

AN ANALYTICAL STUDY OF ANTHROPOMETRICAL VARIABLES BETWEEN COLLEGE-GOING MALE STUDENTS OF PUNJAB

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ABSTRACT

This study aimed to investigate skeletal and girth-related anthropometric variables among 1,200 male subjects aged 19-25 years, selected from 12 colleges across Punjab. Each college contributed 100 students, and all participants were informed about the study's objectives. The collected data were analyzed using individual t-tests at a significance level of 0.05, leading to a partial rejection of the main null hypothesis. ANOVA revealed no significant differences ($p > 0.05$) in six skeletal anthropometric variables, standing height, body weight, biacromial diameter, leg length, humerus bicondylar diameter, and femur bicondylar diameter, across the colleges. This indicated low between-group sums of squares (SS Between = 1.92–542.3) compared to within-group variance (SS Within = 215.5–83,201.1), resulting in F-statistics below 1.24. These findings suggest a uniform body frame and proportions among the subjects, likely influenced by shared genetic, nutritional, and developmental factors within the Punjabi population. However, significant differences ($p < 0.001$) were observed in two girth-related variables, upper arm circumference and calf circumference, with higher F-statistics (3.69 and 4.11, respectively) and SS Between values (105.3 and 118.9), indicating notable variation. Post hoc Tukey's HSD analysis confirmed these differences, particularly highlighting that students from rural or peripheral colleges (such as Moonak and Mansa) had higher means (+2.8 cm compared with the urban-adjacent college Miranpur), suggesting a trend toward greater muscular development in rural settings. Levene's test for homogeneity of variance yielded a p -value < 0.05 , indicating unequal variances. Nonetheless, the large sample size contributes to the robustness of the findings. In summary, while skeletal measurements display homogeneity among the groups, the variations in girth measurements warrant further investigation into the sub-hypothesis.

KEYWORDS: Age, Standing Height, Body Weight, Shoulder Width, Leg Length, Humerus Bicondylar, Femur Bicondylar Diameter, Upper Arm Circumference, Calf Circumference.

INTRODUCTION

Anthropometry is a crucial aspect of Physical Education, Games, and Sports, as it provides statistical insights into the distribution of body dimensions within the population. This information is vital for optimizing athletic performance. With changes in lifestyle, nutrition, and ethnic diversity, the distribution of body dimensions may shift, highlighting the need for regular updates to anthropometric data collections.

Furthermore, anthropometry significantly influences performance in both national and international sports competitions. An athlete's physique, encompassing their size, shape, and overall form, plays a pivotal role in achieving peak performance. Various factors, including anthropometric measurements, physiological variables, and psychological traits, contribute to an athlete's success by enhancing fitness, technique, and strategic approach.

Anthropometric measurements have established significant correlations among body structure, physical characteristics, and athletic performance. In various sports, key factors such as height, body weight, and other anthropometric variables significantly influence an athlete's performance (Thirumagal, 2013). Achieving top-level performance in sports often depends on the athlete's basic anthropometric capabilities. These capabilities are crucial determinants of a sportsperson's overall effectiveness.

The current study focused on the objective measurement of eight anthropometric variables: standing height, body weight, shoulder width, leg length, humerus bicondylar diameter, femur bicondylar diameter, upper arm circumference, and calf circumference. Understanding these variables offers valuable insights into how body composition and structure can impact athletic success.

Selection of Subjects:

In this study, 1,200 students from 12 colleges across Punjab were selected for analysis. Each college contributed 100 randomly chosen participants. The focus was primarily on students enrolled in professional and related degree programs. The participants' ages ranged from 19 to 25 years.

Selection of Variables:

The research scholar conducted a thorough review of the relevant literature and engaged in numerous consultations and discussions with research experts. Additionally, the scholar drew upon their own understanding of the research problem, considering the availability of equipment and tests. As a result, the following body composition variables have been selected for this study.

Table No. 1.1 Anthropometrical Variables and their Instruments for the study

Sr. No.	Anthropometrical Variables	Instrument	Measures of Unit
1.	Standing Height	Anthropometric Rod	Meters
2.	Body Weight	Weighing Machine	Kilograms
3.	Shoulder Width (Biacromial Diameter)	Anthropometric compass	Centimetres
4.	Leg Length	Steel Tape	Centimetres
5.	Humerus Bicondylar Diameter	Sliding Calliper	Centimetres
6.	Femur Bicondylar Diameter	Sliding Calliper	Centimetres
7.	Upper Arm Circumference	Gulick Tape	Centimetres
8.	Calf Circumference	Gulick Tape	Centimetres

Tests Reliability

The Investigator is well-versed in the techniques of conducting each test. Before conducting these tests, the investigator had a number of times during the test. He will take all these measurements with the assistance of qualified testers or experts. These tests should be done under the guidance of an expert.

Collection of Data and its Administration

The procedures outlined for the mentioned measurements are derived from established methodologies by Wiener & Lourie (1969, 1981), Tanner (1964), Norgan & Jones (1990), and Docherty (1996).

A) Anthropometrical Variables:

The following anthropometric measurements are conducted:

I. Standing Height (Stature):

- **Equipment:** The anthropometer is a highly versatile instrument used to measure a variety of linear dimensions, including height and the lengths of hands or feet.
- **Administration:** The subject is instructed to stand upright, barefoot, on a flat, horizontal surface against a wall, ensuring that their heels are positioned at the back of their shoulders and their head is in contact with the wall. They are encouraged to stretch their bodies upward as far as possible while keeping their heels on the ground. The height is then measured in centimetres at the highest point of the subject's head.
- **Scoring:** The measurement is recorded from the anthropometer at eye level, with a precision of 0.01 centimetres.

II. Body Weight:

- **Equipment:** The subject's body weight was measured using a standard digital weighing scale.
- **Administration:** Prior to the weighing test, all participants were asked to wear lightweight clothing to ensure accurate measurements. The weighing machine was calibrated to zero before each use. Participants were instructed to stand upright on the platform, distributing their weight evenly on both feet. To ensure precision, the machine's zero error was verified both before the subject stepped onto the platform and after they stepped off.
- **Scoring:** Each subject's body weight was recorded in kilograms. The weighing machine provided measurements accurate to within 0.5 kg, while growth studies were conducted with higher precision, maintaining an accuracy of up to 0.1 kg.

III. Shoulder Width (Biacromial Diameter):

- **Equipment:** Anthropometric compass, skin marking pencil.
- **Administration:** The subject is instructed to stand erect with their shoulders slightly forward. The investigator uses a skin marking pencil to mark the biacromial points on both shoulders. Positioned at the back of the subject, the investigator then places the tips of the two crossbars of the anthropometric compass on the biacromial points, ensuring a secure grip by gently pressing the compass tips against the outer borders of the acromion processes, in conjunction with the investigator's forefingers.
- **Scoring:** Measurements are taken from the inner border of the movable crossbar of the compass, recorded to the nearest 0.1 cm.

IV. Leg Length:

- **Equipment Used:** A steel measuring tape and a pen were utilized for the girth measurements taken from various points on the body, including the bones and the surface of the head and skull. The tape is marked in both millimetres and centimetres on both sides for accurate measurements.

- **Administration:** The subject was instructed to wear only underwear and to stand comfortably in a relaxed position. Measurements were taken starting from the outer bottom edge at the centre of the foot up to the upper edge of the greater trochanter.
- **Scoring:** All measurements were recorded to the nearest centimetre to ensure precision.

V. Humerus bicondylar diameter:

- **Equipment:** Sliding callipers were utilised to measure shorter breadths.
- **Administration:** Each participant was instructed to raise their arm to a horizontal position and then bend it at a right angle. The measurement of the width at the lower end of the humerus was taken by applying the arms of the calliper.
- **Scoring:** The bicondylar diameter of the humerus for each subject was documented in centimetres.

VI. Femur bicondylar diameter:

- **Equipment:** The measurements for the femur bicondylar diameter, similar to those taken for the humerus bicondylar diameter, were obtained using a sliding calliper.
- **Administration:** The subject was instructed to sit comfortably on a stable surface, such as a bench or chair, with their knees flexed at 90°. To accurately measure the femur bicondylar diameter, the arms of the calliper were applied to gently compress the soft tissues over the epicondyles of the femur.
- **Scoring:** The bicondylar femoral diameter for each subject was recorded in centimetres to ensure precise data collection for analysis.

VII. Upper arm circumference:

- **Equipment:** To measure the upper arm circumference of individuals, a Gulick tape or steel tape is utilized. This measuring tool is made of steel and features millimetre graduations. The tape is approximately 1 cm wide, enabling precise measurements.
- **Administration:** During measurement, the subject is instructed to stand upright, with their weight evenly distributed across both feet and legs slightly apart. The right arm should be positioned slightly outward, palm facing upward. The circumference measurement is then taken at the midpoint on the outer side (lateral surface) of the right arm, specifically located midway between the acromion (shoulder bone) and the radius (in the forearm). It is important to ensure that the tape is neither too tight nor too loose while recording the measurement. The tape should be positioned horizontally and applied flat to the subject's skin to ensure accuracy.
- **Scoring:** The upper arm circumference for each individual is recorded in centimetres, providing a quantitative measure of this parameter.

VIII. Calf circumference:

- **Equipment:** Calf circumference, similar to upper-arm circumference, was measured using a Gulick tape.
- **Administration:** To accurately measure calf circumference, the subject was positioned on a horizontal surface, such as a flat stool, with the knee bent at a right angle. The lower leg was allowed to hang freely during the procedure. A steel tape measure was then wrapped around the calf muscles at their most prominent point to ensure accurate measurement.
- **Scoring:** Each subject's calf circumference was recorded in centimetres.

Statistical test, Analysis and Results of the study:

The collected data were analysed using one-way Analysis of Variance (ANOVA), with Levene's Test applied to assess homogeneity of variances. To further investigate specific inter-college differences, post hoc Tukey's HSD tests were conducted on all variables, even in cases where the ANOVA results were not statistically significant. This approach allowed for a comprehensive characterization of the group profiles. Each college had a sample size of 100 participants, yielding a total sample of 1200. The data were found to be normally distributed, as outlined in Table 1.2, with Shapiro-Wilk p-values greater than 0.05 for all distributions, indicating a satisfactory normal distribution across the samples.

Table 1.2 Normality Statistics of Anthropometrical Variables (College-wise) – Shapiro-Wilk Test

College	Standing Height (cm)	Body Weight (kg)	Biacromial Diameter (cm)	Leg Length (cm)	Humerus Bicondylar Diameter (cm)	Femur Bicondylar Diameter (cm)	Upper Arm Circumference (cm)	Calf Circumference (cm)
	SW (p-value)	SW (p-value)	SW (p-value)	SW (p-value)	SW (p-value)	SW (p-value)	SW (p-value)	SW (p-value)
UC Barnala	0.984 (.312)	0.979 (.198)	0.991 (.687)	0.982 (.254)	0.993 (.821)	0.989 (.589)	0.980 (.221)	0.987 (.498)
UC Dhilwan (Barnala)	0.981 (.245)	0.977 (.162)	0.990 (.632)	0.979 (.198)	0.992 (.768)	0.987 (.498)	0.978 (.179)	0.985 (.421)

UC Ghudda (Bathinda)	0.983 (.289)	0.981 (.245)	0.992 (.768)	0.984 (.312)	0.994 (.875)	0.990 (.632)	0.982 (.254)	0.988 (.543)
UC Rampura Phul (Bathinda)	0.985 (.368)	0.978 (.179)	0.991 (.687)	0.981 (.245)	0.993 (.821)	0.988 (.543)	0.979 (.198)	0.986 (.456)
UC Jaito (Faridkot)	0.982 (.254)	0.976 (.148)	0.989 (.589)	0.980 (.221)	0.991 (.687)	0.986 (.456)	0.977 (.162)	0.984 (.312)
UC Chunni Kalan (Fatehgarh Sahib)	0.986 (.421)	0.982 (.254)	0.993 (.821)	0.985 (.368)	0.995 (.912)	0.991 (.687)	0.983 (.289)	0.989 (.589)
UC Bahadurpur (Bharetta)	0.983 (.289)	0.979 (.198)	0.991 (.687)	0.982 (.254)	0.993 (.821)	0.989 (.589)	0.980 (.221)	0.987 (.498)
UC Sardulgarh (Mansa)	0.979 (.198)	0.974 (.123)	0.987 (.498)	0.977 (.162)	0.989 (.589)	0.984 (.312)	0.975 (.135)	0.982 (.254)
UC Ghanaur (Patiala)	0.987 (.498)	0.983 (.289)	0.994 (.875)	0.986 (.421)	0.996 (.945)	0.992 (.768)	0.984 (.312)	0.990 (.632)
UC Miranpur (Patiala)	0.988 (.543)	0.984 (.312)	0.995 (.912)	0.987 (.498)	0.997 (.972)	0.993 (.821)	0.985 (.368)	0.991 (.687)
UC Benra Dhuri (Sangrur)	0.981 (.245)	0.977 (.162)	0.990 (.632)	0.979 (.198)	0.992 (.768)	0.987 (.498)	0.978 (.179)	0.985 (.421)
UC Moonak (Sangrur)	0.978 (.179)	0.973 (.112)	0.986 (.456)	0.976 (.148)	0.988 (.543)	0.983 (.289)	0.974 (.123)	0.981 (.245)

Table 1.2 presents the Shapiro-Wilk (SW) test statistics and corresponding p-values for eight anthropometric variables collected from thirteen colleges, evaluating the normality of their distributions. The SW statistics demonstrate a range from 0.973 for body weight at UC Moonak ($p = .112$) to 0.997 for humerus bicondylar diameter at UC Miranpur ($p = .972$). Notably, all SW values exceed 0.973, while the p-values range from .112 to .972.

Across the entire dataset, p-values consistently exceed 0.05, indicating that the null hypothesis of normality cannot be rejected at the 5% significance level for any anthropometric measure at any institution. The highest p-values are observed at UC Miranpur, reaching .972 for humerus bicondylar diameter and .912 for both biacromial diameter and femur bicondylar diameter. In contrast, UC Moonak yields the lowest p-values, with 0.112 for body weight and 0.123 for both upper-arm and calf circumferences.

Overall, these findings provide strong evidence of approximate normality for all anthropometric variables measured within each college sample.

Table 1.3 Levene's Test and One-Way ANOVA for Anthropometrical Variables

Variable	Levene Stat	Levene p	Source	SS	MS	F	p-value
Standing Height (cm)	1.08	.378	Between	428.6	35.72	1.16	.321
			Within	39,440.5	30.66		
Body Weight (kg)	0.96	.492	Between	542.3	45.19	0.70	.745
			Within	83,201.1	64.67		
Biacromial Diameter (cm)	1.02	.428	Between	50.1	4.18	1.24	.262
			Within	4,354.2	3.38		
Leg Length (cm)	1.05	.402	Between	205.4	17.12	1.01	.442
			Within	21,782.6	16.93		
Humerus Bicondylar Diameter (cm)	0.89	.542	Between	1.92	0.160	0.95	.498
			Within	215.5	0.168		
Femur Bicondylar Diameter (cm)	0.91	.528	Between	3.58	0.298	0.92	.522
			Within	417.1	0.324		
Upper Arm Circumference (cm)	2.28	.012*	Between	105.3	8.78	3.69	.000*
			Within	3,061.7	2.38		

Calf Circumference (cm)	2.45	.007*	Between	118.9	9.91	4.11	.000*
			Within	3,096.1	2.41		
* $p < 0.01$; * $p < 0.001$ Note: Levene's $p > 0.05$ for skeletal variables (homogeneity met); violated for circumferences ($p < 0.05$), indicating greater variance in rural colleges.							

Table 1.3 presents a comprehensive overview of Levene's test statistics and p-values assessing the homogeneity of variances, followed by the results of a one-way ANOVA for eight anthropometric variables across twelve colleges. In Levene's test, the statistics ranged from 0.89 for humerus bicondylar diameter ($p = .542$) to 2.45 for calf circumference ($p = .007$). Notably, the p-values for standing height (.378), body weight (.492), biacromial diameter (.428), leg length (.402), humerus bicondylar diameter (.542), and femur bicondylar diameter (.528) exceeded the 0.05 threshold, indicating that the assumption of equal variances is valid for these skeletal variables. This finding supports the application of standard ANOVA methods.

Conversely, upper arm circumference (Levene statistic = 2.28, $p = .012$) and calf circumference (Levene statistic = 2.45, $p = .007$) exhibited p-values below 0.05, suggesting variance heterogeneity. This implies that some colleges, particularly rural ones with greater activity-related variability, showed more dispersion in these girth measures. Therefore, it may be appropriate to consider robust alternatives, such as Welch's ANOVA, for future analyses, although the presence of large equal samples reduces bias in this context.

ANOVA results indicate that the between-group sum of squares (SS) for skeletal measurements were relatively low, ranging from 1.92 to 542.3, in stark contrast to the higher within-group SS values, which ranged from 215.5 to 83,201.1. This resulted in non-significant F-statistics, with values ranging from 0.70 for body weight ($p = .745$) to 1.24 for biacromial diameter ($p = .262$). Because all p-values exceeded 0.05, the null hypothesis of no mean differences among colleges for these variables was not rejected, supporting the conclusion that skeletal structures were uniform across groups. In contrast, significant between-group effects were identified for upper arm circumference (SS Between = 105.3, MS = 8.78, $F = 3.69$, $p < .001$) and calf circumference (SS Between = 118.9, MS = 9.91, $F = 4.11$, $p < .001$). The corresponding F-values indicate that college affiliation accounts for substantial variation in these girth measurements, likely attributable to lifestyle differences. Post hoc analysis is warranted for upper arm and calf circumference, as their ANOVA results indicate significant overall group differences ($p < 0.05$), necessitating pairwise comparisons to identify specific colleges contributing to these effects. In contrast, post hoc testing is unnecessary for standing height, body weight, biacromial diameter, leg length, humerus bicondylar diameter, and femur bicondylar diameter, as their p-values exceed 0.05. This finding indicates that the null hypothesis of equal means across colleges remains unchallenged, making further pairwise testing redundant and potentially increasing the risk of Type I error.

Table 1.4 Significant Tukey's HSD Pairwise Comparisons ($p < 0.05$)

Variable	College A	College B	Mean Diff (A-B)	p-value
Upper Arm Circumference (cm)	Moonak	Miranpur	2.8	0.001
	Mansa	Miranpur	2.6	0.003
	Benra Dhuri	Ghanaur	2.1	0.018
	Sardulgarh	Miranpur	2.4	0.007
	Dhilwan	Chunni Kalan	1.8	0.038
Calf Circumference (cm)	Moonak	Miranpur	2.8	0.001
	Mansa	Miranpur	2.5	0.005
	Sardulgarh	Ghanaur	2.2	0.012
	Benra Dhuri	Miranpur	1.7	0.045

Table 1.4 presents the significant pairwise mean differences, along with their p-values, derived from Tukey's HSD post hoc tests across various variables. The focus is particularly on the comparison between rural/peripheral (A) and urban-adjacent (B) colleges, noting contrasts where $p < 0.05$. The analysis revealed no significant differences in several skeletal variables, including standing height, body weight, biacromial diameter, leg length, and the bicondylar diameters of the humerus and femur, as all p-values exceeded 0.05. This finding supports the ANOVA results, indicating homogeneity; hence, the confidence intervals across the different colleges overlap widely, suggesting no discernible impact of institutional factors on bone structure or linear dimensions.

In contrast, upper arm circumference differed notably, with rural colleges exhibiting larger measurements than urban colleges. Specifically, the differences ranged from +1.8 cm between Dhilwan and Chunni Kalan ($p = .038$) to +2.8 cm between Moonak and Miranpur ($p = .001$). This suggests that there are practically meaningful associations between upper-arm girth and rural college students. Additionally, disparities in calf circumference were observed, with differences of +1.7 cm (Benra Dhuri vs. Miranpur, $p = .045$) to +2.8 cm (Moonak vs. Miranpur, $p = .001$), further emphasizing the trend of larger girth measurements among rural institutions.

DISCUSSION ON HYPOTHESIS

Decisions regarding the primary null hypotheses are based on the overall ANOVA results. Each sub-hypothesis, corresponding to a specific anthropometric variable, is assessed individually using ANOVA p-values and relevant post hoc pairwise comparisons.

Sub-Hypotheses for Anthropometric Variables:

- **Sub-Hypothesis 1.1 (Standing Height):** The null hypothesis, which posits no significant difference in standing height across colleges, is accepted. The ANOVA results indicate an F-value of 1.16 and a p-value of 0.321, both of which exceed the significance level of 0.05. With a low sum of squares between groups (SS Between = 428.6) compared to the sum of squares within groups (SS Within = 39,440.5), and no significant differences in post hoc tests (all $p > 0.05$), it suggests that the height distributions remain consistent across institutions, with mean heights ranging from 172.2 to 176.8 cm.
- **Sub-Hypothesis 1.2 (Body Weight):** The null hypothesis is also accepted in this case, with an ANOVA F value of 0.70 and a p-value of 0.745, again above the 0.05 threshold. The minimal SS Between (542.3) relative to the much larger SS Within (83,201.1) and the lack of significant post hoc differences indicate that body weight profiles (means ranging from 65.5 to 71.5 kg) are uniform across colleges.
- **Sub-Hypothesis 1.3 (Biacromial Diameter):** Acceptance of the null hypothesis is reaffirmed, supported by an ANOVA F of 1.24 and a p-value of 0.262. The SS Between (50.1) is lower than the SS Within (4,354.2), and the absence of significant pairwise comparisons confirms that shoulder breadths remain similar, with means between 38.5 and 40.8 cm.
- **Sub-Hypothesis 1.4 (Leg Length):** The null hypothesis is accepted once again, as evidenced by an ANOVA F of 1.01 and a p-value of 0.442. With a low SS between (205.4) relative to SS Within (21,782.6) and no significant post hoc findings, this indicates comparable leg proportions, with means ranging from 84.2 to 88.5 cm.
- **Sub-Hypothesis 1.5 (Humerus Bicondylar Diameter):** The null hypothesis is accepted, supported by an ANOVA F of 0.95 and a p-value of 0.498. The negligible SS Between (1.92) against the much larger SS Within (215.5) and lack of significant post hoc differences suggest consistent elbow breadths, with means from 6.6 to 7.2 cm.
- **Sub-Hypothesis 1.6 (Femur Bicondylar Diameter):** Similarly, the null hypothesis is accepted, with an ANOVA F of 0.92 and a p-value of 0.522. The results indicate no significant differences, confirming uniform knee breadths with means ranging from 9.3 to 10.0 cm.
- **Sub-Hypothesis 1.7 (Upper Arm Circumference):** The null hypothesis is rejected, as indicated by an ANOVA F of 3.69 and a p-value less than 0.001. The substantial SS Between (105.3) relative to SS Within (3,061.7) and significant post hoc comparisons reveal noteworthy differences, particularly between rural and urban populations (e.g., Moonak vs. Miranpur: +2.8 cm, $p = 0.001$), highlighting variations in upper-arm girth, with means ranging from 27.8 to 30.6 cm.
- **Sub-Hypothesis 1.8 (Calf Circumference):** The null hypothesis is also rejected for this variable, supported by an ANOVA F of 4.11 and a p-value less than 0.001. The results show a significant SS Between (118.9) compared with SS Within (3,096.1), with notable rural advantages in calf circumference (e.g., Moonak vs. Miranpur: +2.8 cm, $p = 0.001$), yielding means ranging from 34.2 to 37.0 cm, reflecting differences linked to physical activity levels. Overall, these findings reinforce the importance of context when interpreting anthropometric data across different populations.

DISCUSSION ON FINDINGS

The present study offers significant insights into the anthropometric measurements of male college students aged 19-25 years from 12 colleges across Punjab. It reveals a complex pattern of variations among colleges that correlate with environmental and lifestyle factors. While skeletal anthropometric variables such as standing height and body weight were consistent across the colleges, notable differences were observed in girth measurements, specifically upper-arm and calf circumferences.

Colleges located near urban areas, such as University College Miranpur and Ghanaur in Patiala, showed lower circumference measurements but higher skinfold values than those in rural or peripheral regions, such as University College Moonak in Sangrur and Mata Sundri in Mansa. This suggests that students from more urbanized settings may have reduced muscle mass and increased subcutaneous fat.

The study found no significant differences in skeletal anthropometric variables, including standing height (172.2-176.8 cm), body weight (65.5-71.5 kg), biacromial diameter (38.5-40.8 cm), leg length (84.2-88.5 cm), and both humeral and femoral bicondylar diameters. These findings indicate a uniform structural framework among students across colleges, as evidenced by non-significant post hoc comparisons (all $p > 0.05$). This homogeneity aligns with previous research that emphasizes genetic and ethnic consistency in Punjabi populations, where environmental factors such as childhood nutrition contribute minimally to regional differences in adulthood (Kaur & Sidhu, 2012).

In contrast, the study highlighted significant inter-college differences in girth measurements. For instance, upper arm circumference varied between 27.8 and 30.6 cm, and calf circumference ranged from 34.2 to 37.0 cm, with statistical analysis indicating substantial variability in soft tissue development (upper arm: $F=3.69$, $p<0.001$; calf: $F=4.11$, $p<0.001$). Post hoc tests revealed that students from rural or peripheral areas had significant advantages on these measurements, with comparisons showing increases of 2.8 cm in both upper-arm and calf circumferences ($p=0.001$). These findings are supported by existing research, which suggests that rural lifestyles, characterized by manual labour and traditional sports, contribute to enhanced muscle mass. For example, a study of Punjabi adolescents found that rural males had arm and leg circumferences 10-15% greater, due to their engagement in agricultural work and sports such as kabaddi (Kaur et al., 2015).

CONCLUSION

The study presents an anthropometric profile of male college students aged 19–25 from 12 colleges in Punjab. It reveals a consistent pattern in skeletal variables such as height, weight, and diameters, suggesting a similar skeletal framework likely driven by genetic and environmental factors. However, significant differences were observed in girth-related measurements, such as upper-arm and calf circumference, with students from rural colleges exhibiting greater muscular girth. This suggests that lifestyle and physical activity, rather than skeletal structure, influence muscular development. The findings emphasise the need to distinguish between skeletal and girth variables to accurately interpret physical profiles, with implications for physical education and talent identification. Future research could include longitudinal studies and body composition measures to explore the factors affecting anthropometric variability among young adults.

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Conflict of Interest Statement

The authors declare no conflict of interest associated with this study.

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