

Short Communication

Upper arm strength as a predictor of throwing velocity in university-level male javelin throwers

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ABSTRACT

Muscular strength, including dynamic (isotonic) and static (isometric) forms, is critical for athletic performance and is commonly assessed through maximal effort tests. The javelin throw differs from other throwing events due to its higher release velocity and very short execution time, requiring athletes to generate maximal force rapidly. Consequently, event-specific training is essential. The purpose of this study was to examine the relationship between upper arm strength and throwing velocity in university-level male javelin throwers. Eight male university javelin throwers (mean age=21.50±1.20 years) performed the seated medicine ball throw (5-kg) to assess upper arm strength and three maximal javelin throws to measure throwing velocity. The highest score from each test was used for analysis. Pearson's correlation examined the relationship between upper arm strength and throwing velocity ($p<0.05$). University-level male javelin throwers demonstrated a mean seated medicine ball throw of 2.88±0.35 m and a mean throwing velocity of 87.78±1.94 km/hour. A Pearson correlation showed a very strong positive relationship between upper arm strength and javelin throwing velocity, $r(8)=0.916$, $p=0.001$. The findings indicate that greater upper arm strength is strongly associated with higher javelin throwing velocity. This underscores the importance of upper arm strength in javelin performance, while also suggesting that other factors may contribute to throwing velocity and merit further investigation.

Keywords: Muscular strength, Upper arm strength, Throwing velocity, University level javelin throwers

INTRODUCTION

High speed javelin throwing is the fundamental predictor of throwing capacity for male javelin throwers.¹ Torque and angular velocity for maximizing the release velocity of the javelin throw are produced by the proximal arm.² Strength of the upper arm is not only required for the production of force but it is also needed for synchronization of the overall complex kinetic chain of the throw.³ In throwing biologically, there is the development

of explosive force within a very short time frame, often under 250 milliseconds, where the development of force of the upper arm muscle at a high pace plays a causative role on outcome.⁴ By showing that maximal isometric and dynamic strength of the upper limb correlates with throwing speed, maximal muscle capacity is seen to be related to throwing speed.⁵ Characteristics of strength like rate of force development or maximal force capacity of the muscles of the shoulder and the elbow determine throwing performance potential.^{6,7} Anthropometric variables such as

muscle masses and arm lengths above the elbows also determine throwing velocity through the impact on lever mechanics and power transmission.⁸ Throwing rates can be higher among throwers with longer arms because they can reach higher angular velocities of the terminal segment, therefore the higher speed at the point of releasing the ball.⁹ Nevertheless, optimum strength for their arm length is still the number one priority because overemphasis on mass without corresponding strength results in reduced efficiency.¹⁰

Neuromuscular coordination of the muscles of the upper arm, and that which is formed especially under the acceleration phase provides for the minimization of the risk of injury and reaching high velocities of throw.¹¹ Strength balance among the antagonist and the agonist groups of the muscles around the shoulder joint provides for the stability and the longevity of joint performance.¹² Typical modes of training for the formation of explosive power, i.e., plyometric and strength training of the upper arm, were identified as contributing for the development of throwing performance.^{13,14} There are sexual differences recognized for strength-throwing velocity relationship where male javelin throwers' performance is particularly related to upper arm strength.¹⁵ This can be related to the higher implement weight and male javelin throwing specific biomechanical demands.¹⁶ Hence, individual strength and conditioning prescriptions with particular emphasis on development of the upper arm for strength are needed for optimizing the throwing speed and throwing distance of elite male throwers.¹⁷

However, emphasized within the literature presently available is the necessity for early force producing capacity of the proximate arm musculature not only for maximal strength but for the possibility for the fast development of force within the critical phase of the throw.⁴ Also supportive of training emphasis on the explosive strength of the proximate arm are the considerable correlations indicated between early-phase isometric development of force and maximal throwing velocity for superior throwers.¹⁸ The strength of the upper arm is one of the strongest biomechanical and physiological correlates of the javelin throw velocity amongst men. It facilitates the effective transmission of the force of the kinetic sequence and maintains the optimized function of the joint and has a direct impact upon performance outcomes.¹⁹

Understanding and the appreciation of such strength via emphasis upon focused analysis and exercises is a critical variable within the development of elite javelin performers.²⁰ Javelin throwing requires rapid force production and efficient kinetic chain coordination, with upper arm strength playing a key role in generating release velocity.

This study aimed to examine the relationship between upper arm strength and throwing velocity in university-level male javelin throwers.

METHODS

Study design and participants

This was a descriptive cross-sectional study designed to examine the relationship between upper arm strength and javelin throwing velocity. Eight (n=8) male javelin throwers from Jashore University of Science and Technology, Bangladesh, who had previously competed in inter-university athletic competitions, voluntarily participated in the study. Participants were purposively recruited to ensure relevant competitive experience. The study was conducted at Jashore University of Science and Technology, Bangladesh, over a period of two months (January 2024 to February 2024).

Exclusion criteria included participants with any recent injuries, musculoskeletal disorders, or medical conditions that could limit throwing performance. Prior to data collection, all participants provided written informed consent in accordance with institutional ethical guidelines.

The study protocol was reviewed and approved by the Departmental Examination Committee of the Department of Physical Education and Sports Science, Jashore University of Science and Technology, Bangladesh.

Variables and criterion measures

Upper arm strength was operationally defined as performance on the seated medicine ball throw (SMBT) using a 5-kg medicine ball, a validated field test for assessing upper body power.²¹ Throwing velocity was measured by recording the javelin's release speed with a Bushnell radar gun (Bushnell Corporation, USA), which has demonstrated reliability and validity in throwing sports. Anthropometric data, including height and weight, were obtained using a standard stadiometer and a digital weighing scale to describe participant characteristics. Ancillary equipment, such as measuring tape, marking cones, and whistles, was used to ensure standardized test administration.

Tests procedure

For the seated medicine ball throw, participants sat on the floor with their legs fully extended and feet approximately 60 cm apart behind a designated line. Each participant held the medicine ball against the chest with elbows flexed and forearms parallel to the ground before explosively throwing the ball forward. Distance was measured from the restraining line to the first point of ball contact on the floor. Each participant completed three trials, and the maximum distance achieved was used for analysis.²²

Throwing velocity was assessed using three maximal-effort javelin throws performed in accordance with regulation rules on a prepared pitch. The radar gun was positioned to capture release velocity. The highest velocity

among the three attempts was recorded as the participant’s best performance.²³

Statistical analysis

All statistical procedures were performed using the statistical package for the social sciences (SPSS, version 27). Descriptive statistics (mean±standard deviation) were calculated to characterize the sample and summarize performance variables. The relationship between upper arm strength, and throwing velocity, determined by javelin release speed, was examined using Pearson’s product–moment correlation coefficient (r). The magnitude of the correlations was interpreted according to the benchmarks proposed by Cohen (1988), with values of 0.10, 0.30, and 0.50 considered to represent small, medium, and large effects, respectively. Statistical significance was set at p<0.05.

RESULTS

Table 1 shows demographic characteristics of the subjects. Table 2 show that university-level male javelin throwers demonstrated a mean performance of 2.88±0.35 m on the seated medicine ball throw test, indicating relatively consistent upper arm strength across participants. In contrast, the mean throwing velocity of the javelin was 87.78±1.94 km/hour, reflecting greater variability in performance compared to the medicine ball throw. A

Pearson product–moment correlation (Table 3) was conducted to examine the relationship between upper arm strength and throwing velocity among university-level male javelin throwers. The analysis revealed a statistically significant, very strong positive correlation between seated medicine ball throw distance and javelin throwing velocity, r (8)=0.916**, p=0.001. This indicates that greater upper arm strength is strongly associated with higher javelin throwing velocity. The following scatter plot (Figure 1) shows the relationship between the seated medicine ball throw test (m) and javelin throwing velocity (km/h), with the regression line.

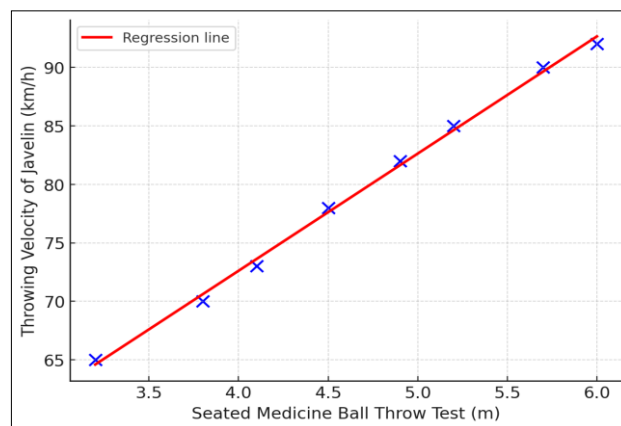


Figure 1: Scatter plot with regression line.

Table 1: Demographic characteristics of the subjects.

Variables	Mean	Standard deviation	Minimum	Maximum
Age	21.50	1.20	20.00	23.00
Height	175.63	4.24	170.00	183.00
Weight	68.50	4.75	60.00	74.00
BMI	22.19	0.81	20.76	23.30

Table 2: Descriptive statistics of upper arm strength and throwing velocity in university-level male javelin throwers.

Variables	Mean	Standard deviation	Minimum	Maximum
Seated medicine ball throw (m)	2.88	0.35	2.50	3.50
Throwing velocity of javelin (km/hour)	87.78	1.94	84.75	91.00

Table 3: Relationship between upper arm strength and throwing velocity among university level male javelin throwers.

Pearson correlation	Throwing velocity of javelin (km/hour)
r	0.916**
Sig. (2-tailed)	0.001
N	8

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

DISCUSSION

This study investigated the relationship between upper arm strength and javelin throwing velocity among university-level male javelin throwers. The results revealed a very

strong positive correlation (r=0.916, p=0.001), indicating that greater upper arm strength is closely associated with higher throwing velocity. This finding is consistent with previous studies demonstrating that upper-arm strength contributes significantly to the rapid acceleration phase of

the javelin throw, which is critical for achieving high release velocity.

Previous research has also connected upper-body power assessments with throwing performance. Strong correlations have been reported between medicine ball throw distances and handball throwing velocities.²⁴ Medicine ball throwing has been shown to reveal upper-body force–velocity and power characteristics transferable to throwing performance.²⁵

Explosive upper-body strength has similarly been identified as a major determinant of ball speed in overhead sports.^{26,21} In javelin events, upper-body power tests focusing on the arm and shoulder have consistently shown strong relationships with release velocity and throwing distance.²⁷⁻²⁹

Evidence also supports the role of medicine ball–based training in enhancing throwing performance. Resistance training with medicine balls has been found to substantially improve throwing velocity compared to conventional programs, emphasizing the value of explosive upper-body power development.³⁰ Similarly, a six-week medicine ball training program has been shown to improve both upper-body strength and javelin performance.³¹

From a biomechanical perspective, the javelin throw relies on an effective kinetic chain extending from the lower limbs, through the trunk, to the upper arm and hand. The upper arm, as the terminal segment, delivers the final force to the javelin, making explosive arm strength a primary determinant of release velocity.¹⁹ The strong association observed in this study suggests that athletes with greater upper-body explosive power, as assessed by the seated medicine ball throw (SMBT), can utilize this proximal-to-distal energy transfer pattern more effectively.³² However, while the SMBT is a valid and practical test of upper-body power, it does not fully replicate the complex multi-segmental actions required in the javelin throw.³³

Despite the importance of upper arm strength, javelin performance is multifactorial. Technique, neuromuscular coordination, and lower-limb power play equally crucial roles.^{34,35} Lower-limb force production, in particular, provides the foundation for effective upper-limb propulsion,³⁶ and maximal leg power has been reported to correlate more strongly with throwing performance than arm strength alone.³⁴ Technical and biomechanical aspects—such as elbow flexion, shoulder horizontal adduction, and joint force transfer—further influence both performance outcomes and injury risk.^{37,29} Additionally, anthropometric factors, including arm length, may enhance throwing velocity by providing biomechanical leverage advantages.³⁸⁻⁴⁰

Limitations

The primary limitation of this study was the small sample size, which reduced the statistical power and limits the

generalizability of the findings. In addition, upper arm strength alone may not fully explain javelin throwing performance, as throwing velocity is influenced by multiple factors, including strength, power, technique, coordination, and body dimensions.

Despite these limitations, the study highlights the importance of upper arm strength as a contributing factor to javelin throwing velocity and emphasizes the value of comprehensive training programs that integrate strength development, biomechanical optimization, and technical skill.

Future research with larger and more diverse athlete populations, combined with advanced biomechanical analyses, is recommended to further clarify the specific role of upper arm strength in optimizing javelin performance.

CONCLUSION

This study demonstrated a very strong positive correlation between upper arm strength and javelin throwing velocity among university-level male javelin throwers, highlighting the significant contribution of upper arm strength to performance. Nonetheless, javelin throwing is a multifactorial skill, influenced not only by arm strength but also by technique, lower-limb power, coordination, and anthropometric characteristics. Given the small sample size, caution is warranted in generalizing these findings. Future research with larger and more diverse populations is recommended to better clarify the relative contributions of strength, biomechanics, and technical factors to optimal javelin performance.

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