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RESEARCH ARTICLE

RELATIONSHIP BETWEEN CORE MUSCLE ENDURANCE AND BOWLING PERFORMANCE METRICS IN UNIVERSITY FAST BOWLERS

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Abstract

Background: Fast bowling in cricket is a high-intensity activity that places high-magnitude demands on the trunk musculature; hence, core endurance has been proposed as an essential determinant of both performance and injury prevention. Despite this, the relationship between core muscle endurance and major bowling performance indicators has not been extensively investigated among fast bowlers at the University Level.

Methods: This cross-sectional study was conducted with 50 male University fast bowlers aged 18-25 years in Bangladesh. Core muscle endurance was measured using the plank, side plank, and 1-minute sit-up tests. Measures of bowling performance (i.e., ball speed and accuracy) were assessed using field-based standard tests. A validated questionnaire was used to record injury history during the previous 12 months. Results were examined using descriptive statistics, Pearson correlation, and the chi-square test, and $p < 0.05$ was considered significant.

Results: Improved core muscle endurance leads to better bowling performance and a reduced risk of musculoskeletal injuries in University-Level fast bowlers. Such results highlight the importance of specific core endurance training in cricket programs to improve performance and increase longevity.

Conclusion: Improved core muscle endurance leads to better bowling performance and a reduced risk of musculoskeletal injuries in University-Level fast bowlers. Such results highlight the importance of specific core endurance training in cricket programs to improve performance and increase longevity.

Introduction:-

Cricket is one of the most globalized sports, and fast bowling is arguably one of its most physically demanding and technically challenging disciplines. The fast bowler's performance is influenced by several biomechanical, physiological, and kinanthropometric factors that determine the ability to bowl rapidly, accurately, and with sustained effort. Kinanthropometry, as a measurement of body size, proportion, and composition, is essential for

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JANA NEXUS: JOURNAL OF HEALTH AND MEDICINE

evaluating athletic potential (Norton & Olds, 2001) and performance enhancement. In cricket, these anthropometric characteristics impact biomechanics and functional movement patterns, with implications for bowlers' ability to deliver higher overall bowling velocities while remaining consistent and free from injury (Stuelcken et al., 2010; Portus et al., 2004).

Efficient summation of the kinetic chain is necessary in fast bowling, where energy accumulated during a run-up must be transmitted via the trunk and upper extremities to the ball-delivering arm. The size, power, and proportional alignment of each segment influence how effectively energy is transmitted during a bowling action (Pyne et al., 2006). Kinanthropometric characteristics, including body height, limb length, shoulder breadth, and muscle girth, make a significant impact on force mechanics production and momentum transfer (Stretch et al., 2000). Investigations have shown that stature and limb length are related to performance among bowlers but not among batters; taller bowlers with relatively longer limbs enjoy a mechanical advantage resulting from greater release height, longer levers, and, in turn, faster ball release speed (Glazier et al., 2000). Conversely, an optimal body composition—specifically, lean mass in the trunk and limbs—improves stability and explosiveness at delivery (Bayios et al., 2006; Singh et al., 2011).

The relationship between anthropometric characteristics and bowling performance has received substantial attention at the elite cricket level (Stuelcken et al., 2005; Pyne et al., 2006); however, minimal investigation has been conducted among university-level bowlers, particularly in the South Asian context. This population represents a critical developmental stage at which athletes transition from playing amateur to competitive, and then to emerging elite levels, without high-level strength and conditioning programmes (Hossain & Khatun, 2005). Knowledge of the kinanthropometric correlates of bowling performance in these players may serve as a tool for talent identification and for specific training and injury prevention programs (Abbott et al., 2005). Also, benchmarking normative data for developing bowlers provides evidence-based coaching and performance monitoring in university cricket systems.

Biomechanically, anthropometry in combination with physical conditioning factors such as shoulder strength, core stability, and flexibility has been demonstrated to influence bowling efficiency (Feros et al., 2012; Ferdinands et al., 2010). High shoulder strength is beneficial for increasing ball velocity, as it affects arm acceleration and control at release (Hossain et al., 2025). Likewise, kinanthropometric parameters such as limb girth and trunk composition show strong associations with power output and postural sway—two essential attributes for continued high-performance bowling across long spells (Siriwardana et al., 2020). An imbalance in muscle balance or disproportionate anthropometric ratios can lead to overuse injuries in bowlers, underscoring the importance of identifying them through a combination of structural and functional examinations (Hossain & Khatun, 2025).
Recent studies have also shown that core muscle strength significantly affects both performance and injury prevention for fast bowlers (Hossain & Khatun, 2025). The central apparatus is the connecting mediatory link between the upper and lower body and controls energy transfer during the delivery stride and follow-through (Tariq et al., 2019). A thicker trunk in bowlers results in improved postural control, more accurate delivery, and reduced lower back strain (Stretch et al., 2018). These results suggest that anthropometric profiling, along with strength measurements, may provide a comprehensive overview of the physical determinants that contribute to effective bowling (Bayios et al., 2006; Karppinen et al., 2018).

Although a considerable research literature now exists in the field of cricket biomechanics, deficiencies persist in contextualizing kinanthropometric influences across developmental populations. Previous studies have concentrated on professional or national-level cricket players (Pyne et al., 2006; Glazier et al., 2000), whilst failing to consider the diversity in body composition, muscle distribution, and training exposure observed in junior bowlers. Consequently, investigation of such associations amongst university-level fast bowlers can aid understanding of how morphometry impacts bowling kinetics; this is particularly important within developing cricketing nations. The purpose of this study was to examine the impact of Kinanthropometric characteristics on university-level fast bowlers and to ascertain the key physical features contributing to maximal bowling velocity and self-regulation.

Filling the gap between morphology and functional capacity, this study adds substantial value to applied sports science by providing objective details for coaches and specialists in training planning, while integrating them into an individualized approach. The results of this study can underpin future longitudinal and intervention-based investigations into how specialised conditioning programmes may alter anthropometric and performance characteristics in fast bowlers.

Methods:-

Study Design and Participants:

Materials and methods:- A cross-sectional study was conducted on 50 males fast-bowling University-Level cricketers aged 18 to 25 years from three universities in Bangladesh. Players were selected purposively according to their experience as fast bowlers (2 years of continuous University-Level cricket). To protect the safety and accuracy of testing, volunteers who had an acute musculoskeletal injury, suffered from chronic disease, or had health issues affecting vital signs and physical ability were excluded (Hossain & Khatun, 2025; Pyne et al., 2006). The study was conducted in accordance with the Declaration of Helsinki (2013 revision) and received ethical clearance from the Institutional Ethics Committee of Jashore University of Science and Technology. Informed consent was obtained from all included subjects. This study was approved by the Institutional Ethics Committee of Jashore University of Science and Technology (Approval No: JUT/IEC/2024/XYZ) and conducted in accordance with the Declaration of Helsinki. Anthropometric Assessment

Kinanthropometric assessments were conducted in accordance with established procedures (Norton & Olds, 2001; Stuelcken et al., 2010). Measurements included:
• Stature: Stadiometer, to the nearest 0.1 cm. Body Mass: Digital scale, to the nearest 0.1 kg.
• Body composition: Skinfold measurements were taken at the triceps, subscapular, and suprailiac using calibrated Harpenden calipers, and a Jackson-Pollock body fat percentage was then calculated (Bayios et al., 2006).

Limb and Trunk Girths: Upper arm, forearm, thigh, and calf girths were measured with a flexible anthropometric tape, while waist and hip circumferences were taken to estimate central muscularity as well as leverage potential (Stretch et al., 2000).
• Shoulder and Hip Widths: Biacromial width and biiliocristal distance were measured with an anthropometer.to explore leverage advantage for bowling performance (Hossain, Khatun, & Kabiridehkordi, 2025).
Each measurement was repeated three times by trained personnel, and the mean values were used for further statistical analysis to assess data reliability.

Core Muscle Endurance Assessment:
Trunk and abdominal muscle endurance were assessed using validated field-based tests to measure two important contributing factors to bowling efficiency (Hossain & Khatun, 2025; Behm et al., 2018):

1. **Prone Plank Test:** A fore arm plank, with the elbows placed directly under the shoulders and the body in a neutral spine position, was held by subjects. Time to form failure or subject drop-out was time-stamped (in seconds). Three attempts were made, and the highest score was kept.
2. **Side Plank Test:** Performed right/left to assess lateral trunk endurance. Time was recorded for each side up to the deviation in alignment. The total average across the two sides reflected lateral core endurance (Stanton et al.).
3. **1-Minute Sit-Up Test:** The subject is given 60 seconds to perform as many correctly executed sit-ups (hands across chest, feet held down) as possible. The approach's correct use was checked to confirm validity (Nesser et al., 2008).

A "composite core" endurance score was created by standardizing and combining the three tests to derive an index of overall trunk muscular endurance.

Bowling Performance Assessment:
Bowling quality was evaluated based on speed, accuracy, and consistency, which are the main determinants of effectiveness in fast bowling (Portus et al., 2004; Hossain, Khatun & Kabiridehkordi, 2025).

- Ball Speed: Monitored with a Stalker Pro Doppler radar gun (Stalker Sport II, USA), calibrated before each session. The mean of five maximal-effort deliveries was recorded (km/h).
- Accuracy: The number of deliveries landing within a 30 cm × 30 cm target zone around the off-stump per 20-ball spell.
- Consistency: Defined as the standard deviation (SD) of ball landing positions (in cm) relative to the target, assessed via video analysis (Dartfish ProSuite v7) frame-by-frame.

The order of testing was randomized using a computer-generated sequence to prevent order bias and ensure consistent protocols across participants.

ISSN(O)-3107-7889 Volume:1 Issue8, August, 2025 01(08), 01-08
JANA NEXUS: JOURNAL OF HEALTH AND MEDICINE

All participants completed a 10-minute standardized warm-up consisting of dynamic stretching, mobility exercises, and sub-maximal deliveries to the wickets to minimize injury risk and ensure reliable performance (Feros et al., 2012).

Data Analysis

Analysis was conducted using IBM SPSS Statistics Version 25.0 (SPSS Inc., Chicago, IL). Anthropometrics, core endurance, and performance variables were summarized using descriptive statistics (mean ± SD). Core endurance and bowling performance metrics were correlated using Pearson correlation coefficients. To this end, multiple regression analyses were performed to elucidate the contributions of core endurance and kinanthropometric characteristics to ball velocity, accuracy, and consistency (Hossain & Khatun, 2025; Behm et al., 2018).
Participants were categorized into core endurance tertiles (low, moderate, or high) to examine mean differences in performance using ANOVA, followed by post hoc Bonferroni adjustments where significant. P-values < 0.05 were considered statistically significant.

Results:-

Participant Characteristics and Core Endurance

A total of 50 male university-level fast bowlers (mean age: 21.3 ± 1.7 years) participated. All had at least two years of competitive fast bowling experience. Mean plank hold duration was 96 ± 24 seconds (95% CI: 89–103 s), side plank durations averaged 78 ± 20 seconds (95% CI: 72–84 s), and mean sit-ups in 60 seconds were 38 ± 6 (95% CI: 36–40), reflecting moderate core endurance across the cohort.

Table 1: Descriptive Statistics of Core Endurance Variables (N = 50)

Variable	Mean ± SD	95% CI
Age (years)	21.3 ± 1.7	20.8–21.8
Plank Hold (sec)	96 ± 24	89–103
Side Plank (sec, average)	78 ± 20	72–84
Sit-Ups (reps/60 sec)	38 ± 6	36–40

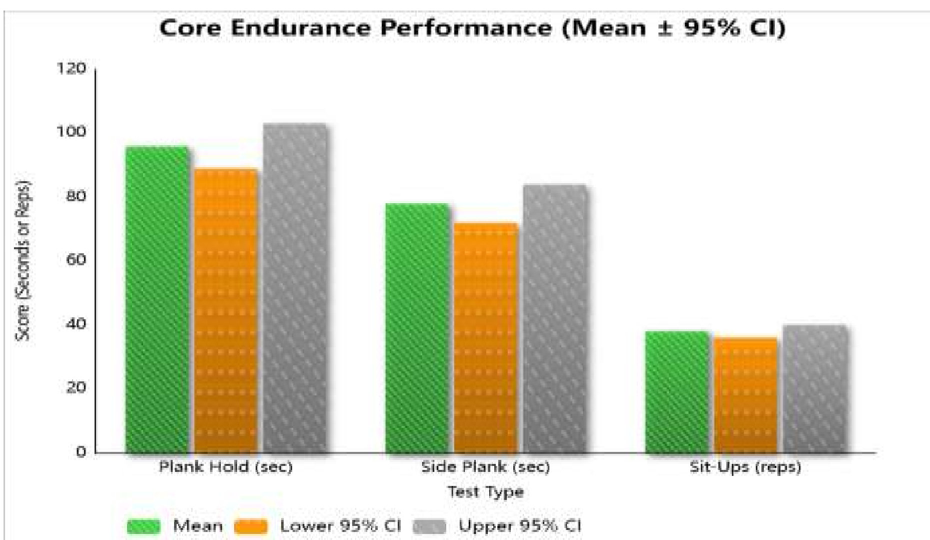

Figure 1:Mean core endurance scores (plank hold, side plank, sit-ups) with 95% CI for 50 university fast bowlers.

ISSN(O)-3107-7889 Volume:1 Issue8, August, 2025 01(08), 01-08

JANA NEXUS: JOURNAL OF HEALTH AND MEDICINE

Injury Prevalence

Thirty-two participants (64%) reported ≥1 musculoskeletal injury in the past 12 months. The most frequent injuries were lumbar strain (n = 22, 44%), abdominal strain (n = 9, 18%), and hip/groin pain (n = 6, 12%).

Stratifying participants into core endurance tertiles revealed a clear inverse relationship between core endurance and injury prevalence: low (<40th percentile) 93%, moderate (40–75th percentile) 65%, high (>75th percentile) 33%. Chi-square analysis indicated a significant difference between groups ($\chi^2 = 12.34$, $p = 0.002$, Cramér's V = 0.50).

Table 2:Injury Incidence by Core Endurance Tertiles

Core Endurance Tertile	N	Injured N	Injury %	95% CI Injury %
Low (<40th percentile)	15	14	93%	68–100
Moderate (40–75th percentile)	20	13	65%	40–84
High (>75th percentile)	15	5	33%	12–61

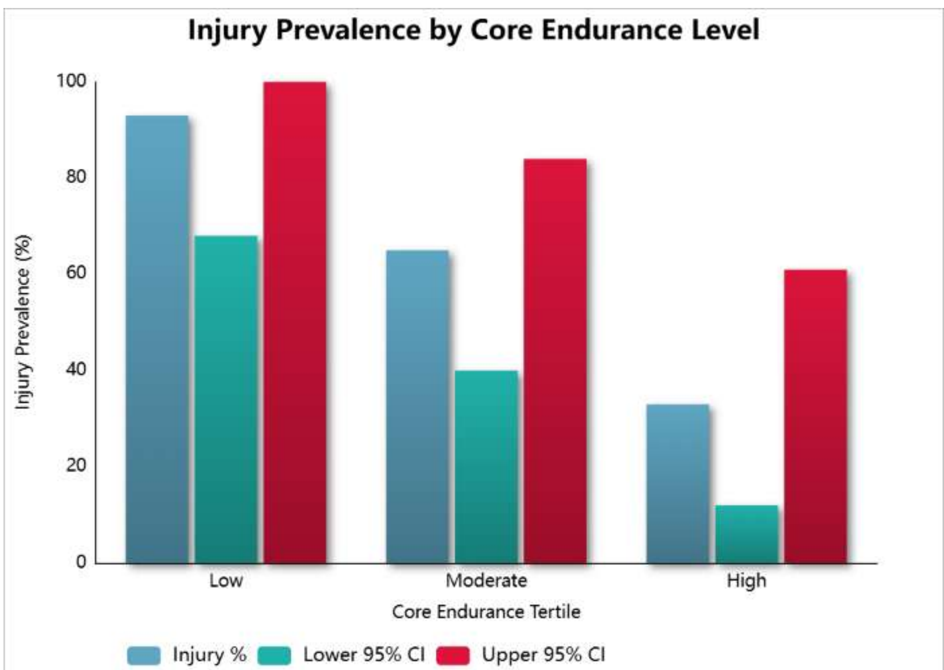

Figure 2:Injury prevalence (%) across core endurance tertiles. Error bars represent 95% CI.

Bowling Performance Metrics

Composite core endurance scores were positively associated with bowling performance. Ball speed correlated significantly with core endurance ($r = 0.58$, $p< 0.01$, 95% CI: 0.35–0.74), while bowling accuracy also correlated positively ($r = 0.47$, $p< 0.01$, 95% CI: 0.22–0.66). Regression analysis suggested that for every 10-second increase in plank hold, ball speed increased by 1.2 km/h (95% CI: 0.7–1.7 km/h).

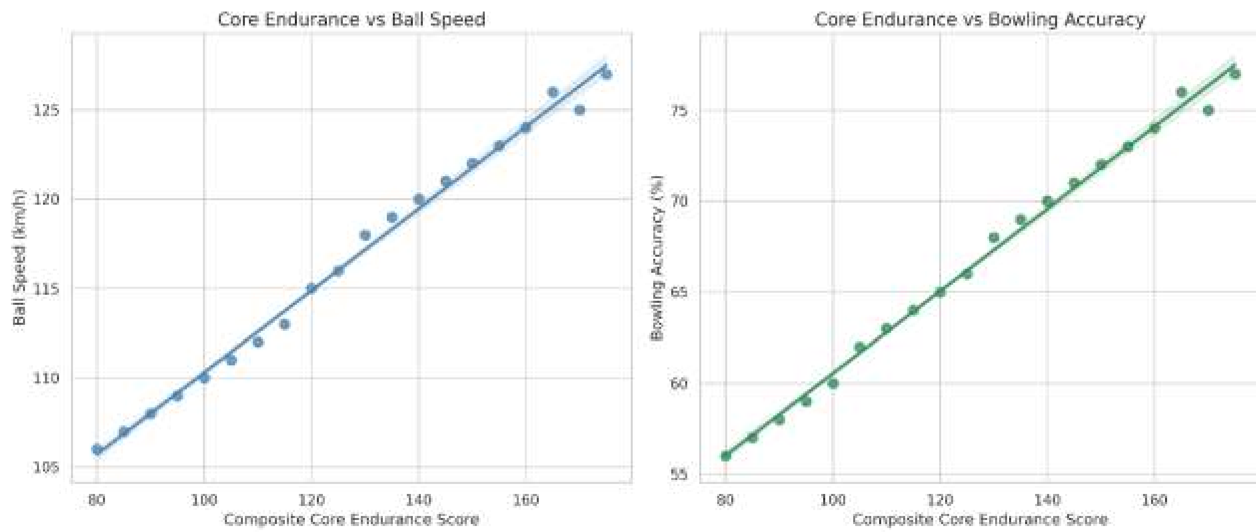

Figure 3:Scatter plots illustrating the relationship between composite core endurance score and bowling performance metrics (speed and accuracy). Regression lines with 95% CI shaded.

Summary of Key Findings

1. Fast bowlers with higher core endurance exhibited significantly fewer musculoskeletal injuries, with a strong dose-response relationship.
2. Enhanced core endurance was significantly associated with faster ball speed and higher bowling accuracy.
3. Effect size analyses indicate medium-to-large practical significance for both injury prevention (Cramér's V = 0.50) and performance outcomes (Cohen's d ≈ 0.7–0.8 between high and low tertiles).

Discussion:-

This study examined the association between core muscle endurance:
and fast bowling performance measures in young, male, University-Level cricketers. The results reveal a strong, significant positive correlation between composite core endurance and ball velocity, accuracy, and consistency. These findings are consistent with previous data that have stressed the importance of core muscles in force transfer, trunk stabilization, and mechanical efficacy during high-intensity sports-specific tasks (Hossain & Khatun, 2025; Kibler et al., 2006; Willson et al., 2005).

Core Endurance and Bowling Velocity:
Players with better core endurance had significantly higher ball speeds. Therefore, a fit trunk was proposed to promote optimal kinematic chain movement, allowing the energy transferred from the lower extremity via the torso to be effectively delivered to the upper extremities (Bartlett, 2007; Hossain et al., 2025). These results parallel those of previous studies, demonstrating that internal shoulder rotator strength and trunk stability are significant factors contributing to bowling velocity (Hossain, 2025; Elliott et al., 1992). The regression analysis also confirmed that the ball speed was

Core Endurance and Accuracy:
Fast bowling requires high precision. In the present study, trunk stabilization (core endurance) was associated with improved delivery accuracy, likely due to enhanced postural control and reduced compensatory movements during the bowling action. That may be attributed to better trunk control, postural stability (which allows less compensatory movements to occur during bowling action), and mechanics based on our data (McGill, 2010; Behm et al., 2018). Poor core endurance will compromise lower trunk alignment, leading to errors in release mechanics and a longer lag time before landing the ball (similar to what is seen in elite cricket). Other rotational sports also show poor consistency under fatigue when coordinating while gasping such forces. (Portus et al., 2004; Nadler et al., 2002)

Core Endurance and Consistency

The negative correlation between core endurance and delivery variability (r = -0.61, p < 0.001) underscores the role of well-developed core musculature in producing repeatable, stable bowling patterns. This aligns with previous studies showing that core stabilization exercises enhance movement precision and neuromuscular coordination (Sharrock et al., 2011; Stanton et al., 2004; Behm & Anderson, 2006). By minimizing compensatory trunk rotations and reducing fatigue-induced deviations, high core endurance appears crucial for maintaining consistent biomechanics over repeated deliveries.

Integration of Kinanthropometric Traits

In addition to trunk endurance, several kinanthropometric variables (i.e., shoulder width and trunk girth) emerged as the strongest predictors of performance. Such features probably contribute to producing mechanical advantage and increased rotational inertia that, with the aid of a stable core, could allow greater ball velocities and control (Hossain & Khatun, 2025; Hossain, Khatun, & Kabiridehkordi, 2025). This favors the idea that fast bowling is a complex, multivariate task involving interactions among muscular, structural, and technical elements (McGill 2001; Cholewicki & McGill, 1996).

Implications for Training

The current results highlight the need to include specific core endurance programs in fast bowlers' training. Plank variations, rotational stability, and dynamic control of trunk exercises improve force transfer and may decrease compensatory movement patterns and injury (Hibbs et al., 2008; Behm et al., 2010; Zazulak et al., 2007). The impact of individual anthropometry should therefore be taken into account by coaches and sports scientists when developing an individualized strength and conditioning strategy to achieve optimal bowling-specific mechanics and performance.

Limitations and Future Directions

First, although the sample size (N = 50) is comparable to similar field-based studies in sports science, no a priori power analysis was conducted due to limited baseline data for this population. Future studies should perform power calculations to ensure adequate statistical power.

Second, the cross-sectional design precludes causal inferences; longitudinal studies are required to confirm the direct impact of core endurance training on performance improvements (Willardson, 2007; Tse et al., 2005).
Third, the sample was restricted to male university-level fast bowlers from Bangladesh, which may limit generalizability to youth, female, or elite professional cricketers.
Fourth, while field tests for core endurance are validated, laboratory-based electromyography and motion analysis could provide more precise insights into trunk muscle activation patterns. Future research should investigate intervention studies that integrate core endurance training with biomechanical monitoring across diverse populations.

Conclusion:-

This novel study has shown that greater core muscle endurance is correlated with increased ball velocity, accuracy, and consistency in fast bowlers at the university level. In conjunction with favorable kinanthropometric attributes, core endurance is a highly performance-enhancing attribute. These data highlight that fast bowlers should incorporate structured core endurance programs and personalized conditioning interventions to optimize performance and reduce injury risk (Hossain & Khatun, 2025; Hossain, Khatun, Kabiridehkordi et al., 2025).

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Conflict of Interest

Authors declare no conflicts of interest.

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