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Correlation Of Upper And Lower Limb Anthropometry On Javelin Throwing Performance Of Indian Athletes

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ABSTRACT

The present study investigated the relationship between selected anthropometrical variables and their impact on javelin throwing performance This study aimed to examine the relationship between selected upper and lower limb anthropometric parameters and javelin throwing performance. The sample consisted of five top-level javelin throwers representing Indian Railways in the 88th All India Inter Railway Athletics Championship (2023–24), with an average performance of 66.80 meters. Anthropometric measurements included full arm length (FAL), upper arm length (UAL), lower arm length (LAL), full leg length (FLL), upper leg length (ULL), and lower leg length (LLL). Correlation analysis revealed a statistically significant and strong positive relationship between throwing distance and both FAL ($r = 0.888$, $p = 0.044$) and LAL ($r = 0.935$, $p = 0.020$), suggesting that longer arm segments contribute to enhanced lever mechanics and release efficiency. While UAL showed a positive trend ($r = 0.767$), it did not reach statistical significance ($p = 0.130$). Leg segment lengths demonstrated moderate, yet statistically insignificant, positive correlations with performance, indicating a potential but less decisive role in supporting stride dynamics and stability. These findings highlight the relevance of upper limb proportions—especially full and lower arm lengths—as key predictors of javelin throwing success and emphasize their value in athlete assessment, training optimization, and talent identification processes.

Important Key: full arm length (FAL), upper arm length (UAL), lower arm length (LAL), full leg length (FLL), upper leg length (ULL), and lower leg length (LLL).

INTRODUCTION

Javelin throw is a highly technical and explosive athletic event that requires an optimal blend of strength, coordination, speed, and biomechanics. Among the various factors influencing performance in this discipline, the anthropometric characteristics of an athlete—particularly the dimensions of the upper limb i.e. upper arm and lower arm and lower limb i.e. upper leg and lower leg—play a critical role. The length, girth, and proportion of the limbs contribute significantly to generating effective force, achieving optimal release angles, and ensuring balance during the run-up and release phases. In throwing events like javelin, the upper limb is responsible for the final act of propulsion, where variables such as arm length and shoulder breadth directly influence the release velocity and angle of the javelin. Similarly, the lower limbs provide the foundational support and explosive power needed during the approach and delivery strides. A well-coordinated interplay between both sets of limbs not only enhances technique but also reduces the risk of injury and improves overall efficiency. Indian athletes have shown remarkable progress in recent years in international javelin competitions. However, limited research exists focusing on how the specific anthropometric dimensions of Indian javelin throwers relate to their performance outcomes. Understanding these correlations can assist coaches and sports scientists in talent identification, training program customization, and biomechanical optimization for enhanced performance. This study aims to examine the relationship between selected upper and lower limb anthropometric variables and javelin throwing distance among Indian athletes. By identifying the key physical traits that influence throwing capability, the research intends to provide a scientific basis for athlete development and performance enhancement in the discipline of javelin throw. Coh, M., Embersic, D., & Zvan, M. (2001) found that certain body measurements, especially upper body and limb lengths, had a positive correlation with javelin throwing performance. This suggests that athletes with favourable body proportions—like longer arms or greater overall height—tend to perform better, likely due to biomechanical advantages such as improved lever mechanics and force generation. The lower limbs (upper leg length and lower leg length) play a crucial role in the performance of a javelin thrower, serving as the primary source of power, stability, and coordination throughout the different phases of the throw. From the initial run-up to the final release, the lower body contributes significantly to the generation and transfer of force, which directly impacts the distance the javelin is thrown. During the approach phase, the legs provide forward momentum through rapid and controlled sprinting. The efficiency of this movement depends on leg strength, stride length, and rhythm, all of which contribute to building the kinetic energy that is transferred through the body during the throw. In the withdrawal and crossover phases, the lower limbs maintain balance and rhythm as the body prepares for the final delivery. Singh, P. (2023) found that both motor fitness and kineanthropometric characteristics showed a significant positive correlation with javelin throwing performance. This means that athletes who had better physical fitness and favorable body measurements tended to perform better in the javelin throw. Emphasizes the importance of a combined assessment of fitness and body structure in evaluating and improving skill performance in javelin throwers. The ability of the legs to absorb impact and maintain posture is essential for keeping the upper body aligned and ready for the explosive action that follows. The most critical role of the lower limbs is observed during the final three strides and the delivery phase. Here, the athlete performs a braking action with the front leg,

especially during the penultimate and final stride. Low Leslie Jean. (1992 found that specific body measurements, despite the shorter stature of dwarf athletes, had a meaningful impact on their sports performance. It highlighted that proportional differences—like limb length relative to torso length—could influence performance in different sports, just as they do in average-stature athletes. This braking action allows for a rapid deceleration of the lower body, creating a strong base against which the upper body can rotate and accelerate the javelin. The power generated by the legs is transferred through the hips and torso, ultimately aiding in a more forceful release. Additionally, the hip extension, knee flexion, and ankle stability all contribute to proper force transmission and body alignment. Strong, flexible, and well-coordinated lower limbs help the thrower maintain balance, absorb ground reaction forces, and avoid injury during the high-impact final phase of the throw. The lower limbs not only generate the initial momentum but also act as a stable and powerful base for transferring force during the delivery. Without well-developed lower limb strength, coordination, and technique, optimal javelin throwing performance is difficult to achieve and also the upper limb plays a crucial role in the execution and effectiveness of the javelin throw, especially during the return, transition and release phases. It is primarily responsible for controlling the spear during its forward motion and generating the final propulsive force that determines the release speed and angle. The throwing arm, composed of the shoulder, elbow and wrist joints, must function in a highly coordinated manner for a smooth and powerful throwing action. The shoulder provides a wide range of motion and serves as the main driver for the acceleration of the arm, while the elbow and wrist contribute to accuracy and speed at the point of release. A longer arm can provide a mechanical advantage by increasing the length of the lever, which can contribute to higher release speeds. In addition, the non-throwing arm also plays a supporting role by maintaining balance and assisting in torso rotation during the delivery phase. Proper strength, flexibility and neuromuscular coordination in the upper limbs are essential not only to maximize throwing distance but also to minimize the risk of injury during the high-speed movements involved in javelin throwing.

METHOD AND PROCEDURE

The sample included 5 top javelin throwers of Indian Railway who competed in the 2023-24 88th All India inter Railway Athletics Championship finals in Raebareily and average result of performance is 66.80 m. Variables were identified for estimating of Anthropometrical parameters.

Independent variables;-

1. Full Arm length (cm) (FLL)
2. Upper arm length (cm) (UAL)
3. Lower arm length (cm) (LAL)
4. Full Leg length (cm) (FLL)
5. Upper leg length (cm) (ULL)
6. Lower leg length (cm) (LLL)

Dependent Variables;- Throwing distance

Anthropometrical variables of finalists are presented below the table

ANTHROPOMETRIC VARIABLES OF FIVE INDIAN JAVELIN THROW ATHLETES

Table a

Leg length (cm)			Arm length (cm)		
FLL (cm)	**ULL (cm)**	**LLL (cm)**	**FAL (cm)**	**UAL (cm)**	**LAL (cm)**
99	48	51	85.3	39	46
100.2	52	48.2	82.5	36.5	46
94.3	48.3	46	76	31	45
102	50	52	78.5	33.5	45
87	43	44	75	32	43

Key ; ULL= Upper Leg Length, LLL=Lower Leg Length, UAL= Upper arm Length, LAL=Lower arm Length**.**

Table b

COEFFICIENTS OF CORRELATION OF FULL ARM LENGTH, UPPER ARM LENGTH AND LOWER ARM LENGTH WITH THE PERFORMANCE OF 5 JAVELIN THROWERS

SL. NO.	ANTHROPOMETRIC VARIABLES (INDEPENDENT VARIABLES)	MEAN	SD	COEFFICIENTS OF CORRELATION (R)	P-VALUE
	INDEPENDENT VARIABLES				
1.	Full arm length (FAL)	79.20	4.207	0.888	0.044
2.	Upper arm length (UAL)	34.40	3.209	0.767	0.130
3.	Lower arm Length (LAL)	45.00	1.225	0.935	O.020
DEPENDENT VARIABLES					
Throwing Distance		Mean = 66.80		SD = 3.493	

Table c

COEFFICIENTS OF CORRELATION OF FULL LEG LENGTH, UPPER LEG LENGTH AND LOWER LEG LENGTH WITH THE PERFORMANCE OF 5 JAVELIN THROWERS

SL. NO.	ANTHROPOMETRIC VARIABLES (INDEPENDENT VARIABLES)	MEAN	SD	COEFFICIENTS OF CORRELATION (R)	P-VALUE
	INDEPENDENT VARIABLES				
1.	Full leg length (FLL)	96.40	6.025	0.634	0.250
2.	Upper leg length (ULL)	48.20	3.347	0.625	0.260
3.	Lower leg length (LLL)	48.20	3.347	0.518	0.372
DEPENDENT VARIABLES					
Throwing Distance		Mean = 66.80		SD = 3.493	

RESULT

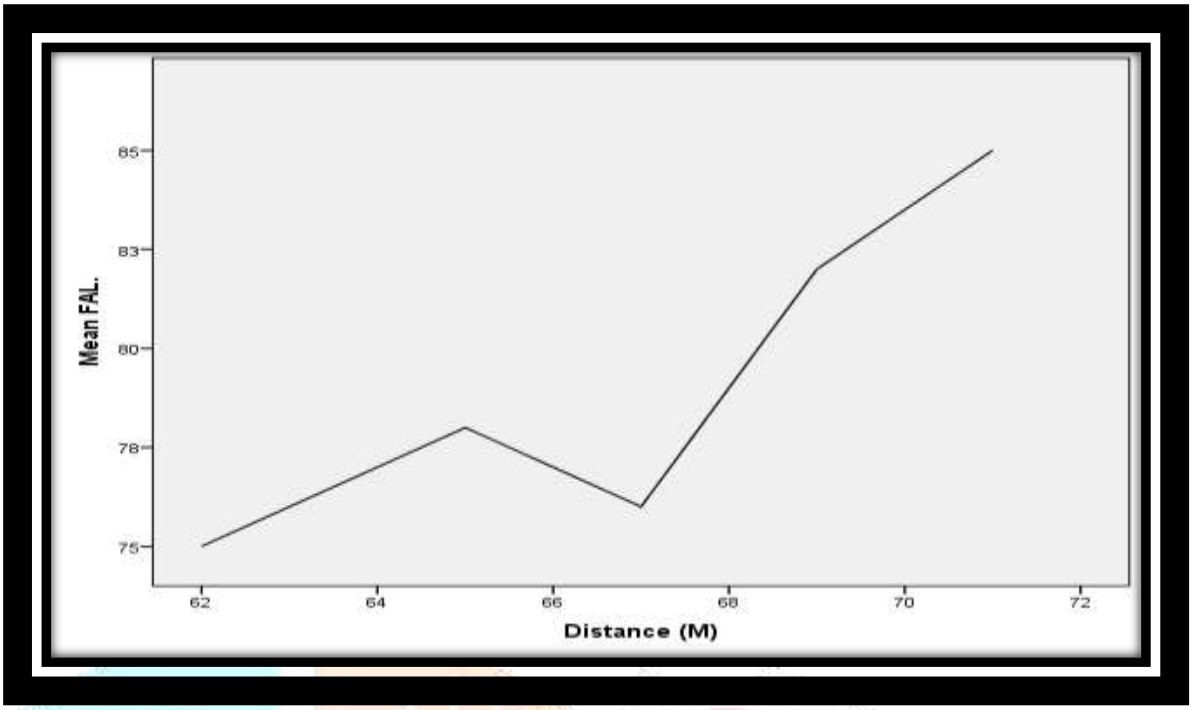
The analysis revealed varying degrees of positive correlation between different limb anthropometric measurements and javelin throwing distance. A strong and statistically significant positive correlation was observed between full arm length (FAL) and throwing distance, with a Pearson correlation coefficient of r = 0.888 and p = 0.044, indicating that greater full arm length is closely associated with improved throwing performance. Similarly, lower arm length (LAL) showed a very strong and statistically significant positive correlation with throwing distance (r = 0.935, p = 0.020), suggesting that lower arm dimensions are critical to throw efficiency. In contrast, the correlation between upper arm length (UAL) and throwing distance, although moderately strong (r = 0.767), did not reach statistical significance (p = 0.130).

Regarding the lower limb, full leg length (FLL) demonstrated a strong positive but non-significant correlation with throwing distance (r = 0.634, p = 0.250). Similarly, upper leg length (ULL) had a positive relationship (r = 0.625) but was not statistically significant (p = 0.260). Lastly, lower leg length (LLL) showed a moderate positive correlation (r = 0.518) that was also not statistically significant (p = 0.372). These findings indicate that while upper limb dimensions, particularly full and lower arm lengths, are closely linked with javelin throwing performance, lower limb measurements did not show statistically significant associations in this sample.

DISCUSSION OF FINDING

The findings of this study highlight the significant influence of upper limb anthropometry, particularly full arm length, on javelin throwing performance. The strong and statistically significant correlation between full arm length (FAL) and throwing distance (r = 0.888, p = 0.044) suggests that athletes with longer arm spans may gain a biomechanical advantage during the throw. This advantage could stem from improved lever mechanics, allowing for greater acceleration of the javelin and a more effective release angle. A longer arm

may also contribute to an extended range of motion and increased release velocity, both of which are critical in maximizing throwing distance.



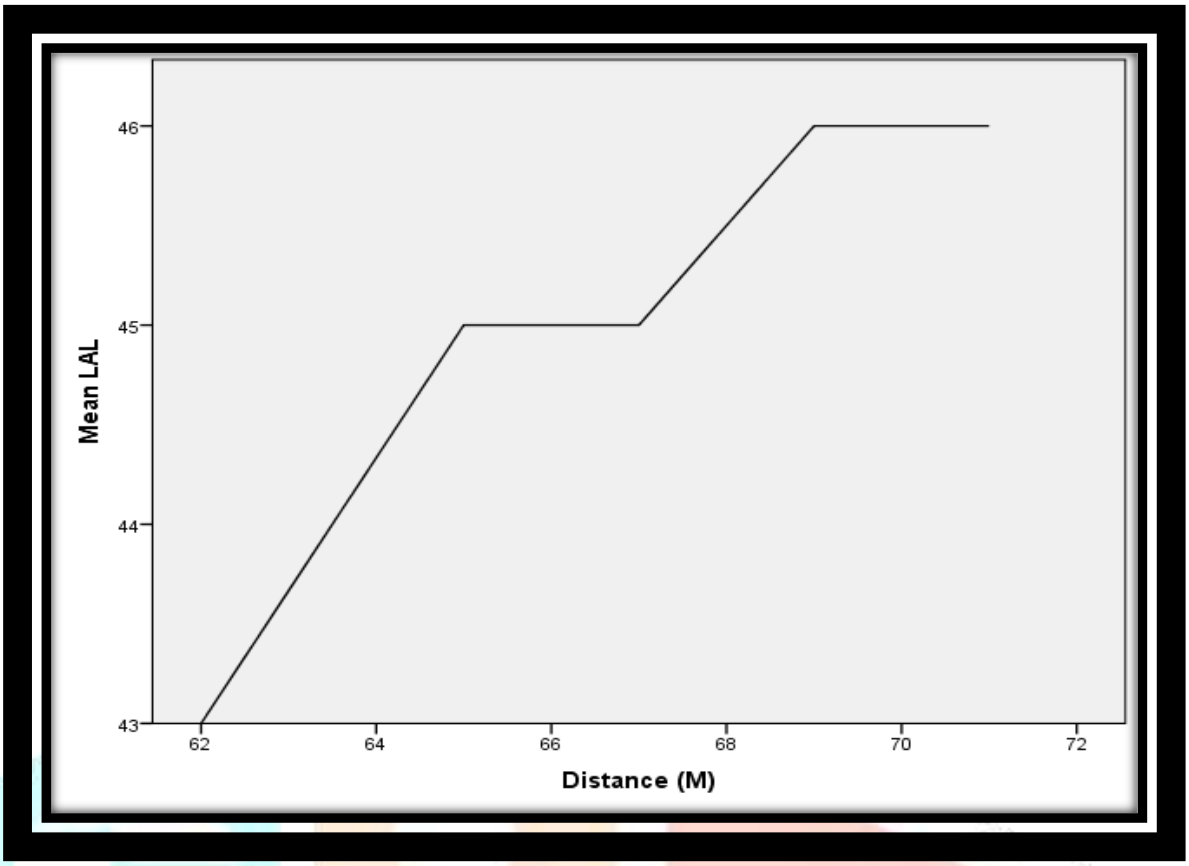
Graph a

Graphical representation of above **graph a** shows a correlations between full arm length and throwing distance

Now the upper arm length (UAL) also showed a moderately strong positive correlation with performance (r = 0.767), the relationship did not reach statistical significance (p = 0.130). This indicates that while upper arm length may contribute to throwing effectiveness, its role may not be as decisive as that of full arm length in this context. The lack of statistical significance could be attributed to the small sample size or individual biomechanical differences among the athletes. Overall, these findings suggest that full arm length is a more reliable predictor of throwing performance compared to isolated upper arm length, underlining the importance of considering complete limb dimensions in performance analysis and talent identification.

And see the graph 1.2 where the correlation analysis revealed a very strong positive relationship between lower arm length (LAL) and javelin throwing distance, with a Pearson correlation coefficient of $r = 0.935$, which is statistically significant at the 0.05 level ($p = 0.020$). This finding suggests that athletes with longer lower arms tend to achieve greater throwing distances. From a biomechanical perspective, this relationship aligns with the principle of levers, where the lower arm acts as a force arm in the kinetic chain. A longer force arm can generate greater torque when combined with adequate angular momentum, ultimately enhancing the velocity and distance of the javelin release. This implies that the structural advantage of increased lower arm length may contribute to more efficient force transmission during the throwing motion, reinforcing the importance of anthropometric characteristics in performance outcomes in javelin throw.

Graph b



Graph b of correlation between javelin throw distance and LAL (lower arm length)

The correlation analysis investigating the relationship between javelin throwing distance and various segments of leg length—full leg length (FLL), upper leg length (ULL), and lower leg length (LLL)—revealed moderate positive correlation. For FLL, a Pearson correlation coefficient of $r = 0.634$ suggests a tendency for athletes with longer legs to achieve greater throwing distances; however, the lack of statistical significance ($p = 0.250$) indicates that this result may be influenced by chance. Similarly, the relationship between ULL and throwing distance, with $r = 0.625$ and $p = 0.260$, points to a potential positive correlation, though it is also not statistically significant. The analysis for LLL produced a moderate correlation ($r = 0.518$), again lacking statistical significance ($p = 0.372$). Although none of these correlations reach the threshold for statistical reliability, the consistent direction of the relationships across all leg segments suggests a possible trend wherein greater leg length may support better performance. This could be attributed to biomechanical advantages in stride length, stability, and force production during the approach and final delivery phases, yet the small sample size may limit the strength and generalizability of these findings.

CONCLUSION

The results of the study underscore the critical role of upper limb anthropometric characteristics—particularly full arm length (FAL) and lower arm length (LAL)—in influencing javelin throwing performance among Indian male athletes. The statistically significant and strong positive correlations of FAL ($r = 0.888$, $p = 0.044$) and LAL ($r = 0.935$, $p = 0.020$) with throwing distance suggest that athletes possessing longer arm segments benefit from biomechanical advantages such as enhanced lever function, increased range of motion,

and more effective force transmission during the throw. These structural features likely contribute to higher release velocities and better control over the release angle, both of which are essential for maximizing throw distance. While upper arm length (UAL) also showed a positive correlation (r = 0.767), its lack of statistical significance (p = 0.130) indicates that, although it may aid performance, it is less predictive of success than overall or segmental arm length. The variability in this relationship could be attributed to inter-individual biomechanical differences or the limited sample size. The findings related to leg segments—full leg length (FLL), upper leg length (ULL), and lower leg length (LLL)—revealed moderate but statistically insignificant positive correlations with throwing distance. Although not conclusive, these trends suggest that leg length may still play a supportive role by contributing to stride efficiency, approach velocity, and balance during the delivery phase. However, the absence of statistical significance, likely due to the small sample size (N = 5), limits the generalizability of these observations. Finaly full arm and lower arm lengths emerge as more reliable anthropometric indicators of performance in javelin throwers, highlighting the importance of considering upper limb proportions in athlete selection, training design, and talent identification programs.

RECOMMENDATION

Future studies with larger sample sizes are recommended to further validate these trends and explore their implications in a broader athletic context**.**

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