

Effects Of 12 Week Upper Limb Strength Training Combined with Ergonomic Intervention When Compared to Static Stretches in Youth Esports Players - A Quasi Experimental Study

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Abstract

Background: Mobile esports players are vulnerable to musculoskeletal issues due to prolonged poor postures and repetitive upper limb movements.

Objective: To evaluate the effectiveness of ergonomic interventions and upper limb strength training in improving musculoskeletal outcomes in collegiate esports athletes.

Design: Quasi-experimental study.

Methods: 46 collegiate mobile esports players were divided into Ergonomics + Strength Training (EST) and Ergonomics + Static Stretching (ESS) groups. Ergonomic correction and strength training were implemented over 12 weeks. Outcomes included RULA scores, grip strength, assessed at baseline, mid, and final phases and QuickDASH scores were assessed at the end of every week.

Results: Repeated measures ANOVA showed significant improvements in RULA ($F=899, p<0.001$), QuickDASH ($F=74.4, p<0.001$), and grip strength ($F=1010, p<0.001$) in the intervention group compared to controls.

Conclusion: Ergonomic correction and upper limb strengthening improve functional outcomes in esports players, suggesting the need for structured training and ergonomic education in this population.

Keywords: esports, ergonomics, grip strength, upper limb, QuickDASH, youth health

1. INTRODUCTION

Electronic sports (esports) have rapidly evolved into a mainstream global phenomenon, particularly engaging younger populations. What began as niche arcade contests in the 1970s has transformed by the 2000s into a structured competitive ecosystem that mirrors traditional sports in many respects (1,2). Today, professional esports draws hundreds of millions of viewers worldwide and generates billions of dollars in revenue (1). This surge includes the rise of scholastic and collegiate esports; for instance, over 50 U.S. colleges have instituted varsity esports programs (complete with athletic scholarships) in recent years (3). Esports was a part of 2022 Asian games, Hangzhou. International Olympic Committee (IOC) has announced the Inaugural Olympic Esports Games in partnership with Esports World Cup Foundation (ECWF) will be held in Riyadh from 2027 (4). Esports has thus become firmly entrenched in youth culture, with surveys indicating that a significant minority of adolescents—about 5% of 16–18-year-olds in one study actively participate in organized esports competition predominantly young males (2). These developments underscore that esports players, even at youth and amateur levels, are increasingly treated as athletes in need of training and health management akin to their counterparts in traditional sports (5).

Despite the virtual nature of competition, esports athletes face very real musculoskeletal stresses. The physical demands of high-level gaming are unique: elite players perform 400–600 fine motor actions per minute with mouse and keyboard or controller, often sustaining 5–10 hours of practice daily in static seated postures (6). Consequentially, a growing body of evidence reports a high incidence of upper limb and axial musculoskeletal problems among esports participants. Cross-sectional surveys have found that over two-thirds of competitive gamers experience musculoskeletal pain or discomfort, with the neck

and shoulder region most frequently affected, followed by the hand, wrist, and lower back (5). Notably, one study of collegiate e-athletes reported 42% prevalence of neck/back pain, 36% wrist pain, and 30% hand pain among players (5,7). Such overuse-related complaints often mirror those seen in sedentary office workers, yet at a greater intensity given the extreme repetitive loads in esports (3). In terms of clinical patterns, the most common upper limb injuries in esports are repetitive strain injuries including carpal tunnel syndrome, tendinopathies of the wrist and forearm, and lateral epicondylitis. These overuse injuries stem from chronic microtrauma and can become severe; alarmingly, they have been cited as causes of premature retirement in prominent young players. Yet despite their frequency and impact, esports-related musculoskeletal disorders remain under-recognized and under-researched in sports medicine.

Multiple risk factors contribute to the development of upper limb injuries in esports, chief among them being inadequate muscular conditioning of the involved regions. Unlike traditional athletes, many competitive gamers do not engage in routine physical exercise or resistance training nearly 40% of collegiate esports players report no regular exercise outside of gaming (3). This lack of fitness may leave the stabilizing muscles of the shoulder girdle, arm, and forearm relatively weak or lacking endurance, thereby reducing their capacity to absorb repetitive strain. Fatigued or weak musculature provides poor support during prolonged gameplay, causing greater load to be transferred to passive structures like tendons, ligaments, and joint surfaces (5). Over time, these tissues can be pushed beyond their physiological recovery capacity, precipitating cycles of micro-injury and inflammation that manifest as chronic tendinopathies and pain syndromes. For example, insufficient strength in the forearm extensors and shoulder stabilizers may expedite the onset of overuse conditions such as lateral epicondylitis or rotator cuff tendinitis under intensive gaming demands (5). In essence, a sedentary lifestyle combined with the repetitive high-frequency movements of esports creates a dangerous mismatch between external loads and the musculoskeletal system's internal tolerance. This imbalance underscores the role of poor upper limb fitness as a modifiable risk factor for esports injuries.

In addition to intrinsic factors, ergonomic stresses and suboptimal playing environments significantly contribute to musculoskeletal strain in youth esports players. Esports athletes typically maintain prolonged static postures – often seated for hours with a forward head, flexed neck posture, rounded shoulders, and flexed elbows/wrists – which leads to continuous low-level loading of postural muscles and joint structures (7,8). Such sustained poor posture is strongly associated with text neck syndrome (TNS), low-back pain, and upper limb disorders as evidenced by parallels in other sedentary populations (8).

Workstation setup and device use further modulate risk: an improper desk or chair height can force non-neutral wrist and shoulder positions, while excessive mouse and keyboard use with poor ergonomics promotes strain on the wrist tendons and median/ulnar nerves (6). For younger gamers, the ubiquitous use of mobile devices for gaming introduces additional concerns. Handheld gaming on phones/tablets often requires awkward grip and intensive thumb motions, and research has linked heavy smartphone use to neck, shoulder, and thumb musculoskeletal problems in adolescents (3). Indeed, studies of mobile esports players document a similar or even higher prevalence of upper extremity issues despite the smaller form factor, indicating that repetitive stress and poor posture are detrimental across platforms (9). Altogether, these ergonomic challenges from chair and monitor positioning to the design of controllers and mobile devices create an environment conducive to overuse injuries if left uncorrected. The sustained muscle tension and compressive forces in suboptimal postures accelerate fatigue and tissue breakdown, compounding the injury risk initiated by long practice hours.



Figure 1 a & b - Posture of collegiate level esports players during game time

Given the raise of injury burden in esports and the identifiable risk factors involved, there is a compelling rationale for proactive intervention. In traditional sports, comprehensive conditioning and attention to biomechanics are cornerstones of injury prevention, and emerging evidence suggests esports should be no different. Targeted upper limb strength training may enhance muscular endurance and shock absorption capacity, thereby protecting tendons and joints from cumulative trauma during play. Recent recommendations in esports medicine have advocated for integrating regular physical exercise into gamers' routines, noting that increasing players' general fitness could mitigate some of the health risks of intensive gaming (6,10). At the same time, ergonomic interventions – such as optimizing desk setup, chair support, monitor height, and input device ergonomics, as well as educating players on posture and scheduled rest breaks – are expected to reduce musculoskeletal stress during gaming (10).

Preliminary consensus guidelines for healthy gaming already emphasize musculoskeletal care (e.g. stretching, ergonomic adjustments) alongside vision, psychological, and sleep hygiene recommendations (10). Esports competitors exhibit similar injury patterns as office workers (3). However, empirical data on the efficacy of such interventions in esports athletes remain scarce. Experts have highlighted a paucity of research on injury prevention in esports and called for evidence-based protocols to address these emerging needs. This is especially pertinent for youth esports players, who may be still developing physically and could be more vulnerable to long-term damage if injuries are not prevented early. In light of these gaps, this study was designed to examine the impact of an upper limb training regimen alongside ergonomic improvements in young esports athletes. We hypothesize that this combined intervention will improve musculoskeletal resilience and reduce the risk of overuse injuries in the upper limbs, thereby promoting safer participation in competitive esports for youth athletes.

2. METHODS

2.1 Study Design: In this quasi-experimental study, ergonomic training was considered a confounding factor, as it could potentially influence musculoskeletal outcomes regardless of the intervention. Therefore, ergonomic training was provided to all participants in both the intervention and control groups prior to the commencement of the actual interventions.

2.2 Study population: Collegiate-level mobile esports players were selected for participation, with a minimum of 4 hours per day of gaming experience and at least 1 year of gaming history. Mobile gamers were prioritized to focus on the unique ergonomic and musculoskeletal challenges presented by handheld devices.

2.3 Inclusion Criteria: Age 18-24 years, both male and female participants, mobile esports gamers with a minimum of 4 hours of gaming per day. Willingness to participate in the full study duration (12 weeks) and complete all assessments and training sessions Ability to provide written informed consent.

2.4 Exclusion Criteria: Prior upper limb disabilities, prior accidents involving upper limb injuries. Non-mobile gamers (primarily engage in PC/console gaming), severe postural deformities (e.g., scoliosis, kyphosis, severe forward head posture), currently undergoing physical therapy or ergonomic treatment for any musculoskeletal condition, pregnancy, known neurological conditions (e.g., Multiple Sclerosis, Parkinson's Disease) affecting muscle strength and coordination, severe psychological conditions (e.g., severe depression, anxiety) that may limit participation or compliance with the study

2.5 Study setting: Sports Medicine Department, Saveetha Medical College and Hospitals, SIMATS, Chennai.

Sample size was determined via G*Power version 3.1.9.6. for an independent samples t-test (two-tailed) comparing post-test means between two groups (intervention and control), with the following statistical parameters effect size (Cohen's d): 0.98, power: 0.80 and 0.05 significance level (α). To find a statistically significant difference with these parameters, a minimum sample size of 39 participants (approximately 20 per group) is needed with an estimated 15–20% attrition rate. Informed written consent was obtained from all participants prior to their recruitment into the study.

2.6 Ergonomic Training: All participants received an ergonomic training session to correct posture, workstation setup, and provide education on posture breaks and stretching exercises. This training was considered necessary due to the potentially confounding effect of poor ergonomic practices on musculoskeletal outcomes.

2.7 Baseline Data Collection: Baseline data (RULA scores, QuickDASH, and grip strength) were collected one week after the ergonomic training to allow participants to become familiar with the changes and to minimize the immediate impact of the training on musculoskeletal outcomes. This one-week period helped ensure that the ergonomic training did not confound the results of the primary intervention.

2.8 ERGONOMICS + STRENGTH TRAINING (EST) GROUP: Participants in the EST group continued the neck and upper limb strength training program, which included resistance band exercises, forearm strengthening, and rotator cuff, shoulder and parascapular strengthening along with fingers and neck strengthening, performed 3 times per week with an individualised progressive regime. In addition, participants continued the stretching routine (focusing on wrist, forearm, and shoulder stretches) to further improve mobility and counteract the muscle tightness from prolonged gaming Figure 4.

2.9 ERGONOMICS + STATIC STRETCHES (ESS) GROUP: The ESS group did not receive any additional interventions beyond the standardized ergonomic training (11).

2.10 Outcome Measures:

i. Rapid Upper Limb Assessment (RULA): A quick ergonomic tool called RULA was developed to evaluate the risk of upper limb problems associated with the workplace in 1993 by McAtamney and Corlett and addresses the postural, muscular, and force concerns associated with activities involving the upper limbs, neck, and trunk, especially in jobs that are repetitive or sedentary. A score ranging from 1 (low risk) to 7 (high risk) is generated by the assessor based on the body postures, force/load, and repetition requirements for a particular task. Greater urgency for ergonomic intervention is indicated by a higher score (12).

ii.

iii. Quick Disabilities of Arm, Shoulder and Hand (QuickDASH): The Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire has been condensed to QuickDASH (13,14). It has 11 measures that evaluates physical function and symptoms in individuals with musculoskeletal disorders of the upper limbs. Because QuickDASH lowers response burden while preserving validity and reliability, it is commonly used in clinical and research settings. By asking patients about their capacity to carry out everyday tasks and the presence and intensity of symptoms, it offers a standardised way to measure upper extremity disability and follow the results of therapies.

iv. Grip Strength: Grip strength was assessed using CAMRY EH101 handheld dynamometer (15) Figure 3.

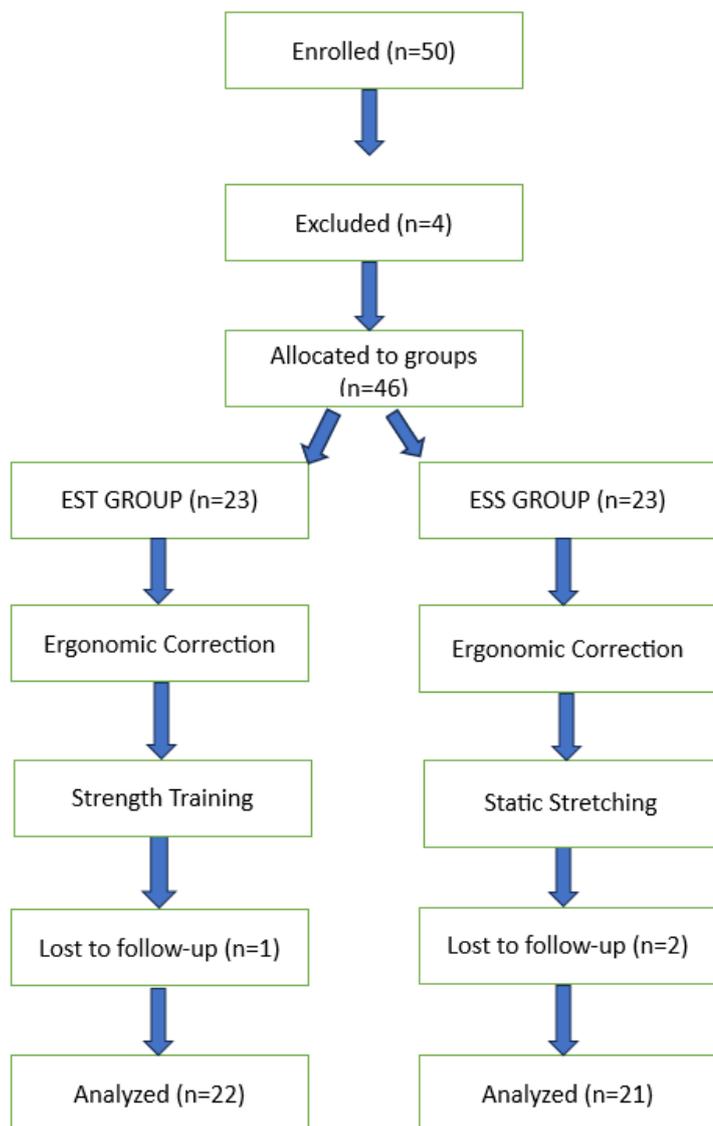


Figure 2 Participants Flowchart



Figure 3 CAMRY EH101 Hand Dynamometer

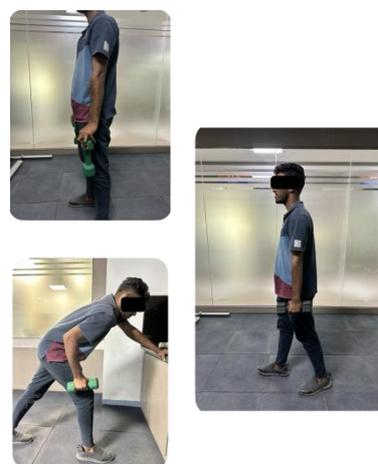


Figure 4 Upper limb Strength training focusing the kinetic chain

Outcomes included Rapid Upper Limb Assessment (RULA) scores, QuickDASH (13,14,16), and grip strength. RULA and grip strength were assessed at the baseline, followed by 6 weeks and 12 weeks. QuickDASH questionnaire was assessed on a weekly basis using the QuickDASH forms.

2.11 Statistical Analysis: Data were entered in Microsoft Excel and analyzed using Jamovi (Version 2.0). Descriptive statistics summarized participant demographics and baseline characteristics. The primary analysis involved repeated measures ANOVA to examine the changes in RULA scores, QuickDASH, and grip strength across the three time points (baseline, mid-intervention, and post-intervention), adjusting for the initial ergonomic training as a confounding factor. A significance level of $p < 0.05$ was considered statistically significant for all analyses.

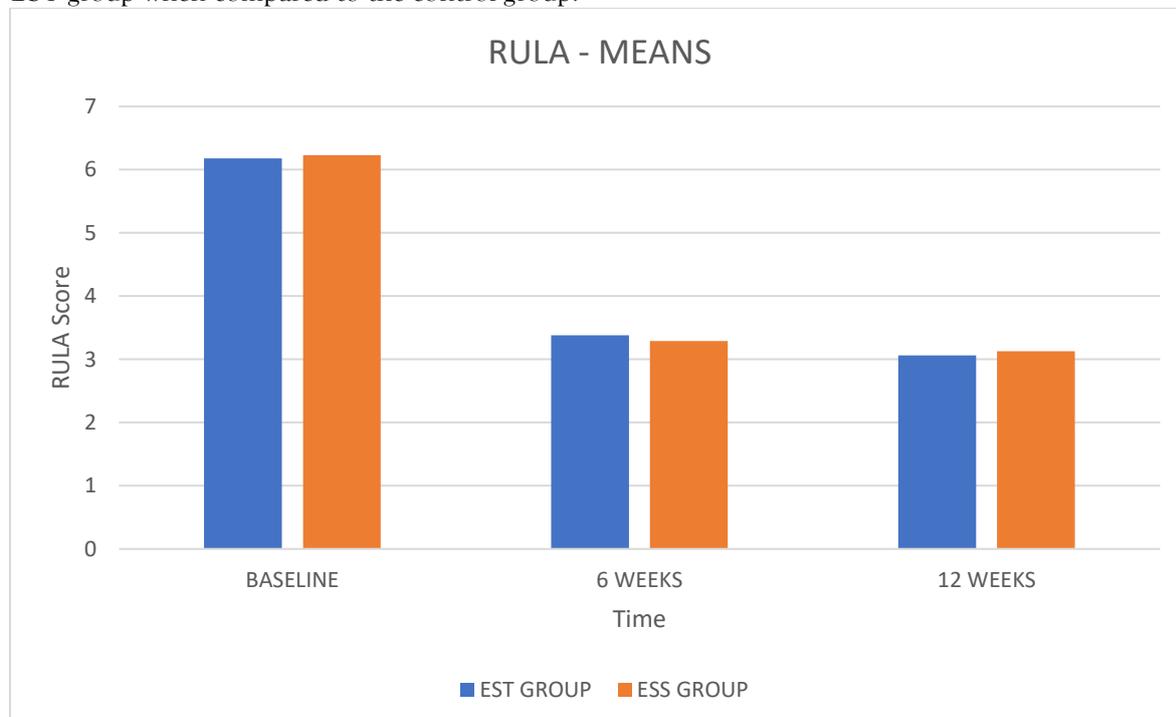
3. RESULTS:

3.1 Demographics: The mean age of the participants was 22 years (± 3 SD). The mean daily gaming duration was 5 hours (± 1 SD), indicating consistent high gaming exposure across the study population. Among the participants, 92.6% were male and 7.4% were female, reflecting the male predominance in the collegiate esports demographic. In terms of grip technique during mobile gaming, 55.6% of participants reported using a two-finger grip, 24.7% used a three-finger grip, and 16% used a four-finger grip. Regarding gyroscope usage, 38.3% of players used the gyroscope function during gameplay, while 61.7% did not use this feature. When assessing ergonomic support, 70.4% of participants reported using pillows or cushions as armrests, whereas 29.6% did not use any form of external support.

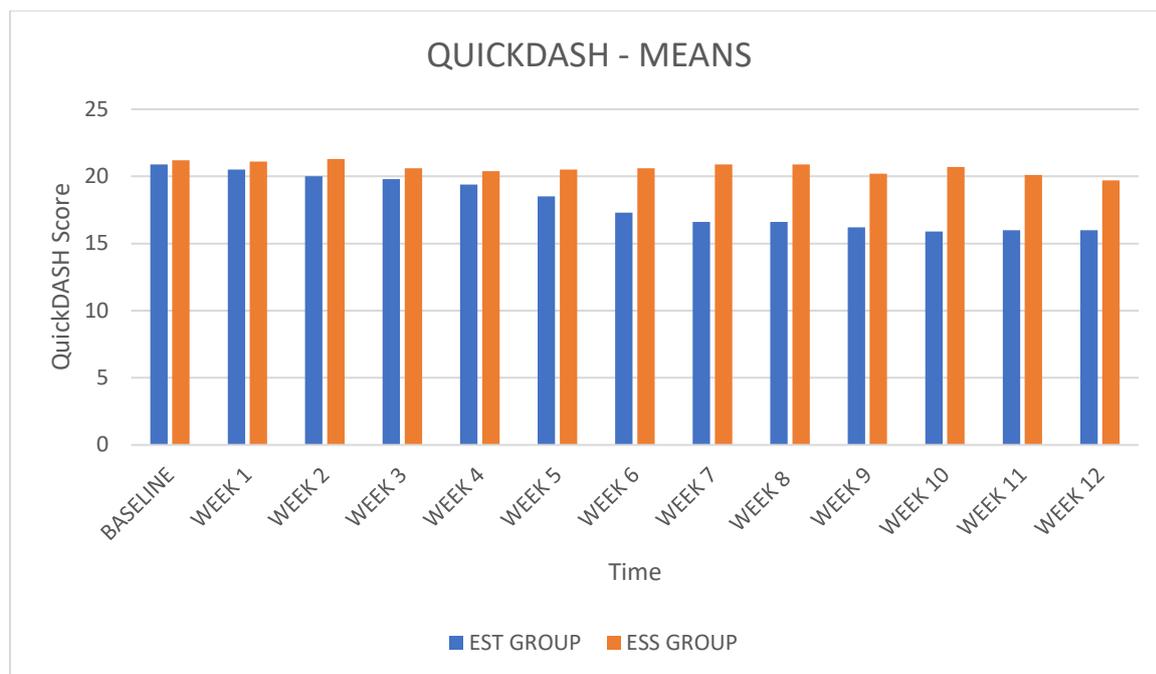
3.2 Data Analysis:

i. RULA: A one-way repeated measures ANOVA demonstrated significant effects on RULA scores in both the EST ($F(2,86) = 899, p < 0.001$) and ESS ($F(1.5, 43.4) = 517, p < 0.001$) groups following the implementation of the ergonomic corrective measures Graph 1 Table -1. The data was normally distributed as assessed by visual inspection of Q-Q plot. This indicates that the ergonomic corrective measures led to significant improvements in ergonomic conditions as evidenced by changes in RULA scores within each group. Post hoc analysis with Tukey's adjustment showed a decreasing trend from the 1st to 3rd readings over time within each group and was found to be statistically significant.

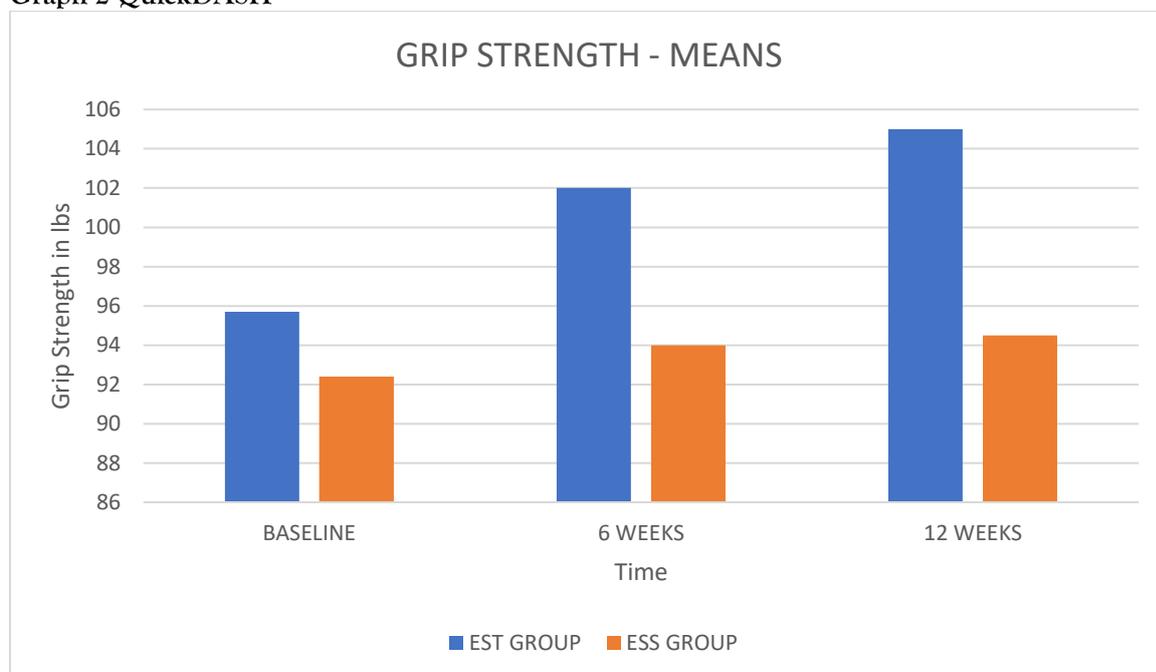
ii. QuickDASH: A one-way repeated measures ANOVA demonstrated significant effects on QuickDASH scores in the EST ($F(2,95) = 74.4, p < 0.001$) but not in the ESS group ($F(3,96) = 2.38, p < 0.071$) Graph 2 Table-2. The data was normally distributed as assessed by visual inspection of Q-Q plot. This indicates that the strength training led to significant improvements in QuickDASH score within the EST group when compared to the control group.



Graph 1 RULA - MEANS



Graph 2 QuickDASH



Graph 3 - GRIP STRENGTH

GROUP	RULA BASELINE MEAN (SD)	RULA 6 WEEKS MEAN (SD)	RULA 12 WEEKS MEAN (SD)	F TEST (df)	P-value
EST GROUP	6.18 (0.59)	3.38 (0.49)	3.06 (0.24)	899 (2,86)	<0.001
ESS GROUP	6.23 (0.71)	3.29 (0.46)	3.13 (0.34)	517 (1.5, 43.4)	<0.001

Table -1 RULA

iii. Grip Strength: A one-way repeated measures ANOVA demonstrated significant effects on grip strength in the EST group ($F(1.5,73.5) = 1010, p < 0.001$) than ESS ($F(2,60) = 16.7, p > 0.09$) group following the implementation of strength training Graph 3 Table-3. The data was normally distributed

as assessed by visual inspection of Q-Q plot. This indicates that the upper limb strength training led to significant improvements in grip strength conditions as evidenced by changes in the dynamometer readings within each group. Post hoc analysis with Tukey's adjustment showed an increasing trend from 1st to 3rd measurements over time within the EST group which was statistically significant.

iv.

Groups	Baseline	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	F test (df)	P-value
EST Group	20.9 (8.39)	20.5 (8.48)	20 (8.08)	19.8 (7.99)	19.4 (7.84)	18.5 (7.56)	17.3 (7.01)	16.6 (6.74)	16.6 (6.60)	16.2 (6.61)	15.9 (6.77)	16.4 (6.54)	16.3 (6.43)	7.2 (2,94)	<0.01
ESS Group	21.2 (6.83)	21.1 (6.50)	21.3 (6.27)	20.6 (5.81)	20.4 (5.80)	20.5 (5.70)	20.6 (5.69)	20.9 (5.64)	20.9 (5.35)	20.2 (5.69)	20.7 (4.96)	20.1 (4.88)	19.7 (5.22)	2.3 (3,96)	0.071

Table-2 QuickDASH

Groups	BASELINE	WEEK 6	WEEK 12	F TEST (df)	P-value
EST GROUP	95.7 (10.6)	102 (10.7)	105 (10.9)	1010 (1.5,73.5)	<0.001
ESS GROUP	92.4 (13.3)	94 (13.70)	94.5 (13.6)	16.7 (2,60)	>0.09

Table-3 GRIP STRENGTH

4. Discussion: This quasi-experimental study evaluated the impact of upper limb strength training combined with ergonomic interventions on musculoskeletal outcomes among collegiate-level mobile esports players. The findings demonstrate significant improvements across all primary outcomes—RULA scores, QuickDASH scores, and grip strength—in the intervention group, compared to controls.

The observed reduction in RULA scores signifies improved upper limb and trunk posture, suggesting that ergonomic education and workstation modifications effectively address high-risk gaming postures. These findings are consistent with previous cross-sectional research, which highlighted poor ergonomics as a key contributor to musculoskeletal symptoms in both office workers and esports athletes (3, 6, 10). The dramatic decrease in RULA scores in both groups after ergonomic education underlines the importance of even brief training, but the EST group's continued improvement points to the added benefit of active exercise.

QuickDASH scores markedly improved in the intervention group, reflecting reduced upper limb disability and symptoms over the 12-week period. This outcome supports the hypothesis that strength training enhances functional capacity and resilience of the shoulder, arm, and hand musculature in youth esports athletes. Reports from sports medicine emphasize muscular conditioning as a cornerstone of injury prevention, and our results affirm the validity of systematic exercise programs in this context. In contrast, the ESS group showed minimal change, highlighting the limited effect of ergonomic instruction alone without physical conditioning.

Grip strength, a recognized biomarker of overall upper limb function, also increased significantly following strength training. Enhanced grip strength likely reflects gains in both muscle power and

endurance, which may help counteract the repetitive stresses typical in prolonged esports play. Improved grip strength has been correlated with decreased risk of overuse injuries, improved daily function, and better long-term health outcomes in comparable populations.

Notably, this study addresses a research gap by empirically demonstrating benefits of combined ergonomic and strength interventions in esports a population where sedentary behaviour and repetitive micro-stress place participants at unique risk. The focus on mobile esports athletes is especially relevant, as handheld devices present particular ergonomic challenges not widely studied previously.

5. Limitations:

Limitations include the quasi-experimental design (rather than randomized control), relatively short intervention duration, and restriction to collegiate mobile gamers, which may limit the generalizability of results to other esports populations (e.g., PC or console gamers, professionals, or older adults). Self-reported outcomes such as QuickDASH may be influenced by participant perception. Nonetheless, objective measures (RULA, grip dynamometry) support the robustness of the findings.

6. CONCLUSION:

Ergonomic education combined with targeted upper limb strength training significantly improves posture (RULA), reduces upper limb disability (QuickDASH), and increases grip strength among youth esports players. These interventions represent accessible, effective, and practical strategies to mitigate injury risk and optimize musculoskeletal health in this rapidly growing population.

Given the sedentary and repetitive nature of esports, structured ergonomic programs and regular physical conditioning should be integrated into training regimens at both amateur and professional levels.

Future studies should explore long-term outcomes, include more diverse gaming cohorts, and evaluate the impact of tailored interventions on injury rates, gaming performance, and quality of life. Overall, our study underscores the importance of proactive musculoskeletal care for ensuring health and longevity in competitive esports participation.

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