1-2 hours	28	41.79	64.82±16.81	0.000	0.12±0.03	0.004	0.14±0.03	0.569
> 2 hours	25	37.31	76.48±6.47		0.10±0.03		0.13±0.03	

m: mean; Sd: Standard deviation; n: number; %: percentage; *One-way ANOVA; $p<0.05$.

Table 3. Correlation between the score of online gaming addiction and reaction time and core muscle endurance of the adolescents

Parameters		Online Gaming Addiction *r*	*p*
Reaction time	Hand reaction time	-0.588	**0.000**
	Foot reaction time	-0.093	0.454
Core muscle endurance	Trunk flexion	-0.120	0.335
	Trunk extension	-0.335	**0.006**
	Side bridge	-0.217	0.078
	Prone bridge	-0.227	0.065

r: Pearson correlation test; $p<0.05$

Discussion

In the current study, a relationship was determined between online gaming addiction and hand reaction time test and trunk extension test of core muscle endurance tests in adolescents who play online games daily. Depending on the daily time spent on video games, significant differences were found in online game addiction score and hand reaction time test, while no significant differences were found in core muscle endurance tests and foot reaction time test. The overall score of the Online Gaming Addiction Scale was 64.79±17.38, which corresponds to a moderate negative reflection on the individual's life.

Online gaming addiction is known to be more common in male than in female. Studies have shown that male adolescents, especially between the ages of 10 and 19, are more likely to engage in excessive gaming and problematic use than female adolescents and other age groups.[20-22] As one of the inclusion criteria was daily online gaming, the number of participants was predominantly male in the current study. Daily time allocated to video games and online gaming addiction was significantly higher in males than in females, which is in line with the literature.

A study revealed that individuals who play online games for more than 14 hours a week have better visual and goal-directed reaction times.[23] One study investigated the correlation between mobile game playing and reaction time in young people aged 18-25 and reported that those who were characterized as gamers recorded better reaction times than non-gamers.[24] A study showed that expert players performed better than non-expert players in tracking moving objects, detecting change, and switching tasks.[25] Aligned with past studies, a moderate significant relationship between online gaming addiction and hand reaction time was observed in this study. Also, according to the daily time allocated to video games, the adolescents who play more than two hours a day have significantly better hand reaction times than those who play online games for less than one hour. Considering the results mentioned earlier and the findings of this study may be associated to greater exposing to images and visual stimuli when playing, as video games often require quick reflexes and decision-making. The adolescents in the current study were not questioned about the type of online video games they played, such as puzzle, logic and card games, sports, strategy, role-playing games, first-person shooters, or racing games. Hence, it is not possible to conclude the effect of game types on reaction time because the reaction time may vary by the type of game being played.

Lower extremity muscle strength may be affected by prolonged sitting. Previously reported in the literature that, poor muscle strength and physical activity have been associated with slower foot reaction time.[26] In the current study, no significant relationship was found between online gaming addiction and foot reaction time, and also no significant difference was found in the foot reaction test according to daily gaming time. The above-mentioned study was conducted with 217 women aged 20-89 years. Although no significant relationship or significant difference was found in the present study, there is a need for studies with a larger sample of adolescents in which lower extremity muscle strength and endurance are examined in relation to sitting time while playing games. Accordingly, it is possible that poor sitting posture and inactivity in adolescents who play games for long periods of time may negatively affect lower extremity posture, and muscles and foot reaction time may also be affected.

Poor muscular endurance can lead to postural misalignments, e.g., positioning the head forward while playing a game can have a negative impact on the spine.[27,28] It has been reported that head posture may have a detrimental effect not only on the cervical spine but also on trunk and lumbar spine alignment and may impair muscle performance.[29,30] Conversely, poor thoracic and lumbar posture and poor trunk muscle endurance can also alter head and cervical posture and the function of the cervico-thoracic muscles.[31] The present study demonstrated that trunk extension muscle endurance was getting worse while the game addiction score was increasing. Hence, the young population who play online games for long times is at risk.

Several studies have shown that musclar fatigue in the trunk muscles occured in healthy individuals who sit for prolonged periods of time in a slumped position.[32,33] It has also been reported that prolonged slumped sitting posture may cause muscle fatigue in the trunk muscles as well as chronic muscle deconditioning with decreased lumbar lordosis and decreased muscle activity.[34,35] No correlation was found between online

gaming addiction and trunk flexion, side, or prone bridge tests, whereas a significant negative correlation was found with the trunk extension test.

Besides, a review reported that depression has a reciprocal relationship with the incidence of online gaming addiction in adolescents.[36] Collapsed posture with forward tilt of the head, increased thoracic kyphosis, posterior tilt of the pelvis, and increased scapular distance have also been reported in depressed individuals.[37] Therefore, another factor that may indirectly affect trunk endurance in adolescents participating in the current study may be emotional disorders. In future studies, it may be important to assess emotional status with a tool while evaluating reaction time and trunk endurance in adolescents who play online games.

Along with above-mentioned literature, there are also studies reporting the harmful impacts of screen exposure among infants, children, and adolescents, which are associated with health and psychological problems, mainly because they spent less time on physical exercise, movement, and sports.[38] Playing digital games in a measured and controlled way is acceptable in terms of its positive benefits, such as promoting young people's psychological well-being.[39] In the current study, no statistically significant relationship was observed between physical exercise frequency and online gaming addiction, and no statistically significant difference was observed between online gaming addiction and core muscle endurance tests according to physical exercise frequency. Though there was no correlation detected with the frequency of physical exercise in the present study, it is very important to underline that the role of physical activity and exercise is undeniable. It is crucial that children are more involved in exercise programs and supported to participate in physical activity programs. The negative effects of poor posture that may occur during gaming, which are emphasized in the literature, may be eliminated by strengthening the core muscles so that proper ergonomics can be achieved and maintained during gaming. In a study in which the effect of core stabilization exercises on upper extremity functions was examined, an increase was observed in core muscle endurance as well as improvement in hand grip strength and speed-dependent hand function tests. It has also been shown that postural oscillation decreased during upper extremity functions.[40] It may be argued that reaction time may change due to the extensive involvement of upper extremity muscles while playing video games and that physical activity may decrease due to the time spent during video games, which may affect core muscle endurance.

There are several limitations that need to be considered. First, this study was based on a relatively small sample of adolescents, second the study was limited to a metropolitan city in the country hence the results may not be applicable to a wide range of groups with different geographic and cultural situation. Third, as the predominance of online gaming addiction in the male gender is frequently reported in the literature, the overwhelming majority of those who met the criteria of playing online games were male. Future research may benefit from specifically targeting female participants and using different recruitment methods to see if gender-related differences exist. Furthermore, it would be very useful to conduct longitudinal studies with larger sample groups to determine both positive and negative outcomes of the gaming addiction on parameters such as motor skills, reaction time, muscle strength and endurance.

Conclusion

Taken together, the results indicate that hand reaction time was better in the gamers who play more than two hours than the players who play less than one hour; however, it was also detected that there was a negative relationship between trunk extension and online gaming addiction among the adolescents. In recent years, video games have been discussed in the literature with both negative and positive consequences, and it is very important for adolescent health to establish a balance and play in moderation in order to take advantage of the potential benefits without encountering negative consequences while playing video games.

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Conflict of Interest

The author has no conflicts of interest to disclose.

Compliance with Ethical Statement

The study was approved by the Bezmialem Vakif University Non-Interventional Clinical Research Ethics Committee with the decision dated 26.07.2023 and numbered 116593.

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