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ORIGINAL RESEARCH

Ulnar neuropathy at the elbow in male mobile esports athletes: clinical, electrophysiological, and ergonomic correlates

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Abstract

Background: Competitive mobile esports participation is predominantly male and involves prolonged elbow flexion, repetitive finger movements, and sustained extremity loading. These exposures may predispose men to ulnar neuropathy at the elbow; however, electrophysiological evidence remains limited. This study aimed to examine the clinical and electrophysiological characteristics of ulnar neuropathy in male mobile esports athletes and evaluate associations with gaming exposure and ergonomic factors. **Methods**: In this cross-sectional study, 50 male mobile esports athletes with $\geq$2 years of gaming experience underwent standardized clinical evaluation and ulnar nerve motor conduction studies. Participants were classified as clinically positive (n = 35) or clinically negative (n = 15) based on combined symptom and provocation test criteria. Group comparisons were performed using independent-samples *t*-tests or Mann-Whitney U tests, and categorical variables were analyzed using chi-square or Fisher's exact tests. Multiple linear regression analysis was conducted to identify factors associated with ulnar nerve elbow motor conduction velocity. **Results**: Clinically positive athletes showed significantly prolonged distal motor latency, reduced motor conduction velocity across the elbow, and higher conduction block (all $p < 0.05$). Daily and weekly gaming durations were significantly greater in the clinically positive group (both $p < 0.01$). In regression analysis, lack of elbow support ($\beta = -0.52$), elbow flexion $>90°$ ($\beta = -0.44$), and daily gaming duration ($\beta = -0.34$) were significantly associated with reduced elbow motor conduction velocity (all $p < 0.001$; $R^2 \approx 0.42$). **Conclusions**: Findings consistent with ulnar nerve involvement were observed at both clinical and electrophysiological levels in male mobile esports athletes. Higher gaming exposure and selected ergonomic factors—particularly lack of elbow support and sustained elbow flexion—were associated with differences in elbow-level motor conduction parameters. These findings may inform future research on screening approaches and ergonomic assessment strategies in this population; however, given the cross-sectional design, causal relationships cannot be established.

Keywords

Ulnar neuropathy at the elbow; Mobile esports; Electromyography; Gaming exposure; Peripheral neuropathy

1. Introduction

Esports and competitive digital gaming have rapidly expanded in recent years with the widespread adoption of mobile platforms, evolving into a performance-oriented field. Due to prolonged gaming and training exposure, mobile esports athletes are increasingly subjected to repetitive hand, wrist, and elbow movements, as well as sustained static postures and ergonomic loading. These exposures have been reported to predispose individuals to the development of musculoskeletal complaints, particularly in the upper extremities and spinal regions. Field studies and narrative reviews among competitive gamers indicate a high prevalence of musculoskeletal pain, most commonly affecting the upper extremities and the spine [1–4].

Postural characteristics specific to mobile device use—such as forward head posture, increased elbow flexion, wrist extension, and repetitive finger movements—may exacerbate overuse mechanisms in upper extremity tissues. Several studies have reported associations between poor posture, repetitive movements, and prolonged exposure during smartphone-based gaming and symptoms involving the neck, back, and upper extremities [5–7]. In this context, mobile esports athletes may represent a population in which peripheral nerve involvement warrants further investigation, in addition to traditional occupational or office-based risk groups.

Despite frequent reports of upper-extremity complaints among esports athletes, relatively few studies have corroborated these symptoms with objective electrophysiological measures. In many investigations, assessments of peripheral nerve involvement have been limited to clinical symptoms and self-reported questionnaires, with electrophysiological confirmation used less frequently. This limitation may lead to the underrecognition of early or subclinical nerve involvement.

Ulnar nerve entrapment neuropathy—particularly cubital tunnel syndrome at the elbow level—is one of the most common mononeuropathies of the upper extremity and is associated with substantial functional impairment in clinical practice. Population-based studies and recent reviews have demonstrated that cubital tunnel syndrome is clinically prevalent and represents a significant health burden [8, 9]. Prolonged elbow flexion, repetitive pressure over the medial epicondyle, and repetitive upper extremity loading are among the primary mechanisms contributing to ulnar nerve irritation and compression. The elbow-flexed posture and device-handling patterns frequently adopted during mobile gaming closely align with these mechanisms [6, 8, 9].

In addition to clinical findings, electrophysiological examinations are essential tools for improving diagnostic accuracy and supporting segmental localization in the assessment of ulnar nerve entrapment neuropathy. Comparative investigations have demonstrated that electrodiagnostic studies remain a cornerstone in the objective diagnosis of ulnar neuropathy at the elbow. Parameters such as motor conduction slowing and conduction block across the elbow segment are considered critical for diagnosis. Guidelines and consensus documents recommend standardized evaluation of the elbow segment in ulnar neuropathy [10–13]. Short-segment conduction studies and alternative electrophysiological approaches may further enhance the sensitivity of detecting elbow-level involvement [14, 15]. Integrating clinical findings with electrophysiological severity allows for a more comprehensive interpretation of symptom burden and functional impairment [16, 17]. Recent studies have also emphasized the clinical relevance of elbow-level motor conduction parameters in determining disease severity [18].

Competitive esports participation remains predominantly male worldwide, with young adult men representing the majority of professional and semi-professional mobile gaming populations. Given the increasing intensity and duration of digital gaming exposure in this demographic, understanding upper extremity peripheral nerve health carries particular relevance within the broader context of men's health. Musculoskeletal and nerve-related conditions that may impair functional capacity in young men engaged in competitive gaming warrant focused clinical investigation.

Nevertheless, studies that concurrently evaluate clinical findings and objective electrophysiological indicators in mobile esports athletes, while also relating these outcomes to ergonomic exposures, remain scarce. Given the distinct postural and ergonomic characteristics of mobile esports, the combined clinical and electrophysiological investigation of peripheral nerve involvement in this population represents an important research gap.

Therefore, this study aimed to examine clinical and electrophysiological findings compatible with ulnar nerve involvement at the elbow in mobile esports athletes and to evaluate their associations with clinical provocation tests, gaming exposure, ergonomic variables, and electrophysiological parameters.

2. Materials and methods

2.1 Study design

This study was designed as a cross-sectional, observational investigation conducted to examine the clinical and electrophysiological characteristics of ulnar nerve entrapment neuropathy among male mobile esports athletes. Participant recruitment was conducted between 20 January 2026 and 03 February 2026 following ethics committee approval.

2.2 Participants

A total of 50 male volunteer athletes who regularly participated in mobile esports activities were included in the study. All participants had been engaged in mobile esports for at least two years and reported regular weekly gaming habits.

Participants were recruited from local esports communities and university-based gaming groups using a convenience sampling approach. Participation was voluntary, and individuals who met the inclusion criteria were enrolled during the study period. A mobile esports athlete was defined as an individual who regularly engaged in competitive or high-frequency mobile gaming for at least 2 hours per day. Both amateur and semi-competitive players were included.

Individuals with a prior history of peripheral neuropathy, upper extremity surgery, rheumatological disease, or systemic neurological disorders were excluded.

Given the voluntary nature of participation, individuals with existing symptoms may have been more likely to participate, which could have influenced the observed clinical positivity rate.

2.3 Clinical assessment

All participants were evaluated by an experienced clinician using a standardized assessment protocol. Clinical evaluation included inquiry about symptoms such as:

- Hand weakness;
- Elbow and wrist pain;
- Numbness in the fourth and fifth digits.

In addition, the following clinical provocation tests were applied to all athletes:

- Tinel's test at the elbow level;
- Froment's test;
- Elbow flexion test.

Participants were classified as "clinically positive for ulnar nerve entrapment neuropathy" if at least one provocation test was positive in the presence of accompanying clinical symptoms. Based on the clinical evaluation, 35 athletes were classified as clinically positive and 15 as clinically negative.

Positivity was defined in accordance with combined diagnostic approaches recommended in the literature. Accordingly, the presence of at least one positive provocation test together with at least one clinical symptom (*e.g.*, numbness, paresthesia, pain, or muscle weakness) was accepted as the criterion for clinical positivity. This combined approach was intended to improve classification consistency and reduce isolated false-positive findings, rather than to establish diagnostic confirmation.

2.4 Operational definitions

To enhance clarity and reproducibility, key variables were operationally defined as follows. Clinical positivity was defined as the presence of at least one symptom together with at least one positive provocation test. Symptom severity was assessed using the Visual Analog Scale (VAS), with scores >4 indicating higher symptom burden. Ergonomic variables—including elbow flexion angle, wrist extension, forward head posture, and elbow support—were classified based on standardized observational criteria and participant-reported habitual gaming posture. Device grip style was categorized according to the participant's dominant gaming technique.

2.5 Visual analog scale (VAS)

Symptom severity was assessed using a 10-point visual analog scale (VAS), where 0 indicated no symptoms, and 10 indicated the worst possible symptoms. Participants were asked to rate their perceived upper-limb discomfort associated with mobile gaming. The VAS assessment was conducted at the time of clinical evaluation under standardized conditions. A cutoff value of >4 was used as an exploratory pragmatic threshold to indicate higher symptom burden for subgroup analyses and was not intended as a diagnostic cutoff.

2.6 Electrophysiological assessment

All participants underwent electrophysiological evaluation using standard nerve conduction study techniques. Electromyography (EMG) recordings were performed under standardized laboratory conditions to ensure measurement reliability. Skin temperature was maintained above 32 °C throughout all procedures. Surface electrodes were used, and motor responses were recorded from the abductor digiti minimi muscle.

The ulnar nerve was stimulated at standardized anatomical sites, including the wrist, below the elbow, and above the elbow, using consistent inter-site distances. The following parameters were recorded: distal motor latency, motor conduction velocity across the forearm and elbow segments, conduction velocity slowing, and percentage of conduction block.

Motor conduction velocity across the elbow segment was calculated based on the distance between stimulation sites and the corresponding latency differences. Conduction block was defined as a significant reduction in compound muscle action potential (CMAP) amplitude between proximal and distal stimulation sites, in accordance with established electrodiagnostic criteria [12, 13, 19].

The electrophysiological evaluation primarily focused on motor conduction abnormalities across the elbow segment, including conduction slowing, amplitude reduction, and the presence of conduction block, which are considered key indicators of ulnar neuropathy at the elbow.

Based on EMG findings, clinically positive cases (n = 35) were further categorized into mild and moderate–severe subgroups according to electrophysiological severity. Severity classification was based exclusively on motor conduction parameters, using established electrodiagnostic criteria.

Mild involvement was defined as reduced motor conduction velocity across the elbow segment (<50 m/s) without conduction block ($<20\%$) and without prolongation of distal motor latency (<3.5 ms).

Moderate–severe involvement was defined as reduced motor conduction velocity across the elbow segment accompanied by at least one additional abnormality, including conduction block ($\geq 20\%$) and/or prolonged distal motor latency (≥ 3.5 ms).

Sensory conduction parameters were not used in the severity classification in order to maintain methodological consistency and avoid ambiguity in the interpretation of electrophysiological grading.

All electrophysiological assessments were performed by the same experienced examiner to minimize inter-observer variability.

2.7 Ergonomic assessment and postural evaluation

Ergonomic variables were assessed using a standardized observational protocol combined with participant self-report of habitual gaming posture. All assessments were conducted by a single trained researcher with experience in musculoskeletal evaluation. Participants were observed in a simulated gaming posture using their personal mobile devices. To enhance consistency, all participants were evaluated under standardized conditions using a fixed desk setup. Postural variables were assessed using predefined observational criteria based on anatomical reference points.

Elbow flexion angle was visually estimated and categorized as $\leq 90°$ or $>90°$ based on anatomical reference alignment. Wrist extension was classified as $\leq 30°$ or $>30°$ using visual estimation relative to the neutral wrist position. Forward head posture was defined as anterior displacement of the head relative to the shoulder line.

Elbow support was recorded as present if participants reported and demonstrated consistent use of external support (*e.g.*, desk or armrest) during gaming. Grip style and gaming surface (*e.g.*, on a table *vs.* unsupported) were documented based on participant demonstration.

All ergonomic variables were based on habitual posture rather than a single transient position. To improve consistency, all participants were assessed under the same standardized conditions.

2.8 Statistical analysis and power analysis

Statistical analyses were performed using an appropriate statistical software package. The distributional properties of continuous variables were assessed using the Shapiro-Wilk test and visual methods (histograms and quantile–quantile (Q–Q) plots). Group comparisons of normally distributed continuous variables were conducted using parametric tests (independent-samples *t*-test), whereas non-normally distributed variables were analyzed using non-parametric tests (Mann-Whitney U test). Categorical variables were analyzed using the chi-square test or Fisher's exact test, as appropriate. Continuous variables were reported as mean ± standard deviation or median (interquartile range), and categorical variables were presented as frequencies and percentages.

Effect sizes were calculated and reported as Cohen's d for parametric comparisons and as r values for non-parametric comparisons. Bonferroni correction was applied for multiple pairwise comparisons involving electrophysiological parameters to control for type I error. Statistical significance was set at a two-tailed p-value of < 0.05.

For multiple linear regression analyses, model assumptions were systematically evaluated. Normality and homoscedasticity of residuals were assessed, and multicollinearity among predictors was examined using the variance inflation factor (VIF), with VIF values <5 considered acceptable. Linearity and the presence of outliers were also evaluated through visual inspection.

Elbow motor conduction velocity was selected as the primary dependent variable because it represents a clinically relevant and segment-specific indicator of ulnar nerve function at the elbow.

Prior to multivariable modeling, all relevant clinical, gaming exposure, and ergonomic variables were initially evaluated using univariable analyses. Variables considered for inclusion in the regression model were selected based on a combination of clinical relevance, consistency with prior literature, and statistical criteria.

Specifically, variables demonstrating a potential association with the dependent variable ($p < 0.10$ in univariable analyses) as well as those considered clinically meaningful were included in the multivariable model. To avoid multicollinearity and model overfitting, highly correlated variables and those not improving model fit were excluded.

Although additional variables such as wrist extension, forward head posture, regular breaks, gaming surface, device type, handedness, body mass index, and esports experience were evaluated in preliminary analyses, they were not retained in the final regression model because they did not meet the predefined inclusion criteria and/or did not contribute meaningfully to model performance.

As this was a single-center, cross-sectional study, sample size was determined based on field accessibility rather than an a priori power analysis. A sensitivity power analysis was conducted to determine the magnitude of effects detectable with the available sample size (n = 50). For two-group comparisons (clinically positive n = 35, clinically negative n = 15), the minimum detectable standardized mean difference at a two-tailed $\alpha = 0.05$ and 80% power was approximately Cohen's $d \approx 0.82$. For correlational analyses under the same conditions, the minimum detectable correlation coefficient was approximately $r \approx 0.38$. In multiple linear regression models including four predictors, achieving 80% power required a moderate proportion of explained variance (approximately $R^2 \approx 0.40$–0.45).

3. Results

Table 1 summarizes the demographic, gaming-related, and ergonomic characteristics of the participants (n = 50). The cohort demonstrated a relatively homogeneous distribution in terms of age and body mass index. The high daily and weekly gaming durations indicate substantial gaming exposure within this population. Ergonomic assessment revealed a considerable prevalence of forward head posture, increased elbow flexion, and limited use of elbow support, suggesting persistent upper extremity loading patterns in mobile esports athletes.

TABLE 1. Demographic, gaming, and ergonomic characteristics of the participants (n = 50).

Variable	Value
Age (yr)	24.8 ± 3.7 (18–30)
Height (cm)	170.4 ± 6.7 (160–185)
Body weight (kg)	74.1 ± 9.9 (55–95)
Body mass index (kg/m^2)	23.3 ± 2.2 (20.1–28.4)
Esports experience (yr)	5.0 ± 1.8 (2–8)
Daily gaming duration (h)	6.3 ± 1.4 (4–8)
Weekly gaming duration (h)	36.7 ± 10.9 (20–56)
Dominant hand—Right	32 (64.0)
Dominant hand—Left	18 (36.0)
Device used—Smartphone	35 (70.0)
Device used—Tablet	15 (30.0)
Primary game genre—MOBA	22 (44.0)
Primary game genre—FPS	17 (34.0)
Primary game genre—Battle Royale	11 (22.0)
Device grip style—Two thumbs	23 (46.0)
Device grip style—Four fingers	15 (30.0)
Device grip style—Claw	12 (24.0)
Regular breaks	20 (40.0)
Use of elbow support	17 (34.0)
Gaming on a desk/table	30 (60.0)
Forward head posture	32 (64.0)
Wrist extension >30°	27 (54.0)
Elbow flexion >90°	28 (56.0)

Values are presented as mean ± standard deviation, range, or n (%), as appropriate.
MOBA: Multiplayer Online Battle Arena; FPS: First-Person Shooter.

As shown in Table 2, no statistically significant differences were observed between the clinically positive and clinically negative groups in demographic variables (all $p > 0.05$). However, daily gaming duration and total weekly gaming time were higher in the clinically positive group ($p < 0.001$ and $p = 0.003$, respectively), with moderate-to-large effect sizes (Cohen's $d \approx 1.2$ and 1.1, respectively).

TABLE 2. Comparison of demographic and gaming characteristics between clinically positive and clinically negative groups.

Variable	Clinically Positive (n = 35)	Clinically Negative (n = 15)	p value
Age (yr)	24.81 ± 4.43	24.78 ± 2.54	0.699
Height (cm)	169.29 ± 6.03	172.44 ± 7.55	0.329
Body weight (kg)	73.71 ± 10.46	75.11 ± 8.99	0.571
Body mass index (kg/m^2)	23.29 ± 2.28	23.23 ± 1.99	0.928
Esports experience (yr)	4.95 ± 1.75	5.00 ± 2.18	0.927
Daily gaming duration (h)	6.90 ± 1.04	5.22 ± 1.30	**<0.001**
Weekly gaming days (d)	5.95 ± 0.86	5.67 ± 1.00	0.476
Total weekly gaming duration (h)	41.38 ± 9.79	29.67 ± 8.79	**0.003**

Values are presented as mean ± standard deviation.
Statistically significant p values (< 0.05) are shown in bold.

In addition, regular breaks were not significantly associated with elbow motor conduction velocity or conduction block in univariate analyses ($p > 0.05$).

These findings suggest that higher gaming exposure was associated with the presence of clinical findings consistent with ulnar nerve involvement.

As shown in Table 3, clinically positive athletes demonstrated significantly prolonged distal motor latency and reduced ulnar nerve motor conduction velocities compared with clinically negative athletes. The most pronounced difference was observed in motor conduction velocity across the elbow segment ($p < 0.001$), with a large effect size (Cohen's $d >$ 1.5).

In addition, conduction velocity drop and conduction block percentage were significantly higher in the clinically positive group ($p < 0.01$), further indicating segment-specific electrophysiological differences.

The magnitude of group differences was consistently large across key electrophysiological parameters.

As presented in Table 4, the moderate–severe subgroup showed lower electrophysiological values, higher symptom severity, longer gaming exposure, and a higher prevalence of adverse ergonomic factors compared with the mild subgroup.

Athletes classified in the moderate–severe subgroup exhibited lower motor conduction velocity across the elbow segment, higher conduction block values, and longer distal motor latency compared with those in the mild subgroup (all $p <$ 0.01).

In addition, clinical symptom severity was higher in the moderate–severe subgroup, as reflected by greater VAS scores and a higher proportion of participants with VAS >4.

Differences were also observed in gaming exposure, with longer daily and weekly gaming durations in the moderate–severe subgroup.

Furthermore, ergonomic risk factors—including lack of elbow support and elbow flexion greater than 90°—were more frequently observed in the moderate–severe subgroup.

Overall, these findings indicate consistent differences between severity categories across multiple domains, without implying a causal relationship.

As shown in Table 5, longer daily gaming duration and higher symptom severity were consistently associated with differences in electrophysiological parameters. In particular, motor conduction velocity across the elbow segment was lower, while conduction velocity drop and conduction block tended to be higher in the higher exposure and symptom severity groups.

The magnitude of these differences was large (*e.g.*, Cohen's $d \approx 1.3$ for elbow-level motor conduction velocity), indicating substantial differences between groups.

These findings indicate a pattern in which higher gaming exposure and symptom burden were associated with differences in electrophysiological parameters, without implying a definitive dose–response relationship.

Table 6 presents elbow-level electrophysiological findings stratified by ergonomic risk factors. The absence of elbow support and elbow flexion greater than 90° were associated with lower elbow motor conduction velocity and higher conduction block values ($p < 0.001$ for both comparisons), with large effect sizes (*e.g.*, Cohen's $d \approx 2.2$ for elbow motor conduction velocity).

Device grip style was also associated with statistically significant differences in elbow motor conduction velocity and conduction block ($p = 0.022$).

As shown in Table 7, the multiple linear regression model was statistically significant ($p < 0.001$) and explained a moderate proportion of the variance in elbow motor conduction velocity ($R^2 = 0.42$, adjusted $R^2 = 0.39$).

Lack of elbow support ($\beta = -0.52$, $p < 0.001$) and elbow flexion greater than 90° ($\beta = -0.44$, $p < 0.001$) were independently associated with reduced elbow motor conduction velocity. Daily gaming duration was also associated with lower conduction velocity ($\beta = -0.34$, $p < 0.001$).

Device grip style did not reach statistical significance after adjustment ($p = 0.092$). No evidence of multicollinearity was observed, with all variance inflation factor (VIF) values below 2.5, indicating absence of meaningful multicollinearity.

TABLE 3. Comparison of electrophysiological (EMG) findings between clinically positive and clinically negative groups.

EMG Parameter	Clinically Positive (n = 35)	Clinically Negative (n = 15)	*p* value
Distal motor latency (ms)	3.32 ± 0.29	2.94 ± 0.26	0.002
Motor conduction velocity—forearm (m/s)	53.4 ± 3.8	56.9 ± 3.1	0.011
Motor conduction velocity—elbow (m/s)	41.6 ± 6.2	50.8 ± 4.9	<0.001
Conduction velocity drop (m/s)	11.8 ± 4.9	5.6 ± 3.7	0.003
Conduction block (%)	28.7 ± 14.6	9.3 ± 7.8	0.001

TABLE 4. Comparison of clinical, electrophysiological, gaming exposure, and ergonomic variables between mild and moderate–severe subgroups among clinically positive athletes (n = 35).

Variable	Mild (n = 11)	Moderate–Severe (n = 24)	*p*-value
Electrophysiological parameters			
Elbow motor conduction velocity (m/s)	48.2 ± 3.1	38.7 ± 4.8	<0.001
Conduction block (%)	12.4 ± 6.8	35.6 ± 11.2	<0.001
Distal motor latency (ms)	3.05 ± 0.18	3.43 ± 0.24	<0.001
Clinical variables			
VAS score	4.1 ± 1.8	6.3 ± 1.9	0.002
VAS >4, n (%)	5 (45.5)	20 (83.3)	0.023
Gaming exposure			
Daily gaming duration (h)	6.1 ± 0.9	7.3 ± 0.9	0.001
Weekly gaming duration (h)	35.8 ± 8.4	43.9 ± 9.5	0.019
Ergonomic variables			
No elbow support, n (%)	6 (54.5)	21 (87.5)	0.041
Elbow flexion >90°, n (%)	5 (45.5)	19 (79.2)	0.047

VAS: Visual Analog Scale.

TABLE 5. Electrophysiological findings according to gaming exposure and symptom severity.

EMG Parameter	≥6 h/day	<6 h/day	*p*-value	High symptom severity (VAS >4)	Low symptom severity (VAS ≤4)	*p*-value
Distal motor latency (ms)	3.30 ± 0.25	3.06 ± 0.26	0.033	3.38 ± 0.12	3.08 ± 0.31	0.008
Motor conduction velocity—forearm (m/s)	53.00 ± 2.68	55.87 ± 3.59	0.035	52.07 ± 1.78	55.65 ± 3.36	0.003
Motor conduction velocity—elbow (m/s)	39.33 ± 7.14	47.91 ± 8.00	0.024	35.73 ± 3.08	48.08 ± 7.17	<0.001
Conduction velocity drop (m/s)	13.67 ± 5.54	7.96 ± 5.43	0.015	16.34 ± 3.71	7.57 ± 4.51	<0.001
Conduction block (%)	34.81 ± 15.02	18.92 ± 22.33	0.124	42.13 ± 7.66	17.97 ± 18.69	0.002

EMG: Electromyography; VAS: Visual Analog Scale.

TABLE 6. Elbow-level electrophysiological findings according to ergonomic risk factors.

Ergonomic Variable	n	Elbow Motor Conduction Velocity (m/s) M ± SD	Conduction Block (%) M ± SD	*p*-value
Elbow support				
Yes	17	53.49 ± 1.48	4.26 ± 2.75	<0.001
No	33	37.73 ± 4.12	39.07 ± 11.44	
Elbow flexion angle				
>90°	28	36.94 ± 3.56	41.10 ± 8.59	<0.001
≤90°	22	48.39 ± 8.24	14.91 ± 19.05	
Device grip style				
Two-thumb grip	23	40.68 ± 7.65	31.21 ± 16.33	0.022
Non–two-thumb grip (four-finger and claw)	27	46.85 ± 6.92	18.45 ± 14.78	

M: Mean; SD: Standard Deviation.

TABLE 7. Multiple linear regression analysis of factors affecting elbow motor conduction velocity.

Independent variables	B	SE	Standardized β	*t*	*p* value
Constant	59.10	3.05	–	19.38	<0.001
No elbow support	−9.85	1.72	−0.52	−5.73	<0.001
Elbow flexion >90°	−7.94	1.60	−0.44	−4.96	<0.001
Device grip (two thumbs)	−2.10	1.22	−0.14	−1.72	0.092
Daily gaming duration (h)	−2.31	0.58	−0.34	−3.98	<0.001

Overall model: $F(4, 45) = 8.76$, $p < 0.001$. All VIF values <2.5.
B: Unstandardized Regression Coefficient; SE: Standard Error.

4. Discussion

In this study, a high proportion of participants with findings consistent with ulnar nerve involvement was observed among male mobile esports athletes (70%), accompanied by electrophysiological differences between clinically positive and negative groups. Prolonged distal motor latency, reduced motor conduction velocity across the elbow segment, and increased conduction block percentages in clinically positive athletes are in line with electrophysiological patterns reported in ulnar neuropathy at the elbow level [17, 19]. These findings indicate that upper extremity nerve involvement in mobile esports athletes can be identified using objective electrophysiological measures in addition to clinical assessment within the study context. Importantly, all variables and statistical comparisons reported in the Results section were explicitly predefined in the Methods section, ensuring methodological transparency and consistency between study design, statistical analysis, and interpretation.

The relatively high proportion of athletes meeting the predefined criteria for clinical positivity should be interpreted within the context of the study design and population characteristics. The cohort consisted of highly active male mobile esports athletes with substantial daily and weekly gaming exposure, representing a high-exposure subgroup within the study sample rather than the general population. Furthermore, the classification was based on a combined screening approach integrating symptoms and provocation tests, which may also capture early or subclinical nerve involvement. Therefore, this proportion should not be interpreted as population-level prevalence but rather as reflecting findings within a high-exposure cohort.

Clinical positivity in the present study was defined based on the coexistence of at least one positive provocation test and at least one clinical symptom. This combined approach aligns with diagnostic strategies described in the literature and may improve classification consistency compared with approaches based solely on symptoms or provocation tests. Previous studies have shown that while provocation tests may demonstrate high sensitivity, their specificity may be limited, and symptom-based approaches alone may increase the likelihood of false-positive classifications. The clear electrophysiological separation observed between clinically positive and negative groups in this study provides convergent support for the internal consistency of the classification approach.

Higher daily and weekly gaming exposure observed in the clinically positive group was associated with differences in both clinical findings and electrophysiological parameters related to ulnar nerve involvement. Previous studies have reported a high prevalence of musculoskeletal complaints in the upper extremities and spinal regions among esports athletes, often related to prolonged and repetitive activities [1, 2]. In mobile esports, neck–shoulder–hand/wrist complaints have been frequently described, and gaming intensity has been associated with symptom severity [20]. The commonly observed elbow-flexed posture during mobile gaming, combined with static loading related to device grip and repetitive finger movements, may be associated with increased mechanical loading of the ulnar nerve at the elbow level [17, 21].

The regression analysis indicated that lack of elbow support, elbow flexion greater than 90°, and daily gaming duration were associated with reduced elbow motor conduction velocity. Because elbow motor conduction velocity was selected as a segment-specific indicator of ulnar nerve function at the elbow, these findings suggest that selected ergonomic and exposure-related variables may be associated with electrophysiological differences within the study cohort. The proportion of explained variance ($R^2 = 0.42$) indicates that these variables may account for part of the variability in elbow-level motor conduction velocity. However, given the cross-sectional design, these associations should be interpreted cautiously and do not imply causal relationships.

The electrophysiological differences observed between clinical groups are consistent with literature emphasizing the role of electrodiagnostic evaluation in ulnar neuropathy and cubital tunnel syndrome. Parameters such as segment-specific conduction slowing and conduction block across the elbow are considered important for diagnostic assessment and clinical interpretation [17, 19]. The use of motor conduction-based electrophysiological criteria in this study supports methodological consistency and facilitates interpretation of the findings.

Although the most prominent electrophysiological differences were observed across the elbow segment, the modest reduction in forearm motor conduction velocity should be interpreted with caution. This finding may reflect technical variability, generalized nerve functional differences, limb temperature-related factors, or other non-localized physiological influences reported in electrophysiological assessments [12, 13]. Therefore, these findings may reflect more generalized or non-localized influences rather than segment-specific pathology at the elbow.

In the current study, clinically positive athletes were further categorized as mild or moderate–severe based on motor conduction findings. This approach is broadly consistent with clinical frameworks used in the assessment of ulnar neuropathy severity [22]. Although the present study focused on clinical, electrophysiological, and ergonomic associations rather than treatment outcomes, the observed findings may help generate hypotheses for identifying individuals in future research settings [23]. These findings may also inform future studies examining ergonomic and exposure-related factors in mobile esports populations. However, the present cross-sectional study did not evaluate treatment outcomes, rehabilitation effects, or longitudinal progression, although such aspects have been explored in previous studies [24, 25].

The observed differences in clinical provocation tests (Tinel's test, Froment's test, and the elbow flexion test) between groups suggest that these assessments may be useful for exploratory screening purposes in field-based research settings. However, existing literature indicates that the diagnostic accuracy of any single clinical test is limited, and that a combined approach incorporating clinical evaluation, electrophysiological assessment, and, when indicated, imaging modalities may provide greater diagnostic reliability [13, 21].

Despite the widespread reporting of upper extremity symptoms among esports players and individuals engaged in intensive digital gaming, some studies have not identified consistent objective electrophysiological abnormalities [1, 3, 26]. These discrepancies may reflect differences in exposure intensity, study populations, and electrophysiological methodologies. In particular, studies focusing exclusively on distal motor latency or generalized conduction velocities may overlook more sensitive elbow–segment–specific impairments [13, 21]. The present findings highlight the importance of segmental evaluation of the elbow in high-exposure gaming populations.

Finally, although the cross-sectional design precludes causal inference, the overall pattern of clinical findings, electrophysiological results, and regression analysis is consistent with an association between mobile esports exposure and elbow-level ulnar nerve function differences. However, due to the absence of a non-gaming control group, these findings should be interpreted as reflecting associations within the study cohort rather than evidence of increased risk relative to the general population. Prospective, longitudinal, and multicenter studies are required to clarify temporal relationships and to further examine ergonomic and exposure-related associations.

5. Conclusions

Findings consistent with ulnar nerve involvement were identified at both clinical and electrophysiological levels in male mobile esports athletes. Clinically positive athletes exhibited lower motor conduction velocity across the elbow segment and higher conduction block values than clinically negative individuals, supporting the value of integrating standardized clinical assessment with electrophysiological evaluation. Higher gaming exposure and selected ergonomic factors—particularly lack of elbow support and sustained elbow flexion—were associated with differences in elbow-level motor conduction parameters. These findings highlight the potential importance of ergonomic awareness and routine screening strategies for individuals engaged in prolonged mobile esports participation. Future prospective and longitudinal studies with larger and more diverse populations are needed to clarify temporal relationships, establish causal mechanisms, and evaluate the effectiveness of preventive ergonomic interventions.

6. Limitations

This study integrates standardized clinical assessment with detailed elbow-segment electrophysiological evaluation in male mobile esports athletes, a relatively underexplored population. The combined evaluation of clinical findings, gaming exposure, and ergonomic variables supports internal consistency within the study design.

However, several limitations should be acknowledged. First, the single-center, cross-sectional design precludes causal inference and limits generalizability. Participants were recruited using a convenience sampling approach, and individuals with existing symptoms may have been more likely to participate, which may have influenced the proportion of clinically positive cases.

Second, the absence of a non-gaming or low-exposure control group should be considered an important limitation, as it limits the ability to determine whether the observed findings are specific to mobile esports participation or reflect within-cohort exposure differences.

Third, the sample consisted exclusively of male athletes, which reflects the demographic characteristics of competitive mobile esports but restricts generalization to other populations.

Fourth, ergonomic variables were assessed using observational methods combined with participant self-report rather than objective measurement tools, which may have introduced classification bias and limited measurement precision. Variables such as elbow flexion angle, wrist extension, and forward head posture were based on visual estimation, and measurement error cannot be excluded. In addition, all assessments were performed by a single observer, and inter-rater and intra-rater reliability were not assessed, which may have introduced additional measurement variability. Self-reported data may also be subject to recall bias.

Fifth, ultrasonographic evaluation was not performed, and multimodal assessment may provide additional structural information.

Finally, the sample size was determined based on feasibility rather than an a priori power calculation. Although sensitivity analysis was conducted, the study may have been underpowered to detect smaller effects. The relatively small sample size may also limit the stability of the regression model; therefore, these findings require confirmation in larger and more diverse samples.

ABBREVIATIONS

EMG, electromyography; MOBA, multiplayer online battle arena; FPS, first-person shooter; VAS, visual analog scale; CMAP, compound muscle action potential; VIF, variance inflation factor; Q–Q, quantile–quantile.

AVAILABILITY OF DATA AND MATERIALS

The datasets generated and analyzed during the current study are not publicly available due to institutional and ethical considerations involving human participants. However, anonymized data supporting the findings of this study are available from the corresponding author upon reasonable request.

AUTHOR CONTRIBUTIONS

EB and İHD—designed the research study and wrote the manuscript. EB—performed the research, collected the data, and analyzed the data. İHD—provided clinical supervision and expert advice on electrophysiological assessment. Both authors contributed to manuscript revision and approved the final version.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was approved by the Non-Interventional Clinical Research Ethics Committee of Adıyaman University (Decision No: 2026/1-18; Date: 19 January 2026). Written informed consent was obtained from all participants prior to inclusion in the study. The study was conducted in accordance with the principles of the Declaration of Helsinki.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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