Journal of Pain Research

Dovepress
Taylor & Francis Group

Open Access Full Text Article

ORIGINAL RESEARCH

A Cross-Sectional Survey on Musculoskeletal Pain Among Professional and Non-Professional Gamers in Saudi Arabia: Associations with Gaming Genre, Duration, and Ergonomic Factors

Samiah Alqabbani[1], Reema Fahad Alhussaini[1], Shumukh Abdullah Alsaedan[1], Manar Khalid Alfaqi[1], Reema I Almudaifer[1], Najd Mohammed Zain Aldeen[1], Hanan A Alsaeed[1], Maha F Algabbani[2], Wafa Alahmari[1], Afrah Almuwais[1], Madawi Alotaibi[1]

[1]Department of Rehabilitation Sciences, College of Health and Rehabilitation Sciences, Princess Nourah Bint Abdulrahman University, Riyadh, Saudi Arabia; [2]Department of Rehabilitation Health Sciences, College of Applied Medical Sciences, King Saud University, Riyadh, Saudi Arabia

Correspondence: Wafa Alahmari, Department of Rehabilitation Sciences, College of Health and Rehabilitation Sciences, Princess Nourah Bint Abdulrahman University, P.O. Box 84428, Riyadh, 11671, Saudi Arabia, Email Wsalahmari@pnu.edu.sa

Purpose: Musculoskeletal (MSK) discomfort is a common concern among gamers globally, with prevalence estimates of 60–80%. Risk factors include prolonged sitting, awkward postures, repetitive hand use, and inadequate hardware setups. This study aimed to examine the prevalence and association of MSK pain with game genre, device type, and gaming duration among gamers in Saudi Arabia, with a focus on comparing professional and non-professional gamers.

Methods: A cross-sectional survey of 593 Saudi gamers aged 18 years and older was conducted from February to April 2024 using the Extended Nordic Musculoskeletal Questionnaire. Demographic and gaming-related variables were analyzed using chi-square tests and logistic regression to examine associations with MSK pain.

Results: MSK pain was reported by 78.2% (neck 49.4%, lower back 40.0%). Pain was associated with gender, age, and genre. Females had higher odds of neck (OR 2.08) and shoulder pain (OR 2.43); puzzle with shoulder pain (OR 2.46); VR with lower neck odds (OR 0.36). Longer duration increased discomfort. Non-professionals more often reported neck/shoulder/lower-back pain; professionals more wrist/hand pain.

Conclusion: MSK pain is highly prevalent among Saudi gamers and is associated with personal factors (eg, gender, age) as well as gaming genre. Competitive status may be associated with specific pain patterns, but ergonomic risk factors appear to be appear broadly relevant. Implementing targeted interventions that focus on posture, education, and proper gaming ergonomics may be warranted to help alleviate the MSK burden in this population.

Keywords: gaming pain, MSK disorders, esports, neck/back pain, ergonomics, Saudi Arabia

Introduction

Over the past five decades, the electronic gaming industry has rapidly expanded, becoming a significant cultural and economic force worldwide. Since the launch of early consoles like the Atari 2600 in 1977, gaming has transformed into a pervasive form of entertainment and competition.[1] However, alongside these advancements, concerns about potential negative health outcomes—particularly regarding musculoskeletal (MSK) health—have emerged. Increasing evidence suggests that prolonged gaming sessions, combined with poor ergonomics and sedentary behavior, are associated with a high burden of MSK pain across ages and levels of play.[2]

Consistent with this, a recent review found that most studies identify gaming as associated with MSK complaints.[3] International data likewise show high rates of 77.8% MSK pain in gamers.[4] In line with the global picture, in Saudi Arabia, a recent survey reported MSK pain in 86.2% of competitive gamers.[5]

https://doi.org/10.2147/JPR.S557124
Received: 30 July 2025
Accepted: 4 February 2026
Published: 24 February 2026

Gamers commonly experience MSK pain in the neck, lower back, shoulders, upper back, and wrists/hands. This pain is associated with prolonged static postures such as forward-head posture, repetitive movements like mouse clicks and keystrokes, and poor ergonomics related to monitor and desk height, which can aggravate the risk of strain and injury.[6] Additionally, personal characteristics such as gender and age seem to influence susceptibility to MSK pain. Female gamers, for instance, tend to report higher pain rates, potentially due to biological, psychosocial, and ergonomic factors.[5,7] Moreover, extended gaming duration has been linked to increased MSK pain in both genders.[8,9] Age and lifestyle factors, such as sedentary behaviors common among older adults and individuals in advanced educational or occupational roles, may further exacerbate the risk of MSK pain.[2,10]

In addition to personal factors, specific gaming-related variables also play a critical role in the development of MSK pain. For instance, a recent study of smartphone-based play-to-earn gamers showed high rates of MSK disorders, suggesting that both the gaming platform and purpose can influence risk.[11] Competitive status may affect MSK pain risk, with professional gamers experiencing greater strain due to longer and more structured training routines.[5] In contrast, non-professional gamers typically have lower exposure. Studies highlight that structured training in esports increases MSK risk, supporting the need to assess differences between gamer subgroups to develop tailored ergonomic and preventive strategies.[8] Moreover, device type has emerged as a key determinant, with desktop and laptop users frequently reporting lower back pain, while smartphone and tablet users more commonly experience neck and shoulder discomfort due to poor posture.[3] Virtual reality (VR) gaming also presents unique ergonomic challenges; prolonged standing and repetitive head and neck movements in VR environments have been linked to higher rates of lower back and neck pain.[12,13] When considering game genres, certain types—such as puzzle games—may contribute to localized MSK discomfort due to prolonged fine motor engagement and static posture requirements.[14] Such genres often require sustained hand positioning or mouse use, which can stress specific muscle groups and joints.Recent literature highlights how repetitive fine motor activities, particularly in puzzle games, can lead to tendinopathy and localized pain. In contrast, motion-controlled and sports-racing games have been associated with shoulder and upper limb strain due to their repetitive and forceful movement demands.[15]

Given the growing popularity of gaming and accumulating evidence of its potential health impacts, a more detailed understanding of MSK pain contributors among gamers is warranted. Previous research has largely focused on isolated factors and specific populations,[5,8,10] leaving gaps in our understanding of how personal characteristics and gaming habits interact to affect MSK outcomes. This issue is particularly relevant in Saudi Arabia, where gaming has expanded rapidly and national policy has made esports a strategic priority; growth and governance are being actively steered to position the Kingdom as a global hub,[16] yet the health implications remain under-investigated. To address this gap, the current study investigated the prevalence and locations of MSK pain among Saudi gamers and examined its predictors, focusing on how demographic and gaming-related variables—such as game genre, device type, gaming duration, and professional gaming status—contributed to pain outcomes. We hypothesized that certain variables, particularly professional gaming status and specific game genres, would significantly predict higher MSK pain prevalence due to prolonged exposure, repetitive movements, and inadequate ergonomic conditions. We further hypothesized that the neck and upper limbs would demonstrate greater pain prevalence compared to other body regions, given their continuous involvement in common gaming activities.

Materials and Methods

Research Design and Sampling

This analytic cross-sectional descriptive study was carried out using a self-administered web-based questionnaire designed with Microsoft Forms between February and April 2024. The study included adult gamers (≥18 years) in Saudi Arabia, both professional and recreational gamers of all genders. Individuals with a history of fractures in the past six months, pre-existing medical conditions, surgical history, physical disabilities, or cognitive impairments were excluded from the study.

Professional gamers were defined as individuals officially registered with the Saudi Esports Federation who compete for awards and monetary prizes. While non-professional gamers participated in gaming purely for leisure without any formal competitive affiliation.

A non-probability convenience sampling method was employed, and the required sample size was determined to be 384 participants based on OpenEpi, ensuring a 5% margin of error at a 95% confidence level.

Participants were invited through Email and WhatsApp. Professional gamers were contacted using information obtained from the Saudi Esports Federation (SEF) registry, while non-professional gamers were invited through the dissemination of the questionnaire via social media platforms.

Data Collection Tool

Data were collected through an online questionnaire comprising two primary components. The first component centered on demographic information and gaming characteristics. Participants provided background data such as age, gender, education level, occupation, and marital status. The frequency of electronic gaming per week, average daily gaming time, registration with the SEF, participation in local or national tournaments, the types or genres of electronic games played, and the devices used for gaming (eg, smartphones, consoles, or PCs). To ensure content validity, the survey was reviewed by three experts in musculoskeletal health and gaming behavior and piloted with five participants to assess clarity, flow, and the functionality of branching logic. Professional gamers reported both competitive and recreational game genres to reflect their full range of gaming activity.

The second component of the questionnaire featured the Extended Nordic Musculoskeletal Questionnaire (NMQ-E), utilized to assess MSK pain. The Arabic version of the NMQ-E was employed in this study, with prior permission obtained from the original authors.[17] The NMQ-E assessed musculoskeletal pain across nine anatomical regions: neck, upper back, lower back, shoulder, elbow, hand/wrist, hip, knee, and ankle/foot.[18] A body map diagram was included to assist participants in accurately identifying pain locations. The questionnaire measured pain prevalence at four points in time: lifetime, annual, monthly, and point prevalence, while also examining the consequences of pain, such as interference with work, healthcare visits, medication use, absenteeism, and hospitalization. Response options were binary ("yes" or "no"). The NMQ-E has demonstrated robust reliability and validity in evaluating musculoskeletal symptoms and their consequences.[18] The Arabic version has also shown strong content and construct validity, along with high test-retest reliability.[18] Furthermore, lifetime prevalence responses were numerically coded (1 for "Yes," 0 for "No") to compute a total score that reflects the number of painful body sites.

Statistical Analysis

Statistical analysis was conducted using SPSS software (version 27.0). Descriptive results are presented as means ± standard deviation (SD) and in percentages. For the association analysis, body regions with a prevalence of MSK pain of 20% or higher—specifically the neck, upper back, lower back, shoulders, and wrists/hands—were selected for further examination. The associations among categorical variables, including gender, device type, prize gains, and types of games played, were evaluated using Pearson's chi-square test (X^2). The effect size was measured using Cramér's V Phi coefficient (φ) for categorical associations and interpreted according to established guidelines. Where associations were identified, odds ratios (OR) with 95% confidence intervals (CI) were calculated. Eta was used to assess the relationship between categorical and interval variables, with interpretation based on conventional cutoffs reported in the literature.[19] Binary logistic regression analysis was conducted to determine the predictive value of the selected demographic and gaming-related factors on MSK pain outcomes, adjusting for potential confounders. Three models were conducted for each body region: Model 1 (unadjusted) analyzed each predictor individually without covariate adjustment; Model 2 (age- and gender-adjusted) included only age and gender as predictors to assess their independent effects; and Model 3 (fully adjusted) simultaneously included all predictors—age, gender, gaming exposure, device type, and game genres—within a multivariable model. In these models, age was treated as a continuous variable, and gender was entered as a binary categorical variable (male = 0, female = 1). Relevant demographic and gaming-related variables were entered into the multivariable regression model to examine their associations with musculoskeletal pain. A subgroup comparison between professional and non-professional male gamers was conducted to account for gender confounding, as all

professional gamers in the sample were male and gender was identified as a significant predictor of MSK pain. The significance level was set at a p-value of <0.05.

Ethical Considerations

This study complies with the Declaration of Helsinki. All participants provided informed consent at the start of the survey, ensuring confidentiality and security. The study received ethical approval from the Institutional Review Board at Princess Nourah Bint Abdulrahman University, which was granted (IRB: 24–0490).

Results

In this study, a total of 641 individuals were approached, with 593 participants included in the analysis. The remaining 48 respondents were excluded for various reasons: 14 chose not to participate, 9 were disqualified due to age, 15 had a history of musculoskeletal injuries in the past six months, 7 had undergone recent surgeries, and 3 did not engage in electronic gaming (Figure 1).

Demographics

The current study involved 593 participants, the majority of whom were male (71.3%), with an average age of 25.70± (8.980) years. Most participants primarily resided in the Central Region (65.3%). As illustrated in Table 1, a significant portion of the participants held a bachelor's degree (67.8%), with half identifying as students (50.4%), and a large majority being single (80.8%).

The study also explored the characteristics of the gamers. Among the participants, 43.7% reported involvement in local or national tournaments, while 30.9% indicated they had won prizes. Additionally, 37.4% were registered with the Saudi Esports Federation as members of a team. When it came to preferred gaming devices, most players (33.4%) used personal computers. In terms of input devices, a substantial number of gamers (55.3%) favored controllers. Notably, 58.2% of players reported gaming for more than four hours each day, with the average gaming duration among participants being 4.83±2.07 hours. Moreover, First Person Shooters (FPS) are the most popular genre (65.1%). This is followed by Competitive (33.7%) and Sports/Racing (33.1%). Role-Playing Games (RPGs) and Card/Board also show notable popularity (28.3% and 28.2%, respectively). (Table 1).

Prevalence and Consequences of Musculoskeletal Pain

The majority of study participants reported experiencing MSK pain in at least one body region, specifically 78.2%, with a higher prevalence observed among females (86.47%) compared to males (74.95%). The most frequently affected areas of MSK pain over a lifetime included the neck (49.4%), lower back (40.0%), shoulder (29.7%), upper back (25.3%), and

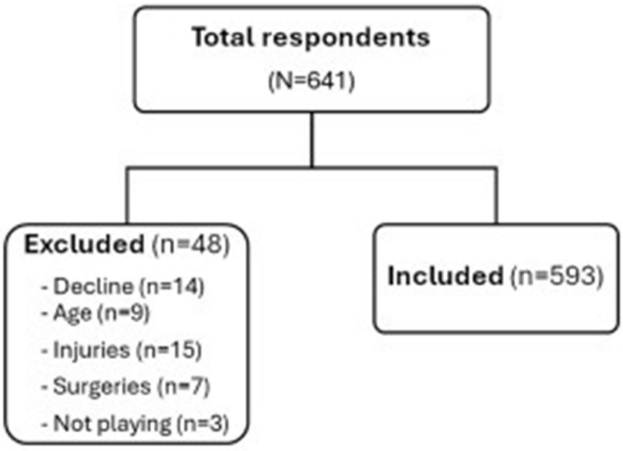

Figure 1 Flow Chart of Inclusion and Exclusion of the Study.

Table 1 Demographics and Gaming Behavior

Player Characteristic	Variable	Frequency	Percent (%)
Gender	Female	170	28.7
	Male	423	71.3
Educational Level	High School	156	26.3
	Bachelor's Degree	402	67.8
	Master's Degree	23	3.8
	PhD	5	0.8
	Other	7	1.1
Employment Status	Employed	183	30.9
	Un-Employed	97	16.4
	Student	299	50.4
	Retired	14	2.4
Hours of Playing/Day	1-2 hours	145	58.2
	3-4 hours	202	34.1
	5-6 hours	151	25.5
	8-7 hours	54	9.1
	<8	43	7.3
Player Characteristics	Variable	Mean	SD
	Days of Playing/Week	4.83	2.074
	Total Hours Played/Week	25.70	18.005
Player Characteristics	Professional Gamers	222	37.4
	Prize-gained players	183	30.9
	Participated in local or international tournaments	259	43.7
Genres played	Virtual Reality	48	8.1
	RPG	167	28.3
	MMO	60	10.1
	Sports/Racing	196	33.1
	Card/Board Games	167	28.2
	Puzzle	141	23.8
	Platformer	75	12.6
	Simulation	75	12.6
	Competitive Games	200	33.7
	Strategy	68	11.5

(*Continued*)

https://doi.org/10.2147/JPR.S557124

Table 1 (Continued).

Player Characteristic	Variable	Frequency	Percent (%)
	Fighting	101	17.0
	First Person Shooter	386	65.1
Most Used Device	PlayStation	185	31.2
	Tablet	11	2.0
	Smartphone	164	27.8
	Laptop	30	4.9
	Desktop	198	33.4
	Other	4	0.8
Playing Exposure	**Variable**	**Mean**	**SD**
	Days of Playing/Week	4.83	2.074
	Total Hours Played/Week	25.70	18.005

hand/wrist (24.5%). The neck also had the longest duration of reported pain, averaging 4.6 years, followed closely by the shoulder and lower back, both with an average duration of 4.4 years (Table 2). Participants reported a range of affected body regions due to MSK pain, varying from one to nine, with the majority experiencing pain in either one (22.3%) or two (18.5%) regions.

Table 3 illustrates the impact of MSK pain among participants. While hospitalization rates due to musculoskeletal pain were relatively low, knee pain was the most frequently reported at 8.8%, followed closely by elbow pain at 8.3%. The effect of musculoskeletal pain on activity and participation was particularly significant for ankle and foot pain (52.3%), followed by knee pain (49.5%) and neck pain (43.9%). Additionally, the interference of pain with daily living activities was notably reported for neck pain (33.9%), knee pain (30.1%), and ankle/foot pain (29.2%). Visits to healthcare practitioners (HCPs) due to MSK pain were predominantly associated with ankle/foot issues (29.2%), neck

Table 2 Prevalence of Musculoskeletal Pain by Period for Each Region

	Lifetime N (%)	Annual N (%)	Month N (%)	Point N (%)	Average Time from Involvement (Years) Mean (SD)
Neck	239 (49.4)	220 (92.0)	151 (63.1)	81 (33.9)	4.6 (4.5)
Shoulder	176 (29.7)	105 (59.6)	77 (43.7)	39 (22.1)	4.4 (4.7)
Upper Back	150 (25.3)	104 (69.3)	80 (53.3)	48 (32.0)	3.5 (3.1)
Elbows	36 (6.1)	24 (66.6)	18 (50.0)	8 (22.2)	2.7 (3.3)
Wrist/hands	145 (24.5)	88 (60.6)	51 (35.1)	27 (18.6)	3.7 (3.7)
Low Back	237 (40.0)	154 (64.9)	112 (47.2)	54 (22.7)	4.4 (4.7)
Hips/thighs	35 (5.9)	26 (74.2)	17 (48.5)	8 (22.8)	3.8 (5.1)
Knees	113 (19.1)	82 (72.5)	54 (47.7)	31 (27.4)	4.1 (4.9)
Ankle/feet	65 (11.0)	46 (70.7)	34 (52.3)	22 (33.8)	4.2 (5.1)

Table 3 Prevalence of Musculoskeletal Pain Consequences for Each Region

	Hospitalization N (%)	Activity/Participation N (%)	Activity of Daily Living N (%)	Visit HCP N (%)	Medications N (%)
Neck (n=239)	8 (3.3)	105 (43.9)	81 (33.9)	57 (23.8)	64 (26.7)
Shoulder (n=176)	6 (3.4)	57 (32.4)	39 (22.1)	27 (15.3)	28 (15.9)
Upper Back (n=150)	3 (2.0)	63 (42.0)	47 (31.3)	27 (18.0)	26 (17.3)
Elbows (n=36)	3 (8.3)	13 (36.1)	8 (22.2)	6 (16.6)	6 (16.6)
Wrists/hands (n=145)	6 (4.1)	62 (42.7)	33 (22.7)	17 (11.7)	19 (13.1)
Lower Back (n=237)	12 (5.0)	103 (43.4)	64 (27.0)	40 (16.8)	44 (18.5)
Hips/thighs (n=35)	1 (2.8)	15 (42.8)	6 (17.1)	6 (17.1)	9 (25.7)
Knees (n=113)	10 (8.8)	56 (49.5)	34 (30.1)	23 (20.3)	26 (23.0)
Ankles/feet (n=65)	3 (4.6)	34 (52.3)	19 (29.2)	19 (29.2)	19 (29.2)

problems (23.8%), and knee pain (20.3%). Furthermore, the need for medication to manage MSK pain was most linked to ankle/foot pain (29.2%), neck pain (26.7%), and hip pain (25.7%).

The Association Between Musculoskeletal Pain and Personal or Gaming Factors

Correlation analysis between pain location and participant demographics uncovered several statistically significant associations (Table 4).

Gender was significantly associated with MSK pain. For neck pain, a significant association and large effect size was observed (χ^2=15.973, df=1, p<0.001, V=0.16); with males had lower odds (OR = 0.478, 95% CI [0.332, 0.689]). A similar pattern was observed for wrist/hand pain, with a significant association (χ^2=12.053, df=1, p=0.001; V=0.14). Males had lower odds of experiencing wrist/hand pain (OR=0.500, 95% CI 0.337–0.724). Additionally, shoulder pain showed a significant association with sex and a moderate effect size, with females more likely than males to report shoulder pain (χ^2=39.317, df=1, p<0.002; V=0.13).

When evaluating the impact of age on MSK pain, the results indicate a moderate relationship between age and pain in the shoulder and lower back, with Eta values of 0.374 and 0.313, respectively. A weak-to-moderate relationship was

Table 4 Association of Pain Location and Sample Characteristics

Variables	N	Gender			Device Type			Prize Wins		
TEST		X^2	Df	*P*	X^2	*Df*	*P*	X^2	*Df*	*P*
Neck pain	N=293	15.973	1	<0.001*	6.822	4	0.146	9.595	1	0.002*
Shoulder pain	N=176	39.317	1	<0.001*	23.349	4	0.001*	22.386	1	<0.001*
Wrist/Hand pain	N=145	12.053	1	0.001*	4.894	4	0.0298*	0.453	1	0.501
Upper limb pain	N=150	0.392	1	0.531	2.107	4	0.716	2.223	1	0.136
Lower back pain	N=237	10.000	1	0.002*	1.089	4	0.896	0.870	1	0.351
Back pain	N=311	7.285	5	0.007*	2.731	5	0.741	3.153	1	0.076
Pain in the neck and upper limbs	N=438	51.803	1	<0.001*	10.921	5	0.053*	6.709	1	0.010*

Notes: N = number of participants, X2 = Pearson's chi-squared; *df* = degrees of freedom. P= Level of significance, * significant α<0.05.

https://doi.org/10.2147/JPR.S557124

identified between age and neck pain, reflected by an Eta value of 0.291. Furthermore, a relatively weak relationship was noted between age and pain in the upper back, hands, upper limbs, and back, with Eta values of 0.235, 0.264, 0.254, and 0.268, respectively.

In addition, significant associations were found between MSK pain and gaming-related variables. The type of device used was associated with shoulder pain ($X^2 = 22.386$, df = 1, p <0.001, V = 0.19). Prizes won demonstrated a moderate association with neck pain ($X^2 = 9.959$, df = 1, p =0.002, V = 0.13) and a strong association with shoulder pain ($X^2 = 22.386$, df = 1, p <0.001, V = 0.19). Moreover, neck and upper limb pain exhibited a moderate correlation with prizes won ($X^2 = 6.709$, df = 1, p =0.010, V = 0.10).

To investigate the association between daily gaming hours and pain experienced in different body regions, Eta values were computed to evaluate the strength of these relationships. The findings indicated various levels of correlation, with the strongest associations identified for wrist and hand pain, as well as combined neck and upper limb pain, both showing an Eta value of 0.396. In contrast, lower back and shoulder pain demonstrated weaker correlations.

The Association Between Musculoskeletal Pain and Game Type/Genre

The correlation analysis examining the relationship between pain location and game type uncovered several significant findings. Puzzle games were notably linked to various pain regions, with the exception of wrist and hand pain. In contrast, sports and racing games displayed significant correlations with pain in the shoulder and upper back. However, no significant associations were identified between any pain regions and virtual reality (VR), role-playing games (RPG), massively multiplayer online (MMO), or competitive game types (Table 5).

Table 5 Associations Between Pain Location and Game Type/Genre Played

Variables	Neck Pain N=239			Shoulder Pain N=176			Wrist/Hand Pain N=145			Upper Back Pain N=150			Lower Back Pain N=237		
Test	X^2	Df	*P*	X^2	*Df*	*P*	X^2	*Df*	*P*	X^2	*Df*	*P*	X^2	*Df*	*P*
Virtual reality	2.964	1	0.085	0.169	1	0.681	0.067	1	0.796	1.184	1	0.277	0.749	1	0.387
Role-playing game	2.686	1	0.101	0.138	1	0.710	0.748	1	0.387	1.332	1	0.249	0.282	1	0.595
Strategy	1.287	1	0.257	1.392	1	0.238	6.693	1	<0.010*	0.004	1	0.953	0.230	1	0.631
Simulation	8.709	1	<0.003*	2.410	1	0.121	0.228	1	0.633	0.085	1	0.770	4.097	1	<0.043*
Sports-racing	0.527	1	0.468	6.335	1	<0.012*	0.000	1	0.988	4.380	1	<0.036*	1.411	1	0.235
Puzzle	15.388	1	<0.001*	26.005	1	<0.001*	0.117	1	0.733	4.290	1	<0.038*	16.533	1	<0.001*
First-person -shooter	1.341	1	0.247	15.036	1	<0.001*	1.758	1	0.185	5.069	1	<0.024*	1.635	1	0.201
Platform	0.949	1	0.330	2.410	1	0.121	0.921	1	0.337	3.990	1	<0.046*	1.031	1	0.310
Fighting	0.801	1	0.371	4.607	1	<0.032*	0.705	1	0.401	1.877	1	0.171	3.708	1	0.054
Massive multiplayer online game	0.009	1	0.923	0.058	1	0.810	0.011	1	0.917	1.434	1	0.231	0.315	1	0.574
Cardboard	3.000	1	0.083	5.222	1	<0.022*	0.061	1	0.805	2.014	1	0.156	9.181	1	<0.002*
Competitive	0.001	1	0.975	1.958	1	0.162	0.685	1	0.408	0.464	1	0.496	0.296	1	0.586

Notes: N = number of participants, X2 = Pearson's chi-squared; *df* = degrees of freedom. P= Level of significance α<0.05; * significant at α<0.05.

Regression Analysis

Binary logistic regression identified predictors of MSK pain across five regions. In unadjusted Model 1 analyses, female sex was associated with higher odds of neck, shoulder, wrist/hand, and lower-back pain, while age showed region-specific effects.

In the age- and gender-adjusted models (Model 2), female gender remained significantly associated with pain in the neck (OR = 2.06, 95% CI: 1.43–2.98, $p < 0.001$), shoulder (OR = 3.23, 95% CI: 2.18–4.77, $p < 0.001$), wrist/hand (OR = 2.02, 95% CI: 1.36–3.00, $p < 0.001$), and lower back (OR = 1.75, 95% CI: 1.22–2.51, $p = 0.003$). Gender was not significantly associated with upper back pain ($p = 0.544$). Age was a significant predictor of shoulder pain (OR = 1.06, 95% CI: 1.04–1.08, $p < 0.001$), and a borderline association was observed for lower back pain (OR = 1.02, 95% CI: 1.00–1.04, $p = 0.051$). No significant association was found between age and pain in the neck, upper back, or wrist/hand regions. Model 2 results are presented in Table 6.

In the fully adjusted models (Model 3), which included all demographic variables, gaming exposure, and game genres, gender and age remained significantly associated with MSK pain in several regions. Female participants had higher odds of reporting pain in the neck (OR = 2.080, $p = 0.002$), shoulders (OR = 2.426, $p < 0.001$), upper back (OR = 2.426, $p = 0.001$), and lower back (OR = 1.787, $p = 0.014$) compared to males. Increasing age was also associated with higher odds of pain in the shoulders (OR = 1.047, $p < 0.001$). No significant associations were found between device type (eg, laptop, PlayStation), tool used (eg, keyboard/mouse, touch), or average gaming hours per day and pain in any of the examined regions.

Several game genres were significantly associated with MSK pain. Puzzle games were a consistent predictor, associated with increased odds of pain in the neck (OR = 1.189, $p = 0.008$), shoulders (OR = 2.459, $p < 0.001$), and lower back (OR = 1.839, $p = 0.009$). Participants who frequently played first-person shooter (FPS) games had higher odds of reporting wrist and hand pain (OR = 1.920, $p = 0.010$). Likewise, sports/racing games were significantly associated with both upper back pain (OR = 1.627, $p = 0.026$) and lower back pain (OR = 1.532, $p = 0.035$). Conversely, engagement with fighting games was associated with lower odds of pain in the shoulders (OR = 0.441, $p = 0.010$). Notably, VR games were associated with a reduced likelihood of neck pain (OR = 0.364, $p = 0.004$), potentially reflecting different physical demands compared to sedentary gaming styles. Other genres such as strategy, simulation, role-playing, MMO, and platformers did not show significant associations with pain in any region (Table 7).

Table 6 Age- and Gender-Adjusted Logistic Regression Results for Predictors of Musculoskeletal Pain Across Body Regions

Body Region	Predictor	B	OR	95% CI	p-value
Neck	Female gender	0.72	2.06	1.43–2.98	<0.001
	Age	0.01	1.01	0.99–1.03	0.19
Shoulder	Female gender	1.17	3.23	2.18–4.77	<0.001
	Age	0.05	1.06	1.04–1.08	<0.001
Upper Back	Female gender	0.13	1.13	0.76–1.70	0.544
	Age	0.00	1.00	0.98–1.02	0.805
Wrist/Hand	Female gender	0.70	2.02	1.36–3.00	<0.001
	Age	−0.01	0.99	0.97–1.02	0.599
Lower Back	Female gender	0.56	1.75	1.22–2.51	0.003
	Age	0.02	1.02	1.00–1.04	0.051

https://doi.org/10.2147/JPR.S557124

Table 7 Binary Logistic Regression Models for Predictors of Gamers' Musculoskeletal Pain

Neck Pain N=239					**Shoulder Pain N=176**				
Predictor	**B**	**P**	**OR**	**95% (CI)**	**Predictor**	**B**	**P**	**OR**	**95% (CI)**
Age in Years	0.019	0.101	1.02	0.10–1.04	**Age in Years**	0.046	<0.001	1.047	1.020–1.073
Female Gender*	0.732	0.002	2.080	1.302–3.321	**Female Gender***	0.886	0.001	2.426	1.468–4.009
VR	−1.011	0.004	0.364	0.182–0.728	**VR**	−0.488	0.203	0.614	0.290–1.300
Puzzle	0.636	0.008	1.189	1.184–3.016	**Puzzle**	0.900	<0.001	2.459	1.495–4.046
Fighting	−0.026	0.919	0.974	0.586–1.618	**Fighting**	−0.818	0.010	0.441	0.237–0.822
Simulation	0.610	0.051	1.840	0.997–3.397	**Simulation**	0.303	0.360	1.354	0.707–2.593
FPS	−0.062	0.769	0.940	0.621–1.423	**FPS**	0.026	0.915	1.026	0.642–1.641
Sport racing	0.286	0.148	1.330	0.903–1.959	**Sport Racing**	−0.162	0.487	0.850	0.538–1.344
Upper Back Pain N=150					**Lower Back Pain N=237**				
Predictor	**B**	**P**	**OR**	**95% (CI)**	**Predictor**	**B**	**P**	**OR**	**95% (CI)**
Age in Years	0.014	0.267	1.015	0.989–1.041	**Age in Years**	0.020	0.091	1.020	0.997–1.043
Female Gender*	0.275	0.295	1.317	0.787–2.202	**Female Gender***	0.580	0.014	1.787	1.123–2.843
VR	−0.635	0.131	0.530	0.232–1.209	**VR**	−0.013	0.968	0.987	0.512–1.901
Puzzle	0.424	0.098	1.529	0.924–2.528	**Puzzle**	0.609	0.009	1.839	1.165–2.901
Fighting	0.008	0.978	1.008	0.578–1.758	**Fighting**	0.294	0.255	1.341	0.809–2.223
Simulation	−0.041	0.904	0.960	0.494–1.866	**Simulation**	0.260	0.383	1.297	0.723–2.326
FPS	0.594	0.018	1.811	1.108–2.958	**FPS**	−0.004	0.948	0.966	0.655–1.514
Sport Racing	0.487	0.026	1.627	1.059–2.500	**Sport Racing**	0.426	0.035	1.532	1.032–2.274
Wrist and Hand Pain N= 145									
Predictor	**B**	**P**	**OR**	**95% (CI)**					
Age in Years	0.012	0.351	1.013	0.986–1.040					
Female Gender*	0.927	<0.001	2.528	1.502–4.253					
VR	0.013	0.973	1.013	0.464–2.213					
Puzzle	0.164	0.542	1.178	0.696–1.994					
Fighting	0.157	0.593	1.169	0.659–2.076					
Simulation	0.290	0.400	1.336	0.681–2.662					
FPS	0.652	0.010	1.920	1.67–3.159					
Sport Racing	0.086	0.710	1.090	0.694–1.711					

Notes: *(Reference Category Males). B= beta; CI= confidence interval; OR = Odds Ratio; P = Level of significance; α<0.05; VR= Virtual Reality; FPS = first-person shooter.

Comparison of Pain Locations and Consequences Between Professional and Non-Professional Male Gamers

Table 8 compares the prevalence of MSK pain between professional and non-professional gamers across various body regions. The statistical analysis showed no significant differences between the two groups regarding the number of pain sites or specific pain locations. A chi-square test was utilized to compare the prevalence of MSK pain in five key body regions. Among these areas, upper back pain revealed no statistically significant difference between professional and non-professional male gamers ($X^2 = 0.656$, df = 1, p =0.418), with a negligible effect size (φ = 0.04) and similar odds of experiencing pain (OR = 0.871, 95% CI [0.624, 1.216]).

In contrast, significant associations were noted in the other body regions assessed. Neck pain was found to be more prevalent among non-professional gamers than their professional counterparts ($X^2 = 5.666$, df = 1, p =0.017), with a small effect size (φ = 0.12) and lower odds for professionals (OR = 0.771, 95% CI [0.524, 1.136]). A similar trend was identified for shoulder pain, which was significantly higher in non-professional gamers ($X^2 = 8.343$, df = 1, p =0.004) and demonstrated a moderate effect size (φ = 0.14). Professionals exhibited lower odds of experiencing shoulder pain (OR = 0.588, 95% CI [0.377, 0.916]). Additionally, lower back pain was less prevalent among professionals compared to non-professionals, with a significant difference ($X^2 = 6.718$, df = 1, p =0.010), a small effect size (φ = 0.13), and reduced odds of pain (OR = 0.714, 95% CI [0.552, 0.923]). Conversely, wrist and hand pain was significantly more common among professional gamers ($X^2 = 4.036$, df = 1, p =0.045), with a small effect size (φ = 0.10) and increased odds of experiencing pain compared to non-professionals (OR = 1.482, 95% CI [1.004, 2.186]).

Discussion

This study explored the prevalence and predictors of MSK pain among gamers, with particular attention to pain locations and how demographic and gaming-related factors contributed to these outcomes. A majority of participants reported experiencing MSK pain in at least one area of their body, with the neck, lower back, shoulders, upper back, and wrists/hands being the most commonly affected regions. Neck pain was identified as the most disruptive to daily activities, followed by lower back and wrist/hand pain—areas that are crucial for mobility and everyday tasks. Although hospitalizations were relatively rare, they were most frequently associated with lower back pain, followed by neck and shoulder pain. Interestingly, professional gamers were significantly less likely to report neck, shoulder, and lower back pain, although wrist/hand pain was more prevalent in this group. No significant differences were observed between groups for upper back pain.

Many gamers reported seeking healthcare services and using medications, indicating the chronic nature of pain in some cases. However, it is important to note that literature specifically investigating hospitalization, healthcare visits, and medication use in gamers is still scarce. In this study, gender, age, and certain game genres emerged as significant predictors of MSK pain.[5]

Table 8 Comparison Between Professional and Non-Professional Gamers

	Professional Gamers n=222 Percent (Number)	**Non-Professional Gamers n= 201% (Number)**	**X^2**	**P**
		Percent (Number)		
Neck	46.0% (86)	54.0% (101)	5.666	0.017
Shoulder	39.4% (37)	60.6% (57)	8.343	0.004
Wrist/Hand	62.1% (54)	37.9% (33)	4.036	0.045
Upper Back	49.0% (51)	51.0% (53)	0.656	0.418
Lower Back	44.1% (67)	55.9% (85)	6.718	0.010

Notes: X^2 = Pearson's chi-squared; P= Level of significance, α<0.05.

Gender emerged as a consistent risk factor, with female gamers significantly more likely to report pain in the neck, shoulders, upper back, and lower back. These findings align with broader literature noting gender-related differences in MSK pain, potentially influenced by physiological, ergonomic, or hormonal factors. This pattern is supported by Wijnhoven et al (2006), who linked higher MSK pain prevalence in females to hormonal, physiological, and psychosocial factors.[20] Similarly, Fathuldeen et al (2023) found that neck, lower back, and hands/wrists were the most painful regions for gamers, areas heavily engaged during gaming sessions.[5] Cankurtaran et al (2022) further demonstrated that females, despite playing less than males, reported higher rates of head, hand/wrist, and back pain.[21] Additionally, Arvidsson et al (2020) highlighted the role of psychosocial factors and ergonomics in MSK pain among females.[7] Such patterns underscore the importance of incorporating gender-specific ergonomic education and targeted interventions. Nevertheless, further research is needed to clarify gender-specific risk factors, especially given the underrepresentation of female gamers. Age was positively associated with pain in the shoulders, indicating that even within a relatively young gaming population, age-related vulnerability exists and may compound ergonomic strain. This study's findings agree with Lindberg et al (2020), who suggested that older adults often maintain poor ergonomics during work and leisure activities, which, combined with age-related physiological changes and sedentary habits, may increase MSK susceptibility.[2]

Beyond demographic influences, gameplay genre emerged as an important determinant of MSK pain. In addition to personal factors, specific gaming-related variables—particularly game genre—were associated with MSK pain in several body regions. Puzzle, FPS, and sports/racing games showed significant associations with pain in the neck, lower back, and wrists/hands, highlighting the potential impact of specific game genres on physical strain. Virtual reality (VR) gaming stood out, with participants reporting considerable neck and lower back pain, likely due to prolonged standing and head movements. Gregory et al (2008) found that standing for two hours without rest could result in lower back pain.[12] Furthermore, Tyrrell et al (2018) linked VR gameplay to excessive neck and head motion, which may aggravate pre-existing conditions.[13] Puzzle games were a consistent predictor across multiple regions, while sports/racing and FPS games were also associated with specific pain areas, such as lower back and wrist/hand. Conversely, fighting games were associated with lower odds of shoulder and upper back pain.

These findings emphasize the importance of considering game genre as a central factor when evaluating MSK pain risk among gamers. Puzzle games, FPS, and sports/racing genres showed consistent associations with pain in multiple body regions, underscoring the need for genre-specific prevention strategies. Ergonomic interventions that address prolonged static postures, repetitive inputs, and device use—tailored to common patterns within specific game genres—may help reduce MSK burden in gaming populations.[15,22,23] This highlights the need for genre-specific ergonomic guidelines, as certain game mechanics may place disproportionate strain on the musculoskeletal system.

In addition to game genre, the type of device and the ergonomics of its use also played a critical role in shaping MSK outcomes. Although device type initially showed a significant association with shoulder and wrist/hand pain in the bivariate analysis, this relationship did not remain significant after adjusting for covariates in the regression models. This suggests that device type may not independently contribute to MSK pain risk, but instead may be confounded by other factors such as gender, game genre, or input method. This interpretation is supported by Gholami et al (2025), who found high rates of MSK disorders among smartphone-based play-to-earn gamers, indicating that both platform and gaming motivation can influence musculoskeletal outcomes.[11] However, overall, the device appeared to outweigh the game genre in determining MSK pain risks. Alnuman et al (2022) concluded that device type was a critical factor in MSK pain prevalence, a conclusion supported by our findings.[22]

While the regression models suggest device type may not independently drive MSK pain, ergonomics related to device use remain a decisive factor. Consistent with Geer et al (2023), poor posture, long gaming hours, and sleep disruption significantly exacerbate MSK pain risk. Taken together, these findings support the need for ergonomic training, adaptive seating, and scheduled breaks, particularly in high-risk device contexts.[23] Alnuman et al (2022) also found higher pain rates among gamers compared to non-gamers, particularly in the upper body, reinforcing the impact of device-specific strain patterns observed in the current study.[22] Tholl et al (2022) identified smartphones and tablets as common contributors to neck and shoulder pain due to hunched postures.[3] While these device-specific patterns were

noted, the adjusted regression model suggests that device type alone may not be an independent predictor of MSK pain. Despite these observations, research on device-specific MSK pain patterns remains limited.

Similar to the current study, several investigations have highlighted high rates of MSK pain among professional gamers, particularly affecting the neck, shoulders, and lower back. Lindberg et al (2020) reported that 42.6% of Danish esports athletes experienced MSK pain, while DiFrancisco-Donoghue et al (2019) observed analogous trends among collegiate players.[2,24] Goh et al (2023) corroborated these risks in a systematic review; however, none of these studies included non-professional gamers for comparison.[1]

In contrast to earlier research, our findings revealed significant differences in the prevalence of pain across various regions. Non-professional gamers were more likely to report neck, shoulder, and lower back pain, whereas wrist and hand pain were more prevalent among professional gamers. Notably, upper back pain showed no significant differences between the two groups. These results diverge from those of Reeves et al (2024), who found no distinctions in MSK disorder indicators between professional and casual gamers, suggesting that the interplay between professionalization, ergonomics, and pain is complex and merits further study.[25] The current findings suggest that while competitive status may influence pain in specific areas, other factors—such as prolonged sitting, poor ergonomics, and repetitive strain—are likely significant contributors for all types of gamers.[9] It is important to recognize that the gender distribution differed between the professional and non-professional groups in our sample, which may have influenced our comparisons. Future research should adopt stratified or matched designs to more effectively isolate the effects of gender and professional status on musculoskeletal outcomes. These findings highlight the need for tailored prevention strategies that consider both gaming roles and ergonomic risks, ensuring support for musculoskeletal health regardless of professional status. The clinical implications are significant, as early identification and intervention for at-risk gamers could help mitigate long-term musculoskeletal issues and enhance functional outcomes.

Recognizing that both professional and casual gamers are vulnerable to MSK disorders highlights the importance of health promotion programs, workplace-style ergonomic education, and early screening in gaming populations. This is particularly critical in the Saudi Arabian context, where gaming is rapidly expanding as both a leisure activity and a professional pursuit. Cultural factors—such as prolonged sedentary behavior, preferences for indoor leisure, and evolving health-seeking behaviors—may uniquely influence both pain prevalence and healthcare utilization among Saudi gamers. These contextual elements enhance the applicability of the findings regionally, while also providing a valuable perspective for global comparisons in gaming-related MSK research.

While this study provides important insights into the relationship between gaming behaviors and MSK pain among Saudi gamers, several methodological considerations warrant attention. Its cross-sectional design limits causal inference, and reliance on self-reported data may introduce recall or reporting biases. Future studies would benefit from longitudinal designs to assess causality, the incorporation of objective ergonomic/postural measures, and consideration of cumulative exposure (total years of gaming). Furthermore, objectively assessing pain severity, functional disability, and comorbidities such as sleep disturbance or sedentary lifestyle could add critical clinical relevance. Given the underrepresentation of female gamers and the rapid growth of e-sports in Saudi Arabia, further gender-sensitive and culturally contextualized research is warranted. Additionally, the observed differences between professional and non-professional gamers must be interpreted with caution, as gender imbalance across groups likely influenced prevalence patterns. The use of convenience sampling and exclusion of individuals with prior injuries may limit generalizability. Cultural factors unique to the Saudi context, such as gaming preferences and health-seeking behavior, merit further exploration. Future research would benefit from incorporating comparative experimental designs with control variables to enable stronger causal interpretation.

Conclusions

This study revealed a notable prevalence of MSK pain among gamers in Saudi Arabia, with the most commonly affected areas being the neck, lower back, shoulders, upper back, and wrists/hands. Pain occurrence was influenced by various factors, including gender, age, and game genres. Notably, puzzle, FPS, and sports-racing games were associated with heightened discomfort levels, while virtual reality gaming was significantly linked to neck pain. These findings underscore that MSK disorders are common among gamers and that individual characteristics and genre-specific demands are

critical predictors, supporting the need for ergonomic education and gender-sensitive prevention programs. While the study offers valuable insights, its reliance on a young, culturally specific sample and self-reported data limits generalizability, highlighting the need for future work with diverse populations and objective clinical measures. Future research should adopt longitudinal and interventional designs to test ergonomic strategies and better establish causal relationships. In conclusion, this study emphasizes the widespread incidence of MSK pain among gamers and the importance of culturally contextualized, evidence-based approaches to prevention and intervention.

Abbreviations

MSK, Musculoskeletal; VR, Virtual reality; FPS, First Person Shooter; SEF,Saudi Esports Federation; NMQ-E, Extended Nordic Musculoskeletal Questionnaire.

Data Sharing Statement

The datasets generated and/or analyzed during the current study are not publicly available but are available from the corresponding author upon reasonable request.

Ethics Approval and Informed Consent

Princess Nourah Bint Abdulrahman University granted ethical approval for the study (IRB No. 24-0490). Participants provided their written informed consent. Informed consent was obtained from all subjects involved in the study. The study complies with the Declaration of Helsinki.

Consent for Publication

Not applicable. This study did not involve any identifiable personal data, images, or recordings requiring individual consent for publication.

Acknowledgments

The authors acknowledge the support provided through the Princess Nourah Bint Abdulrahman University Researchers Supporting Project (No. PNURSP2026R285), Princess Nourah bint Abdulrahman University, Riyadh, Saudi Arabia.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Funding

The authors declare that this study received no funding from any public, private, or non-profit agencies.

Disclosure

The authors state that the research was conducted without any commercial or financial relationships that could lead to a conflict of interest.

References

1. Goh E, Al-Tabbaa O, Khan Z. Unravelling the complexity of the video game industry: an integrative framework and future research directions. *Telematics Informatics Reports*. 2023;12:100100. doi:10.1016/j.teler.2023.100100
2. 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(1):000799. doi:10.1136/bmjsem-2020-000799
3. Tholl C, Bickmann P, Wechsler K, Froböse I, Grieben C. Musculoskeletal disorders in video gamers – a systematic review. *BMC Musculoskelet Disord*. 2022;23(1). doi:10.1186/s12891-022-05614-0

4. Forman GN, Holmes MWR. Upper-body pain in gamers: an analysis of demographics and gaming habits on gaming-related pain and discomfort. *J Electronic Gaming Esports*. 2023;1(1). doi:10.1123/jege.2022-0018
5. Fathuldeen A, Alshammiri MF, Abdullah Abdulmohsen. Fathuldeen A. Prevalence and awareness of musculoskeletal injuries associated with competitive video gaming in Saudi Arabia. *Cureus*. 2023. doi:10.7759/cureus.37733
6. Khan MA, Chaikumarn M. Musculoskeletal disorders, perceived stress, and ergonomic risk factors among smartphone eSports athletes: a cross-sectional study. *J Musculoskeletal Surg Res*. 2024;8:247. doi:10.25259/JMSR_113_2024
7. Arvidsson I, Gremark Simonsen J, Lindegård-Andersson A, Björk J, Nordander C. The impact of occupational and personal factors on musculoskeletal pain - a cohort study of female nurses, sonographers and teachers. *BMC Musculoskelet Disord*. 2020;21(1):621. doi:10.1186/s12891-020-03640-4
8. DiFrancisco-Donoghue J, Jung M-K, Balentine MJ, Zwibel H. Where muscle matters: how regional differences, pain, and gender define gamer health. *Int J Environ Res Public Health*. 2025;22(5):687. doi:10.3390/ijerph22050687
9. Sarıkaya M, Avcı P, Satılmış N, Kılınçarslan G, Bayraktar I, Bayrakdar A. The effect of digital gaming duration on musculoskeletal system symptoms: a systematic study. *Int J Disabilities Sports Health Sci*. 2023;6(3):564–573.
10. Daneshmandi H, Choobineh A, Ghaem H, Karimi M. Adverse effects of prolonged sitting behavior on the general health of office workers. *J Lifestyle Med*. 2017;7(2):69–75. doi:10.15280/jlm.2017.7.2.69
11. Gholami M, Ahmadi Shoar A, Kalantari R. Musculoskeletal disorders in smartphone play to earn gamers: a comparative study. *J Back Musculoskelet Rehabil*. 2025;39(1):171–177. doi:10.1177/10538127251354965
12. Gregory DE, Callaghan JP. Prolonged standing as a precursor for the development of low back discomfort: an investigation of possible mechanisms. *Gait Posture*. 2008;28(1):86–92.
13. Tyrrell R, Sarig-Bahat H, Williams K, Williams G, Treleaven J. Simulator sickness in patients with neck pain and vestibular pathology during virtual reality tasks. *Virtual Real*. 2018;22(3):211–219. doi:10.1007/s10055-017-0324-1
14. Jiwal S, Jiwal S, Jiwal S, Jiwal S, Jain P, Jain AK. Impact of playing action and puzzle video-games on attention and executive function: a comparative study. *Indian J Physiol Pharmacol*. 2019;63:122–129.
15. Chrzanowski W, Mądrzak L, Kwiecińska J, et al. Upper limb injuries in esports and videogaming – a narrative review of pathology, risk factors and prevention methods. *Int J Innov Technol Soc Sci*. 2025;3(47).
16. Kingdom of Saudi Arabia. Saudi Vision 2030. 2016.
17. Al Amer HS, Alharbi AA. Arabic version of the Extended Nordic Musculoskeletal Questionnaire, cross-cultural adaptation and psychometric testing. *J Orthop Surg Res*. 2023;18(1). doi:10.1186/s13018-023-04161-1
18. Dawson AP, Steele EJ, Hodges PW, Stewart S. Development and test-retest reliability of an extended version of the nordic Musculoskeletal Questionnaire (NMQ-E): a screening instrument for Musculoskeletal pain. *J Pain*. 2009;10(5):517–526. doi:10.1016/j.jpain.2008.11.008
19. Cohen J, Cohen P, West SG, Aiken LS. *Applied Multiple Regression/Correlation Analysis for the Behavioral Sciences, Third Edition*. Routledge; 2013.
20. Wijnhoven HAH, De Vet HCW, Picavet HSJ. Prevalence of musculoskeletal disorders is systematically higher in women than in men. *Clin J Pain*. 2006;22(8):717–724. doi:10.1097/01.ajp.0000210912.95664.53
21. Cankurtaran F, Menevşe Ö, Namlı A, et al. The impact of digital game addiction on musculoskeletal system of secondary school children. *Niger J Clin Pract*. 2022;25(2):153–159. doi:10.4103/njcp.njcp_177_20
22. Alnuman N, Jbara AA. Video games and the prevalence of musculoskeletal disorders in young adults. In: 2022 IEEE Zooming Innovation in Consumer Technologies Conference, ZINC 2022. 2022.
23. Geer R, Cheng J, Rothman R, Abutalib Z, Davenport K. Characterization of gaming-related symptoms and musculoskeletal pain complaints in individuals who participate in electronic gaming. *Am J Lifestyle Med*. 2023;155982762311753. doi:10.1177/15598276231175396
24. 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(1):e000467. doi:10.1136/bmjsem-2018-000467
25. Kurniawan AA, Darusman KR, Chesar TIP, Azalia X, Kholinne E. Comparing health risks and musculoskeletal issues between professional and casual mobile esports players: a cross-sectional descriptive study in Jakarta. *Front Sports Act Living*. 2024;6. doi:10.3389/fspor.2024.1372979