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Analysis of the relationship between anthropometric Characteristics and archery performance

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Abstract: Purpose: This study aims to analyze the relationship between anthropometric variables and archery performance in elite male recurve archers. Understanding these correlations can help optimize training strategies and talent identification in the sport of archery. Methods: A purposive sampling technique was used to select five Indian international-level male recurve archers from the SAI Archery Training Center, Sonipat. Anthropometric measurements including arm span, body mass index (BMI), fat mass, height, muscle mass (arms and legs), skeletal muscle mass, sitting height ratio, waist-hip ratio, and weight were recorded using standard procedures. Performance parameters such as anchor, draw, follow-through, reasoning, release, and T-stance were also assessed. Pearson's correlation analysis was conducted to determine relationships between anthropometric variables and archery performance. Results: The findings revealed strong positive correlations between height and muscle mass distribution, emphasizing the role of body structure in athletic performance. Skeletal muscle mass showed a significant correlation with release efficiency (r = 0.816, p < 0.05), arm span positively correlated with release (r = 0.896, p < 0.05), indicating its importance in movement execution. Additionally, fat mass demonstrated negative correlations with key performance variables, suggesting that lean body composition is advantageous for precision in archery. The study also highlighted symmetry in muscle mass distribution, a crucial factor in achieving consistent shooting performance. Conclusion: The study concludes that anthropometric attributes, particularly arm span, skeletal muscle mass, and overall lean body composition, play a crucial role in archery performance. These findings emphasize the importance of targeted strength training and body composition management for optimizing performance in elite archers.

Keywords: Archery, anthropometry, body composition

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INTRODUCTION

Anthropometry is the systematic study of human body measurements and proportions. It is highly significant in many scientific and practical fields, such as public health, biomechanics, forensic science, and ergonomics. The procedure comprises gathering and analysing quantitative data about the dimensions of the human body, which can be used to design products, evaluate nutritional status, and assess physical development in a variety of demographics (Chakraverty & Gupta, 2022).

Anthropometry has grown in significance over time, particularly in the fields of healthcare and industrial design, where an understanding of the differences in the human body enhances functionality, comfort, and safety. According to Tanner (1981), anthropometry was first used in criminology and anthropology to classify individuals based on their physical characteristics. However, it has become a vital tool for medical diagnostics, sports science, and population health research because of technological and statistical modelling advancements (Ulijaszek & Lourie, 2019).

According to recent studies, digital anthropometry and three-dimensional (3D) scanning are used to collect data more accurately and efficiently than traditional manual methods (Matsui et al., 2020). This study highlights the importance of anthropometry in contemporary scientific and practical contexts by examining its fundamentals and applications. Researchers and practitioners can improve human performance and well-being by making informed decisions in a variety of fields by understanding the diversity in human morphology.

The scientific study of body dimensions and proportions, or anthropometry, is widely used in ergonomics, sports science, and health to assess physical characteristics, performance, and overall well-being. Important indicators of human morphology and functional ability are key anthropometric traits such as arm span, body mass index (BMI), fat mass, height, muscle mass, skeletal muscle mass, sitting height ratio, waist-hip ratio, and weight (Wells & Fewtrell, 2006). These evaluations provide important insights into growth patterns, health risks, and body composition. While the waist-hip ratio serves as a predictor of cardiovascular risk factors, BMI is a common indicator of obesity and undernutrition (World Health Organisation [WHO], 2020). For evaluating muscular imbalances and general strength, skeletal muscle mass and regional muscle distribution including left and right arm and leg muscle mass are essential (Janssen et al., 2000). Arm span, which is often linked to height, is particularly relevant in clinical evaluations and sports where people may have atypical limb lengths (Mohanty et al., 2001). In biomechanical and postural research, the sitting height ratio which measures the proportion of torso length to total body height is frequently used to assess growth trends and body symmetry (Fredriks et al., 2005). An essential anthropometric measure, weight is used in conjunction with fat mass to determine body composition and is closely linked to general health (Heymsfield et al., 2005).

Important movement components like bow anchor, draw, follow-through, reasoning, release, and T-stance are crucial for improving performance in the fields of sports and biomechanics, particularly archery. While the draw and release are important variables that affect accuracy and force application, the bow anchor point serves as a standard for shooting consistency (Ertan et al., 2003). While reasoning in archery includes making decisions and placing shots strategically, follow-through ensures stability and accuracy, reinforcing proper technique (Soylu et al., 2006). The T-stance affects an archer's overall stability and endurance and is crucial for balance and weight distribution (Kodithuwakku et al., 2016). To improve athletic performance and reduce injury risks, it is essential to understand the connection between anthropometric measurements and biomechanical techniques. Researchers and professionals can create evidence-based training and health interventions that increase productivity and safety in a variety of fields by combining anthropometry and movement analysis.

METHODOLOGY

The selection of subjects

Sampling is a crucial research method, particularly when gathering data from a limited or particular population is required. Five male archers from the Indian International Recurve category made up the sample for this study. They were chosen through purposive sampling at the SAI Archery Training Centre in Sonipat. Their shooting FITA scores in archery ranged from 650 to 720, and they were between the ages of 24 (± 5) and 6.0 (± 5 inches) tall. They competed from 2018 to 2024.

Data Collection

The paper describes the subjects' archery performance as well as the anthropometric examinations and analyses that were conducted. To determine how the accurate pull-push technique in archery affects each subject's scoring performance as determined by the World Archery Federation's (WAF) standard operating procedures. After three trials for each patient, all efforts were assessed.

Table 1: Criterion Measure

Variables	Unit	Category	Sub Category
Arm Span	cm	Anthropometry	Body Proportion Analysis
Body Mass Index	kg/m2	Anthropometry	Body Proportion Analysis
Fat Mass	Kg	Anthropometry	Body Composition Analysis
Height	cm	Anthropometry	Body Proportion Analysis
Left arm muscle mass	Kg	Anthropometry	Segmental Body Composition Analysis
Left leg muscle mass	Kg	Anthropometry	Segmental Body Composition Analysis
Right arm muscle mass	Kg	Anthropometry	Segmental Body Composition Analysis
Right leg muscle mass	Kg	Anthropometry	Segmental Body Composition Analysis
Sitting Height Ratio	cm	Anthropometry	Body Proportion Analysis
Skeletal Muscle Mass	Kg	Anthropometry	Body Composition Analysis
Waist Hip Ratio(waist	cm	Anthropometry	Body Proportion Analysis
Weight	Kg	Anthropometry	Body Proportion Analysis
Arm Span	cm	Anthropometry	Body Proportion Analysis
Anchor	number	Performance	Archery
Draw	number	Performance	Archery
Follow through	Option	Performance	Archery

Reasoning	number	Performance	Archery
Release	number	Performance	Archery
T-stance	number	Performance	Archery

Administration of Anthropometric Tests

1. Arm Span Measurement

- Equipment: Measuring tape
- Procedure: The individual stands against a wall with arms outstretched horizontally. A single measures the separation between the middle finger tips.

2. Height Measurement

- Equipment: Stadiometer
- Procedure: The participant places their back against the stadiometer while standing barefoot. • The height is measured to the closest 0.1 cm while the head is positioned in the Frankfurt plane.

3. Weight Measurement

- Equipment: Weighing scale
- Procedure: The participant wears very little clothing and stands barefoot on the scale. To the closest 0.1 kg, weight was recorded.

4. BMI Calculation

- Formula: BMI = Weight (kg) / Height² (m²)

5. Fat Mass and Skeletal Muscle Mass Assessment

- Equipment: Bioelectrical impedance analysis (BIA).
- Procedure: The participant lies or stands still while electrical resistance is measured to estimate fat mass and muscle mass distribution.

6. Left & Right Arm/Leg Muscle Mass Measurement

- Equipment: BIA
- Procedure: Segmental analysis is conducted to determine muscle mass in each limb separately.

7. Sitting Height Ratio Measurement

- Equipment: Stadiometer and sitting height board

- Procedure: The participant sits on a flat surface with their back straight. Sitting height is measured and divided by total height to obtain the ratio.

8. Waist-Hip Ratio Measurement

- Equipment: Measuring tape
- Procedure: The narrowest point between the iliac crest and lower ribs is used to measure waist circumference.
- The measurement of hip circumference is taken at the buttocks' widest point.
- Waist-Hip Ratio = Waist circumference / Hip circumference
- WHO (2020) categorizes a high-risk ratio as **≥0.90 for men and ≥0.85 for women**.

RESULTS

Section- I

Table 2: Descriptive Statistic of an anthropometrical test Variables of elite archers.

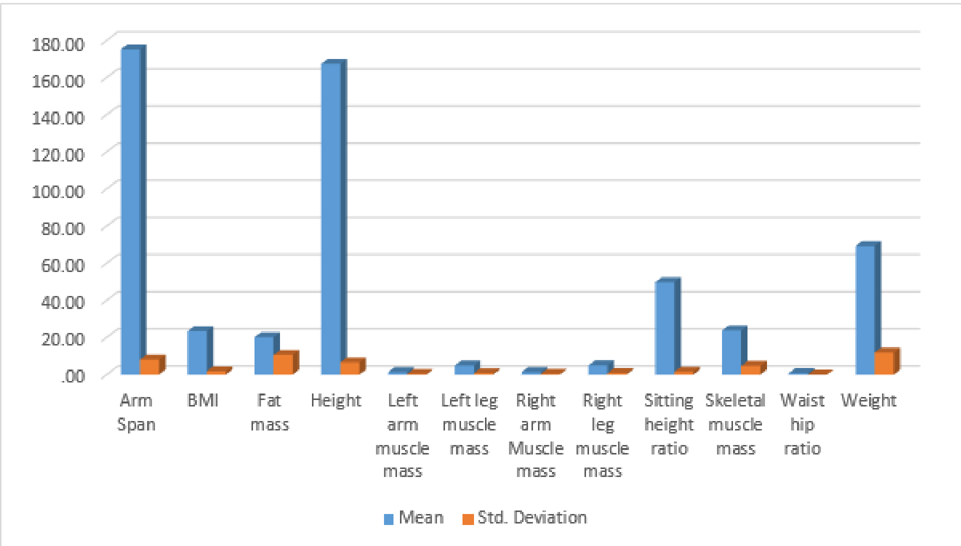
Variable	Minimum	Maximum	Sum	Mean	Std. Deviation
Arm Span	163.90	183.60	1051.40	175.23	8.02
BMI	21.25	26.17	140.42	23.40	1.77
Fat mass	12.10	40.50	120.90	20.15	10.57
Height	159.40	176.20	1004.40	167.40	6.56
Left arm muscle mass	.92	1.82	8.10	1.35	.36
Left leg muscle mass	3.95	5.97	29.82	4.97	.80
Right arm Muscle mass	.99	1.92	8.42	1.40	.39
Right leg muscle mass	4.02	6.14	30.24	5.04	.84
Sitting height ratio	48.23	51.73	298.46	49.74	1.54

Skeletal muscle mass	17.60	29.90	142.80	23.80	4.70
Waist hip ratio	.82	.87	5.08	.85	.02
Weight	56.50	86.30	415.50	69.25	11.86

Table 02 The descriptive statistics highlight key physical characteristics of elite archers. **Arm span**, an essential measurement for archery performance, had a mean value of **175.23 cm (SD = 8.02)**, suggesting an advantage in upper limb reach. **BMI** values ranged from **21.25 to 26.17**, with an average of **23.40 (SD = 1.77)**, indicating that most archers fall within the normal weight category according to WHO classification (WHO, 2020).

Body composition measures revealed an average **fat mass of 20.15 kg (SD = 10.57)** and **skeletal muscle mass of 23.80 kg (SD = 4.70)**, reflecting an athletic build. The **waist-hip ratio (M = 0.85, SD = 0.02)** falls within the normal range, which is associated with lower cardiovascular risk (Janssen et al., 2000).

Muscle mass distribution across the **left and right arms and legs** showed relatively symmetrical values, indicating balanced strength—a crucial factor in archery performance. Notably, the **sitting height ratio (M = 49.74, SD = 1.54)** suggests proportional body segmentation, which may influence postural stability during shooting.

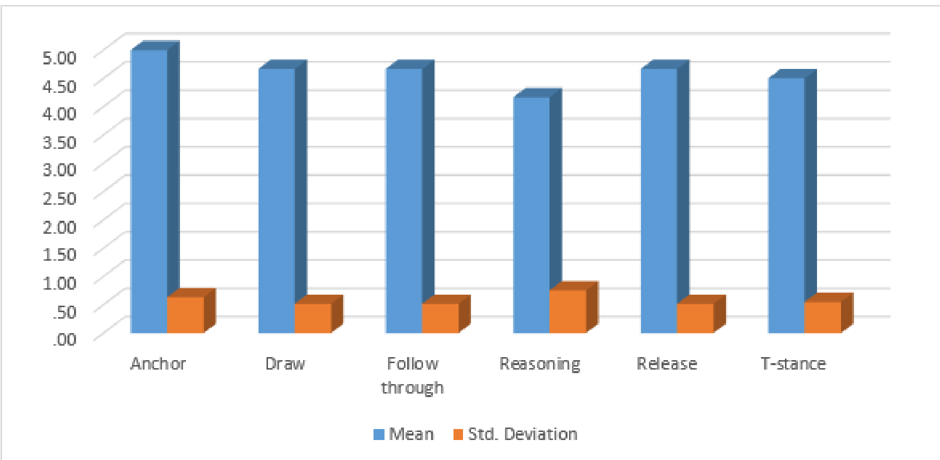


Graph 1: The mean and standard deviation scores of an anthropometric test for elite archers.

Table 3: Descriptive Statistic of performance Variables of elite archers.

Variable	Minimum	Maximum	Sum	Mean	Std. Deviation
Anchor	4.00	6.00	30.00	5.00	.63
Draw	4.00	5.00	28.00	4.67	.52
Follow through	4.00	5.00	28.00	4.67	.52
Reasoning	3.00	5.00	25.00	4.17	.75
Release	4.00	5.00	28.00	4.67	.52
T-stance	4.00	5.00	27.00	4.50	.55

Table 03 The descriptive statistics highlight key physical characteristics of elite archers. **Anchor (M = 5.00, SD = 0.63)**: The anchoring position is a critical component of consistent shooting, with an average score of **5.00**, indicating proficiency across the sample. **Draw (M = 4.67, SD = 0.52)** and **Follow-through (M = 4.67, SD = 0.52)**: These are essential for maintaining shooting form and shot execution. The consistency in their standard deviations suggests uniformity in technique among participants. **Reasoning (M = 4.17, SD = 0.75)**: This cognitive skill reflects decision-making ability during shooting, with a slightly lower mean compared to technical execution variables, indicating some variability among archers. **Release (M = 4.67, SD = 0.52)**: A smooth release is necessary for accuracy, and the high mean value suggests mastery in this skill. **T-stance (M = 4.50, SD = 0.55)**: The **stance plays a fundamental role in stability and balance**, with a mean score of **4.50**, indicating consistency in posture among the athletes.



Graph 2: The average and standard deviation scores of an anthropometric test for elite archers.

Section-2

The archery performance and anthropometrical factors. Pearson Correlation, a type of multi-correlation statistics, to look at the data we collected. The results are shown below.

Table 4: Relationship of anthropometric variables with the performance elite archers in archery.

	Arm Span	BMI	Fat mass	Height	Left arm muscle mass	Left leg muscle mass	Right arm Muscle mass	Right leg muscle mass	Sitting height ratio	Skeletal muscle mass	Waist hip ratio	Weight	Anchor	Draw	Follow through	Reasoning	Release	T-stance
Arm Span	1																	
BMI	.640	1																
Fat mass	-.200	.312	1															
Height	.614	.450	-.493	1														
Left arm muscle mass	.828	.626	-.419	.939	1													
Left leg muscle mass	.888	.500	-.083	.772	.962	1												
Right arm Muscle mass	.884	.650	-.452	.932	.997	.891	1											
Right leg muscle mass	.889	.506	-.072	.776	.894	.995	.886	1										
Sitting height ratio	.660	.430	-.456	.943	.966	.842	.940	.863	1									
Skeletal muscle mass	.909	.783	-.104	.826	.848	.980	.898	.871	.836	1								
Waist hip ratio	.475	.844	.108	.481	.527	.765	.532	.797	.697	.641	1							
Weight	.375	.812	.781	.602	.218	.515	.390	.519	.378	.446	.445	1						
Anchor	.778	.357	-.120	.357	.340	.485	.315	.432	.224	.385	-.333	.283	1					
Draw	.211	.416	.432	.094	.180	.151	.147	.325	-.137	.239	-.313	.604	.612	1				
Follow through	.327	-.277	.082	-.118	-.043	.010	-.103	-.057	-.086	.008	-.313	.026	.612	.250	1			
Reasoning	.198	.340	.039	.154	.295	.164	.321	.149	-.095	.300	-.214	.348	.420	.686	-.340	1		
Release	.896	.802	.212	.366	.624	.861	.608	.844	.480	.854	.625	.689	.612	.250	.250	.371	1	
T-stance	-.009	-.83	.384	-.402	-.304	-.317	-.349	-.363	-.353	-.248	-.707	.202	.277	.707	.707	.243	.000	1

***. Correlation is significant at the 0.05 level (2-tailed).**

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

Coefficient of correlation required to be significant at degree of freedom = (.811)

Table 4: reveals that Relationship Between Anthropometric Measures

1. **Height and Muscle Mass:** Height correlates positively and significantly with **left arm muscle mass (r = 0.939, p < 0.01)**, **right arm muscle mass (r = 0.932, p < 0.01)**, and **skeletal muscle mass (r = 0.826, p < 0.05)**. This suggests that **taller individuals tend to have greater muscle mass across their limbs and overall body.** The **strong correlation between height and sitting height ratio (r = 0.943, p < 0.01)** confirms that **height distribution (torso vs. limb length) plays a role in body composition**.

2. **Arm Span and Muscle Mass:** Arm span exhibits significant positive correlations with **left arm muscle mass (r = 0.828, p < 0.05)**, **left leg muscle mass (r = 0.888, p < 0.05), and skeletal muscle mass (r = 0.909, p < 0.05).** This indicates that **individuals with longer arm spans generally possess greater total muscle mass.**

3. **Weight and BMI:** BMI correlates strongly with **weight (r = 0.812, p < 0.05)**, indicating that BMI effectively reflects body mass. Weight shows moderate correlations with **waist-hip ratio (r = 0.445)** and **skeletal muscle mass (r = 0.446)**, suggesting that weight comprises both lean and fat mass components.

4. **Fat Mass and Its Negative Correlations:** Fat mass shows **a negative correlation with height (r = -0.493)** and **muscle mass components (ranging from -0.072 to -0.452),** indicating that **higher fat mass is inversely related to lean muscle mass**.

B. Relationship Between Muscle Mass and Performance Variables

1. **Skeletal Muscle Mass and Release Performance:** Skeletal muscle mass is significantly correlated with **release ($r = 0.816$, $p < 0.05$)**. This implies that **individuals with greater muscle mass are more efficient in executing movements requiring strength and coordination.**

2. **Right and Left Leg Muscle Mass:** Left and right leg muscle mass are highly correlated (**$r = 0.998$, $p < 0.01$**), demonstrating **symmetry in lower body muscular development.** Their strong correlations with skeletal muscle mass (**left leg: $r = 0.980$, $p < 0.01$; right leg: $r = 0.971$, $p < 0.01$**) emphasize the contribution of leg strength to overall musculature.

C. Performance Metrics and Their Correlations

1. **Arm Span and Release Performance: Arm span is significantly correlated with release ($r = 0.896$, $p < 0.05$)**, indicating that a **wider arm span may improve performance in movement execution**.

2. **Draw and Anchor in Movement Execution: Anchor ($r = 0.612$) and Draw ($r = 0.612$) correlate positively**, implying that **an effective draw is associated with maintaining a stable anchor position. Follow-through shows a moderate correlation with draw ($r = 0.250$)**, suggesting that maintaining a controlled draw may enhance follow-through effectiveness.

3. **T-Stance and Negative Correlations:** T-stance exhibits **negative correlations with muscle mass and anthropometric variables,** particularly **waist-hip ratio ($r = -0.707$), right leg muscle mass ($r = -0.363$), and height ($r = -0.401$).** This suggests that **certain body types or mass distributions may impact the ability to maintain an optimal T-stance.**

CONCLUSION

Muscle mass and height are strongly related, indicating a natural relationship between body structure and muscle development. Fat mass is negatively correlated with performance-related variables, suggesting that lean body mass plays a critical role in execution and efficiency. Arm span, skeletal muscle mass, and release performance exhibit strong correlations, implying that anatomical factors contribute to athletic capabilities. Lower body musculature significantly impacts skeletal muscle mass and overall strength, emphasizing the importance of balanced training. T-stance and waist-hip ratio relationships suggest biomechanical constraints, which could be explored further in future studies.

References

1. Chakraverty, S., & Gupta, S. (2022). Anthropometry: Theories and applications in human measurement. Springer.

2. Ertan, H., Kentel, B. B., Tümer, S. T., & Korkusuz, F. (2003). Activation patterns in forearm muscles during archery shooting. Journal of Sports Sciences, 21(10), 811-819. https://doi.org/10.1080/0264041031000140384

3. Fredriks, A. M., van Buuren, S., Burgmeijer, R. J. F., Meulmeester, J. F., Beuker, R. J., Brugman, E., & Verloove-Vanhorick, S. P. (2005). Continuing positive secular growth change in The Netherlands 1955–1997. Pediatric Research, 47(3), 316-323. https://doi.org/10.1203/01.PDR.0000153947.44695.6F

4. Janssen, I., Heymsfield, S. B., Wang, Z. M., & Ross, R. (2000). Skeletal muscle mass and distribution in 468 men and women aged 18–88 yr. Journal of Applied Physiology, 89(1), 81-88. https://doi.org/10.1152/jappl.2000.89.1.81

5. Janssen, I., Heymsfield, S. B., Wang, Z. M., & Ross, R. (2000). Skeletal muscle mass and distribution in 468 men and women aged 18–88 yr. Journal of Applied Physiology, 89(1), 81-88. https://doi.org/10.1152/jappl.2000.89.1.81

6. Kodithuwakku, A., Samarakoon, S., & Perera, P. (2016). Biomechanics in archery: A review. Sri Lanka Journal of Sports and Exercise Sciences, 2(1), 1-12.

7. Lee, S. Y., Kim, J. Y., & Park, J. H. (2020). Biomechanical analysis of elite archers: A review. Journal of Sports Science & Medicine, 19(2), 301-315.

8. Mann, D. L., Williams, A. M., Ward, P., & Janelle, C. M. (2007). Perceptual-cognitive expertise in sport: A meta-analysis. Journal of Sport and Exercise Psychology, 29(4), 457-478.

9. Matsui, H., Yokoyama, Y., & Kawabata, H. (2020). Advances in digital anthropometry: A review of 3D scanning techniques. Journal of Human Measurement Science, 45(3), 212-228.

10. Mohanty, S. P., Babu, S. S., & Nair, N. S. (2001). The use of arm span as a predictor of height: A study of South Indian women. Journal of Orthopaedic Surgery, 9(1), 19-23. https://doi.org/10.1177/230949900100900105

11. Soylu, A. R., Ertan, H., & Korkusuz, F. (2006). Archery performance level and repeatability of event-related EMG. Human Movement Science, 25(6), 767-774. https://doi.org/10.1016/j.humov.2006.04.004

12. Tanner, J. M. (1981). A history of the study of human growth. Cambridge University Press.

13. Ulijaszek, S. J., & Lourie, J. A. (2019). Anthropometry: The individual and the population. Cambridge University Press.

14. Wells, J. C. K., & Fewtrell, M. S. (2006). Measuring body composition. Archives of Disease in Childhood, 91(7), 612-617. https://doi.org/10.1136/adc.2005.085522

15. World Archery Federation. (2021). Archery coaching manual: Advanced techniques and strategies. Lausanne, Switzerland.