www.journalmsr.com

الجمعية السعودية لجراحة العظام
Saudi Orthopedic Association

Journal of Musculoskeletal Surgery and Research

Original Article

Musculoskeletal disorders, perceived stress, and ergonomic risk factors among smartphone eSports athletes: A cross-sectional study

Muhammad A Khan, MS.C.[1], Montakarn Chaikumarn, Ph.D.[1]

[1]Department of Physical Therapy, Faculty of Allied Health Sciences, Chulalongkorn University, Pathumwan, Thailand.

***Corresponding author:**
Montakarn Chaikumarn, Department of Physical Therapy, Faculty of Allied Health Sciences, Chulalongkorn University, Pathumwan, Thailand.

montakarn.c@chula.ac.th

Received: 10 April 2024
Accepted: 12 June 2024
Epub ahead of print: 12 July 2024
Published: 02 August 2024

DOI
10.25259/JMSR_113_2024

Quick Response Code:

ABSTRACT

Objectives: Smartphone eSports athletes face various health risks due to prolonged sitting and poor posture. The objective of this study was to investigate the frequency of musculoskeletal disorders (MSDs), perceived stress levels, health risks, and ergonomic risk factors among smartphone eSports athletes (skilled gamers who participate in organized competitions utilizing smartphones) and determine the association between levels of perceived stress and MSDs.

Methods: A cross-sectional study was conducted on 145 participants. Nordic musculoskeletal questionnaire, Perceived Stress Scale-10, questionnaire on health risks, and rapid upper limb assessment were used to collect data. Our study included 18–30-year-old smartphone gamers with over a year of eSports experience. Our study excluded participants who had spinal surgery for musculoskeletal complaints, acute traumatic events, such as accidents or injuries from non-gaming-related factors, physical therapy, chiropractic care, or surgery for musculoskeletal conditions of the upper limb and trunk.

Results: Neck pain was most prevalent, at 41.4%, followed by the shoulders at 31% and the lower back at 29%. The participants had moderate-to-high levels of perceived stress and ergonomic risks for MSDs due to poor posture and muscle use. There was no significant association between the 12-month prevalence of MSDs and perceived stress. However, the 7-day prevalence of pain in elbows was associated with perceived stress ($\chi^2 = 20.15$, $P = 0.003$).

Conclusion: Our study reveals a significant prevalence of MSDs and moderate-to-high levels of perceived stress among eSports athletes. These athletes are exposed to high ergonomic risk due to poor posture. There is no significant association between the prevalence of MSDs and perceived stress levels, except for pain in elbows in the last seven days.

Keywords: Ergonomics, Musculoskeletal pain, Posture, Prevalence, Risk factors

INTRODUCTION

Smartphone eSports, also known as mobile eSports, refers to the competitive playing of video games on smartphones and tablets, and this particular kind of eSports has seen a surge in popularity as a result of its unique characteristics and ease of access, enabling users to engage

How to cite this article: Khan M, Chaikumarn M. Musculoskeletal disorders, perceived stress, and ergonomic risk factors among smartphone eSports athletes: A cross-sectional study. J Musculoskelet Surg Res. 2024;8:247-55. doi: 10.25259/JMSR_113_2024

in competitive gameplay through mobile devices.[1] Around 2.5 billion people globally participate in competitive and virtual video gaming.[2] Well-known smartphone eSports games include Arena of Valor, PUBG Mobile, Clash Royale, and Call of Duty Mobile.[3] While conventional sports focus on physical conditioning, professional eSports players dedicate 5.5–10 h daily to their regular game training to improve eye-hand coordination, develop quick response speeds, and refine rapid decision-making abilities.[2,4-6] The heightened training intensity in a specific posture and work environment might lead to health issues similar to those linked to sedentary lifestyles.[5,7] Unlike desktop eSports players, eSports players who mostly use cell phones for gaming are more susceptible to musculoskeletal illnesses and other health issues due to extended sitting in specific postures and lack of suitable equipment. Typical health issues include neck and back discomfort, kyphosis, and lordosis due to poor posture.[8]

Mobile eSports players spend most of their time in the forward head position. Thus, smartphone eSports players are more susceptible to acquiring musculoskeletal issues that specifically impact the spine, such as neck stiffness and backache. Prior research found that 40% of smartphone eSports players reported neck discomfort, and 25% reported upper back pain.[9] ESports players may have psychological issues alongside physical ones as they need to handle stress from social media, competition, cultural expectations, and group interactions.[10] Research has shown that stress is a notable risk factor for the development of chronic musculoskeletal pain problems.[11,12] Investigating eSports athletes may uncover information about their overall health and musculoskeletal conditions, which may help develop injury prevention strategies and educational programs.[8]

ESports athletes often have musculoskeletal disorders (MSDs), especially those involved in various hand and finger movements, because repeated motions, extended sitting, and inadequate ergonomics expose them to ergonomic risk factors for MSDs.[13] Prior research has shown a significant occurrence of MSDs among computer eSports competitors,[8] and a study on smartphone eSports athletes found that they have poor spine posture, mobility, and stability.[14] The research on MSDs among smartphone eSports is very limited, and only prior studies on smartphone eSports athletes were conducted in China.[8,14,]

Further, documentation is needed to fully understand the prevalence of the problem among smartphone eSports athletes. Furthermore, no study has assessed the stress levels and ergonomic risk factors among smartphone eSports athletes in Pakistan. Therefore, this study aimed to investigate the frequency of MSDs, perceived stress levels, health risks, and ergonomic risk factors among smartphone eSports athletes (skilled gamers who participate in organized competitions utilizing smartphones) and determine the association between levels of perceived stress and MSDs. We hypothesized that there would be a high prevalence of MSDs and high-stress levels among smartphone eSports athletes in Pakistan. There will be risk factors for developing MSDs due to faulty posture and ergonomics. There will be an association between the prevalence of MSDs and high-stress levels.

MATERIALS AND METHODS

Study design and settings

The study used a cross-sectional observational method and focused on Pakistani smartphone eSports athletes from diverse elite and tier 1 teams from major cities in Pakistan.

Sample size

The sample size was calculated using Cochran's Formula with a 95% confidence level (two-sided z = 1.96) and an 8% margin of error. The original sample size was 150. The non-response rate was anticipated at 5%, so the final sample size was adjusted to 158. We interviewed 158 participants for this study. However, due to incomplete data from self-reported questionnaires on MSDs and perceived stress levels, the final analysis included responses from 145 participants.

Participants

We recruited 158 eSports athletes using a simple random sampling method. However, data from 13 participants was incomplete, so data from 145 was analyzed. The participants were included in our study if they were actively participating in smartphone games, aged 18–30 years, and had eSports experience of more than a year. The participants were excluded from our study if they had undergone spinal surgery due to musculoskeletal complaints in the past, experienced acute traumatic events, specifically accidents or injuries resulting from non-gaming-related factors, and previously had treatment such as physical therapy, chiropractic care, or surgical treatments for musculoskeletal conditions of trunk and upper extremities.

Study procedure

A well-trained physiotherapist carried out the data collection. We used a pre-inclusion screening questionnaire to identify individuals who satisfied the inclusion requirements. The pre-inclusion screening questionnaire was designed in-house to meet our study's goals. It was based on field practices and expert opinions but not a template. It was validated through professional evaluation and pilot testing to ensure its compatibility with our target population. The pre-inclusion screening questionnaire was distributed to the public through online platforms like Google Forms. Participants provided

demographic information, including age, sex, gaming habits, daily time spent on smartphone gaming, and any medical or surgical history. After screening the participants, we generated a list of eligible candidates, selected 158 participants using simple random sampling and invited them for a face-to-face interview. At the time of the interview, the participants were explained about the study, and their written consent to participate in the study was obtained. After signing the consent forms, the participants were given the self-administered questionnaires, including the Nordic Musculoskeletal questionnaire (NMQ) to assess the prevalence rate of MSDs and the Perceived Stress Scale (PSS) version PSS-10 to determine stress levels among eSports athletes. Participants also responded to a questionnaire on health risks. To avoid any influence or bias, the participants completed the NMQ for the prevalence rate of MSDs. Then, they completed the PSS-10 independently for the stress levels. After completing self-reported questionnaires to investigate the ergonomics risk factors, participants were requested to be involved in the eSports games on their smartphones. Rapid upper limb assessment (RULA) was used to investigate the ergonomics risk factors. The posture and movement of the participants were observed while gaming to evaluate the postural loading of the upper limbs, neck, and trunk using a set of action levels and a scoring system.

NMQ

This is a valid assessment tool for musculoskeletal symptoms in the neck, shoulders, elbows, wrist and hands, the upper and lower back, hips, knees, ankles, and feet. The NMQ has 27 items to explore the presence of musculoskeletal symptoms in the past 12 months. It covers the nine regions of the body. The responders were asked if they had experienced musculoskeletal problems in the past 12 months and the past seven days, preventing regular activity.[15] The reliability of the NMQ was assessed using the test re-test approach, revealing variations in participant responses ranging from 0 to 23%. Furthermore, comparing the findings of the NMQ with the clinical history of subjects reveals a discrepancy rate ranging from 0% to 20% for validity.[16] Additional clinical investigations indicate that the discrepancy in responses compared to clinical history varies from 0 to 26% for yearly prevalence and 6–19% for weekly prevalence.[17]

PSS

The PSS-10 was used to assess stress levels. The PSS-10 is a validated and widely used self-reported questionnaire that measures how individuals perceive their lives as unpredictable, uncontrollable, and overloaded with stress. It typically contains ten questions that assess the frequency and intensity of stress-related thoughts and feelings in the past month. Participants rate their responses on a Likert scale, ranging from 0 (never) to 4 (very often), with higher scores meaning higher perceived stress levels. Sheldon Cohen and his colleagues created the PSS in 1983.[18] The PSS-10 has strong internal consistency, with Cronbach's alpha values ranging from 0.78 to 0.91 in various trials.[19] It shows a strong correlation with other assessment instruments for stress, anxiety, and depression, such as the State-Trait Anxiety Inventory and the Beck Depression Inventory. The PSS-10 substantially correlates with the State-Trait Anxiety Inventory (r = 0.60) and the Beck Depression Inventory (0.54).[20]

RULA

The RULA was developed by McAtamney in 2005. The RULA is a validated observational method for assessing ergonomic risks associated with repetitive movements, awkward postures, and other factors contributing to the development of MSDs. It involves observing and evaluating a specific activity's posture, force, and ergonomic factors. The RULA provides a systematic approach to identifying and quantifying ergonomic risk factors, which can help understand the relationship between ergonomics and MSDs. It helped us assess the ergonomic risk factors among smartphone eSports athletes, such as their posture, force exertion while tapping or swiping, duration of exposure to eSports activities, and repetitive movements involves observing and assessing a particular activity's posture, force, and ergonomic aspects. RULA demonstrates a test-retest capacity with an intraobserver repeatability of 91.7% and an interobserver repeatability of 94.6%.[21]

Questionnaire on health risks

Based on previous research findings,[8] this questionnaire assessed the prevalence of specific health risks among Pakistani smartphone eSports athletes. It consisted of questions related to health risks (Headaches, Sleep disturbance, dry eyes, and anxiety) and questions related to the type of gaming chair used by the players and their preferred posture while gaming.

Statistical analysis

Statistical analysis was conducted using the Statistical Package for the Social Sciences program version 29.0.1.0. Descriptive statistics were used to analyze the demographic characteristics of smartphone eSports athletes, focusing on central tendency (mean) and variance (standard deviation). The study evaluated the occurrence of MSDs among smartphone eSports athletes by analyzing how often and what percentage of players reported experiencing MSDs. The Chi-square test assessed the statistical connection between perceived stress levels (low, moderate, high, and very high) and the presence of MSDs. The Chi-square test *P*-value

determined the statistical significance of the association. A *P*-value below the predetermined significance threshold (0.05) suggests a statistically significant association between stress levels and the occurrence of MSDs.

RESULTS

Characteristics of participants

The characteristics and gaming behaviors of the participants are shown in Table 1.

Prevalence of MSDs

The 12-month prevalence of MSDs, the 7-day prevalence, and the absence from work due to discomfort are shown in Table 2. Within the past 12 months, neck pain was the most common (41.4%), followed by shoulder pain (31%) and lower back pain (29%). The neck was the most afflicted body location in the 7-day prevalence, with 41.4% of individuals experiencing pain in this area, followed by the shoulders at 35.2% and the lower back at 32.4%. Neck pain was the primary cause of activity limitations for 27.58% of participants, followed by lower back pain for 15.2% and wrist pain for 12.4%.

Table 1: Characteristics of participants (*n*=145).

Characteristics	Mean±SD
Age (years)	23.03±2.64
Height (meters)	1.679±0.111
Weight (kg)	68.11±12.54
BMI	22.29±3.14
Gaming experience (years)	4.59±2.54
Duration of gaming per day (hours)	8.14±3.951
Sex of players	Male=111 (76.6%) Female=34 (23.4%)

Data is presented in mean±standard deviation (SD). BMI: Body mass index

Stress levels

Out of 145 players, 100 (69%) experienced moderate stress. Only 12 players (8.3%) exhibited low stress levels. PSS-10 scores showed 33 (22.8%) players under high stress levels. In our study, most users experienced moderate gaming-related stress.

Ergonomic risk assessment

The posture of the players was assessed using the RULA worksheet while the eSports players engaged in smartphone gaming. None of the participants had a grand RULA score of 1 or 2, which falls under the category of acceptable posture. Forty-nine (33.8%) participants had a score of either 3 or 4, which meant that their posture required further investigation and that a change might be needed. Most of the participants, 89 (61.4%), had a RULA score of either 5 or 6, which means their posture is critically faulty, and they need to implement a change soon according to the needs of players. Only 7 players (4.82%) had a RULA score of 7, meaning they needed to immediately implement the change in their postures. Most players played the games with their necks flexed and arms unsupported and flexed to hold the phones. The posture of an athlete during assessment from different angles is shown in [Figure 1a and b].

Health risks

Based on previous research findings,[8] the questionnaire on the health risks was used to assess the health risks among smartphone eSports athletes. Out of the total, 11.7% of subjects reported headaches regularly, whereas just 4.8% always experienced headaches, 8.3% experienced severe headaches, and 2.1% experienced severe migraines. Ninety-three (64.1%) participants experienced dryness and discomfort in the eyes. Only 61 (42.1%) took a break to rest their eyes. At the same time, 49.7% of the participants had

Table 2: Prevalence of MSDs in the last 12 months and last 7 days (*n*=145).

Body region	Prevalence of MSDs in the last 12 months (%)	Refrain from work in the last 12 months (%)	Prevalence of MSDs in last 7 days (%)
Neck	41.4	27.58	41.4
Shoulders	31	10.34	35.1
Elbows	12.4	2.8	18.6
Wrists	18	12.4	20.7
Upper back	18.6	5.5	23.4
Lower back	29	15.2	32.4
Hips/thighs	11	4.2	10.3
Knees	11.7	0.7	13.1
Ankle/feet	9.7	2.1	7.6

Data is presented as a percentage (%). Prevalence is given in each body region as (% prevalence). MSDs: Musculoskeletal disorders

sleep disturbances due to eSports gaming. Around 9.7% of the participants experienced severe sleep disturbances, while only 1.4% experienced severe sleep disturbances.

Furthermore, 50.3% of the participants were suffering from anxiety and restlessness related to eSports gaming.

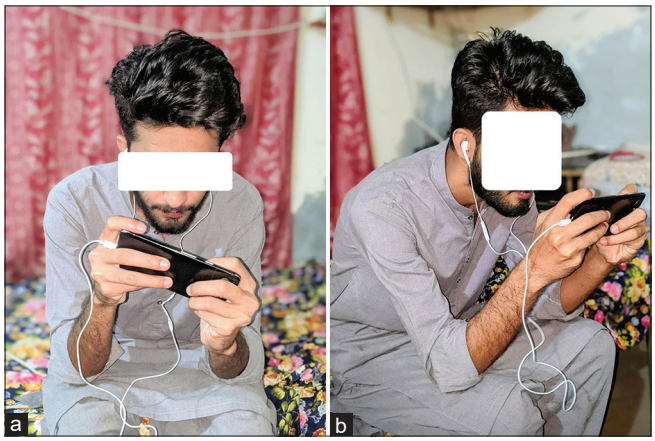

Figure 1: (a and b) Posture of an athlete from different angles during rapid upper limb assessment.

Only 6.9% of the participants experienced severe anxiety, while 1.4% experienced very severe anxiety. In addition, 45.5% of the participants experienced changes in appetite due to smartphone eSports gaming. Most players, 44.8%, preferred using ergonomic gaming chairs for playing eSports, 33.8% preferred reclining gaming chairs, and only 21.4% preferred simple gaming chairs. Furthermore, 28.3% of the participants played games with their heads mildly flexed forward and arms supported, while 35.9% played games with forward head posture and unsupported arms. Only 35.9% of the participants played games with their heads in neutral positions and arms supported.

Association between MSDs and perceived stress levels

There was no significant association between the perceived stress and the 12-month prevalence of MSDs in different body regions [Table 3].

Pain in the elbows in the past seven days was significantly associated with the levels of perceived stress (χ^2 = 20.15, P = 0.003) [Table 4].

Table 3: Association between the 12-month prevalence of MSDs and level of perceived stress (n=145).

Pain in the body region	Stress category			Chi-square	*P*-value
	Mild	Moderate	Severe		
Neck					
Yes	4	43	13	0.482	0.786
No	8	57	20		
Shoulders					
Yes	3	31	11	5.079	0.534
No	9	69	22		
Elbows					
Yes	0	13	5	3.653	0.724
No	12	87	28		
Wrists/hands					
Yes	5	14	7	9.604	0.142
No	7	86	26		
Upper back					
Yes	2	19	6	3.456	0.486
No	10	81	26		
Lower back					
Yes	5	30	7	1.957	0.376
No	7	70	26		
Hips thighs					
Yes	2	14	0	5.377	0.068
No	10	86	33		
Knees					
Yes	2	14	1	3.294	0.201
No	10	86	22		
Ankles feet					
Yes	2	11	1	2.544	0.280
No	10	89	32		

Yes or no responses mean the presence of MSDs in relation to different stress categories with Significance level at P<0.05. MSDs: Musculoskeletal disorders

Table 4: Association between 7-day prevalence of MSDs and levels of perceived stress (n=145).

Pain in the body region	Stress category			Chi-square	*P*-value
	Mild	Moderate	Severe		
Neck					
Yes	4	37	19	4.680	0.096
No	8	63	14		
Shoulders					
Yes	5	33	13	3.706	0.716
No	7	67	20		
Elbows					
Yes	4	15	8	20.215	0.003*
No	8	85	25		
Wrists/hands					
Yes	3	18	9	3.984	0.679
No	9	82	24		
Upper back					
Yes	2	22	10	1,288	0.525
No	10	78	23		
Lower back					
Yes	6	30	11	1.973	0.373
No	6	70	22		
Hips thighs					
Yes	9	92	29	3.484	0.175
No	3	8	4		
Knees					
Yes	2	13	4	0.163	0.922
No	10	87	29		
Ankles feet					
Yes	1	8	2	0.144	0.931
No	11	92	31		

Yes or no responses mean the presence of MSDs in relation to different stress categories. Significant values are highlighted. *Significance level at $P<0.05$.
MSDs: Musculoskeletal disorders

DISCUSSION

We hypothesized that there would be a high prevalence of MSDs among smartphone eSports athletes, and they would have high levels of perceived stress. We also hypothesized that faulty posture would be the risk factor for the ergonomic risk causing MSDs, and there is an association between the prevalence of MSDs and the level of perceived stress. Our findings revealed a high prevalence of MSDs and moderate-to-high levels of perceived stress among the athletes. We also discovered that the eSports players were using their phones in a faulty posture, leading to a high RULA score. However, we did not find any significant association between the 12-month prevalence of MSDs and perceived stress levels. Pain in the elbows in the past seven days was significantly associated with the levels of perceived stress ($\chi^2 = 20.15$, $P = 0.003$).

The results of our study were similar to a previous study conducted on smartphone eSports athletes, where neck pain was 40%, shoulder pain was 16%, and lower back pain was 20%.[8] In our study, neck pain was the most common, affecting 41.4% of individuals, followed by shoulder pain at 31% and lower back pain at 29%; research on typical smartphone users also found that neck discomfort was the most frequent condition, followed by shoulder pain and lower back pain, which aligns with our findings.[22] These results are well supported by the facts that prolonged usage of mobile phones or excessive gaming without breaks and maintaining improper posture can lead to MSDs in the neck and upper limb, and flexing the neck for a longer duration is associated with discomfort in the neck, shoulder, and upper limb.[8,23,24] Unlike a previous study on computer eSports competitors, where back discomfort was most common, our research on smartphone eSports athletes found neck pain to be the leading MSD. This difference might be due to several factors related to how smartphone and computer games are played. Smartphone gaming typically involves a hunched posture looking down at the screen, while computer games can be played with a more upright posture, depending on the setup. In addition, variations in gaming environments, like ergonomic chairs for computer players compared to less supportive seating for smartphone gamers, could also influence posture and contribute to the differing prevalence of MSDs.[8,25]

None of the participants in our study had a RULA grand score of 1 or 2, which means acceptable posture. However, 49 participants (33.8%) had an RULA score of 3 or 4, suggesting that their posture needed further investigation and potential changes. A higher percentage (61.4%) of the participants received a RULA score of 5 or 6, indicating severely poor posture that necessitates immediate adjustment to meet the players' demands. Our findings are consistent with those of a recent study by Namwongsa *et al.* on smartphone users, in which none of the participants had a RULA score of 1 or 2, and 80% had a RULA score of 6.[26] Literature has identified a correlation between the RULA grand score and neck MSDs, and smartphone users' poor posture puts them at significant risk of experiencing ergonomic problems.[26,27] Poor posture may be the reason for our study's high incidence of MSDs, especially in the neck. In our study, the average gaming duration per day was 8.14 ± 3.951 h, higher than university students' average use time of 7.5 h per day and overall smartphone usage of 4 h and 4.5 h per day.[28,29] Research has shown that extended and frequent use of cell phones and repetitive upper limb movements in an uncomfortable position are the primary variables contributing to MSDs.[15,23]

We found that 69% of the participants had moderate stress, 22.8% had severe stress, and 8.3% had low stress. Another similar study explored the perceived stressors and found that competitive eSports players and conventional sports athletes endure comparable stresses. ESports players have identified new stress factors, including technical problems, anti-social behavior, managing personal responsibilities, and performance at crucial moments. Highly skilled eSports athletes seem to have more stressors linked to performance, whereas less skilled eSports athletes tend to report more stressors related to their teammates.[30] Without an "off-season," eSports requires proficient fine motor coordination while managing a demanding cognitive workload, including attention, information processing, and visuospatial abilities. All these factors could be the reason for high-stress levels among eSports athletes.[31] In the present study, there was no significant association between perceived stress and the 12-month prevalence of MSDs. Still, the 7-day prevalence of pain in elbows was significantly associated with the levels of perceived stress. In contrast, other studies on different populations found a significant association between perceived stress and the incidence of MSDs.[32] We could not detect any correlation between the degree of stress and the presence of MSDs. This may be because most eSports athletes in our study experienced moderate stress levels. The other factor could be that the MSDs among eSports athletes were due to ergonomics risks and poor posture.

This was the first study conducted on smartphone eSports athletes in Pakistan. Our study revealed a significant occurrence of MSDs among smartphone eSports players, particularly in the neck, shoulders, and upper back, due to prolonged and incorrect body positioning. Athletes also encounter varying levels of gaming-related stress, which often does not have a direct association with the development of MSDs except for instances of elbow discomfort. The results indicate that coaches may use practical solutions such as implementing ergonomic training, encouraging frequent breaks, and introducing stress management approaches. Healthcare practitioners can do regular examinations and create specific rehabilitation regimens. ESports organizations may establish protocols for conducting ergonomic evaluations and ensuring health-care availability while advocating for healthy practices. Athletes can include self-care routines, such as engaging in stretching exercises and minimizing eye fatigue, to maintain a well-rounded way of life. These assessments may improve the well-being and performance of athletes and provide valuable insights for future research on their health issues.

Limitations

Still, the scope of our investigation was limited. We conducted a restricted analysis that focused just on 145 eSports competitors. We used an observational method, which hinders the capacity to establish causal linkages. The study used self-reported questionnaires to evaluate MSDs and perceived stress levels, which may introduce biases such as recall bias and the possibility of participants either underreporting or overreporting their MSDs.

CONCLUSION

There is a high prevalence of MSDs among smartphone eSports athletes, especially in the neck, shoulders, and upper back, mainly due to poor posture for extended periods. eSports athletes have moderate-to-high levels of perceived stress due to gaming-related factors. However, there is no significant association between the perceived stress levels and MSDs except for the pain in the elbows in the past seven days and stress levels. Muscle use and poor posture expose eSports athletes to ergonomic risk factors for MSDs. ESports athletes are exposed to various health risks, such as headaches, dry eyes, anxiety, loss of appetite, and sleep disturbances.

Recommendations

Future investigations should prioritize examining a more extensive and diverse group of eSports competitors. Utilizing experimental designs is necessary to promote the formation of cause-and-effect linkages. Integrating physical examinations with questionnaires to evaluate the occurrence of MSDs should help reduce biases linked to self-reporting. Using physiological approaches to assess stress levels in smartphone eSports players might provide more objective data.

ACKNOWLEDGMENTS

We thank everyone who participated in this study and the Chulalongkorn University Research Ethics Committee for permitting us to conduct it.

AUTHORS' CONTRIBUTIONS

MAK contributed to the design, literature search, clinical studies, and data acquisition. MC and MAK contributed to concepts, statistical analysis, and manuscript preparation and editing. Both authors have critically reviewed and approved the final draft and are responsible for the manuscript's content and similarity index.

ETHICAL APPROVAL

Before commencing our investigation, we secured ethical permission from the Research Ethics Review Committee at Chulalongkorn University for research involving human participants. The data collection was approved on October 3, 2023, under research title no. 660116. Participation of the subjects in our study was voluntary, and written consent was obtained from the participants before the study. All the ethical guidelines were followed.

DECLARATION OF PARTICIPANTS CONSENT

The authors certify that they have obtained all appropriate participant consent forms. In the form, the participants have given their consent for their images and other clinical information to be reported in the journal. The participants understand that their names and initials will not be published, and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

USE OF ARTIFICIAL INTELLIGENCE (AI)-ASSISTED TECHNOLOGY FOR MANUSCRIPT PREPARATION

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

CONFLICTS OF INTEREST

There are no conflicting relationships or activities.

FINANCIAL SUPPORT AND SPONSORSHIP

This study did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

REFERENCES

1. Mobile eSports - statistics and facts; 2024. Available from: https://www.statista.com/topics/8199/mobile-esports/#topicoverview [Last accessed on 2024 Apr 03].
2. Truong P, Truong L, Le T, Kuklova K. Orthopedic injuries from video games: A literature review and implications for the future. Int Arch Orthop Surg 2020;3:20.
3. These are the most popular eSports mobile games of 2021; 2022. Available from: https://www.phonearena.com/news/most-popular-esports-mobile-games_id138887 [Last accessed on 2024 Apr 03].
4. DiFrancisco-Donoghue J, Balentine J, Schmidt G, Zwibel H. Managing the health of the eSport athlete: An integrated health management model. BMJ Open Sport Exerc Med 2019;5:e000467.
5. Emara AK, Ng MK, Cruickshank JA, Kampert MW, Piuzzi NS, Schaffer JL, *et al*. Gamer's health guide: Optimizing performance, recognizing hazards, and promoting wellness in esports. Curr Sports Med Rep 2020;19:537-45.
6. Lewis J, Trinh P, Kirsh D, editors. A Corpus Analysis of Strategy Video Game Play in Starcraft: Brood War. Proceedings of the Annual Meeting of the Cognitive Science Society; 2011.
7. Yin K, Zi Y, Zhuang W, Gao Y, Tong Y, Song L, *et al*. Linking Esports to health risks and benefits: Current knowledge and future research needs. J Sport Health Sci 2020;9:485-8.
8. Lam WK, Liu RT, Chen B, Huang XZ, Yi J, Wong DW. Health risks and musculoskeletal problems of elite mobile esports players: A cross-sectional descriptive study. Sports Med Open 2022;8:65.
9. McGee C, Ho K. Tendinopathies in video gaming and esports. Front Sports Act Living 2021;3:689371.
10. Leis O, Lautenbach F, Birch PD, Elbe AM. Stressors, associated responses, and coping strategies in professional esports players: A qualitative study. Int J Esports 2022;3:3.
11. Kopec JA, Sayre EC. Work-related psychosocial factors and chronic pain: A prospective cohort study in Canadian workers. J Occup Environ Med 2004;46:1263-71.
12. Buscemi V, Chang WJ, Liston MB, McAuley JH, Schabrun S. The role of psychosocial stress in the development of chronic musculoskeletal pain disorders: Protocol for a systematic review and meta-analysis. Syst Rev 2017;6:224.
13. Tholl C, Bickmann P, Wechsler K, Froböse I, Grieben C. Musculoskeletal disorders in video gamers-a systematic review. BMC Musculoskelet Disord 2022;23:1-16.
14. Lam WK, Chen B, Liu RT, Cheung JC, Wong DW. Spine posture, mobility, and stability of top mobile esports athletes: A case series. Biology (Basel) 2022;11:737.
15. Crawford JO. The Nordic musculoskeletal questionnaire. Occup Med 2007;57:300-1.
16. Kuorinka I, Jonsson B, Kilbom A, Vinterberg H, Biering-Sørensen F, Andersson G, *et al*. Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. Appl Ergon 1987;18:233-7.
17. Dickinson CE, Campion K, Foster A, Newman SJ, O'Rourke AM, Thomas PG. Questionnaire development: An examination of the Nordic Musculoskeletal questionnaire. Appl Ergon 1992;23:197-201.
18. Cohen S, Kamarck T, Mermelstein R. A global measure of

perceived stress. J Health Soc Behav 1983;24:385-96.
19. Huang F, Wang H, Wang Z, Zhang J, Du W, Su C, *et al*. Psychometric properties of the perceived stress scale in a community sample of Chinese. BMC Psychiatry 2020;20:130.
20. Lee B, Jeong HI. Construct validity of the perceived stress scale (PSS-10) in a sample of early childhood teacher candidates. Psychiatry Clin Psychopharmacol 2019;29:76-82.
21. Valentim DP, de Oliveira Sato T, Comper ML, da Silva AM, Boas CV, Padula RS. Reliability, construct validity and interpretability of the Brazilian version of the Rapid Upper Limb Assessment (RULA) and Strain Index (SI). Braz J Phys Ther 2018;22:198-204.
22. Walankar PP, Kemkar M, Govekar A, Dhanwada A. Musculoskeletal pain and risk factors associated with smartphone use in university students. Indian J Occup Environ Med 2021;25:220.
23. Al-Hadidi F, Bsisu I, AlRyalat SA, Al-Zu'bi B, Bsisu R, Hamdan M, *et al*. Association between mobile phone use and neck pain in university students: A cross-sectional study using numeric rating scale for evaluation of neck pain. PLoS One 2019;14:e0217231.
24. Mustafaoglu R, Yasaci Z, Zirek E, Griffiths MD, Ozdincler AR. The relationship between smartphone addiction and musculoskeletal pain prevalence among young population: A cross-sectional study. Korean J Pain 2021;34:72-81.
25. Lindberg L, Nielsen SB, Damgaard M, Sloth OR, Rathleff MS, Straszek CL. Musculoskeletal pain is common in competitive gaming: A cross-sectional study among Danish esports athletes. BMJ Open Sport Exerc Med 2020;6:000799.
26. Namwongsa S, Puntumetakul R, Neubert MS, Chaiklieng S, Boucaut R. Ergonomic risk assessment of smartphone users using the Rapid Upper Limb Assessment (RULA) tool. PLoS One 2018;13:e0203394.
27. Kristanto A, Wati E, Bariyah C. The correlation between smartphone use and musculoskeletal symptom. J Curr Sci Technol 2023;13:326-38.
28. Jacquier-Bret J, Gorce P. Effect of day time on smartphone use posture and related musculoskeletal disorders risk: A survey among university students. BMC Musculoskelet Disord 2023;24:725.
29. Odole C, Olutoge DA, Awosoga O, Mbada CE, Fatoye C, Oyewole OO, *et al*. Musculoskeletal pain and postural abnormalities among smartphone-using digital natives. J Musculoskelet Disord Treat 2020;6:089.
30. Poulus D, Coulter T, Trotter M, Polman R. Perceived stressors experienced by competitive esports athletes. Int J Esports 2022;1:73.
31. Smith MJ, Birch PD, Bright D. Identifying stressors and coping strategies of elite esports competitors. Int J Gaming Computer Mediat Simul 2019;11:22-39.
32. De Almeida LB, Vieira ER, Zaia JE, de Oliveira Santos BM, Lourenço AR, Quemelo PR. Musculoskeletal disorders and stress among footwear industry workers. Work 2017;56: 67-73.