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ORIGINAL PAPER

THE IMPACT OF ELECTRONIC GAMING ON UPPER LIMB NEUROPATHIES AMONG ESPORTS ATHLETES

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Abstract

Background: The authors aimed to explore carpal tunnel syndrome (CTS) among electronic sports (esports) athletes, to compare hand symptoms and their severity between esports athletes and the control group and within the esports athletes, and to study the relationship between esports athletes' variables. **Material and Methods:** A cross-sectional survey study via telephone with systematic randomized approach was used for esport athletes sampling. Control group were non-esports athletes who do not use computer for prolonged duration. The survey consisted of sports athletes' characteristics, hand symptoms and functions, and the *Boston Carpal Tunnel Questionnaire* (BCTQ). The unpaired student's t-test, Mann-Whitney U test, and χ^2 test were utilised for statistical comparison, with $p < 0.05$. Pearson's and Spearman's correlation coefficient tests were used for relationship analyses. **Results:** Eligible participants were 198 out of 229. Compared to control group, esport athletes reported more CTS ($p = 0.01$), and radiated pain and numbness in their hands ($p = 0.05$). Males complained of hand symptoms ($p < 0.01$) and its radiation ($p < 0.01$) more than females among esports athletes. Higher BCTQ *Symptom Severity Scale* (BCTQ-SSS) scores were reported for esports athletes who had been playing esports for prolonged periods compared to those who had playing recently ($p = 0.003$), with a moderate positive correlation (+0.59, $p = 0.004$). A significant moderate positive correlation was reported for BCTQ *Functional Severity Symptoms* (BCTQ-FSS) scores in terms of hours of playing (+0.44, $p = 0.04$). Esports athletes who used armrests and a PC with a controller for gaming reported less hand symptoms and had milder BCTQ scores than those who used a PC with a keyboard/mouse. Generally, esports athletes spend 5–10 h/day on gaming. **Conclusions:** Esports athletes might be at risk of developing upper-extremity nerve compression and CTS. Prolonged playing, hours of playing, type of esports device, and using armrests are possible risk factors. Med Pr Work Health Saf. 2023;74(4):279–87.

Key words: carpal tunnel syndrome, upper extremity, esports athletes, computer games, neuropathies, hand symptoms

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INTRODUCTION

In recent years, electronic sports (esports) have significantly increased in popularity among the general population worldwide [1]. Esports gamers have come to be labelled as athletes, and esports is increasingly recognized as a competitive sport worldwide [2–4]. A systematic review in 2020 described esports as organized competitive online playing in competitions and leagues with adequate training, skill development, and professional commitment towards the sport and the viewers [3]. While esports athletes receive various positive benefits from participating, gaming might increase risk factors affecting their health and make them prone to overuse injuries, particularly in the upper extremities. A study by Di Francisco-Donoghue et al. has reported that 42% of esports athletes complain of neck and back pain, followed by wrist (36%) and hand pain (32%) [5], while numbness followed by tingling were found to be the most common symptoms for computer game players [6]. Esports athletes spend most of their daytime playing and training for tournaments and leagues; time spent ranges 3–10 h daily [5]. As a result of the prolonged time spent playing computer games, hand discomfort and carpal tunnel syndrome (CTS) symptoms increase [6]. Improper workstation designs, including monitor, desk, chair, keyboard, and mouse, are significantly associated with the body discomfort of online gamers and could lead to musculoskeletal disorders [7].

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A study conducted by Liu et al. employed clinical examinations and median nerve conduction tests focused on symptomatic office workers who spent >6 h/day working on computers and reported a significant positive association between a larger wrist angle (<20 degrees of extension) when using a keyboard and a high risk of developing CTS [8]. Excessive force, repetitive movements, and awkward posture can all cause discomfort [5]. Compressive neuropathy of the upper-extremity sensory and motor functions due to repetitive manual tasks, such as damage to the median nerve, can lead to histologic changes and symptoms, such as numbness, pain, and weakness [9].

Peripheral nerve compression syndromes are considered one of the common neuropathies of the upper extremity. Nerve compression that is due to repetitive movement will gradually lead to a reduction in perfusion, disruption of the function of the peripheral nerve, and excessive tissue inflammation, leading to symptoms such as pain, swelling, numbness, tingling, weakness, stiffness, or even severe damage in the affected area [9–11].

Although the Middle Eastern region shows high growth among adults and youth in esports communities, evidence-based studies in the Kingdome of Saudi Arabia (KSA) that investigate the impact of esports on upper-limb neurological outcomes are limited, and the literature is scarce on esports in the KSA. Finding possible risks is essential to minimize the possibility of neurological hand injuries. Thus, this study aims: first, to explore carpal tunnel syndrome (CTS) based on interview-based diagnosis among esports athletes; second, to compare hand symptoms and their severity of esports athletes withthose of the control group, and among the esports athletes; and finally, to study the relationship between esports athletes' study group variables.

MATERIAL AND METHODS

For this cross-sectional study, a survey was developed and then conducted using telephone interviews. The study group consisted of esports athletes who took part in Saudi Esports Federation (SEF) official tournaments in Saudi Arabia, while the control group consisted of non-esports athletes who do not play esports as athletes nor spend >5–10 h/day in esport activates or in any computer works. The inclusion criteria for participants in both groups were: Saudi individuals, aged 18–40 years, and individuals who had not been diagnosed with diabetes mellitus, upper-extremity trauma or surgery during the last 6 months, rheumatoid arthritis, or cervical radiculopathy.

Recruitment of the study group participants was done via a randomized systematic sampling method using an Excel formula using an interval of every fifth person from a list of all eligible local esports athletes. The control group was recruited using convenient sampling. The sample size was estimated to be 348 using the OpenEpi website.

Researchers collected data between February 2023, and April 2023, administering structured surveys by phone interview. A pilot survey was conducted with 5 esports athletes to test the clarity and functionalities of the survey before utilising it. All comments were considered, and the survey questions were corrected as necessary.

The survey includes 4 sections. The first section is the demographic section, which asked participants about their age, gender, nationality, past medical history, residency, occupation, height, weight, body mass index (BMI), handedness, past medical history, and upper-extremity exercise, and also included a question asking whether the participant had stopped playing esports for >6 months.

The second section is more specifically about esports, and asks when the sports athletes started playing esports in general, playing frequency, types of devices used, hand support usage and playing, hours spent on a computer using a keyboard and mouse, and the presence of upper-extremity symptoms. Only those participants who reported upper-extremity issues in both groups proceeded to sections 3 and 4.

The third section is about hand symptoms involving the upper-extremity nerves. This is essential to identify whether participants experienced pain, numbness, tingling, or decreased sensation and function, to detect the specific affected nerve, and to screen individuals who were at substantial risk of upper-extremity nerve compression. When the individual complains of whole hand numbness, including the little finger, this would show involvement of the ulnar nerve, not just the median nerve. But if the individual reports that they are wearing gloves or mittens, it is important to consider the possibility of systemic neuropathy rather than a single peripheral neuropathy [12–14]. If the median nerve is affected, the participant had to complain of the following criteria to receive a positive CTS diagnosis [11]:

1) hand pain, numbness, or tingling;
2) symptoms worsen while playing or after playing esports, while sleeping, in the morning, when driving a car, or while working or after work;

3) symptoms in the thumb, index finger, or middle finger;
4) symptoms decrease by handshaking, massaging, with warm water, bracing, stretching, or other techniques.

The fourth section of the survey comprised the *Boston Carpal Tunnel Questionnaire* (BCTQ). The validated Arabic version of the BCTQ was used [15]. The questionnaire includes 19 questions that assess 2 aspects: symptom severity and functional status. The BCTQ is the most widely employed patient-reported outcome measure for CTS. The BCTQ is a reliable and valid self-reported symptom severity and functional status measure [15,16].

Participation in the study was voluntary. Ethical approval was explained in the first part of the survey, and participants were asked to give their informed consent to participate. Participants had the right to withdraw from the study at any point. The study was conducted in accordance with the guidelines proposed by the Declaration of Helsinki and was reviewed and approved by the Ethics Committee of Princess Nourah bint Abdulrahman University, Riyadh, Kingdom of Saudi Arabia (IRB, HA-01-R-104).

The data were analysed using the Social Science Statistics website and Excel. The descriptive statistics were analysed to report frequencies and percentages for the categorical, median for the ordinal, and mean ± standard deviation for the continuous variables. The continuous variables were tested for normal distribution using the Kolmogorov-Smirnov test. The statistical significance of differences between continuous variables was analysed using the unpaired student's t-test, or the Mann-Whitney U test if the assumptions for the t-test were not met, and for the ordinal data. For comparison of the nominal data, the χ^2 test was used. Pearson's (Pe) or Spearman's (r) correlation coefficients were used to determine the strength of linear relationships between 2 continuous variables. The data were calculated at a 95% CI, and statistical inference was based on the criterion $p < 0.05$.

RESULTS

A total of 229 potential participants were approached to be included in the study: of these, 198 (86.4%) were included and 31 (13.53%) were excluded as they did not meet the inclusion criteria. The study group included 95 esports athletes, and the control group included 103 participants; the ages for the 2 groups were M±SD 24.6±4.2 years and 24.8±4.2 years, respectively. Males represented 58.08% and females 41.92% of the sample. Table 1 presents the demographic characteristics of the sample, including gender, employment status, province, and BMI.

The esports athletes indicated a significant result of a higher incidence of positive CTS diagnoses compared to the control group, using the χ^2 test ($p = 0.01$). The proportion of esports athletes who reported CTS (15%) was more than the proportion of control participants (4%) who reported the same (Table 2).

Comparisons of the presence of hand symptoms and their radiation were conducted between the study group and the control group for only those who reported upper-extremity issues in both groups. The results of the χ^2 test analysis indicate no significant difference in the numbers of participants who complained of hand pain or numbness between the study group and the control group ($p = 0.41$). However, those who complained of radiated pain and numbness in their hands were significantly higher in the study group than in the control group ($p = 0.05$). Interestingly, the authors found that male esport athletes had higher significant results for the presence of hand symptoms ($p < 0.01$) and their radiation ($p < 0.01$) compared to female esport athletes, using the χ^2 test and the Mann-Whitney U test, respectively.

Comparisons of BCTQ scores were conducted between the study group and the control group for only those who reported upper-extremity issues in both groups ($N = 41$). A non-significant difference was found between the 2 groups for the BCTQ *Symptom Severity Scale* (BCTQ-SSS) ($p = 0.99$) and the BCTQ *Functional Severity Symptoms* (BCTQ-FSS) ($p = 0.36$) scores, using the unpaired student's t-test and the Mann-Whitney U test, respectively. The comparison of percentages of the BCTQ-SSS and the BCTQ-FSS scores for both the control and the study groups was stratified according to the severity scale (Table 3). The authors also reported a significantly higher BCTQ-SSS score in esports athletes who had been playing esports for prolonged periods (>10 years) compared to esports athletes who had started playing recently (<10 years), using the unpaired student's t-test ($p = 0.003$).

The authors correlated the radiation of hand pain and numbness symptoms, BCTQ-SSS, and BCTQ-FSS with age, the onset of when participants had started to play (years), the intensity of playing, upper-limb exercise, hours of playing, and BMI. The results of the Spearman test indicateda non-significant negative weak correlation

Table 1. Description of participants characteristics in the study (esport athletes) and control group in Saudi Arabia

Variable	Participants (N = 198)							
	study group (N = 95)			control group (N = 103)			total	
	n	%	M±SD	n	%	M±SD	%	M±SD
Gender								
male	80	84.21		35	33.98		58.08	
female	15	15.79		68	66.02		41.92	
Employment								
employee	53	55.79		36	34.95		44.95	
non-employee	42	44.21		67	65.05		55.05	
Province								
central	55	57.89		84	81.55		70.20	
eastern	18	18.95		4	3.88		11.11	
western	14	14.74		11	10.69		12.63	
southern	4	4.21		4	3.88		4.04	
northern	4	4.21		0	0		2.02	
Duration of esports activity								
0 h/day	0	0		54	52		27.27	
<5 h/day	48	50.53		40	39		44.44	
5–10 h/day	41	43.16		9	9		25.25	
10–15 h/day	5	5.26		0	0		2.53	
15–20 h/day	1	1.05		0	0		0.51	
>20 h/day	0	0		0	0		0	
BMI			24.28±5.11			21.66±5.24		23.03±5.08

between the radiation of hand pain and numbness symptoms and age and hours of playing (r = –0.002, p = 0.99) and (r = –0.17, p = 0.10), respectively. The results also indicate that a non-significant positive weak correlation was found with the onset of when participants started to play (r = 0.09, p = 0.39), upper-limb exercise (r = 0.16, p = 0.12), the intensity of playing (r = 0.10, p = 0.32.), and BMI (r = 0.01, p = 0.94). The results of the Pearson's and Spearman's correlation coefficients were utilized for the BCTQ correlation analysis (Table 4). The BCTQ-SSS scores were correlated for esports athletes who had started playing esports over a prolonged period and showed a significant moderate positive relationship (Pe = 0.59, p = 0.004), while non-significant weak relationships were found for age (Pe = 0.33, p = 0.14), BMI (Pe = –0.06, p = 0.79), hours of playing (r = –0.22, p = 0.33), intensity of playing (r = –0.01, p = 0.97), and upper-limb exercise (r = 0.07, p = 0.76). The authors found a significant positive moderate correlation of BCTQ-FSS scores with hours of playing (r = 0.44, p = 0.04). The correlation with BMI was non-significant weak relationships (r = 0.30, p = 0.17). The authors report a non-significant weak correlation with intensity of playing (r = 0.32, p = 0.15), age (r = –0.14, p = 0.54), when esports athletes started playing esports

Table 2. Carpal tunnel syndrome in study group (esport athletes) and control group participants

Carpal tunnel syndrome	Participants (N = 198) [n (%)]	
	esports athletes (N = 95)	control group (N = 103)
Positive	14 (15)*	4 (4)*
Negative	81 (85)	99 (96)

Significant difference at $p < 0.05$.
* Significant difference p = 0.01 using χ^2 test.

Table 3. Comparisons of *Boston Carpal Tunnel Questionnaire* (BCTQ) score stratified by severity scale between study group (esport athletes) and control group

BCTQ score	Participants (N = 41) [n (%)]			
	Symptom Severity Scale		*Functional Severity Symptoms*	
	esports athletes	control group	esports athletes	control group
1 (asymptomatic)	1 (2.44)	2 (4.88)	10 (24.39)	10 (24.39)
2 (mild)	19 (46.34)	15 (36.59)	10 (24.39)	8 (19.51)
3 (moderate)	2 (4.88)	2 (4.88)	2 (4.88)	1 (2.44)
4 (severe)	0	0	0	0
5 (very severe)	0	0	0	0

Significant difference at $p < 0.05$.
[a] Chi^2 test.

Table 4. Spearman's and Pearson's correlation results for *Boston Carpal Tunnel Questionnaire* (BCTQ) scores with other variables among the study group (esport athletes)

BCTQ	Correlation		p	Remark
	Pearson's	Spearman's r		
Symptom Severity Scale				
age	0.33		0.14	weak positive
BMI	0.06		0.79	weak negative
when esports athletes start playing esports in general (years)	0.59		0.004*	moderate positive
upper limb exercise		0.07	0.76	weak positive
intensity of playing		0.01	0.97	weak negative
hours of playing		0.22	0.33	weak negative
Functional Severity Symptoms				
age		0.14	0.54	weak negative
BMI		0.30	0.17	weak positive
when esports athletes start playing esports in general (years)		0.04	0.87	weak positive
upper limb exercise		0.03	0.89	weak negative
intensity of playing		0.32	0.15	weak positive
hours of playing		0.44	0.04*	moderate positive

* Significant difference at $p < 0.05$.

in general (r = –0.04, p = 0.87), and upper-limb exercise (r = –0.03, p = 0.89).

Further descriptive analysis for exploration was conducted for esports athletes' symptom severity based on the device type and use of armrests while playing (Table 5). The authors found that radiated hand symptoms were found only in those who do not use armrests (27.27%), while none of those who used armrests reported radiation of symptoms. Also, the percentage of esports athletes using a PC with a keyboard/mouse and/or controller (22.74%) reported radiation of their symptoms more frequently than those using a PC with a controller alone (4.55%). Esports athlete participants who are non-armrest users reported mild and moderate scores in the BCTQ-SSS (77.73%) and the BCTQ-FSS (40.9%), while 22.73% of the armrest users reported only mild scores in BCTQ-SSS and 13.64% reported the same scores in BCTQ-FSS scores. Participants who use a PC controller had milder BCTQ-SSS and BCTQ-FSS scores than those who use other PC types. Also, the authors reported that the median time spent on gaming during the daytime for those participants was 5–10 h/day.

Table 5. Assessment of symptoms and their severity and *Boston Carpal Tunnel Questionnaire* (BCTQ) scores based on the device type, and use of armrest while playing among esports athletes

Variable	Participants [n (%)] (N = 22)					
	device used for playing				use of armrest while playing	
	PC "keyboard/ mouse"	PC "controller"	PC "keyboard and mouse, controller"	other	yes	no
BCTQ-SSS						
1 (asymptomatic)	0	0	1 (4.55)	0	1 (4.55)	0
2 (mild)	7 (31.82)	2 (9.09)	5 (22.73)	5 (22.73)	5 (22.73)	14 (36.64)
3 (moderate)	1 (4.55)	0	1 (4.55)	0	0	2 (9.09)
4 (severe)	0	0	0	0	0	0
5 (very severe)	0	0	0	0	0	0
BCTQ-FSS						
1 (asymptomatic)	4 (18.18)	1 (4.55)	2 (9.09)	3 (13.64)	3 (13.64)	7 (31.82)
2 (mild)	4 (18.18)	1 (4.55)	3 (13.64)	2 (9.09)	3 (13.64)	7 (31.82)
3 (moderate)	0	0	2 (9.09)	0	0	2 (9.09)
4 (severe)	0	0	0	0	0	0
5 (very severe)	0	0	0	0	0	0
Radiation of pain and numbness						
not radiating	5 (22.73)	3 (13.64)	5 (22.73)	3 (13.64)	6 (27.27)	10 (45.45)
under the elbow	2 (9.09)	1 (4.55)	1 (4.55)	0	0	4 (18.18)
above the elbow	0	0	0	0	0	0
all the forearm to the shoulder	1 (4.55)	0	1 (4.55)	0	0	2 (9.09)

BCTQ-SSS – BCTQ *Symptom Severity Scale*; BCTQ-FSS – BCTQ *Functional Severity Symptoms*.

DISCUSSION

This study investigated the impact of electronic gaming on upper-limb neuropathies of esports athletes. This study found that esports athletes are more at risk of developing upper-limb neuropathies than non-esports athletes. The findings reveal that esports athletes in Saudi Arabia spend considerable daytime, ranging 5– 10 h, on gaming, and they are at risk of developing CTS. The results also indicate that hand symptoms among esports athletes correlate significantly with the onset and the duration of gaming, while males indicated more significant symptoms than females.

The authors found that there is a significant difference between the results of the interview-based CTS positive diagnosis where, interestingly, esports athletes reported positive CTS more frequently than the control group. Median nerve compression due to pressure in the wrist in repetitive hand movement resulted in CTS [9]. Esports athletes who were exposed to a number of repetitive and forceful hand movements reported complaints of neck, back, hand, and wrist pain [5,6]. Similarly, the study using the BCTQ indicated that computer games players had similar complaints [6].

This study found that esports athletes spend considerable daytime, ranging 5–10 h, on gaming, which is consistent with studies on the association between CTS and individuals who have high computer exposure, such as computer workers and esports athletes. A bibliometric study conducted by Ram et al. concluded that CTS is commonly associated with prolonged use of computers or keyboards [17]. Ali et al. demonstrated that computer professionals who have worked >12 h daily for 8 years are at a high risk of developing CTS [18]. Another study reported a significant difference in hand symptoms between players who played computer games for >5 h/day

and those who played less; however, the median nerve conduction velocity between computer game players and non-players did not differ significantly [19]. Furthermore, Di Francisco-Donoghue et al. found that esports athletes who practised 3–10 h/day frequently complained of hand and wrist pain in addition to other complaints [5].

Comparison of the assessment of symptoms and their severity of sports athletes and members of the control group in this study reveals significant differences in radiated hand pain, which is a clinical symptom of median nerve compression due to pressure in the wrist in repetitive hand movement, resulting in CTS [4,10]. Eleftheriou et al. demonstrated that the use of a keyboard for extended periods of time is an independent risk factor for CTS [20]. The wrist and hand regions are innervated by the sensory and motor fibres of the median nerve. The sensory pathway supplies feeling in the palmar and dorsal surfaces of the thumb, index finger, middle finger, and radial halves of the ring finger. Motor innervation controls 9 tendons of the thumb and finger flexors as well as the thenar muscle. Carpal tunnel syndrome occurs due to compression of the median nerve within the tunnel that runs through the wrist and gets squeezed under the ligaments, causing pain and other symptoms. Increased pressure on the median nerve can cause CTS, including repeated forceful hand movements and extreme wrist flexion and extension over a prolonged period. The compression of the median nerve at the tunnel can cause pain, numbness, or tingling in the wrist and hand that radiates to the thumb, middle, and index fingers. Over time, the symptoms progress to a weak grip and dropping heavy objects [9–11].

Esports athletes in this study who complained of hand sensory and functional symptoms spend most of their daytime playing, ranging 5–10 h daily. Similarly, another study reported that esports players spend most of their daytime playing and training for tournaments and leagues, 3–10 h daily [5]. Among the esports athletes in this study, gender revealed interesting results. The authors found that males suffer more significantly than females in terms of the presence of hand pain and numbness and their radiation. In line with authors' results, a study by Ali and Sathiyasekaran found that there is a greater prevalence of CTS among male computer users than female users [18]. These results might be related to the higher proportion of male esports athletes who participated in authors' study group, which is similar to previous studies [7,18,19].

The findings of this study reveal a significant moderate positive correlation between esports athletes' BCTQ-SSS scores and the early onset of playing (when esports athletes start playing esports in general) ($p = 0.004$). Further comparison of BCTQ-SSS scores among esports athletes in this study indicate that participants who started playing sports games for prolonged periods tend to experience more symptoms than those who had just recently started playing. Authors' results are consistent with those of Ali and Sathiyasekaran on computer professionals, which indicated that participants with prolonged periods of computer work were at a statistically significant higher risk for CTS [18]. Similarly, studies found that cumulative exposure to keyboard use and playing computer games for prolonged periods of time could be associated with hand symptoms [6,19,20]. This study also indicates that a longer duration of esports playing (h/day) correlates significantly with experiencing more functional severity symptoms (BCTQ-FSS) among esports athletes ($p = 0.04$). In line with authors' results, mobile gaming athletes who are spending prolonged times (4–8 h) on mobile esports playing are at risk of developing physical fatigue [21]. This study also found that esports duration is not associated with BMI in mobile gaming athletes, which is consistent with authors' study [21].

The exploration of device type reveals that the majority of esports athletes who reported BCTQ symptoms and complained of hand pain and numbness symptoms use the PC keyboard/mouse or mouse, or use the PC with both keyboard/mouse or controller, compared to esports athletes who use the controller only or other types of devices (e.g., mobile, Nintendo Switch, PlayStation). A recent study by Urbiztondo et al. found that using the mouse, which is one of the explored workstation tools in their study, was significantly associated with symptoms, due to body discomfort among esports athletes [7]. This may explain the results of authors' study, as most of the reported cases of BCTQ-related symptoms tend to use the keyboard/mouse. The findings also reveal that a high proportion of reported cases with BCTQ symptoms do not utilize hand support while engaging in gaming activities. In addition, authors observe that 27.27% of esports athletes who do not use armrests experience radiated hand pain and numbness below the elbow and in the forearm to shoulder, compared to armrest users who do not report any symptoms. An armrest supports the wrist joint to be in a natural position, which prevents carpal tunnel pressure. Wrist extension increases

the carpal ligament pressure and ultimately results in carpal content compression, leading to increase fluid pressure, nerves and tendons compression at the wrist [13]. Studies on computer users indicate that a higher risk of developing CTS is associated with a flexed or extended wrist position; those who extend the wrist joint for >20° are at greater risk of developing CTS [8,18].

The current study has certain limitations. First, participants were esports athletes who play on desktop computers using a keyboard and mouse or controllers only and not non-PC devices such as smartphones. Second, the sample recruited for this study was relatively small due to the weak responses of the participants, which hampered authors' data collection. A third limitation is that the assessment method used in this study was based on participants' recall of their earlier experiences, which is prone to over- or underestimation. Despite these shortcomings, this study is the first to explore the upper-limb neuropathies among esports athletes in Saudi Arabia. Fourth, the sample size is too small for some analyses due to the branching questions. Finally, the esports athletes in this study were predominantly male; this is due to male members constituting the majority of SEF members, where authors recruited the sample. Future studies should include more participants to increase generalisability. Furthermore, to provide a more comprehensive assessment of upper limb neuropathies of esports athletes, authors suggest incorporating objective measures such as nerve conduction studies. Based on authors' results, the authors recommend that esports athletes consider using PC controllers and implement proper armrests to mitigate the risk of experiencing hand pain and numbness.

CONCLUSIONS

This study confirms that esports athletes might be more at risk of developing CTS than non-esports athletes. In Saudi Arabia, esports athletes spend a considerable amount of their daytime on gaming, ranging 5–10 h, which could put them at higher risk of upper limb neuropathies. Based on the results, authors recommend that esports athletes consider using PC controllers and implement proper armrests to mitigate the risk of experiencing hand pain and numbness. The results of this study will contribute to a better understanding of the impact of esports games on the occurrence of CTS symptoms in esports athletes.

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