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RESEARCH ARTICLE

Effect of Ergonomic Training and Exercise in Esports Players: A Randomized Controlled Trial

Atakan GÜRGAN[1] and Ömer ŞEVGİN *[2]

[1]Üsküdar University, Institıte of Health Sciences, Department of Physiotherapy and Rehabilitation, Istanbul / Türkiye
[2]Üsküdar University, Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Istanbul / Türkiye
*Corresponding author: omer.sevgin@uskudar.edu.tr

Abstract

This study aimed to investigate the effectiveness of exercises given with ergonomics training on sleep, neck, and upper extremity functions in esports players. Fifty professional or amateur esports players were randomly divided into two groups: an exercise group that received exercise and ergonomics training and a control group that received only ergonomics training. The exercise program was applied three days a week for eight weeks. Before and following the study, the participants were evaluated using the Disabilities of the Arm, Shoulder, and Hand Questionnaire (DASH), the Neck Disability Questionnaire (NDI), the Rapid Upper Extremity Assessment (RULA), and the Pittsburgh Sleep Quality Index (PSQI). Following the implementation of an intervention, there were notable declines in both the NDI and RULA scores in both groups. Conversely, while a reduction in the DASH and PSQI scores was observed in the exercise group, this was not evident in the control group. The decline in NDI and DASH scores in the exercise group following the intervention period was found to be statistically significant when compared to the control group ($p < 0.01$). The application of physical exercise improving thoracic and shoulder mobility, nerve stretching, and hand/wrist strength and mobility, along with ergonomics training, has been shown to have a positive impact on the neck, upper extremity functions, and sleep quality of the esports players.

Keywords
Ergonomics, Exercise, Esports, Neck pain, Sleep

INTRODUCTION

Electronic sports (esports) emerged as a popular phenomenon within the gaming community during the early 2000s, attracting an estimated audience of 395 million individuals globally by 2018 (Giakoni-Ramírez et al., 2022). Esports is characterized by its reliance on computer games and has been referred to by various terms in literature, such as computer games, electronic games, cyber games, online games, video games, and virtual games (Macey & Hamari, 2018). It can be described as a sport where players compete on digital platforms, often within multiplayer online games (Peter et al., 2019). The proficiencies essential for esports are similar to those demanded in traditional sports, including traits like astute decision-making, imaginative reasoning, and a comprehensive grasp of the game (Pedraza-Ramirez et al., 2020).

Furthermore, esports aim to enhance mental and physical abilities that are closely linked to information and communication technology (Wagner, 2006). It has been shown that participation in esports can enhance cognitive abilities, such as improved thinking, reaction time, and hand-eye coordination skills, while also fostering a sense of teamwork (Dongsheng et al., 2011). Similar to modern sports, electronic sports involve matches and tournaments, each game requiring its own distinct strategy, tactics, and individual or team motivation. Therefore, a high level of physical fitness in esports players can confer a competitive edge in this field (Bányai,

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Griffiths, Király, & Demetrovics, 2019; Yükçü & Kaplanoğlu, 2018).

However, since esports players often engage in prolonged periods of sedentary activity, there is a risk of adverse effects on their physical health (Giakoni-Ramírez et al., 2022). Due to the prolonged periods of sedentary behavior commonly observed in esports players, there exists a potential risk of detrimental effects on their physical well-being (Borbély & Achermann, 1999). In addition, the physical and environmental conditions of the workspace may also play a role in the onset of such health issues (Pandey et al., 2020). Ergonomics assumes a pivotal role in the genesis of musculoskeletal disorders, underscoring the significance of comprehending ergonomic principles to avert such occurrences (Babak Vahdatpour, 2015; Pandey et al., 2020). Several studies highlighted the importance of ergonomics training to protect desk workers from musculoskeletal diseases and to prevent such occupational diseases (Hoe et al., 2018; Mahmud et al., 2011). Previously, physical exercise has been suggested for the prevention and treatment of musculoskeletal complaints (De la Corte-Rodriguez et al., 2024). Several studies have drawn attention to the correlation between computer-related tasks and musculoskeletal discomfort, highlighting the beneficial influence of physical activity on both physical and mental health (Dockrell et al., 2015; Kaliniene et al., 2013). Nonetheless, the scarcity of empirical investigations into the efficacy of ergonomic training and physical exercise interventions for esports players is noteworthy.

In view of these revelations, the aim of this study was to explore the impact of ergonomics training and physical exercise on postural alignment, quality of sleep, as well as dysfunctions in the neck, arms, shoulders, and hands among esports players.

MATERIALS AND METHODS

Study Design

This study followed ethical standards and received approval from the Üsküdar University Non-Interventional Research Ethics Committee (reference number 61351342/September 2023-20). Participants provided informed consent, with the volunteer form covering research details, risks, benefits, confidentiality, and participant rights. The research strictly adhered to the ethical principles of the Declaration of Helsinki, prioritizing participant's rights and well-being in design, procedures, and confidentiality measures.

Determination of Sample Size

The G*Power 3.1.9.7 program was employed to determine the requisite sample size for the study. The minimum sample size necessary to achieve a statistical power of 0.80 and alpha level of 0.05 in 2 groups and 2 repeated measurement designs with an effect size of 0.50 was calculated as 50 individuals (25 in each group). The study population consisted of 50 licensed players who participated in professional and amateur esports organizations or tournaments of the related games. The research was conducted as a single-blind, randomized controlled study, adhering to the ethical principles outlined in the Declaration of Helsinki and approved by the ethics committee.

Randomization

The research was carried out following established research design principles as a single-blind randomized controlled trial. The assessor assessed the investigation as single-blinded. Fifty individuals were randomly assigned to either the exercise group (n:25) or the control group (n:25). Randomization was achieved through the utilization of sealed envelopes. To ensure unbiased randomization, the names of eligible participants were written on paper and placed in a container. A random selection process was then used by an evaluator to create different groups. Initially, 57 participants underwent assessments by a medical specialist to determine their eligibility for the trial. The trial ultimately involved 50 participants. The flow of participants through the study is depicted in Fig. 1.

The inclusion criteria included individuals who had actively participated in esports organizations and tournaments in the preceding six months (Tang et al., 2023), were free from chronic conditions affecting the musculoskeletal system, had not experienced any health issues that precluded exercise and had not undergone a surgical procedure within the previous six months.

The exclusion criteria were defined as being under the age of 18 years, not having participated in esports organizations or tournaments in the previous six months, having a chronic disease that would affect the musculoskeletal system, and having undergone a surgical operation that would preclude interest in esports games over the previous six months.

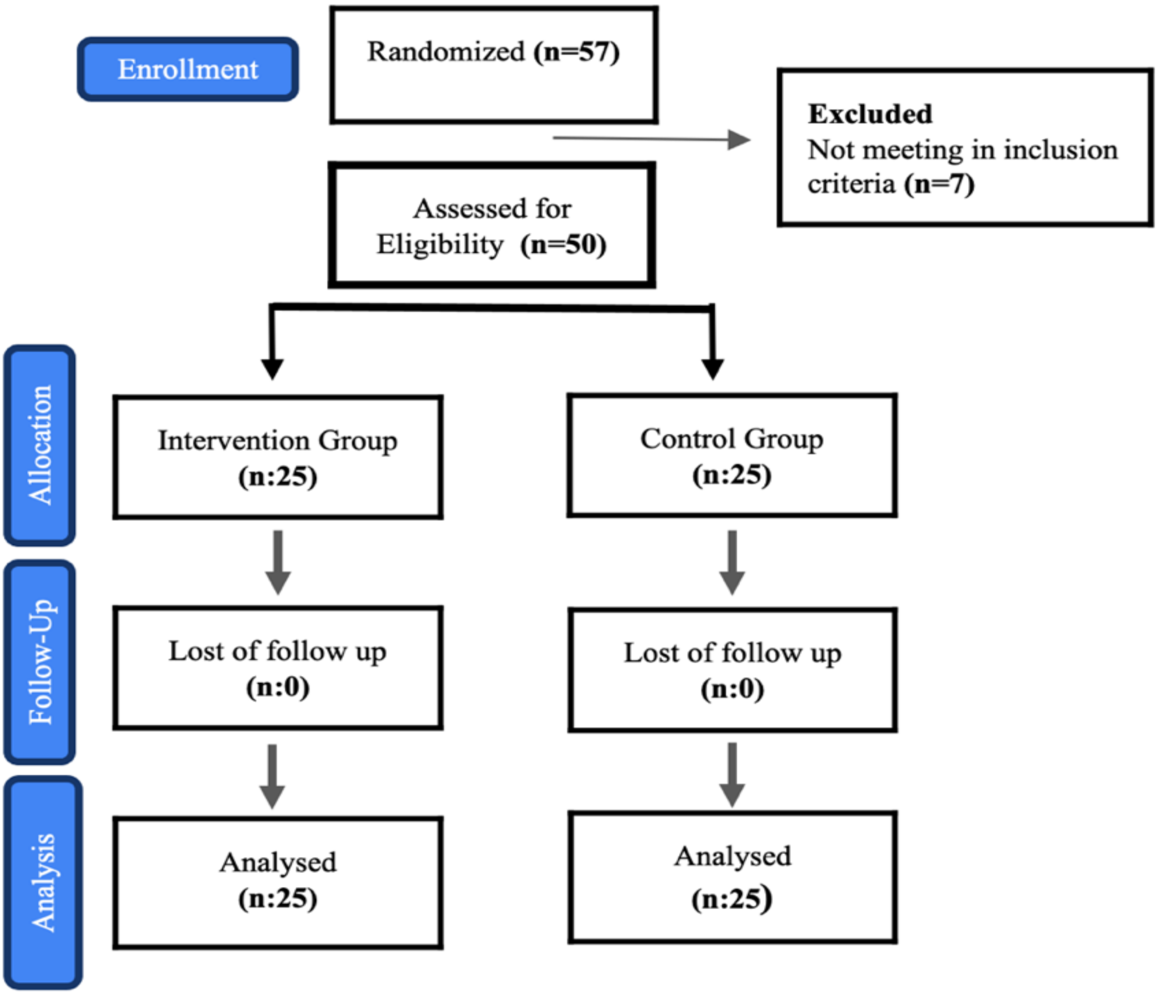

Figure 1. CONSORT flowchart

Intervention and procedure

Once the individuals to be included in the study had been informed in detail about the study, they were asked to sign an informed consent form, indicating their voluntary agreement to participate. Participants were divided into the control group and the exercise group. All participants received ergonomics training. The exercise group was additionally given an exercise program for eight weeks, three days a week, and 45 minutes a day.

Ergonomic Training

All participants in the study underwent ergonomic training. This training encompassed the following elements: the definition, importance, purpose, and risk factors for musculoskeletal disorders that can be seen in esports players, ergonomic arrangements that can be made in the working environment, and methods of protection from musculoskeletal injuries, posture disorders, and various ergonomic arrangements that can be made for posture disorders, chair selection, screen selection, rest breaks. The participants were trained on two occasions: on the first day of the study and at the end of the fourth week. The training was conducted interactively, with the use of videos and visual aids. The training sessions were conducted individually and lasted approximately two hours.

Exercise Training

The exercise training program was conducted three days a week for eight weeks, with an average duration of 45 minutes. Before the commencement of the exercise training program, all participants were informed about the exercises that would be performed. The exercise protocol was designed in three parts, comprising a warm-up, exercise, and cool-down. Stretching exercises, mobility exercises, and strength exercises were performed. Rest time was 30-45 seconds between sets and 2-3 minutes between exercises. The participants were instructed in the performance of dynamic and static stretches, nerve stretches, postural strength, and functional exercises for the upper extremity. The related movements were modified according to the exercise capacity of the participants. The exercise content also included median, ulnar, and radial nerve stretching, neck and thoracic mobility exercises, and functional strength exercises for the shoulder, arm, hand, and wrist. Regular online interviews were conducted to monitor the exercise follow-up.

Outcome Measurements

The sociodemographic information form, the Disabilities of the Arm, Shoulder and Hand Questionnaire (DASH), the Neck Disability Index (NDI), the Rapid Upper Limb Assessment (RULA) and the Pittsburgh Sleep Quality Index (PSQI) were used to obtain data from the players.

Disabilities of the Arm, Shoulder, and Hand Questionnaire

The Disabilities of the Arm, Shoulder, and Hand Questionnaire (DASH) is a region-specific self-administered assessment tool that is used to evaluate self-reported levels of upper-extremity disability and symptoms. It consists of three sections that scored 0 (no disability) to 100. The initial part of the questionnaire is focused on assessing the patient's function/symptom (DASH-FS) score. This section includes 30 questions, with 21 questions dedicated to evaluating the patient's strain during daily activities, 5 questions examining symptoms such as pain, activity-related pain, tingling, stiffness, and weakness, and the remaining 4 questions assessing social function, work, sleep, and self-confidence individually. The working model (DASH-W) encompasses an additional four questions beyond the initial 30 questions to gauge the individual's disability in the workplace. The Sports-Musicians Model (DASH-SM), which also contains four questions and demands high performance, determines the extent of disability in patients engaged in sports or music. A Turkish validity and reliability study of the questionnaire was conducted (Tülin Düger, 2006; Hudak, 1996).

Neck Disability Index

The Neck Disability Index (NDI) is used to evaluate neck pain severity, self-care, lifting, reading, headache, concentration, work, driving, sleep, and leisure activities. Each parameter is rated on a scale from 0 to 5, with 0 indicating no pain or functional limitation and 5 representing the most significant pain and limitation. Participants were required to choose the most suitable option for each parameter. Subsequently, the scores for each selected option were tallied to calculate the total score. In the NDI, scores of 35 points or higher were categorized as complete disability, 25 to 34 points as severe disability, 15 to 24 points as moderate disability, 5 to 14 points as mild disability, and 0 to 4 points as no disability. The validity and reliability of the Turkish version of the questionnaire were assessed by Aslan et al. (Aslan et al., 2008; Vernon H., 1991).

Rapid Upper Limb Assessment

The RULA (Rapid Upper Limb Assessment) is used to identify and interpret inappropriate working postures and to inform the implementation of corrective measures. It is typically employed by employees engaged in desk-based or seated work. In the observational approach, individuals are directly observed while working and the body postures they adopt during the work are recorded by a physiotherapist. The method comprises two main components. In the initial phase of the assessment, the arm, forearm, and wrist are evaluated. Subsequently, the neck, trunk, and lower extremities are assessed. In the sagittal plane, additional points are awarded if there is a rotation, lateral flexion, shoulder abduction and elevation, and wrist deviation accompanying the aforementioned body parts. The main sections under evaluation are static or intermittent loading, static posture, or repetitive movements lasting longer than 10 minutes. Points are increased according to the severity of the condition. The total RULA score is between 1 and 7, with an increase in score indicating a worsening of the working posture. The total RULA score allows for the identification of four distinct categories, each accompanied by a corresponding action level. RULA-1 (1-2 points) indicates that the current working posture is acceptable if it is not maintained or repeated for an extended period. RULA-2 (3-4 points) indicates that further research is necessary and changes may be required. RULA-3 (5-6 points) indicates that research and changes should be conducted without delay. Finally, RULA-4 (7 points and above) indicates that research and changes are required immediately (McAtamney & Nigel Corlett, 1993).

Pittsburgh Sleep Quality Index

The PSQI is a questionnaire that assesses sleep quality through a series of questions grouped into seven main categories: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disorders, sleep medication use, and daytime functioning. The responses to each question are scored on a scale of 0 to 3, with higher scores indicating poorer sleep quality. Each of the seven main topics is first evaluated independently, and then the scores for the seven components are summed. A total score of 5 or above indicates impaired sleep quality. The validity and reliability study of the PSQI in Turkey was conducted by Ağargün et al. (Ağargün MY, 1996; Buysse, D, 1989).

Data Analysis

A statistical analysis was conducted using the IBM SPSS 24.0 package program. Descriptive statistics were employed to express categorical data as frequency (%), numerical data as mean ± standard deviation. The compliance of the data with normal distribution was determined by the Kolmogorov-Smirnov test, skewness and kurtosis values, and histogram graphs. In intergroup comparisons, the Mann-Whitney U test was employed for non-normally distributed parameters, whereas the independent sample t-test was used for normally distributed parameters. Statistical significance was accepted at the $p < 0.05$ level.

RESULTS

Table 1 presents the demographic characteristics of the participants. A total of fifty esports players participated in the study.

The average age of the participants in the exercise and control groups was 23-24 years. At the same time, approximately 60-70% of the participants were male within the groups. Participants with different levels of education were approximately homogeneously distributed in the groups.

Table 1. Demographic information of the participants

Variable	Group	Exercise Group n(%)	Control Group n(%)
Age (X±SD)		23.48±4.33	24.24±4.23
Gender	Female	10(40)	8(32)
	Male	15(60)	17(68)
Education Level	High School	11(44)	7(28)
	University	13(52)	17(68)
	Master	1(4)	1(4)
Game	Valorant	8(32)	8(32)
	League of Legends	7(28)	6(24)
	Rise Online World	8(32)	4(16)
	FIFA	2(8)	2(8)
	Counter Strike	0(0)	5(20)

ANOVA; p: Chi-square test. p<0.05 was considered significant. SD: Standard Deviation; X: mean

Table 2 shows the NDI, DASH, PSQI, and RULA scores before and after the intervention in the exercise and treatment groups. NDI, DASH, and RULA scores decreased significantly in the control group after treatment ($p < 0.05$). However, no significant difference was observed in the PSQI score in the control group ($p > 0.05$). In the exercise group, NDI, DASH, PSQI, and RULA scores decreased after treatment ($p < 0.001$).

Table 2. Within-group comparisons before and after the interventions

Group	Assessment	Before X±SD	After X±SD	t	p
Control	NDI	14.44±4.77	9.04±4.13	7.030	.000***
	DASH	8.26±6.38	7.56±5.55	2.355	0.027*
	PSQI	6.88±1.64	6.44±1.60	1.901	0.069
	RULA	3.28±1.27	2.16±0.68	5.527	.000***
Exercise	NDI	20.92±6.45	8.52±3.46	11.242	.000***
	DASH	10.80±6.87	8.51±4.99	4.612	.000***
	PSQI	7.16±1.99	6.12±1.53	4.578	.000***
	RULA	3.4±1.44	2.56±1.12	4.257	.000***

*p<0.05, **p<0.01, ***p<0.001, DASH: Disabilities of the Arm, Shoulder, and Hand Questionnaire, RULA: Rapid Upper Limb Assessment, NDI: Neck Disability Index, PSQI: Pittsburgh Sleep Quality Index, X: Mean, SD: Standard Deviation.

Table 3 shows the comparison of changes in NDI, DASH, PSQI, and RULA scores among the groups. Following the intervention, there was no notable distinction was detected in PSQI and RULA scores in the exercise group compared to the control group. Conversely, a substantial reduction was noted in NDI and DASH scores within the exercise group compared to the control group ($p < 0.001$).

Table 3. Between-group comparison of differences in NDI, DASH, PSQI, and RULA scores

Variable	Control Group X±SD	Exercise Group X±SD	t	p
NDI	5.40±3.84	12.40±5.51	-5.208	0.000***
DASH	0.69±1.48	2.28±2.47	-2.750	0.008**
PSQI	0.44±1.15	1.04±1.13	-1.850	0.070
RULA	1.12±1.01	0.84±0.98	0.990	0.327

**p<0.01, ***p<0.001, DASH: Disabilities of the Arm, Shoulder, and Hand Questionnaire, RULA: Rapid Upper Limb Assessment, NDI: Neck Disability Index, PSQI: Pittsburgh Sleep Quality Index, X: Mean, SD: Standard Deviation.

DISCUSSION

This study aimed to investigate the efficacy of ergonomics training and physical exercise on posture alignment, sleep quality, and physical disabilities related to the neck, arms, shoulders, and hands in esports players. The results of our study indicated that exercise programs integrated with ergonomics training were associated with a reduction in musculoskeletal pain and functional limitations in esports players.

This study showed that a physical exercise program applied with ergonomics training was more effective than ergonomics training alone in reducing upper-extremity disability and symptoms (including the neck, arm, shoulder, and hand) in e-athletes. Previous research suggests that individuals involved in esports typically exhibit sedentary behaviors for approximately 4.2 hours daily (Kari & Karhulahti, 2016). The prolonged periods of sitting among esports participants may lead to adverse effects, including a higher likelihood of injuries and chronic ailments like upper extremity dysfunction, metabolic imbalances, sleep pattern disturbances, and neck/back issues (Zwibel et al., 2019). The studies point out that esports players who deliberately adhered to the proper sitting positions showed a notably reduced probability of encountering discomfort or tension in the upper and lower back. Likewise, individuals who integrated short breaks into their extended gaming sessions exhibited a notably diminished experience of neck discomfort (Tang et al., 2023). Poor posture worsens improper positioning and contributes to various symptoms that may result in postural disorders, muscle imbalances from overuse, nerve compressions, and other conditions. Seated positions that are deemed suboptimal can exert pressure exceeding 150% of the body weight on the spinal column (Quka et al., 2015). When considering posture in the context of esports, ergonomics can provide posture efficiency to enhance performance and mitigate the risk of repetitive strain injuries as seen in this study. Although a control group without any intervention was not considered, upper extremity injuries and symptoms in e-athletes decreased with ergonomics training, indicating that the effect of ergonomics on physical health protection should not be ignored. Several studies in the literature corroborate the findings of the present study. Emara et al. examined the ergonomic considerations for keyboard sensitivity to prevent repetitive strain disorders like back pain, carpal tunnel syndrome, and tendinopathies (Emara et al., 2020). Recently, it was reported that ergonomic training in esports players was effective in protecting body health in athletes (Nicholas Nalic Pierides JR., 2023). Similarly, Robertson et al. observed a notable enhancement in the level of ergonomic knowledge and awareness among individuals following training on office ergonomics (Robertson et al., 2009). Previously, office workers demonstrated a significant decrease in RULA scores following the training which demonstrates the impact of ergonomic regulations in the workplace on the reduction of musculoskeletal complaints (Murat Dalkılınç, 2011).

These results highlight the significance of ergonomic considerations in competitive gaming, as they play a role in the overall health and wellness of gamers. The American College of Sports Medicine (ACSM) stated that "Exercise is a Medicine," to incorporate exercise therapy as an integral part of maintaining healthcare (The American College of Sports Medicine, 2024). This study is the first to address integrated ergonomics training and physical exercise in e-athletes. Prior research exists in the literature that employs exercise regimens similar to our investigation. A study incorporating stretching routines as part of exercise protocols found that such exercises served as a preventive measure against work-related musculoskeletal disorders (da Costa & Vieira, 2008). Another study has demonstrated a negative correlation between the increase in regular physical activity and the incidence of work-related musculoskeletal diseases (Sharma & Golchha, 2011). Therefore, we suggest physical exercise combined with ergonomics training to maintain the physical health of e-athletes.

Sleep is crucial for learning and memory consolidation, as well as attention renewal (Lowe et al., 2017). Poor sleep quality can lead to memory and attention issues, increasing the risk of accidents (Fullagar et al., 2015). However, there is limited research on the sleep quality of esports players. Esports players who incorporate physical exercises into their routines have been shown to enhance gameplay and cope with stress (Guillen Pereira et al., 2017). Nevertheless, only a small percentage of esports athletes, ranging from 6% to 9%, report exercising for performance-related advantages, while a larger portion, between 32% and 47%, engage in physical activities primarily for general health benefits (Kari & Karhulahti, 2016). Studies have shown that sleep quality decreases in esports players (Sanz-Milone et al., 2021). Several factors can affect sleep patterns directly in adolescents, including a delay in melatonin secretion and high exposure to electronic devices (Sanz-Milone et al., 2021). Research has revealed an association between television watching and diminished sleep quality. Similarly, computer game playing has been linked to an increased likelihood of sleeping later and experiencing shorter sleep durations (Harbard et al., 2016). In this study, the PSQI demonstrated that esports players who implement ergonomic training and physical exercise exhibited a high subjective sleep quality post-intervention. These findings are consistent with those reported in the literature. It has been demonstrated that participation in an exercise training program has a positive effect on sleep quality in middle-aged and older adults (Yang et al., 2012). It may be concluded that physical exercise and ergonomic training could be an alternative or complementary approach to maintaining the well-being of esports athletes. However, the inclusion of exercise in ergonomics training did not make any difference, so an analysis of the sleep-wake cycle would be useful to improve the results found in this study. Additionally, it would be advantageous to evaluate the population of esports players in terms of their sleep parameters, with different screening procedures for different game categories.

Like traditional sports, esports have a physical impact (Sánchez et al., 2019). Research in this field shows that esports athletes require not only tactical analysis or the ability to respond to something that appears on the screen but also endurance to perform these activities over long periods of time. In this study, we investigated the contribution of ergonomic training and physical exercise to the physical health of esports athletes. The findings have significant implications for promoting a more objective understanding and appreciation of esports and the sustainable development of esports players. Also, further research is necessary to explore potential causal relationships between esports participation and health outcomes and to develop a healthier sports practice modality from a sports science perspective. It was observed that the severity of pain, fatigue, and functionality decreased in e-athletes to whom ergonomic training and an exercise program were applied. It was determined that there was no significant difference in the findings regarding sleep quality. It was observed that thoracic mobility, shoulder mobility exercises, nerve stretching exercises, strength and mobility exercises for the hand and wrist, and ergonomics training applied to the exercise group were effective in the arm, shoulder, hand, neck, and upper extremities. Therefore, regular exercise and ergonomics positively affect the musculoskeletal system of esports players. An interprofessional medical team would represent the final step in the future. However, for the present, it is essential to invest more research and time into the various factors that influence the performance of an esports athlete, including the technical skill required for each game, physical health, nutrition, mental health, and ergonomics.

Conflict of interest

The authors declare no conflict of interest. Also, no financial support was received.

Ethics Committee

The approval was taken from the Üsküdar University Non-Interventional Research Ethics Committee (reference number 61351342/September 2023-20).

Author Contributions

The authors accomplished this study by making significant contributions including designing the study according to the formulation of its objectives. AG and ÖŞ performed on conception and design of the study. AG collected the data. ÖŞ performed data analysis and interpretation. All authors were contributors and responsible for the manuscript's content and approved the version submitted for publication.

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