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ORIGINAL ARTICLE

Effects of Game Addiction on Musculoskeletal System Discomfort and Mental Toughness in E-Sport Players

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Main Points

- As the game addiction score increases in e-sports players, the risk of musculoskeletal discomfort increases.
- Neck, upper back, lower back, hip, and ulnar side of the hand in the Musculoskeletal System
- Discomfort Questionnaire were higher in the game-addicted e-sports players.
- As the game addiction score increases in e-sports players, mental endurance decreases.
- Mental toughness was significantly better in the non-game-addicted e-sports players than the game addicted e-sports players.

Abstract

The aim of this study is to reveal the level of game addiction, musculoskeletal system complaints, and mental toughness and to investigate musculoskeletal system discomfort risk and mental toughness by the addiction level in e-sports players. The population of the study consisted of a total of 204 e-sports players on various platforms in Turkey, 94 of whom were game addicted and 110 were not according to the seven-item Game Addiction Scale. The players were given the Demographic Data Form, the Cornell Musculoskeletal Discomfort Questionnaire (CMDQ), the Cornell Hand Discomfort Questionnaire (CHDQ), and the Sports Mental Toughness Questionnaire (SMTQ). In CMDQ and CHDQ parameters, neck (7.55 ± 18.16 vs. 2.06 ± 4.26; p = .014), upper back (9.32 ± 19.41 vs. 3.32 ± 7.56; p = .024), lower back (12.27 ± 24.93 vs. 2.75 ± 5.47; p = .007), hip (2.89 ± 9.90 vs. .88 ± 2.89; p = .013), right hand B (2.18 ± 10.34 vs. .24 ± 1.24; p = .005) and F regions (1.76 ± 3.81 vs. .82 ± 2.96; p = .041) were significantly better in the non-addicted group. In SMTQ, the control sub-dimension (10.68 ± 3.27 vs. 12.75 ± 2.67; p < .001) and total scores (36.32 ± 6.74 vs. 38.46 ± 7.11; p = .021) were significantly better in the non-addicted group. These findings reveal that as the game addiction score increases, the risk of musculoskeletal system discomfort increases and mental toughness decreases. These results should be taken into account in e-sports players where a sedentary lifestyle is at the forefront.
Keywords: Addictive, internet addiction disorder, mental health, musculoskeletal system, sports

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Introduction

Video games have been widely recognized in recent years as an activity that may be associated with addictive behavior. The intensive use of digital gaming platforms is not the same as addiction; gamers can develop a deep passion and commitment to video games by playing or not playing online, without experiencing the negative consequences typical of addiction scenarios in everyday life (Triberti et al., 2018). Addiction to computer games is an important social problem associated with the use of digital devices. If computer games exceed a certain level of appropriate use, they lead to addiction and can cause individual problems, including difficulties in daily life, psychological problems, musculoskeletal difficulties, compulsive disorder, withdrawal symptoms, tolerance, and difficulties in discerning reality (Chae & Jung, 2018).

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It is suggested that escapism in the internet gaming disorder (IGD) criteria is independent of socialization motives and used as a way to reduce or relieve real-world stress (Hellström et al., 2015). Internet addiction is not a *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* (*DSM-IV*) criteria for diagnosis, but its definition is based on the *DSM-IV* criteria for addictive behavior (Irmak & Erdoğan, 2019). The increasing acceptance of video game addiction led to the inclusion of "internet gaming disorder" as a "further study condition" in the *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition* (*DSM-5*) in 2013. Evidence points to commonalities between internet and video game addictions, including IGD, and more established addictions, including substance use disorders and gambling disorders (Sussman et al., 2018). Digital games and related platforms are seen as online applications with an incredibly high addictive output (Heidarimoghadam et al., 2020). Internet and video game addictions are associated with psychological and social comorbidities such as depression, sleep disorders, attention deficit hyperactivity disorder, alcohol use, anxiety, and poor psychosocial support (Sussman et al., 2018).

Electronic sports (e-sports) is the term used to describe the casual or organized competitive playing of video games in a way that provides professional or personal development to the player. There are still definitional debates about what are e-sports and video games (Poulus et al., 2020). Defined by Wagner as "an area of sports activities in which people develop and train mental or physical abilities in the use of information and communication technologies," e-sports is a new and interesting competitive field in the field of sport (McGee & Ho, 2021). All e-sports are video games, but not all video games are e-sports. The defining feature of e-sports is the competitive nature of video games. E-sports are specially designed video games focused on competition. Other video games are leisure activities designed to entertain (Trotter et al., 2020).

The e-sports industry has grown significantly over the past decade, generating over 450 million viewers worldwide and over $1 billion in revenue in 2019 alone. Although this sector is growing rapidly and is considered a sports activity, the health infrastructure to support this sector is growing at a much slower rate. Unlike traditional sports players, not all professional e-sports players have direct access to team doctors, physiotherapists, or athletic trainers. Instead, e-sports players make health claims from independent medical professionals who may be less familiar with their physiological demands. These demands may include unique ergonomic and postural considerations across the wrist and upper extremity, particularly hand region muscular endurance, and the potential physiological effects of psychological stress during the competition (McGee & Ho, 2021).

A college e-sports player can spend an average of 3 – 4 hours a day sitting in front of a computer screen and practicing. This amount of hours can go up to 8 – 10 hours a day before a tournament or a competition. This does not include other forms of screen time that can add significantly more sedentary screen time, such as cell phone or television use (DiFrancisco-Donoghue et al., 2020). E-sports players spending too much time sitting in front of a screen can cause adverse health outcomes in competitive e-sports players, such as behavioral problems, sleep abnormalities, circadian rhythm problems, digital eye strain, degenerative musculoskeletal injuries, upper extremity dysfunction, neck and back problems, turtle neck syndrome, metabolic disorders, and central obesity (Chae & Jung, 2018; DiFrancisco-Donoghue et al., 2020; Trotter et al., 2020).

Although there is a lack of bodily movement in athletes in e-sports activity, it can cause significant demands on the body due to rapid and continuous movements of the fingers and concentration demands. E-sports athletes train 5.5 – 10 hours a day before the competition. It is unclear how such high job demands will affect musculoskeletal pain and subsequent performance in e-sports athletes (Lindberg et al., 2020). Physical symptoms and pathologies caused by sedentary screen time, as well as addiction to digital games, include excessive stiffness of the shoulder or neck muscles and back pain, carpal tunnel syndrome, other tendinopathies, and degenerative musculoskeletal disorders (Heidarimoghadam et al., 2020). If these symptoms persist, they can turn into scoliosis in the spine (Moon & Park, 2014; Park et al., 2012).

On a psychological level, it has been suggested that the competitive and collaborative nature of e-sports requires similar mental skills (staying in the moment, using pre-performance routines, adapting to competition, coping with momentary stress, etc.) as traditional sports (Campbell et al., 2018). Mental toughness, which has been shown to affect performance in sports, is the way athletes cope with the stressors they encounter. In mental toughness, after evaluating an event as stressful, the person requires a voluntary coping response to manage the stress. Coping responses are defined in three common, high-level dimensions. These are strategies aimed at changing the stressful situation, strategies for regulating the emotions associated with a stressful situation, and cognitive efforts to get rid of the physical stressor (Poulus et al., 2020). E-sports athletes display similar mental toughness as traditional athletes. E-sports athletes with strong mental toughness are more likely to use problem-solving coping strategies rather than avoidance coping strategies (Campbell et al., 2018).

In this study, it was aimed to reveal the level of digital game addiction, musculoskeletal system complaints, and mental toughness in e-sports players and to determine the effects of musculoskeletal system discomfort risk and mental toughness according to addiction level.

Methods

Study Design and Study Group Sample and Application

The descriptive survey model has been applied in this study. The population of the study consisted of players occupied with doing e-sports on various platforms in Turkey. By performing statistical power analysis, it was determined that the sample size should be at least 190 participants when the power was 80% and the margin of error was accepted as 5% (p = .05). A total of 204 e-sports players, aged between 15 and 40, who were involved in e-sports professionally or as an amateur and continued to play digital games in the last 6 months, and who approved the voluntary consent form to participate in the study, were included in the study. Participants were divided into two groups according to the seven-item Game Addiction Scale (GAS) as game-addicted (94 people) and non-game-addicted (110 people). Those who did not volunteer to participate in the study, did not play digital games or took a break in the last 6 months, and had a history of psychiatric and/or neurological diseases, or used psychiatric drugs were excluded from the study.

The study was conducted in accordance with the Declaration of Helsinki, and ethical approval was obtained from the Ethics Committee of İstanbul Gedik University with registration number E-71457743-050.01.04-2021.2.692-216. The research was carried out with a questionnaire form on the electronic environment between March and May 2021. All scales and questionnaires to be used in the evaluation of the participants were converted into online questionnaires in accordance with their originals. Online surveys, voluntary consent forms, and demographic data were delivered to the participants via Google forms. It took about 10 minutes to fill out the electronic questionnaires. Participants were informed about the research name, purpose, importance, and related data collection forms on the consent page. In addition, it was informed that no information about their personal information will be included and that no one other than the researchers can access these surveys.

Data Collection Tools

The Demographic Data Form, the Cornell Musculoskeletal Discomfort Questionnaire (CMDQ), the Cornell Hand Discomfort Questionnaire (CHDQ), the seven-item GAS, and the Sports Mental Toughness Questionnaire (SMTQ) were applied to both groups. Statistical analyses were performed by dividing the participants into two groups according to the GAS: game addicts and non-game addicts.

The Demographic Data Form

A form prepared by the researchers within the framework of the purposes of the research was used. The questions included participant's age, sex, height, weight, finding oneself generally successful, whether they do regular physical activity or not, daily total sleep time, for how long they played, weekly game frequency, how many hours they played a day, and the longest time they played without a break between two games.

The Seven-Item Game Addiction Scale

The GAS is a seven-item short form of the scale, which was developed by Lemmens et al. (2009), adapted into Turkish by Ilgaz (2015), and consists of 21 items and 7 factors. The five-point Likert-type scale has a one-factor structure, and each one of the seven items scores between 1 and 5 (1 = never, 2 = rarely, 3 = sometimes, 4 = often, and 5 = very often) (range: 7 – 35). Monothetic and polythetic diagnoses were used to determine whether a person is addicted to games according to the GAS. According to the monothetic diagnosis, if the person scores 3 (sometimes) or more on all seven items, they are defined as a game addict (Anlı & Taş, 2018).

The Cornell Musculoskeletal Discomfort Questionnaire

The questionnaire focuses on the frequency, the severity of pain, ache or discomfort, and work performance in 11 different body regions (neck, shoulder, upper back, upper arm, lower back, forearm, wrist, hip, thigh, knee, lower leg, and foot) during the last week. When calculating the dimensioned score, 0 points are converted to 0 points, 1 point to 1.5 points, 2 points to 3.5 points, 3 points to 5 points, and 4 points to 10 points in the area where the questionnaire evaluates the frequency of pain, ache or discomfort. The weighted score for each body region takes a value between 0 and 90. An increase in the score indicates that the frequency and severity of pain and its effect on work performance also increase. The validity and reliability study for the Turkish version of the CMDQ was conducted by Erdinc et al. (2011).

The Cornell Hand Discomfort Questionnaire

In the questionnaire, the right and left hands were divided into areas A-B-C-D-E-F. Area A represents index finger, middle finger, and vertical half of ring finger; area B represents the other vertical half of ring finger and little finger; area C represents thumb; area D represents distal part of the palm; area E represents thenar region, and area F represents the ulnocarpal and radiocarpal joint level. Its scoring is the same as CMDQ. In computational analysis, missing values may be coded as 0 (Hedge et al., 1999). The validity and reliability study for the Turkish version of the questionnaire was conducted by Erdinc et al. (2011).

Sports Mental Toughness Questionnaire

The Sports Mental Toughness Scale was developed by Sheard et al. (2009). The validity and reliability study for the Turkish version of the questionnaire was conducted by Pehlivan (2014). The first version of the scale was created with a 14-item four-point Likert-type scale; after the confirmatory factor analysis was applied in the validity and reliability study, the first item was removed from the scale. As a result, the scale was reduced to 13 items in the Turkish validity and reliability study. The dimensions of "Confidence" were included in the items 1, 2, 3, 4, and 5, "Constancy" in the items 6, 7, 8, and 9, and "Control" in the items 10, 11, 12, and 13. There are four Likert types: "Very True," "Usually True," "Rarely True," and "Not at all True." Reverse scoring was applied to items 8, 9, 10, 11, 12, and 13 (Menteş & Saygın, 2019).

Statistical Analysis

Statistical analysis was performed using IBM SPSS Statistics Ver. 22.00 (IBM SPSS Corp., Armonk, NY, USA). Descriptive features are presented as mean $\pm$ standard deviation (X $\pm$ SD) or n (%). In the comparison of GAS, CMDQ, CHDQ, and SMTQ values between two groups with and without digital game addicts, one-sample Kolmogorov – Smirnov and Shapiro – Wilk tests were used to draw histograms to determine whether the distribution was normal or not and to examine the center and prevalence criteria. For normally distributed variables, the differences between the two groups were compared with the independent samples t-test. For variables that did not show a normal distribution, the differences between the two groups were compared with the Mann – Whitney U-test. In statistical analysis, the significance value was accepted as $p < .05$.

Results

The chi-square test revealed significant group differences in terms of sex (p = .13). A two-tailed t-test revealed no significant group difference in terms of age (p = .469) (Table 1).

Neck, upper back, low back, hip, B, and F regions of the right hand in the CMDQ and CHDQ parameters were significantly better in the non-game-addicted group than the game-addicted group (p = .014, p = .024, p = .007, p = .013, p = .005, and p = .041, respectively) (Table 2).

Table 1.
Comparison of the Sociodemographic Data of the Groups

	Game-Addicted (n = 94)	**Non-Game-Addicted (n = 110)**	p
Age (mean ± SD)	21.14 ± 5.58	21.70 ± 5.47	.469
BMI (mean ± SD)	24.41 ± 4.97	23.76 ± 4.45	.327
Sex			
Female (n [%])	11 (11.7)	28 (25.5)	.013*
Male (n [%])	83 (88.3)	82 (74.5)	
Self-success percentage (mean ± SD)	67.1 ± 21.8	72.6 ± 17.2	.049*
Daily sleep time (mean ± SD)	7.63 ± 1.44	7.44 ± 1.25	.317
Total years played the game (mean ± SD)	5.39 ± 5.33	4.75 ± 4.36	.345
Daily game time (mean ± SD)	4.61 ± 2.57	3.00 ± 2.39	<.001*
Weekly game frequency (mean ± SD)	5.73 ± 1.68	4.74 ± 1.93	<.001*
Time played without a break (mean ± SD)	10.65 ± 11.12	5.55 ± 7.00	<.001*
Regular physical activity			
No (n [%])	68 (72.3)	55 (50)	.001*
Yes (n [%])	26 (27.7)	55 (50)	

*p < .05. SD = standard deviation; BMI = body mass index.

The Sports Mental Toughness Questionnaire's control score and total scores were significantly better in the non-game-addicted group than the game-addicted group (p < .001 and p = .021, respectively) (Table 3).

Discussion

In this study, there were no significant differences between the groups in terms of age and BMI. Sociodemographic characteristics such as male sex, daily game time, weekly game frequency, time played without a break, and not doing regular physical activity were higher in the game-addicted e-sports group than in the non-game-addicted e-sports group. In the literature, it has been determined that boys are more interested in spare time for computer games than girls, that the level of game addiction is higher than girls, and that they are more exposed to the effects of computer games, and this is in line with the findings of the research (Çavuş et al., 2016; Erboy & Akar Vural, 2010; Evren et al., 2020; Gökçearslan & Durakoğlu, 2014; Horzum, 2011; Kurtbeyoğlu, 2018). In our study, similar to the literature, the addiction level of male e-sports players was found to be higher than that of female players. For this reason, it is emphasized in the literature that acquiring different hobbies, being active, and socializing are good solutions in addiction studies (Şimşek & Yılmaz, 2020).

In a study, it was found that digital game addiction levels of 330 middle school students were related to sex, age, regular sports, average daily game playing time, and digital game addiction increased as physical activity levels decreased (Hazar et al., 2017). In our study, it was revealed that e-sports players who do regular physical activity have a lower level of digital game addiction, and daily and weekly game time is significantly higher in athletes with digital game addiction. The reason why game addiction is lower in athletes with a higher level of physical activity may be that doing physical activity shortens the daily and weekly playing time and reduces the risk of game addiction by focusing the mind on different activities other than playing games.

In a study that examined the relationship between musculoskeletal pain prevalence and playing time in 188 e-sports players, 42.6% of the participants reported musculoskeletal pain, while the most prevalent pain sites were the back (31.3%), neck (11.3%), and shoulders (11.3%). Athletes with musculoskeletal pain participated in significantly less e-sports training compared with athletes without musculoskeletal pain (mean difference −5.6 h/week; 95% CI, 10.6 to −.7, p = .035) (Lindberg et al., 2020). The prevalence of musculoskeletal pain in another study was similar to DiFrancisco-Donoghue et al. who found that one in three college e-sports athletes suffered from back or neck (Difrancisco-Donoghue et al., 2019). Another study investigating health problems in e-sports players reported that low back pain (42.5%) was the most common health problem, and there was a moderately positive relationship (r = .367, p < .05) between pain and screen time (Bahrilli et al., 2020). In our study, it was revealed that the scores obtained in the neck, upper back, lower back, and hip sections according to the CMDQ, which scores the frequency, severity, and effect of musculoskeletal discomfort on work performance, were significantly higher in athletes with digital game addiction. These results show parallelism with previous studies. The main reason for this can be associated with players sitting for too long and the poor posture of e-sports players (Hwu, 2018).

DiFrancisco-Donoghue et al. (2019) found a high prevalence for both wrist (36%) and hand pain (30%). In our study, it was revealed that the right-hand area B (vertical to the other half of the ring finger and little finger) and F region (ulnocarpal and radiocarpal joint level) scores according to CHDQ were significantly higher in athletes with digital game addiction. Playing video games requires quick, repetitive movements involving the fingers, hands, and wrists. These repetitive movements result in hypertrophy of the flexor tendons in the carpal tunnel and increased cross-sectional area and swelling ratio in the median nerve. The increase in pressure begins within 30 – 60 minutes of

Table 2.
Comparison of the Cornell Musculoskeletal Discomfort Questionnaire and Cornell Hand Discomfort Questionnaire Scores of the Groups

	Game-Addicted (n = 94), mean ± SD	Non-Game-Addicted (n = 110), mean ± SD	p
Neck	7.55 ± 18.16	2.06 ± 4.26	.014*
R-Shoulder	2.67 ± 11.25	1.55 ± 6.60	.249
L-Shoulder	3.36 ± 13.81	1.21 ± 4.62	.612
Upper Back	9.32 ± 19.41	3.32 ± 7.56	.024*
R-Upper Arm	2.00 ± 10.38	.31 ± 1.14	.363
L-Upper Arm	1.69 ± 9.68	.19 ± .68	.47
Lower Back	12.27 ± 24.93	2.75 ± 5.47	.007*
R-Forearm	1.56 ± 9.59	.42 ± 1.44	.916
L-Forearm	1.47 ± 9.58	.15 ± .74	.245
R-Wrist	2.64 ± 7.16	.97 ± 2.15	.313
L-Wrist	2.15 ± 10.60	1.04 ± 8.59	.648
Hip	2.89 ± 9.90	.88 ± 2.89	.013*
R-Thigh	.90 ± 3.87	.21 ± 1.01	.237
L-Thigh	1.62 ± 9.63	.13 ± .56	.337
R-Knee	2.83 ± 12.05	.55 ± 2.18	.551
L-Knee	1.86 ± 9.72	.35 ± 2.04	.113
R-Lower leg	1.68 ± 9.88	.29 ± 1.04	.845
L-Lower leg	1.59 ± 9.62	.28 ± 1.46	.373
R-Foot	1.48 ± 9.57	.20 ± .74	.383
L-Foot	1.43 ± 9.58	.17 ± .76	.714
R-Area A	1.94 ± 9.82	.34 ± 1.71	.069
L-Area A	.64 ± 2.97	.18 ± 1.37	.078
R-Area B	2.18 ± 10.34	.24 ± 1.24	.005*
L-Area B	1.49 ± 9.58	.07 ± .37	.120
R-Area C	.97 ± 3.35	.34 ± 1.16	.277
L-Area C	.53 ± 2.00	.17 ± 1.04	.136
R-Area D	1.03 ± 4.22	.39 ± 1.99	.924
L-Area D	.86 ± 4.14	.03 ± .19	.106
R-Area E	1.08 ± 4.97	1.81 ± 8.92	.316
L-Area E	.38 ± 2.14	1.16 ± 6.95	.584
R-Area F	1.76 ± 3.81	.82 ± 2.96	.041*
L-Area F	.55 ± 2.43	.67 ± 5.73	.658

*$p < .05$. SD = standard deviation; R = right; L = left.

keyboard use and is exacerbated by an accompanying ulnar deviation of the wrist (Toosi et al., 2015).

In a study of 316 e-sports players in the literature, they stated that as the ability of the athletes to cope with the stressors they encounter increases, the mental endurance increases and overlaps with each other (Poulus et al., 2020). Bányai et al. (2019) reported that only a few scientific studies in the literature have analyzed the mental abilities of e-sports athletes. Initial research by Himmelstein et al. (2017) investigated how League of Legends players cope with stress during competitive performances, using qualitative methodology to analyze the mental skills of e-sports players. It was observed that as mental toughness increased, the ability to cope increased. There is no study in the literature investigating mental toughness and digital game addiction. In our study, it was observed that as the level of game addiction decreased, mental toughness increased, that is, the ability to cope with stress increased.

Table 3.
Comparison of the Sports Mental Toughness Questionnaire Scores of the Groups

	Game-Addicted (n = 94), mean ± SD	Non-Game-Addicted (n = 110), mean ± SD	p
Confidence	13.65 ± 3.56	13.43 ± 3.86	.89
Constancy	11.99 ± 2.46	12.28 ± 2.57	.386
Control	10.68 ± 3.27	12.75 ± 2.67	<.001*
Total	36.32 ± 6.74	38.46 ± 7.11	.021*

*$p < .05$. SD = standard deviation.

Due to the sedentary nature of e-sports and the hundreds of repetitive movements during play, athletes are likely to be at risk for musculoskeletal injuries, including cervical, thoracic, and lumbar spine and upper extremity dysfunctions. Physical activity habits not found in a traditional athlete can aggravate these problems. Finally, e-sports players with gaming addiction may have lower levels of mental toughness. Researching and addressing these problems early on will improve health, prevent further injury, and possibly improve performance in e-sports.

Limitations and Directions/Suggestions for Future Research

This study has some limitations. First, using the online questionnaire excluded people without internet access. Therefore, these results cannot be generalized to people who mostly play offline games due to a lack of internet access. Second, because all individuals participated in the study by their choice, it is not possible to generalize the present results to the general population. Third, research data were collected by self-report questionnaires which are considered a method with limitations.

Ethics Committee Approval: The study was conducted in accordance with the Declaration of Helsinki, and ethical approval was obtained from the Ethics Committee of İstanbul Gedik University with registration number E-71457743-050.01.04-2021.2.692-216.

Informed Consent: The consent of the participants who agreed to participate in the study was obtained in the electronic environment.

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