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Effect of PUBG Game Addiction on Overusing Hand Grip and Upper Trapeziusin Adolescents

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Abstract

Background: Technological advancements have made gaming a central part of adolescents' lives, with PUBG being a popular yet addictive game linked to prolonged screen use and poor postures. This can lead to musculoskeletal issues like upper trapezius fatigue and reduced hand functionality. While the psychological effects of gaming addiction are well-documented, its physical impacts on muscle activity and grip strength remain under explored, high lighting the need for this study.

Aim of Study: To investigate the effect of Player Unknown's Battle Grounds (PUBG) game addiction on upper trapezius muscle activity, hand grip strength and pinch grip strength in adolescents.

Material and Methods: This cross-sectional study investigated the effect of PUBG game addiction on upper trapezius muscle activity, hand grip strength, and pinch grip strength in adolescents. The study was conducted in international schools and clubs in 10th of Ramadan City, Cairo, Egypt, and included sixty adolescents aged 10–19 years. Participants were divided into two equal groups: Group (A), the non-addicted group, and group (B), the addicted group. The main outcome measures included upper trapezius (UT) root mean square (RMS), electromyography (EMG) turns, hand grip strength, and pinch grip strength. Additionally, data from the addicted group were collected regarding UT RMS and EMG turns before starting PUBG, after 15 minutes of playing, and after 30 minutes of playing.

Results: Statistically significant differences were observed between groups in All measured outcomes ($p<0.001$). From baseline to 15 minutes of gameplay, significant reductions were recorded in Upper Trapezius Root mean square (MD = –7.87, 95% CI: –9.16 to –6.57, $p<0.001$) and Electromyography turns (MD = –1.43, 95% CI: –1.81 to –1.05, $p<0.001$). Similarly, from baseline to 30 minutes of gameplay, Upper trapezius Root mean square (MD = –16.6, 95% CI: –18.68 to –14.52, $p<0.001$) and Electromyography turns (MD = –3.33, 95% CI: –3.8 to –2.87, $p<0.001$) showed further significant reductions.

Conclusion: PUBG game addiction significantly affects physical health in adolescents. Specifically, it leads to increased activity in the upper trapezius muscle and decreased hand grip and pinch grip strength when comparing addicted adolescents to non-addicted adolescents one. These findings suggest that excessive gaming could negatively impact muscle activity and physical function in this age group. The sustained muscle activity could result in muscle imbalance and discomfort over time. Additionally, the decrease in hand grip and pinch grip strength indicates impaired physical function and reduced muscle endurance.

Key Words: *PUBG game – Addiction – Hand grip – Pinch grip – Adolescents.*

Introduction

TECHNOLOGICAL advancements have significantly transformed how adolescents engage with digital entertainment, making smartphones and gaming a central part of their lives. PUBG, an online multiplayer game, has gained massive popularity, especially among adolescents, but it also poses risks of addiction due to its competitive and immersive nature **[1]**.

The musculoskeletal impact of smartphone gaming is profound. Prolonged usage often involves sustained neck flexion, repetitive thumb movements, and awkward wrist postures. These factors can contribute to musculoskeletal disorders, including fatigue in the upper trapezius muscle, carpal tunnel syndrome, and reduced hand functionality **[2,3]**.

Most of the studies focusing on youths, use of the new technologies (smartphones, tablets, etc.) have addressed children and adolescents age 8 to 18 years **[4]**. High user of screens was found to show poorer emotion regulation, impaired capacity of

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finishing tasks, lower curiosity, lower self-control, higher anxiety, and depression symptoms [5].

Player Unknown's Battle Grounds (PUBG) is a multiplayer online "battle royale" endurance game where players are parachuted onto an island and must find weapons and then kill everybody else on the island to win [1]. It is a game which attracts all the youngsters. The game is based on violation, aggressiveness, fearfulness and much more factors which lead to PUBG addiction [6]. Some of the well-known consequences of playing PUBG to the neglect of everything else include exhaustion, eye strain, headaches, obesity, insomnia, poor quality of sleep, withdrawal symptoms (irritability and rage), drug abuse, and suicide [7].

Although the psychological effects of gaming addiction are well-documented, its physical implications, particularly on muscle activity and grip strength, remain underexplored. This study addresses this gap by analyzing the effects of PUBG addiction on the musculoskeletal health of adolescents, with a focus on upper trapezius muscle activity, hand grip strength, and pinch grip strength [8].

Material and Methods

Study design and participants:

This cross-sectional study was conducted between March and October 2023 in Cairo, Egypt. Sixty adolescents (30 males and 30 females) aged 10–19 years were recruited from schools and clubs. The current study was conducted in accordance with the guidelines and approved by the local Ethics committee of the Faculty of Physical Therapy, Cairo University No: P.T.REC/012/004160.

Participants were categorized into two groups: Group A (Non-Addicted): Adolescents with minimal or no PUBG gaming exposure. Group B (Addicted): Adolescents scoring high on the PUBG Addiction Test (PAT), indicative of significant gaming addiction. The inclusion criteria required participants to have at least 12 months of smartphone usage exceeding 4 hours daily [9]. Adolescents with neuromuscular disorders, mental disabilities, or recent upper limb surgeries were excluded.

Instrumentation:

A- *PUBG Addiction Test (PAT):*

This validated tool quantifies addiction levels across dimensions like excessive use, obsession, and escapism. The authors framed 55 statements, the data were subjected to Factor Analysis and 7 components were derived, which included components like disengagement, lack of control, excessive use, obsession, distress, escapism and over enthusiasm & impulsive use [10]. PUBG addiction (PAT) test Likert scale was used for scoring ranging from Strongly disagree (5), Disagree (4), Can't say (3), Agree (2), Strongly agree (1).

B- Surface Electromyography (SEMG):

Surface Electromyography used to measure muscle activity in the upper trapezius during gaming sessions. Deymed Surface EMG (Model: TruTrace EMG, PT Type: BF class, Czech Republic) was used in this study. Upper trapezius (UT) activity was measured at three intervals: Baseline, after 15 minutes, and after 30 minutes of continuous PUBG gaming. The Root Mean Square (RMS) and EMG Turns values were used to assess muscle activity, as it reflects the intensity or magnitude of the muscle's electrical output. It's widely used in clinical settings for evaluating muscle performance, rehabilitation, and detecting neuromuscular disorders [11].

C- Jamar hand grip dynamometer:

The Jamar dynamometer is a reliable tool for assessing grip strength, demonstrating high inter-instrument reliability (ICC 0.80–0.83) and strong concurrent validity (r=0.99) with certified standard weights. Its durable, isometric design ensures accurate measurements, making it ideal for routine screening and evaluation of hand conditions. The assessment was carried out with the adolescent's sitting on an adjustable–height chair with back support, hip and knees at right angles and feet maintained on the supporting surface in neutral position with 90-degree elbow flexion. Then, each adolescent was instructed to squeeze the handle of the dynamometer as maximum as he or she can. The measurement was carried out by the same therapist for all adolescents, the mean value of the three all–out gripping trials is considered as hand grip strength value [12].

D- Jamar Pinch Grip Gauge:

It is the most widely used instruments for measuring grip and pinch strength and it is valid and reliable as a tool of hydraulic dynamometer have been used in clinical practice. Patients pinch the silver tab to get an instant kilogram per square inch (PSI) reading on the gauge needle. The pinch gauge is designed to be used with the thumb; however, accurate readings will be obtained whether the thumb or finger (s) is placed on the pinch button. The instrument was designed to be held by a therapist, so that the weight of the pinch gauge is not supported by the patient being tested. This allows for more accurate measurement [13].

Statistical analysis:

The measured variables were statistically analyzed and compared using SPSS for windows version 23 (SPSS, Inc., Chicago, IL) with an Alpha level set at 0.05. Data were screened for normality assumption, homogeneity of variance, and presence of extreme scores. Shapiro-Wilks test for normality showed that the measured variables were normally distributed (p>0.5). Data are expressed as mean and standard deviation for all outcomes except for gender (counts). One-way MANOVA was used to compare among the groups on the combined effect of all outcomes. Repeated measure MANOVA was used to compare between three levels of measurement (baseline, after 15 minutes and after 30 minutes) regarding UT RMS and EMG turns within the addicted group. When MANOVA shows statistically significant, follow-up univariate ANOVAs with Bonferroni correction were performed for every outcome measure to protect against type I error.

Results

The data in Tables (1) showed no statistically significant difference between both groups in baseline demographic characteristics of participants (*p*>0.5).

Between group's comparison:

Results of One-Way multivariate analysis of Variance (MANOVA):

One-way multivariate analysis was conducted to assess the difference between participants in both groups in the amount of change in their scores on the outcome measures. Statistically Significant difference were found for the main effects of groups, Wilk's A = 0.04, $F_{(4,55)}$ = 342.78, $p<0.001$, n^2 = 0.96, for time.

Results of Univariate analysis of Variance (ANOVA):

Follow-up univariate ANOVAs in both groups reveal that statistically significant difference for UT RMS, $F_{(1,58)=1074.59}$, $p<0.001$, n^2=0.95, for EMG turns, $F_{(1,58)=313.17}$, $p<0.001$, n^2=0.85, for hand grip strength, $F_{(1,58)=5.85}$, p=0.02, n^2=0.09, and for pinch grip strength , $F_{(1,58)=13.57}$, p=0.001, n^2=0.19. The results showed statistically significant differences between groups regarding all measured outcomes ($p<0.05$) as in Table (2).

Within group comparison in addicted group:

Results of repeated measures MANOVA:

Repeated measure MANOVA was conducted to assess the difference between three levels of measurements in their scores on the outcome measures in addicted group. Statistically Significant difference were found for the main effects of time, Wilk's A=0.03, $F_{(4,26)=245.01}$, $p<0.001$, n^2=0.97, for time

Results of Univariate ANOVA:

Follow-up univariate ANOVAs reveal that there were statistically significant differences for UT RMS, F=336.85, $p<0.001$, n^2=0.92 and EMG turns, F=248.49, $p<0.001$, n^2=0.9.

Comparison between levels of measurement in addicted group:

From baseline to 15 minutes of playing PUBG:

There were statistically significant differences were found in UT RMS where the MD (95% CI) was –7.87 (–9.16, –6.57) with $p<0.001$ and EMG turns where the MD (95% CI) was –1.43 (–1.81, –1.05) with $p<0.001$ as shown in Tables (3-4).

From baseline to 30 minutes of playing PUBG:

There were statistically significant differences were found in UT RMS where the MD (95% CI) was –16.6 (–18.68, –14.52) with $p<0.001$ and EMG turns where the MD (95% CI) was –3.33 (–3.8, –2.87) with $p<0.001$ as shown in Tables (3-4).

Table (1): Baseline Demographic Characteristics of participants (N=60)*.

Characteristics	Addicted Group (n=30)	Non-addicted Group (n=30)	MD (95% CI)	*p*-value
Age (years)	14.37±2.14	15.27±2.03	–0.9 (–1.98, 0.18)	0.1
Weight (kg)	52.87±6.71	56.17±7.61	–3.3 (–7.01, 0.41)	0.08
Height (cm)	156.97±6.05	159.4±6.86	–2.43 (–0.06, 0.01)	0.15
BMI (kg/m^2)	21.38±1.17	21.99±1.28	–0.61 (–1.24, 0.02)	0.06
Gender, n (%):				
Female	17 (56.67%)	12 (40%)	X^2=1.67	0.2
Male	13 (43.33%)	18 (60%)		

BMI : Body mass index.
X2 : Chi Square.
M.D.: Mean Difference.
CI : Confidence interval.
* Data are mean ± SD for all demographics except gender (%).
p-value <0.05 indicate statistical significance.

Table (2): The clinical characteristics of participants in both groups (N=60)*.

Outcomes	Addicted Group (n=30)	Non-addicted Group (n=30)	MD (95% CI)	*p*-value
UT RMS (µv)	182.23±6.81	115.83±8.76	66.4 (62.35,70.46)	<0.001
EMG turns (Hz)	13.4±1.07	8.5±1.07	4.9 (4.35, 5.45)	<0.001
Hand grip strength (kg)	22.8±2.98	25.23±4.64	–2.43 (–0.42, –4.45)	=0.02
Pinch grip strength (kg)	5.83±0.93	7.1±1.69	–1.27 (–1.96, –0.58)	=0.001

UT : Upper trapezius.
RMS: Root mean square.
Hz : Hertz.
µv : Microvolt.
kg : Kilogram.
MD: Mean Difference.
CI : Confidence interval.
* Data are mean ± SD.
p-value <0.05 indicate statistical significance.

Table (3): The clinical characteristics of participants after 15 and 30 minutes of playing PUBG in addicted group (N=30)*.

Outcomes	Baseline	After 15 minutes	After 30 minutes	*p*-value
UT RMS (µv)	182.23±6.81	190.1±7.95	198.83±9.11	<0.001
EMG turns (Hz)	13.4±1.07	14.83±0.95	16.73±0.98	<0.001

UT : Upper trapezius.
RMS: Root mean square.
Hz: Hertz.
µv: Microvolt.
* Data are mean ± SD.
p-value <0.05 indicate statistical significance.

Table (4): Within group comparisons for all outcome measures in addicted group (N=30)*.

Outcomes	From baseline to 15 minutes	*p*-value
	MD (95% CI)	
UT RMS (µv)	–7.87 (–9.16, –6.57)	<0.001
EMG turns (Hz)	–1.43(–1.81, –1.05)	<0.001
	From baseline to 30 minutes	
UT RMS (µv)	–16.6 (–18.68, –14.52)	<0.001
EMG turns (Hz)	–3.33 (–3.8, –2.87)	<0.001

UT : Upper trapezius.
RMS: Root mean square.
Hz : Hertz.
µv : Microvolt.
MD: Mean Difference.
CI : Confidence interval.
* Data are mean ± SD.
- *p*-value <0.05 indicate statistical significance.

Discussion

Three key risk factors contributing to upper-limb musculoskeletal disorders are poor posture, excessive muscle force, and repetitive muscle use. Among smartphone users, common problematic postures include: (1) Protracting and bending the shoulders beyond 20 degrees, (2) Positioning the elbows at angles greater than 100 degrees while bending the wrists more than 15 degrees with ulnar deviations, and (3) Maintaining forward neck and trunk flexion of 20 degrees or more **[14].**

To optimize device usage in sitting, mounting devices may be considered. For handheld devices (tablets and smart phones, etc.), mounting devices such as tablet cases, mounting stands, tablet cradles, etc. may be considered. For users who input data through tablets, a keyboard case may be considered. For adolescents accessing gaming technology through gadgets, head mounted virtual reality technology may be considered to encourage neutral posture **[15].**

As a golden rule, the more the posture deviates from neutral, the greater stress placed on joints, ligaments, muscles, discs, and nerves; this may directly, decrease upper-extremity function. The two other risk factors are muscle force and muscle use. Continuous static contraction of the upper-limb muscles with no or little resting time in between and the weight of the smartphone device, results in fatigue and muscle weakness. The main affected muscles are the upper trapezius (UT), extensor pollicislongus (EPL), and abductor pollicis (AP) **[16].**

According to the data analysis of the current study, the findings revealed statistically significant differences between the two groups in the mean values of UT RMS, EMG turns, handgrip strength and pinch grip strength. Data collected from the addicted group before starting PUBG, after 15 minutes of game play, and after 30 minutes of game play showed statistically significant increases in upper trapezius (UT) root mean square (RMS) and EMG.

The results of this study revealed a significant difference between the two groups in UT muscle activity. The addicted group showed significant increase in UT muscle activity compared to the non-addicted group ($p<0.001$). The findings of the present study regarding UT muscle activity were aligned with those of previous research. Mehta and Vijayakumar [17] demonstrated that smartphone addiction is significantly associated with postural changes and the development of myofascial trigger points. Given the increasing prevalence of smartphone use, particularly among young individuals, it has been observed that excessive smartphone use reduces social interaction, contributes to insomnia, and is linked to various musculoskeletal issues. These findings underscore the need to raise awareness about smartphone addiction, as its excessive and compulsive use can lead to notable postural alterations and associated health problems [17].

Also, the results of this study agreed with that of Yasarer et al., [18] who found that smartphone addiction, which has been associated with long-term usage in university students, can be associated with postural changes and trigger points in the bilateral levator scapula, UT and right cervical erector muscles.

The study of Radwan et al., [16] confirmed that the risks of using smartphones in adolescents should be mentioned. Two-handed use and decreasing the time of chatting and searching less than 4 hours per day are considered as important factors to reduce the mechanical loads on hand and shoulder girdle. Moreover, enhancing working or studying environment by preventing wrong body alignment as a lying position ensures decreasing the overpressure on the cervical spine. Finally, using a larger display screen may reduce the complaint rate of musculoskeletal symptoms through diminishing the bending angle of the cervical spine while using smartphones.

The significant correlation that was found between smartphone addiction and hand grip strength in normal teenage students indicates that the heavy usage of smartphones is considered a risk factor for hand grip strength that leads to hand pain [19]. In this context, faulty postures such as prolonged wrist flexion and repeated thumb use may affect median nerve.

The comparison of the present study's results between addicted and non-addicted groups, based on EMG turns, aligns with the findings of Wang et al. [20]. Wang and colleagues conducted a study to assess the impact of repetitive thumb movements caused by playing a smartphone game continuously for 30 minutes. Local muscle fatigue was evaluated using surface electromyography (SEMG) signals, which offer the advantages of being non-invasive and providing real-time monitoring. Their results indicated that continuous smartphone gaming could lead to chronic muscle injuries, recommending that gaming sessions should be limited to less than 20 minutes.

Additionally, the significant difference in EMG turns observed in the present study between addicted and non-addicted groups was consistent with the findings of Bahathiq et al. [21]. Their research highlighted a plausible link between smartphone addiction and musculoskeletal pain in the hand, wrist, and thumb, as assessed through SEMG analysis. Similarly, Wang et al. [20] reported a statistically significant increase in pain levels following 30 minutes of continuous smartphone gaming, emphasizing the detrimental effects on the muscles responsible for thumb movements. These findings collectively underscore the negative musculoskeletal impacts of excessive smartphone use.

In their study, Gustsfsson et al., [22] compared the upper limb muscle activity with the thumb kinematics for typing with keypad phones and touchscreen. The results showed that there are significant differences in the risks due to mobile touch screen devices use that causes musculoskeletal disorders. The findings also suggest that while using smartphones, there is a high possibility for developing musculoskeletal disorders with the different key action tools. The study has revealed that the participants with shorter hands have differences in thumb flexion, while those with longer hands have differences in muscle activity.

Using smartphones for texting and playing games in a stationary position for extended periods strains the hand muscles, causing pain. Constant pain in the hands and fingers may result from a decrease in blood flow and the delivery of nutrients to the muscles [8].

A comparison of the present study's results regarding pinch grip strength between addicted and non-addicted Groups aligns with the findings of Radwan et al. [16]. Radwan et al., observed that hand dominance affected hand grip and pinch grip strength based on the extent of smartphone use. Their findings indicated that excessive smartphone use predominantly impacted the dominant hand, as it is more commonly engaged in both smartphone-related and daily activities, resulting in greater fatigue compared to the non-dominant hand.

This study results agreed with the studies of Osailan, [24] and Radwan et al., [16] who found that handgrip and pinch strengths decreased with increased smartphone use, and this was explained by the modified position of the hand and thumb while holding the device. The median nerve supplies the muscles used to grasp and pinch, hence overusing those muscles might weaken grip and pinch.

The findings of this study, which focused on normal adolescent students, contradict those of other research. For example, Jayaram et al. [17] studied 220 medical students and found that prolonged active smartphone use (e.g., texting and scrolling) did not negatively affect hand dexterity. Similarly, Ernsting et al. *[25]* found no relationship between smartphone use and finger dexterity, despite lower-than-average dexterity being observed among students. The contradiction between this study and the findings of Jayaram et al. *[17]* and Ernsting et al. (2017) *[25]* can be attributed to several key differences in population characteristics, smartphone usage patterns, methodologies, and confounding factors, all of which highlight the complex relationship between smartphone use and hand functionality.

Our result also comes in disagreement with Alshahrani et al. *[23]* who found that no significant differences between the addicted and non-addicted groups in handgrip and pinch strengths. Additionally, Aswathappa et al. *[26]* studied 100 students aged 18–25 years and reported that smartphone addicts, compared to non-addicts, exhibited significantly reduced upper limb coordination and lower upper trapezius muscle activity.

Also, Osailan *[24]* found a weak relationship between smartphone usage duration and handgrip, and pinch-grip strength. The disagreement between our study and these findings may be attributed to differences in the study populations and methodologies. Alshahrani et al. *[23]* focused on 40 healthy adult male college students aged 18 to 27, a population that differs significantly from the adolescent group examined in the current study. Young adults may have greater physical resilience, better muscle conditioning, and higher adaptability to repetitive tasks like smartphone use, which could explain the lack of significant differences in handgrip and pinch strength between addicted and non-addicted groups in their study.

Similarly, Osailan *[24]* found only a weak relationship between smartphone usage duration and handgrip or pinch-grip strength in his observational study. This discrepancy may stem from differences in the assessment tools, sample size, or study design. For instance, variations in smartphone usage patterns (e.g., type of tasks performed, intensity, or duration) and other confounding factors such as physical activity levels, lifestyle habits, or ergonomic practices could also influence the results. In contrast, all these studies may have captured more nuanced impacts of smartphone overuse, particularly in adolescents, whose musculoskeletal systems are still developing and may be more sensitive to repetitive strain

Conclusion and Recommendations:

Excessive PUBG gaming significantly impacts musculoskeletal health, manifesting as increased trapezius muscle activity and decreased hand and pinch grip strength. These effects underline the importance of preventive measures and educational campaigns to mitigate gaming addiction's physical risks.

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Conflict of Interests:

Authors declare no potential conflicts of interest.

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تأثير إدمان لعبة ببجي على فرط استخدام قبضة اليد والجزء العلوى من العضله شبه المنحرفه عند المراهقين

تتناول الدراسة تأثير إدمان لعبة ببجى على النشاط العضلى والصحة البدنية لدى المراهقين، حيث هدفت إلى التحقق من تأثير هذا الإدمان على نشاط العضلة شبه المنحرفة العلوية وقوة قبضة اليد وقوة القبضة الدقيقة. أجريت الدراسة على عينة مكونة من ٦٠ مراهقًا تتراوح أعمارهم بين ١٠ و١٩ عامًا، تم تقسيمهم إلى مجموعتين متساويتين، الأولى غير مدمنة ولم تمارس اللعبة، والثانية مدمنة وتمارس اللعبة بانتظام. تضمنت النتائج فروقًا ذات دلالة إحصائية في المقاييس المتعلقة بنشاط العضلة شبه المنحرفة العلوية (UT RMS) وعدد الإشارات الكهربائية للعضلات (EMG Turns) وقوة قبضة اليد وقوة القبضة الدقيقة بين المجموعتين، حيث أظهرت المجموعة المدمنة انخفاضًا كبيرًا فى هذه القيم عند مقارنتها بغير المدمنة، مع استمرار الانخفاض بعد ١٥ و٣٠ دقيقة من اللعب. خلصت الدراسة إلى أن إدمان ببجى يؤثر سلبًا على النشاط العضلي والوظائف البدنية لدى المراهقين، مما يشير إلى مخاطر الإفراط فى ممارسة الألعاب الإلكترونية على الصحة البدنية فى هذه المرحلة العمرية.