Effect of E-Sports Training on Hand Functions and Reaction Time in Young Adults: Randomized Controlled Study*

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Abstract

Aim: To examine the effects of first-person shooter (FPS), a type of electronic sport that is increasingly popular, on reaction time, hand grip and pinch strength in healthy young adults when played regularly.

Method: Forty-four young adults with similar physical activity levels completed this randomized controlled prospective study. Participants were randomized into the study group (SG) (n=22) and the non-gaming control group (CG) (n=22). While SG played games with the AIM LAB program for 15 minutes a day for 4 weeks, CG did not do any practice. After the demographic characteristics of all participants were noted, their grip strength was evaluated with a hand dynamometer, pinch strength with a pinchmeter, and reaction time with the ruler drop test. All tests were repeated at the end of 4 weeks in SG and CG.

Results: The groups were similar in terms of demographic data and baseline evaluations ($p>0.05$). In SG, significant improvement was observed in strengths and reaction time after 4 weeks of practice compared to baseline ($p<0.05$). CG showed no improvements in terms of hand grip and pinch strength, and reaction time ($p>0.05$). There were significant differences between SG and CG in the changes in strength and reaction time values in 4 weeks long period ($p<0.05$).

Conclusion: FPS played regularly for four weeks led to improvements in reaction time, hand grip and pinch strength in young adults. Young adults who want to develop these functional components can play FPS regularly, even if they are not gamers.

Keywords: E-Sports, gamer, hand function, reaction time.

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E-Spor Antrenmanının Genç Yetişkinlerde El Fonksiyonları ve Reaksiyon Zamanına Etkisi: Randomize Kontrollü Çalışma

Öz

Amaç: Popülaritesi gittikçe artan elektronik sporun bir türü olan birinci şahıs nişancı (FPS)'nin düzenli oynandığında sağlıklı genç erişkinlerde reaksiyon zamanı, el kavrama ve çimdik kuvvetine olan etkisini incelemektir.

Yöntem: Bu randomize kontrollü prospektif çalışmayı benzer fiziksel aktivite seviyelerindeki 44 genç yetişkin tamamladı. Katılımcılar çalışma grubu (ÇG)(n=22) ve oyun oynamayan kontrol grubuna (KG)(n=22) randomize edildi. ÇG 4 hafta boyunca, günde 15 dakikalık AIM LAB programı ile oyun oynarken, KG hiçbir uygulama yapmadı. Tüm katılımcıların demografik özellikleri not edildikten sonra başlangıç kavrama kuvvetleri el dinamometresi ile, çimdik kuvveti pinchmetre ile, reaksiyon zamanı Ruler Drop testi ile değerlendirildi. Tüm testlemeler ÇG ve KG'de 4 haftanın sonunda tekrarlandı.

Bulgular: Demografik veriler ve başlangıç değerlendirmeleri yönünden gruplar benzerdi ($p>0,05$). ÇG'de 4 hafta sonunda tüm parametrelerde başlangıca göre anlamlı iyileşme gözlendi ($p<0,05$). KG, el kavrama ve çimdikleme kuvveti ile reaksiyon süresi açısından herhangi bir gelişme göstermedi ($p>0,05$). Dört haftalık periyotta kuvvet ve reaksiyon süresi değerlerindeki değişimler açısından ÇG ve KG arasında anlamlı fark vardı ($p<0,05$).

Sonuç: Dört hafta boyunca düzenli olarak oynanan FPS, genç yetişkinlerde reaksiyon zamanı, el kavrama ve çimdik kuvvetinde iyileşmeye sebep olmuştur. Bu fonksiyonel bileşenleri geliştirmek isteyen genç yetişkinler, oyuncu olmasa da düzenli olarak FPS oynayabilir.

Anahtar Sözcükler: E-Spor, oyuncu, reaksiyon zamanı, el fonksiyonu.

Introduction

Thanks to its rapidly increasing momentum, technology has contributed to the emergence of developments in the field of sports, as in every field. Both playing competitive video games and watching the games with excitement have given rise to the concept of electronic sports (e-Sports)[1]. It is a branch that emerged in the 1990s as a result of the blending of the concepts of "game" and "sport". E-Sports can be defined as an organized sports branch in which individuals or teams compete with each other to achieve a certain goal through video games[1]. E-Sports is an online, interactive and multiplayer competition system that requires sensorimotor skills as in traditional team sports, as well as strategic skills such as tactics, logistics, team cooperation and analyzing the game situation[2]. In addition, this sport can be practiced in a virtual environment, it does not require serious physical resources in terms of equipment and facilities compared to other sports branches, it does not cause muscle fatigue, it is accessible, can be played individually or in teams, and most importantly, can be played in an organized manner with a team[3]. The most popular genres of e-Sports are first-person shooter (FPS), real-time strategy (RTS) and sports games. In FPS games, the virtual environment of the game is controlled with a virtual avatar, and the hand of this avatar and the tools they use appear on the screen[4].

New generation e-Sports allow players to demonstrate their skills more actively than ordinary computer games, to use the mouse and keyboard skillfully, and in addition to reveal strategic and tactical thinking skills[5]. It is known that games have positive features such as increasing attention, hand-eye coordination and multitasking abilities. It is also suggested that RTS games can improve cognitive function, and action games can be used as an exercise to increase reaction time[6].

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Hand-eye coordination is the ability to process visual signals in the mind and create appropriate motor responses to the hand, such as reaching and grasping. This ability enables the hands and eyes to work in coordination, allowing us to maintain our daily functions. The developed ability is closely related to the person's daily independence, education and social success[7]. Reaction time is a concept related to hand-eye coordination that represents the time between receiving a sudden and unexpected stimulus and the minimal reaction given in response to the stimulus. Reaction time is a critical component to athlete success, the faster the reaction the individual is more likely to continue the game or avoid danger[8]. Shortening the reaction time improves response readiness and cognition[9].

There are many studies proving the natural connection between e-Sports and hand-eye coordination[10-12]. RTS, played 5-10 hours a week, increases the transfer effect, in which the information learned in one scenario can be used for different purposes in another scenario,[10] the change in the spatial perception of those who play FPS for 30 days is higher than those who do not play video games[11], and e-Sports has a significant effect on spatial perception and reaction time[12].

However, no studies have been found in the literature investigating how reaction time, hand grip and pinch strength are affected in young adults playing FPS. This randomized controlled study is planned to examine the effect of FPS e-sports on hand functions and reaction time. Our hypothesis is that e-sports will improve hand functions and reaction time.

Material and Methods

This prospective, randomized controlled study, based on volunteerism, completed by 44 healthy university students between the ages of 18-25, was conducted at Istanbul Medipol University between March 2022 and December 2023. This study was approved by the Non-Interventional Research Ethics Committee of Istanbul Medipol University (No: E-10840098-772.02-6695 Date: 27.12.2021). The procedures followed during the study were in accordance with the 2008 Declaration of Helsinki.

Male and female young adult students with similar physical activity levels who had not participated in any e-sports activities before, were included in the study. The International Physical Activity Questionnaire (IPAQ) was used to determine the physical activity levels of the participants and minimally active participants were included in the study. Those with cognitive problems, a history of injuries involving the hand, arm or shoulder that might interfere with evaluations and playing, or those with neuromuscular or musculoskeletal problems were excluded from the study. Of the 56 students who applied, 44 met the inclusion criteria and were included in the study. Participants were first categorized based on their voluntary engagement in e-sports activities. Those who actively participated in e-sports were considered potential candidates for the study group (SG), while those who did not play video games were considered for the control group (CG). Randomization was then performed separately within these two categories using a computer-generated random number sequence (www.random.org) to assign 22 students to each group. This approach ensured that participants were randomly allocated within their respective categories while maintaining the distinction between e-sports players and non-players.

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Assessment

After the age, height, weight and gender characteristics of the individuals were noted, grip strength was measured with a hand dynamometer (*Baseline®Synamometer-Smedley Spring, NewYork, USA*), pinch strength was measured with a pinchmeter (*Baseline Hydraulic Pinch Gauge, Patterson Medical, Bolingbrook, IL*), and reaction time was evaluated with the ruler drop test. All tests were repeated at the end of 4 weeks in SG and CG.

Handgrip strength: The individual was seated on a chair with back support, with his feet flat on the ground, and the shoulder was positioned in adduction, the elbow in 90° flexion, and the forearm and wrist in neutral flexion and rotation. By applying maximum force for 3 seconds with the dominant hand, the device was asked to squeeze 3 times with 15-second intervals. The average of 3 trials was recorded and the force was measured in kilograms with an accuracy of 0.1 kg[13].

Pinch strength: Which is an important criteria for measuring hand fine motor skills, was evaluated with a pinchmeter in the standard position recommended by the American Association of Hand Therapists. Key pinch measurement was performed by sitting the individual upright on a chair with the shoulder in adduction and neutral rotation, the elbow in 90 degrees of flexion, and the forearm supported in neutral rotation. Three evaluations were made, with a 30-second rest between repetitions, and their average was taken as the outcome measure[14].

Reaction time: Ruler drop test is technically based on measuring the sum of reaction time and action time. In this test, the person to be tested was seated on a chair in a position where he could put his elbow on the edge of the table. The ruler was held perpendicular to the ground, parallel to the participant's thumb and index finger. After the tester gave the 'ready' command, assessor kept a random number between 1 and 3 in his mind, silently counted up to that number and left the ruler when the time was up. The participants were asked to hold the ruler as fast as they could and the number their thumb hit was noted. Each participant was given a period of habituation to the 3-repeat test, and then the test was repeated 12 times. For each participant, the 3 results with the fastest and slowest reactions were excluded from evaluation and the average of the other 6 results was taken and noted[15].

E-Sports Activity

AIM LAB program, one of the FPS games, has adopted a working principle that involves shooting rapidly at objects appearing on the screen and/or tracking those objects[16]. Players can often create their own playlist with various options within this program. In the 15-minute program we designed for this research; There were sphere tracking, plane shooting, detection, line tracking and reaction shooting options. The game was played by the study group for 4 weeks, everyday.

Game Scenario

Sphere tracking: Focuses on following the moving sphere as best as possible with the mouse cursor on the computer plane. For every second the mouse cursor is spent on the sphere, the user earns points (Fig. 1).

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Figure 1. AIM LAB game, sphere tracking scenario

Plane shooting: Three targets appear randomly on the invisible plane on the screen. When one of the targets is hit, a new target appears and there are always three targets on the screen. Participants start by focusing on any of three targets, earning points for each target hit and losing points for each missed shot (Fig. 2).

Figure 2. AIM LAB game, shooting on the plane scenario

Detection: Focuses on measuring and training the speed of visually detecting targets in the field of view. As soon as the sphere appears on the screen, the left click of the mouse is pressed and points are earned; if it is clicked before the target appears on the screen, the user loses points (Fig. 3).

Figure 3. AIM LAB game, detection scenario

Line tracking: Focuses on following the line between two targets with the mouse cursor and points are earned for every second on the line. (Fig. 4)

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Figure 4. AIM LAB game, line follow scenario

Statistical Analysis

Comparison and data analysis of the data collected in the baseline and final measurements were made using the statistical program "Statistical Package for Social Sciences" (SPSS version 23.0 (SPSS Inc., Chicago, IL USA). Descriptive statistics were used for demographic data and rates were expressed as "%". "Shaphiro-Wilks" test was used to investigate the suitability of the variables for normal distribution and it was determined that they did not show normal distribution. “Wilcoxon Signed Ranks” test was used to compare dependent groups and “Mann Whitney U” test was used to compare independent groups. Significance was accepted as less than 0.05 within the 95% confidence interval ($p<0.05$).

According to the power calculation made with G-Power sample analysis, the power of our study reached 0.815 with a total of 44 participants ($\alpha= 0.05$, $d=0.78$).

Results

Forty-four participants (23 female, 21 male) completed the study with 1:1 allocation into groups. Study group mean age was 20.10 years, control group mean age was 21.50 years. Study group participants had a mean height of 172.27 cm, whereas control group participants had a mean height of 176.50 cm. The study group had a mean weight of 66.41 kg, while the control group had a mean weight of 77.73 kg. The mean BMI in the study group was 22.17 kg/m², compared to 24.62 kg/m² in the control group. Sex distribution was balanced in both groups, with the study group consisting of 11 females and 11 males, and the control group consisting of 12 females and 10 males. Demographic data are presented in Table 1, showing no significant differences between groups in terms of age, height, weight, body mass index, and sex distribution (Table 1).

Table 1. Baseline characteristics of participants

	SG (n=22)	**CG (n=22)**	**p**
	Mean ± SD	**Mean ± SD**	
Age (years)	20.10 ± 1.34	21.50±1.06	0.436
Height (cm)	172.27 ± 9.24	176.50±11.94	0.131
Weight(kg)	66.41±15.35	77.73±22.66	0.086
BMI (kg/m²)	22.17±3.41	24.62±5.38	0.214
Sex (Female/Male)	(11/11)	(12/10)	0.763

Significance: $p<0.05$ Abbreviations: SG: Study group, CG: Control group, SD: Standard deviation

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Table 2 presents the mean values and standard deviations of functional parameters such as hand grip and pinch strength, and reaction time measured at baseline and after 4 weeks for both the Study Group (SG) and Control Group (CG) without any additional practice. Within-group comparisons reveal significant improvements in all parameters for SG after 4 weeks compared to baseline ($p<0.05$). Conversely, CG did not demonstrate significant changes in hand grip, pinch strength, or reaction time over the 4-week period ($p>0.05$). Between-group analysis of the differences in these parameters at week 4 compared to baseline indicates a significant improvement in SG compared to CG ($p<0.05$).

Table 2. Comparison of functional parameters and measurements within and between study and control groups at baseline and 4 weeks

	SG (n=22) Mean ± SD			**CG (n=22) Mean ± SD**			**Between group comparison**
	Baseline	**4 weeks**	**p**	**Baseline**	**4 weeks**	**p**	
Hand grip strength	29.98±11.83	32.21±12.30	**0.008**[w]	33.61±9.41	33.79±9.26	0.363[w]	**0.046**[u]
Pinch strength	5.55±8.12	6.18±8.72	**0.011**[t]	4.38±1.61	4.56±1.55	0.068[t]	**0.026**[T]
Reaction time	13.82 ± 2.97	10.79 ± 1.55	**0.001**[w]	12.28±1.46	11.88±1.23	0.076[w]	**0.005**[u]

Significance: $p<0.05$ Abbreviations: SG: Study group, CG: Control group, SD: Standard deviation

[w]: Wilcoxon Signed Ranks, [t]:Paired Sample t-test, [u]:Mann Whitney U test, [T]:Independent Sample T-test

Discussion

In this study, the effect of FPS e-sports activity, performed for 15 minutes every day for 4 weeks, on hand functions and reaction time in university-aged adults with similar physical activity levels and who had never played FPS before, was examined. The results revealed that e-sports activity increased grip and pinch strength and improved reaction time. We think that this development is achieved by the game protocol, which provides hand-eye coordination and quick decision-making, and by increasing rapid response and motor firing by providing neural adaptation.

E-sports research to date includes physical and behavioral studies related to players' behavior, motivation and preferences, gaming behavior and choices, skills, mouse selection, keyboard dynamics and biomechanics in the gaming chair[17-19]. In addition to keeping individuals in poor postures for a long time, such a popular activity also has positive effects on hand-eye coordination, reaction time and cognition[6]. Playing FPS video games changes the neural processes that support spatial selective attention[20]. It has been shown that visual attention and cognitive skills are improved in individuals who play FPS video games and that there are behavioral changes compared to those who do not play[21]. To our knowledge, there is no study examining the hand functions and reaction times of individuals playing FPS. The specific effect of e-sports on hand functions and reaction time creates a gap in the literature. With this physical and

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cognitive improvement, it can actually reveal its potential for use as a therapeutic and performance enhancer.

Bickmann et al. reported that e-Sports players and traditional athletes had similar reaction times. In addition, it has been shown that different types of games may affect abilities differently by requiring different reaction times, and different results can be obtained in acoustic and selective reaction tests[22]. For athletes, reacting quickly to a stimulus is seen as an important factor, especially in terms of preventing injuries and sports success, and is a parameter that needs to be improved. Another study examining fifty-three participants grouped according to whether they played more or less than 14 hours per week. While visual and aiming reaction times were better in players who played e-sports for more than 14 hours a week compared to those who played less, no difference was seen in auditory reaction time[23]. In our study, it was concluded that the reaction times of individuals who do e-sports improved compared to controls who did not do e-sports. These findings align with previous research indicating that engaging in activities such as FPS games can enhance various cognitive functions, including attention, spatial awareness, and perceptual-motor skills[24,25]. In sports fields, reaction time and predictive ability are critical aspects of perceptual abilities that are thought to be advantageous for a player's successful performance[26]. Our results therefore highlight the potential benefits of e-sports participation in improving reaction times in young adults; this can lead to increased performance and security in various competitive environments.

It is known that video game-based therapies applied to different diseases or healthy individuals improve hand functions, grip and pinch strength, and reaction time[27-30]. In our study, it was found that the FPS game, which requires mouse control and involves repetitive hand functions, increased reaction time, grip and pinch strength in the study group. When our results are combined with the literature showing that small-field games and video training can also be effective in increasing agility in athletic performance, we can say that e-Sports can be used to increase athletic performance[31]. Moreover, integrating our findings with literature suggesting that small-field games and video-based training can enhance agility in athletic performance, our study highlights the potential of e-Sports as a tool for improving overall athletic abilities. By emphasizing the specific benefits of FPS games in enhancing motor skills and reaction times, our results suggest that strategic incorporation of e-Sports into training regimens could potentially optimize athletic performance across different sports disciplines. Future studies could explore these benefits further and consider the broader implications of e-Sports in sports science and performance enhancement strategies.

Limitation in this study, which suggests that FPS games can therapeutically increase physical fitness and reaction time, is that the development mechanisms were not examined and they were not tested in different pathology situations. Finally, we cannot generalize our findings to all healthy young adults. More studies need to be conducted using larger sample sizes and measurements expressing performance parameters.

Future research can further explore the underlying mechanisms and long-term effects of FPS games on physical health and athletic performance, providing valuable information for both players and practitioners in the sports and rehabilitation fields.

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Conclusion

As a result, FPS played regularly for 4 weeks caused improvements in reaction time, hand grip and pinch strength. This study may shed light on future studies in the field of e-Sports. This could pave the way for innovative approaches to using e-sports as a tool to improve motor skills and cognitive abilities beyond its gaming aspect.

Ethical Approval: The protocol was approved by the Non-Interventional Research Ethics Committee of the Istanbul Medipol University, Türkiye (Number: E-10840098-772.02-6695, Date:27.12.2021). Informed consent was obtained from all participants.

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