

The Relationship Between Upper Extremity Dynamic Balance and Hand Grip Strength in Male Softball Players in Jakarta

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Submitted : 2026-07-31; Accepted : 2026-09-18; Published : 2026-10-01

ABSTRACT

Introduction: A This study aimed to analyze the relationship between upper extremity dynamic balance and hand grip strength in active male softball players in Jakarta. **Methods:** Adhering to STROBE guidelines, a cross-sectional study was conducted in July 2025 involving 32 active male softball players (aged 19–34 years) selected via purposive sampling based on Slovin's formula (10% error margin). Upper extremity dynamic balance was evaluated using the Upper Quarter Y Balance Test (UQYBT) to calculate composite scores for dominant and non-dominant sides. Grip strength was measured using a digital hand grip dynamometer. Statistical analysis was performed using SPSS v25, utilizing Shapiro-Wilk for normality, and Spearman and Pearson correlation tests for side-specific analyses. **Results:** The results demonstrated a significant, moderate positive relationship on the dominant (right) side ($r_s = 0.477$, $p = 0.006$; mean UQYBT: $80.59 \pm 6.57\%$, mean grip strength: 37.07 ± 4.10 kg). Conversely, no significant relationship was observed on the non-dominant (left) side ($r = 0.212$, $p = 0.244$; mean UQYBT: $75.48 \pm 6.55\%$, mean grip strength: 35.22 ± 4.29 kg). **Conclusion:** Upper extremity dynamic balance is positively associated with hand grip strength on the dominant throwing side in male softball players, while no correlation exists on the non-dominant side. Sports coaches and physiotherapists should incorporate bilateral dynamic stabilization exercises into training regimens to correct pathological muscle imbalances and reduce overuse injury risks.

Keywords: Hand grip strength, male softball players, shoulder stability, upper extremity dynamic balance, UQYBT.

ISSN 2722 – 9610
E –ISSN 2722 - 9629

INTRODUCTION

Softball is a highly dynamic team sport that demands high-velocity unilateral actions, including throwing, pitching, catching, batting, and rapid base running (Iswandi and Darisman 2022). Among these fundamental techniques, the ability to throw the ball accurately and at a high velocity is a crucial factor governing defensive performance and overall team success (Oktariyana 2018). Repetitive and explosive overhead throwing specifically engages the muscles of the rotator cuff, namely the supraspinatus, infraspinatus, subscapularis, and teres minor. These four muscles act as essential dynamic stabilizers of the glenohumeral joint, retaining the alignment of the humeral head against massive eccentric forces during the deceleration and follow-through phases of the throw (Fite 2023). Consequently, athletic success in softball relies heavily on an intricate balance

between shoulder joint mobility and neuromuscular stability (da Silva et al. 2020).

In this context, dynamic shoulder stability and distal force output are theoretically linked via kinetic chain principles. According to kinetic chain models, proximal stabilization of the scapulothoracic and glenohumeral joints provides a solid base of support for the transfer of force from the trunk to the hand. A highly stable proximal base enhances the recruitment efficiency of the distal forearm musculature, thereby directly maximizing hand grip strength (Sciascia et al. 2012). Hand grip strength is a vital determinant of performance in softball, influencing glove control during catching, bat control during swinging (batting), and ball release mechanics during throwing (Cronin et al. 2017). Adequate grip strength, paired with optimal proximal balance, is essential to minimize the risk

of overuse injuries in competitive overhead throwing athletes (Cools et al. 2015).

While the importance of shoulder dynamic balance and hand grip strength is recognized, their specific relationship remains under-investigated in competitive softball players. Most prior studies have utilized the Upper Quarter Y Balance Test (UQYBT) as a reliable and valid tool to measure dynamic balance in sports such as handball (Bauer et al. 2021) and swimming (Schwartz et al. 2020), but have analyzed these parameters in isolation without checking their systemic correlation. Other researchers have shown that upper body stabilization protocols can improve general athletic outcomes (Gokalp and Kirmizigil 2020). However, there is a clear research gap regarding bilateral functional asymmetry and its specific relationship with hand grip strength in sub-elite, competitive softball players in Indonesia. Particularly in Jakarta, where club players undergo intensive unilateral training, there is an absence of localized biomechanical and clinical screening data. To address this gap, this study aims to investigate the relationship between upper extremity dynamic balance (measured via UQYBT) and hand grip strength on both the dominant and non-dominant sides of active male softball players in Jakarta. By shedding light on these biomechanical interactions, the study provides valuable physiological insights for coaches and physical therapists to optimize performance and establish targeted injury-prevention protocols.

METHODS

This observational, cross-sectional study was conducted in July 2025 at the Gelora Bung Karno (GBK) Softball Stadium, Jakarta, Indonesia. To ensure a high standard of reporting and methodological transparency, the design and

reporting of this study adhered strictly to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.

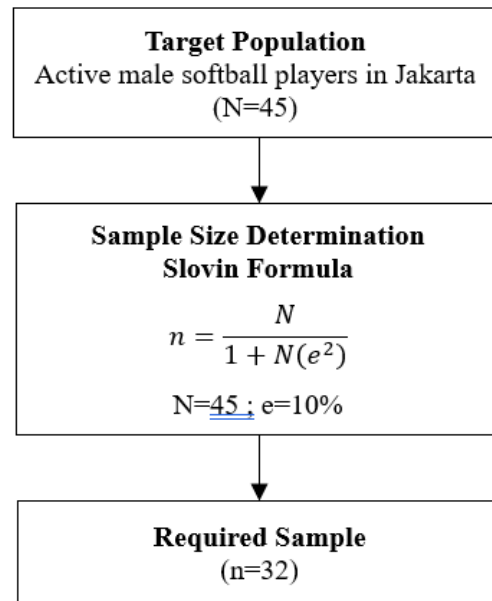


Figure 1. Sample Size Determination and Participant Selection

The target population consisted of active male softball players from competitive clubs in the Jakarta region, with a total estimated population of 45 players. The final sample size of 32 participants was determined using Slovin's formula: $n = N / [1 + N * (e^2)]$ where N represents the total population of 45 and e represents the margin of error of 10% (0.10). This yielded a required sample of 31.03, which was rounded up to 32 active players. This formula was selected because it is a reliable statistical approach for establishing representative sample sizes in finite, small-scale populations when previous variance estimates are unknown (Purwitasari et al. 2020). Purposive sampling was applied to select participants.

The selection criteria were defined as follows: (1) active male softball players aged 18 to 45, (2) members of an active Jakarta softball club, and (3) fully compliant with all study testing protocols. The exclusion criteria were: (1) a history of musculoskeletal injuries, fractures, or surgeries in the upper extremities within the past 6 months, (2) any neurological disorders, (3) participation in active injury rehabilitation, and (4) systematic upper extremity weight lifting or strength-training programs within the last 6 months to prevent confounding adaptive muscle hypertrophy.

The flow of participants was structured as follows: Out of the 45 screened players, 13 were excluded (8 did not meet age or club activity standards, 3 had a history of shoulder injuries within 6 months, and 2 had engaged in systematic upper extremity weight training). Consequently, 32 eligible players were enrolled, and all 32 completed the assessments and were included in the final analysis.

The dominant hand was defined as the hand used for unilateral overhead throwing. For 100% of the participants (N = 32), the dominant hand was the right hand, while the non-dominant hand was the left hand. This clear distinction resolved any potential methodological ambiguity between side-specific measurements and functional dominance, addressing a key clinical limitation.

Dynamic upper extremity balance was evaluated using the UQYBT, following the standard protocol of Westrick et al. (2012). Participants assumed a push-up (high plank) position on a validated testing apparatus, keeping the feet shoulder-width apart. While maintaining a stable, three-point stance, participants reached as far as possible with the free hand to push the target indicators in three distinct directions: medial (MD), superolateral (SL), and inferolateral (IL). Three trials were performed for each arm, and the maximum reach distance in each direction was recorded. To control for individual anthropometrics, the reach distances were normalized to the participant's upper limb length (measured from the C7 spinous process to the tip of the middle finger). The UQYBT composite score was calculated as: Composite Score (%) = [(Maximum MD + Maximum SL +

Maximum IL) / (3 * Limb Length)] * 100. UQYBT composite scores were categorized as "Baik" (Good) if $\geq 80\%$ and "Kurang" (Poor) if $< 80\%$ (Butler et al. 2016).

Hand grip strength was measured using a calibrated digital hand grip dynamometer (Camry, China) according to the American Society of Hand Therapists (ASHT) guidelines. Participants stood with the shoulder adducted, elbow fully extended, and forearm in a neutral position. They were instructed to squeeze the dynamometer with maximum effort for 3 seconds. Three trials were performed for each hand, with a 1-minute rest interval to prevent muscle fatigue, and the peak value was recorded in kilograms (kg). Hand grip strength was categorized as "Normal" if ≥ 30 kg and "Lemah" (Weak) if < 30 kg (Purwitasari et al. 2020).

Statistical analysis was conducted using IBM SPSS Statistics version 25. Descriptive statistics, including means, standard deviations, and frequencies, were computed. The normality of the data was assessed using the Shapiro-Wilk test ($p > 0.05$ representing normal distribution) given the sample size. For normally distributed variables, Pearson's product-moment correlation coefficient (r) was applied. For non-normally distributed variables, Spearman's rank correlation coefficient (r_s) was utilized. The level of statistical significance was set at $p < 0.05$.

Prior to the initiation of any testing, all participants received a thorough briefing regarding the research objectives, risks, and protocols, and signed a written informed consent form. This study was conducted in accordance with the Declaration of Helsinki and was officially approved by the Research Ethics Committee of Universitas Esa Unggul (Ethical Approval Number: 0926-09.020/DPKE-KEP/FINAL-EA/UEU/IX/2026)."

RESULTS

The demographic and anthropometric characteristics of the 32 male softball players are presented in Table 1. The cohort represented a young, physically fit group of athletes with a narrow age range (19 to 34 years).



Table 1. Demographic and Anthropometric Characteristics of Participants (N = 32)

Variable	Mean $\pm$ SD	Min-Max
Age (years)	25.91 $\pm$ 4.18	19.00 - 34.00
Height (cm)	173.50 $\pm$ 5.51	165.00 - 185.00
Weight (kg)	76.38 $\pm$ 9.45	60.00 - 95.00

Descriptive statistics of the primary research variables upper extremity dynamic balance (UQYBT composite scores) and hand grip strength are compiled in Table 2. Participants demonstrated higher mean values for both dynamic balance and grip strength on their dominant (right) side compared to their non-dominant (left) side, indicating a consistent baseline asymmetry.

Table 2. Descriptive Statistics of UQYBT and Hand Grip Strength (N = 32)

Variable	Mean $\pm$ SD	Min-Max
UQYBT Right (Dominant) (%)	80.59 $\pm$ 6.57	59.69 - 90.20
UQYBT Left (Non-Dominant) (%)	75.48 $\pm$ 6.55	61.72 - 85.68
Hand Grip Right (Dominant) (kg)	37.07 $\pm$ 4.10	29.45 - 44.39
Hand Grip Left (Non-Dominant) (kg)	35.22 $\pm$ 4.29	28.09 - 42.58

Categorical analysis of the research variables (Table 3) revealed significant functional discrepancies. A majority of the participants (53.1%) had good dynamic balance on their dominant right side, but 68.8% exhibited poor balance on their non-dominant left side. For grip strength, exactly half (50.0%) were categorized as normal on their dominant side, while an overwhelming 71.9% were categorized as weak on their non-dominant side.

Table 3. Categorical Distribution of Variables (N = 32)

Variable & Category	Frequency (n)	Percentage (%)
UQYBT Right (Dominant)		
Good ($\geq$ 80%)	17	53.1%
Poor ($<$ 80%)	15	46.9%
UQYBT Left (Non-Dominant)		
Good ($\geq$ 80%)	10	31.3%
Poor ($<$ 80%)	22	68.8%
Hand Grip Right (Dominant)		
Normal ($\geq$ 30 kg)	16	50.0%
Weak ($<$ 30 kg)	16	50.0%
Hand Grip Left (Non-Dominant)		
Normal ($\geq$ 30 kg)	9	28.1%
Weak ($<$ 30 kg)	23	71.9%

Prior to conducting correlation analysis, the normality of the data was verified. As presented in Table 4, Shapiro-Wilk testing showed that UQYBT Left ($p = 0.252$), Hand Grip Right ($p = 0.389$), and Hand Grip Left ($p = 0.120$) were normally distributed ($p > 0.05$). In contrast, UQYBT Right was significantly non-normally distributed ($p = 0.013 < 0.05$). Therefore, Spearman's rank correlation was selected for dominant-side analysis, whereas Pearson's product-moment correlation was selected for non-dominant side analysis.

Table 4. Shapiro-Wilk Normality Test Results (N = 32)

Variable	Statistic	df	p-value
UQYBT Right (Dominant)	0.912	32	0.013*
UQYBT Left (Non-Dominant)	0.959	32	0.252
Hand Grip Right (Dominant)	0.966	32	0.389
Hand Grip Left (Non-Dominant)	0.947	32	0.120

*Note: * $p < 0.05$ indicates a significant deviation from normality.*



To resolve the inconsistencies noted in previous evaluations, side-specific correlation analyses were conducted and compiled in a separate table (Table 5). The analysis demonstrated a statistically significant, moderate positive correlation between UQYBT composite scores and hand grip strength on the dominant right side ($r_s = 0.477$, $p = 0.006$). Conversely, no statistically significant relationship was observed on the non-dominant left side ($r = 0.212$, $p = 0.244$). This directly corrects the erroneous assertion that both sides were statistically significant, establishing a clear lateralization of physiological association.

Table 5. Correlation Analysis Between Upper Extremity Dynamic Balance and Hand Grip Strength (N = 32)

Side of the Body	Statistical Test	Correlation Coefficient (r / r _s)	p-value
Dominant Side (Right)	Spearman Correlation (r _s)	0.477	0.006*
Non-Dominant Side (Left)	Pearson Correlation (r)	0.212	0.244

*Note: *Correlation is statistically significant at the 0.01 level (2-tailed).*

DISCUSSION

This study investigated the relationship between upper extremity dynamic balance and hand grip strength on both dominant and non-dominant sides of active male softball players in Jakarta. The findings demonstrate a statistically significant, moderate positive relationship between upper extremity dynamic balance and hand grip strength on the dominant side ($r_s = 0.477$, $p = 0.006$), but no such relationship was found on the non-dominant side ($r = 0.212$, $p = 0.244$). By verifying these parameters side-by-side, this study provides clear support for the kinetic chain theory, while highlighting profound functional asymmetries associated with high-velocity unilateral throwing.

The significant positive correlation observed on the dominant side aligns with the kinetic chain framework established in competitive throwing athletes (Sciascia et al.

2012). During high-velocity throwing, the shoulder girdle acts as a dynamic force transmitter. Coordinated muscular contraction of the rotator cuff muscles (supraspinatus, infraspinatus, subscapularis, and teres minor) and scapular stabilizers is required to maintain humeral head stability. The UQYBT assesses the capacity of these stabilizer muscles to maintain core and shoulder girdle alignment during multidirectional reaches under load. When proximal shoulder stability is high, it provides a stable platform that enables the distal forearm musculature to recruit motor units more efficiently, generating greater mechanical torque and resulting in higher hand grip strength (Biaggi et al. 2021). Conversely, if proximal stability is compromised, the distal segments must overcompensate, reducing contraction efficiency and distal force output while increasing injury risk (Cools et al. 2015). Our findings are consistent with prior athletic evaluations showing that dynamic upper extremity stability directly influences distal hand grip performance (Gokalp and Kirmizigil 2020; Koacoglu 2024).

In contrast, the lack of a statistically significant correlation on the non-dominant side ($p = 0.244$) is a key finding that reflects the chronic asymmetric loading typical of competitive softball. Softball involves repetitive, highly lateralized motor patterns—unilateral overhead throwing, swinging, and single-hand glove fielding (Fite 2023). This repetitive asymmetric loading induces unilateral neuromuscular adaptations on the throwing side, tightly coupling proximal dynamic stability with distal grip power. On the non-dominant side, however, the muscle groups are primarily recruited for passive or stabilizing tasks, such as supporting the glove. Because the non-dominant limb does not undergo the high-velocity eccentric and concentric kinetic chain loading of the throw, its dynamic stabilization and grip strength profiles remain functionally uncoupled. This lateralized decoupling of stability and strength on the non-dominant side is consistent with unilateral adaptations reported in other overhead and asymmetric sport cohorts, including swimmers (Schwiertz et al. 2020) and handball players (Bauer et al. 2021).



the underlying neuromuscular mechanisms of this kinetic connection.

CONCLUSION

This study demonstrated a statistically significant, moderate positive relationship between upper extremity dynamic balance and hand grip strength on the dominant side of active male softball players in Jakarta. In contrast, no statistically significant relationship was observed on the non-dominant side. These findings highlight the presence of severe bilateral functional asymmetries within this cohort, characterized by high rates of poor dynamic balance and weak hand grip strength on the non-dominant left side. To mitigate these imbalances, sports coaches, athletic trainers, and physical therapists should incorporate structured bilateral dynamic stabilization and strengthening protocols into training regimens. Addressing these functional asymmetries is essential to restore muscle symmetry, optimize athletic kinetic transfer, and reduce the overall risk of overuse shoulder injuries in overhead throwing athletes.

ACKNOWLEDGEMENT

The authors would like to express their sincere gratitude to all the active softball players and participating club coaches in Jakarta who volunteered their time and effort for this study. We also acknowledge the Faculty of Physiotherapy, Universitas Esa Unggul, for providing the necessary testing instruments and technical support to complete this research.

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The clinical and practical implications of these findings are substantial. While unilateral asymmetry is a natural physiological adaptation to specific sports, excessive functional discrepancies can become pathological. In our cohort, 68.8% of the players exhibited poor dynamic balance (UQYBT < 80%) on the non-dominant left side, and 71.9% exhibited weak grip strength on their non-dominant side. This pronounced bilateral imbalance disrupts muscular symmetry, often leading to compensatory mechanisms during athletic movements. In throwing sports, significant bilateral muscular imbalances are major risk factors for overuse shoulder injuries, such as rotator cuff tendinopathy, glenohumeral internal rotation deficit (GIRD), and scapular dyskinesis (Guermont et al. 2023). Therefore, training regimens for softball players should not focus exclusively on unilateral sport-specific skills on the dominant side. Athletic coaches, trainers, and physical therapists must design and implement bilateral dynamic stabilization and conditioning programs. Integrating closed-kinetic chain exercises, proprioceptive shoulder drills, and targeted scapular strengthening (such as the Thrower's Ten protocol) can effectively restore muscular balance, reduce non-dominant dynamic instability, and prevent chronic overuse shoulder pathologies (Gokalp and Kirmizigil 2020).

Several limitations of this study must be acknowledged. First, the cross-sectional study design prevents the establishment of direct causal relationships. We cannot confirm whether improving dynamic shoulder stability causes an increase in hand grip strength, only that they are moderately associated on the dominant side. Second, the sample size of 32 male participants was drawn from a single geographic region (Jakarta), which restricts the generalizability of these findings to a broader, elite, or mixed-gender athlete population. Third, the study did not utilize electromyography (EMG) to directly analyze muscle activation patterns during UQYBT or hand grip trials. Future research should employ longitudinal study designs, recruit larger and more diverse athletic cohorts (including female athletes and multiple geographic locations), and integrate surface electromyography to investigate



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