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Research Report on Anthropometric Analysis of Female Adults (20–25 Years) : Implications for Ergonomic Design and Health Assessment

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ABSTRACT

The measuring of human body dimensions, or anthropometry, is essential to product design, ergonomics, and health evaluation. Body dimensions and stature give vital information for assessing physical development, assessing nutritional health, and creating goods that are both age-appropriate and easy to use. Young adult females between the ages of 20 and 25 are the subject of this study since they are a demographic that is crucial for both physical maturity and active participation in higher education. In order to determine distributional features like percentiles (5th, 50th, 75th, 90th, 95th), skewness, and kurtosis, as well as descriptive parameters like mean, standard deviation, and range, anthropometric data were gathered and examined using statistical software and Excel-based procedures. To categorize people into various body type groups, the Body Mass Index(BMI) was also computed. The study population's variations in stature, weight, and body composition were reflected in the results, which showed a significant amount of variability in body dimensions. Descriptive tables and histogram representations provide the measurement distribution statistical and visual clarity. These results are very important for creating consumer goods, furnishings, and instructional materials that are ergonomically appropriate for female college students. Additionally, the BMI classification aids in the comprehension of nutrition and health-related concerns in this age range. The results demonstrated a considerable degree of variability in body dimensions, reflecting the differences in stature, weight, and body composition among the research population. The measurement distribution is statistically and visually clear thanks to descriptive tables and histogram representations. These findings are crucial for developing ergonomically suitable consumer products, furniture, and educational resources for female college students. Furthermore, the BMI classification facilitates understanding of health and dietary issues in this age group. By offering anthropometric information relevant to age and gender, this study helps create extensive databases that are useful for health sciences, nutrition, and ergonomics. The results underline the significance of routine anthropometric assessment in health monitoring in addition to supporting useful applications in product and space design.

Keywords: Anthropometry, Stature, Body dimensions, BMI (Body Mass Index), Ergonomics, Health assessment

INTRODUCTION

The methodical study of human body measurements, or anthropometry, is crucial for assessing physical development, ergonomic design, and nutritional health. Anthropometric examination is important in young people, particularly female college students between the ages of 20 and 25, as this stage signifies the passage from adolescence to adulthood, a time of changing lifestyles, reaching physical maturity, and establishing health habits.

In this population, precise anthropometric measurements are essential for ergonomic applications as well as for tracking diet and health. Commonly used body measurements in the design of consumer goods, workstations, and classroom equipment may not accurately represent the unique demands of young

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women.

Reduced academic productivity, musculoskeletal problems, and pain might result from poor ergonomic compatibility. Similar to this, body type distribution and BMI offer early warning signs of undernutrition, overweight, or obesity—health issues that are becoming more common in young adults as a result of sedentary lifestyles and shifting eating patterns.

The goal of this study is to create a thorough anthropometric profile of young female students in order to assist with health treatments, clothing sizing, and ergonomic design.

Importance of Anthropometric Data:

- Serves as a health and nutritional status indicator
- Provides baseline for BMI calculation and body type classification
- Essential in ergonomic design of furniture, clothing, and digital devices
- Helps in consumer product evaluation and testing

Objectives:

The present study aims to:

1. Compute statistical parameters (mean, SD, percentiles, skewness, kurtosis) for anthropometric data.
2. Assess BMI and body type distribution among young college-going females (20–25 years).
3. Interpret anthropometric data for ergonomic design and health assessment.
4. Demonstrate use of formulas and Excel functions for replicability.
5. Statistically analyze stature and related dimensions to derive design implications.

Review of literature:

Sommer *et al.* (2020)studiedthe performance of anthropometric tools to determine obesity: a systematic review and meta-analysis.Systematic review/meta-analysis comparing anthropometric indices (BMI, waist circumference, etc.) vs. body-composition reference standards. Found BMI has high specificity but modest sensitivity to detect excess body fat (i.e. it misses many people with high body fat). Relevant to 20–25-yr females because many field studies of young women still rely on BMI alone.

Piqueras *et al.* (2021)studied anthropometric indicators as a tool for diagnosis of obesity and other health risk factors: a literature review. Frontiers in Psychology.

Reviews a broad set of Anthropometric Health Indicators (AHIs) including BMI, waist-to-height, waist circumference, body roundness, 3D indices; emphasizes central/visceral adiposity as more predictive of cardiometabolic risk than BMI alone and reviews age/sex/ethnic cut-off issues. Highly relevant because it synthesises which measures give better risk detection than BMI in adults.

Palumbo *et al.* (2025) studied Validity of non-traditional measures of obesity compared to total body fat across the life course: a systematic review and meta-analysis. (Obesity Reviews). Recent systematic review of "non-traditional" indices (e.g., relative fat mass, body roundness index, abdominal volume index) compared to DXA/other reference standards — helpful for researchers wanting better field proxies for body fat in young adults. (preprint / early-online 2024–2025 material).

Fayyaz *et al.* (2024) studiedvalidity of measured vs self-reported weight and height: systematic review. Systematic review of validity of self-reported anthropometrics. Here, women tend to underreport weight and men overreport height, producing biased BMI estimates — important because many large studies of 20–25-yr females use self-report.

Synthesised insights (what the reviews collectively show):

- ***BMI is easy and widely used but imperfect:*** Systematic reviews show BMI has high specificity but only moderate sensitivity for excess adiposity — many people with high body fat (especially with normal BMI) are missed if BMI is used alone. This is especially relevant for women, where body-fat distribution and muscle mass patterns can vary.
- ***Central adiposity measures (waist circumference, waist:height, waist:hip) are stronger predictors of cardiometabolic risk*** than BMI in adults; several reviews recommend including at least one central-obesity measure in studies. For young adult females, waist measures add meaningful risk information even when BMI is in the "normal" range.
- ***Emerging/"non-traditional" indices*** (body roundness index, relative fat mass, abdominal volume index, ABSI, etc.) show promise

compared to BMI in some life stages — recent reviews/meta-analyses are actively evaluating which of these best track DXA-measured fat across ages. Results are heterogeneous; no single index is universally superior yet. If possible, combine classic measures (BMI + waist) with one validated non-traditional index.

- ***Self-report bias matters*** — systematic reviews show young women commonly under report weight, which underestimates BMI and obesity prevalence when measured indirectly. For research on 20–25-yr females, direct measurement (height, weight, waist) is preferable; if self-report is unavoidable, apply correction equations or report measurement method clearly.
- ***Population (ethnic/region/age)-specific cut-offs are important.:*** Reviews emphasise that cut-offs developed in one population may misclassify risk in another (e.g., South Asian populations have higher cardiometabolic risk at lower BMI). For females age 20–25 you should consider whether local reference percentiles or cut-offs exist.
- ***Most reviews are general-adult or life-course; few systematic reviews focus exclusively on the 20–25 female subgroup*:** Instead, the literature contains many cross-sectional studies of university/college female students (18–25) from different countries. That means evidence specific to 20–25 females often comes from primary studies rather than dedicated systematic reviews — a gap worth noting.

Practical conclusions and recommendations for studies of females aged ~20–25:

- ***Measure, don't rely solely on self-report*.** If feasible, directly measure height, weight and waist circumference; if self-report must be used, apply validated correction factors and clearly state limitations.
- ***Report at least BMI + one central adiposity measure*** (waist circumference or waist:height). These together better identify cardiometabolic risk than BMI alone.
- ***If resources allow, add a body-composition reference (BIA or DXA)*** for a subsample to validate anthropometric proxies — this is especially useful when assessing prevalence of high body fat among normal-BMI individuals. Recent reviews show this approach clarifies BMI sensitivity limitations.
- **Use or report population-specific cut-offs/ percentiles** where available (or present your raw continuous measures in addition to categorical cut-offs so others can re-apply different thresholds).
- **Be cautious extrapolating from university samples** to all 20–25-yr females — student samples can have different socioeconomic, lifestyle, and ethnic composition. The literature contains many such student studies but fewer nationally representative reviews for this age group.
- **Opportunity for a dedicated review:** because there's a relative paucity of reviews focused solely on 20–25-yr females, a systematic review/ meta-analysis restricted to that age group (pooling university and community studies) would be valuable.

METHODOLOGY

Sample and locale :

20 female students, (age group 20–25 years, gender female) from I.C. College of Community Science, College of Basic Science and Humanities, College of Agriculture, Chaudhary Charan Singh Haryana Agricultural University, Hisar

Measures:

21 anthropometric dimensions (in cm) like stature, eye height, elbow height, vertical grip reach, side arm reach , thumb tip reach, maximum body breadth,, maximum body depth, midshoulder height sitting, shoulder breadth, elbow to elbow breadth, hip breadth, elbow rest height, thigh clearance, knee height, popliteal height, buttock popliteal length, buttock knee length, buttock toe length, buttock heel length, vertical reach height sitting. And age, weight, height, BMI these also included.

Tools of data collection:

Weighing scale for weight, measuring tape for different measurements, microsoft excel for formula application, statistical analysis and graph

Table 1 : Statistical Concepts and Formulas

Parameter	Definition	Excel Formula	Implication
1. Mean (μ)	Average of data	=AVERAGE (range)	Represents central tendency
2. Standard Deviation (σ)	Measure of spread	=STDEV (range)	Shows variability in stature
3. Percentile (P^k)	Value below which k% of data falls	=PERCENTILE.INC (range,k)	Used in ergonomics to design for population segments
4. Range	Difference between max and min	=MAX (range) - MIN(range)	Indicates spread of data
5. Skewness	Measure of asymmetry	=SKEW (range)	Tells if data leans left/right
6. Kurtosis	Measure of peakedness	=KURT (range)	Explains shape (flat/sharp peak)
7. BMI	Weight relative to height	=Weight/(Height^2)	Identifies body type
8. Body Type	Based on BMI	Logical Excel formulas	Categorizes into underweight, normal, overweight

Statistical Analysis:

Descriptive statistics (mean, standard deviation, percentiles), range, BMI, body type, distribution analysis (skewness, kurtosis, histograms)

Statistical Concepts and Formulas (Table 1):

BMI :

Body Mass Index (BMI) is a simple index of weight-for-height that is commonly used to classify underweight, overweight, and obesity in adults.

- **Formula:**BMI=weight (kg)/height (m)^2
- **According to WHO:**
  - BMI is universally expressed in units of kg/m^2.
  - It provides a useful measure of overweight and obesity at the population level.
  - It does not measure body fat directly, but it correlates with more direct measures of body fat.

For adults (18 yrs and older)

- Underweight: < 18.5
- Normal range: 18.5 – 24.9
- Overweight: ≥ 25
- Obesity: ≥ 30

Children and Adolescents:

WHO uses BMI-for-age growth references to define overweight and obesity in children aged 5–19 years and weight-for-height standards for under 5 years.

- **Importance:**
- BMI is widely used for epidemiological studies, public health monitoring, and as a screening tool.
- However, it may not perfectly represent fat distribution or health risk for every individual (e.g., athletes, elderly).

Body type:

- Body type refers to the general classification of human physique and build based on skeletal frame, muscle distribution, and fat composition.
- The most widely recognized system was developed by William H. Sheldon (1940s), known as the Somatotype theory.
- Most common index used for evaluating Somatotype/Body types are:

1.Ponderal Index: Weight(kg)/Height(m^3)
2.Quetelet's Index: Weight(kg)/Height(m^2)

Acc. to these indexes, population can be classified under 3 body types.

Body type	Quetlet's index Score	Ponderal index Score
1. Endomorph	<20	<21.5
2. Mesomorph	20-25	21.5-25
3. Ectomorph	>25	>25

- Implication: Useful in designing chairs, desks, and clothing sizes for young adults.

Range:

In statistics, the range is a measure of dispersion that indicates the spread between the highest and lowest values in a dataset.

- It is calculated as:
  Range = Maximum Value – Minimum Value
- This formula provides a simple understanding of the variability within a dataset. However, it's important to note that the range is sensitive to

outliers and doesn't account for the distribution of values between the extremes.

Mean:

The mean (also called arithmetic mean or average) is a measure of central tendency that represents the sum of all values in a dataset divided by the number of values.

Properties of Mean:
1. Simple to calculate and understand.
2. Uses all observations in the dataset.
3. Affected by extreme values (outliers).
4. Provides a balanced point of the data distribution.
5. Most suitable for continuous and normally distributed data.

Standard deviation:
- Standard deviation is a measure of dispersion that shows how much individual data points deviate from the mean of a dataset.
- It indicates whether the values are closely clustered around the mean (small SD) or widely spread out (large SD).
- Standard Deviation is defined as the square root of the variance, representing the average amount by which each observation differs from the mean.

Properties of Standard Deviation:
- Always non-negative.
- Sensitive to outliers (extreme values).
- Measured in the same units as the original data.
- If all values are the same, SD = 0.
- Works best for interval and ratio scale data.

Uses of Standard Deviation:
- *Statistics and Research*: To measure data variability.
- *Economics*: To assess risk and volatility (e.g., stock market).
- *Education*: To evaluate variation in student performance.
- *Science and Engineering*: To measure experimental precision.
- *Public Health*: To understand variability in health indicators.

Percentiles:

The k-th percentile (Pk) is the value below which k per cent of the observations fall.
- Example: The 25th percentile (P25) is the value below which 25% of the data lies.
- Percentiles are statistical measures that divide a dataset into 100 equal parts.
- A percentile indicates the relative standing of a value within a dataset.

Common Percentiles:
- 25th percentile (Q1) – First quartile
- 50th percentile (Q2) – Median
- 75th percentile (Q3) – Third quartile
- 90th percentile – Often used in performance evaluation
- 99th percentile – Used in extreme case analysis

Properties of Percentiles:
- Not affected by the exact magnitude of extreme values (more robust than mean).
- Useful in non-normal data distributions.
- Divide data into relative ranks instead of absolute measures.
- Provide information about spread and skewness of data.

Uses of Percentiles:
- *Education:* To compare student performance (e.g., standardized tests).
- *Health and Nutrition:* Growth charts use percentiles to track children's weight and height (e.g., WHO growth standards).
- *Economics:* Income distribution and inequality studies.
- *Research and Data Analysis*: To describe data spread and identify outliers.
- *Sports Science*: To benchmark athletes' performance levels.

Skewness:
- Skewness measures the asymmetry of a probability distribution around its mean.
- A perfectly symmetrical distribution has skewness = 0.

Types of Skewness
- ***Positive Skew (Right-skewed)*****:** Long tail on the right; mean > median.
- ***Negative Skew (Left-skewed)*****:** Long tail on the

left; mean < median.
- ***Zero Skew:*** Symmetrical distribution (e.g., normal distribution).

Uses:
- Understanding distribution shape in finance, health, education.
- Identifying bias or outliers in data.

Kurtosis:
- Kurtosis measures the "tailedness" or sharpness of the peak of a distribution.
- It shows whether data produce more or fewer outliers than a normal distribution.

Types of Kurtosis:
- ***Mesokurtic (K = 3)*:** Normal distribution.
- ***Leptokurtic (K > 3)*:** Sharper peak, fatter tails (more outliers).
- ***Platykurtic (K < 3)*:** Flatter peak, thinner tails (fewer outliers).

Uses:
- Risk assessment in finance (market volatility).
- Outlier detection in research and medical data.
- Statistical modeling (validating normality).

Histogram:

Definition:
- A histogram is a graphical representation of the frequency distribution of a dataset.
- Data is grouped into intervals (bins), and bars represent frequencies.

Features:
- *X-axis:* Data intervals (class boundaries).
- *Y-axis:* Frequency of data points.
- Bars are adjacent (no gaps, unlike bar charts).

Uses:
- Visualizing distribution shape (normal, skewed, uniform).
- Identifying outliers, spread, and central tendency.
- Widely used in quality control, education, health sciences.

RESULTS AND DISCUSSION

Personal profile (age, height, weight), BMI classification, body type distribution (Table 2).

Table 2 : Personal profile (age, height, weight), BMI classification, body type distribution

Sr. No. of person	Age (yrs)	Height (cm)	Weight (kg)	BMI (kg/m*m)	Body types
1.	23	164.7	42	15.48 (underweight)	Ectomorph
2.	23	155.55	62.5	25.83 (overweight)	Endomorph
3.	22	161.65	46	17.60 (underweight)	Ectomorph
4.	24	158.6	52	20.67 (overweight)	Mesomorph
5.	23	170.8	44	16.83 (underweight)	Ectomorph
6.	23	158.6	47	18.68 (normal weight)	Ectomorph
7.	23	155.55	60	20.56 (overweight)	Mesomorph
8.	25	152.5	43	17.09 (underweight)	Ectomorph
9.	23	155.55	52	21.49 (normal weight)	Mesomorph
10.	25	152.5	53	22.78 (normal weight)	Mesomorph
11.	24	155.55	58	23.97 (normal weight)	Mesomorph
12.	24	161.65	42	16.07 (underweight)	Ectomorph
13.	25	152.5	60	25.79 (overweight)	Endomorph
14.	22	170.8	48	16.45 (underweight)	Ectomorph
15.	21	152.5	49	21.06 (normal weight)	Mesomorph
16.	25	164.7	45	16.58 (underweight)	Ectomorph
17.	20	152.5	50	21.49 (normal weight)	Mesomorph
18.	21	155.55	49	20.25 (normal weight)	Mesomorph
19.	24	167.75	59	20.96 (normal weight)	Mesomorph
20.	25	173.85	51	16.87 (underweight)	Ectomorph

Descriptive Statistics of Stature (range, mean, standard deviation, percentiles, skewness and kurtosis for each variable) (Table 3).

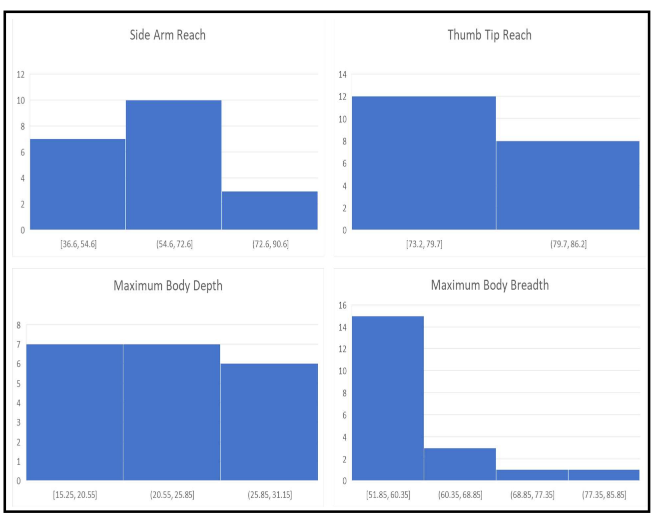
Table 3 : Descriptive Statistics of Stature (range, mean, standard deviation, percentiles, skewness and kurtosis for each variable)

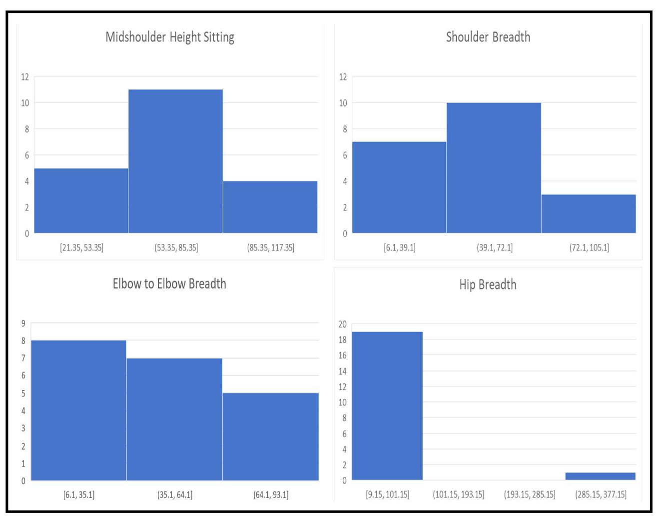
Sr. No.	Name of dimension	Stature	Eye height	Elbow height	Vertical grip reach	Side arm reach	Thumb tip reach	Maximum body depth	Maximum body breadth	Midshoulder height sitting	Shoulder breadth
1.	Range	21.35	15.25	101.26	18.3	42.7	12.2	12.2	27.45	67.1	79.3
2.	Mean	160.27	128.55	4.97	39.04	57.34	78.84	22.87	58.56	61.76	40.87
3.	deviation	152.04	128.55	94.55	6.37	13.35	4.94	4.03	6.44	24.09	24.65
4.	Percentiles										
	a.5th	152.5	122	94.5	30.5	36.6	73.2	18.1	51.85	21.35	8.99
	b.50th	158.6	128.1	102.1	36.6	59.4	79.3	24.4	57.95	70.15	42.7
	c.75th	164.7	131.1	106.7	43.4	67.1	83.1	27.4	58.71	80.06	57.95
	d.90th	170.8	131.4	106.7	48.8	73.5	85.4	27.4	64.66	85.4	76.55
	e.95th	170.9	134.3	106.9	48.8	76.4	85.4	27.4	64.66	85.55	79.60
5.	Skewness	0.61	0.20	0.02	0.28	-0.26	0.11	-0.35	1.88	-0.92	0.10
6.	Kurtosis	-0.66	0.10	-1.51	0.37	-0.32	-1.69	-1.40	4.51	-0.75	-1.11

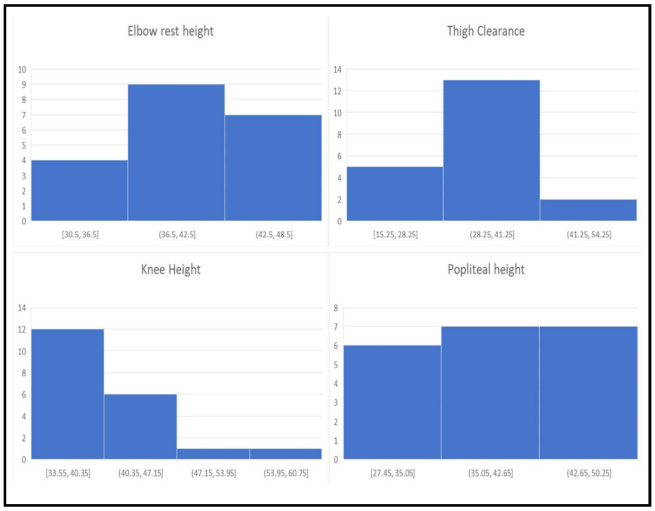
Table 2 contd…

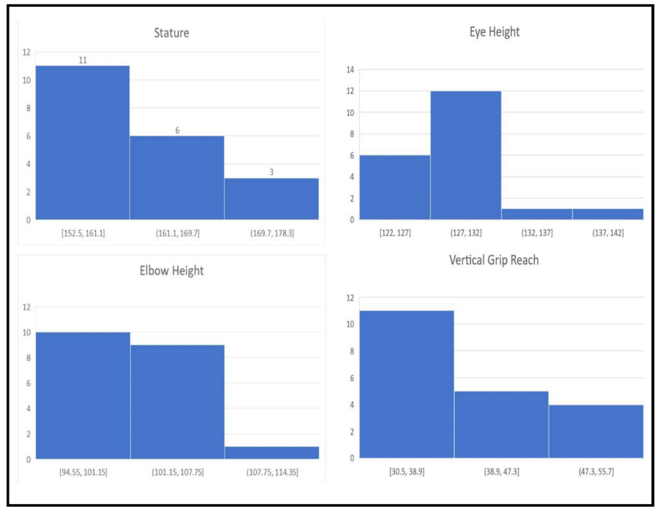
Table 3 contd…

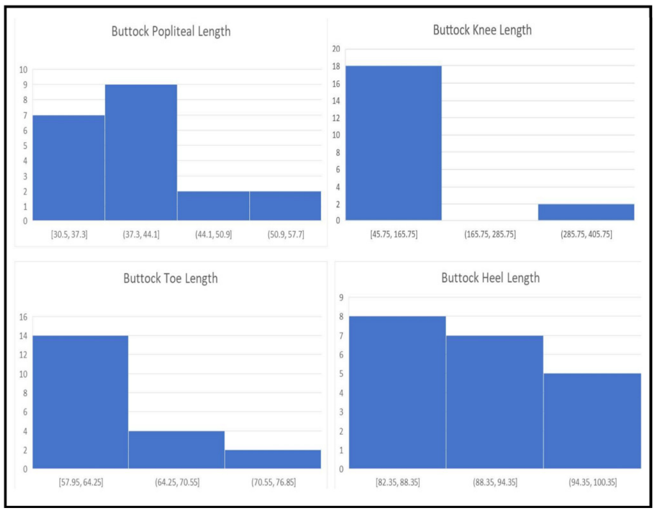
Sr. No.	Name of dimension	Elbow to elbow breadth	Hip breadth	Elbow rest height	Thigh clearance	Knee height	Popliteal height	Buttock popliteal Length	Buttock knee Length	Buttock toe length	Buttock heel length	Vertical reach height sitting
1.	Range	67.1	326.35	15.25	33.55	21.35	21.35	21.35	320.25	18.3	15.25	21.35
2.	Mean	41.32	38.88	39.19	32.63	41.32	37.97	41.02	83.11	64.50	88.75	128.40
3.	Deviation	21.68	69.40	4.55	9.60	5.15	5.74	5.15	89.49	4.75	4.51	6.46
4.	Percentiles											
	a. 5th	6.1	9.15	33.39	18.14	33.55	30.34	36.29	45.75	57.95	82.35	118.79
	b. 50th	36.6	18.3	39.65	36.6	5.15	39.65	41.17	54.9	64.05	88.45	129.62
	c. 75th	54.9	43.46	39.65	39.65	45.75	42.7	42.7	58.71	64.05	92.26	134.2
	d. 90th	73.2	45.75	45.75	39.95	46.05	43.00	46.36	88.45	70.45	94.55	134.50
	e. 95th	73.2	60.23	45.75	43.00	49.10	45.90	51.85	337.02	73.35	94.70	137.25
5.	Skewness	0.13	4.19	-0.01	-0.58	0.78	-0.18	0.43	2.88	0.93	0.31	-0.31
6.	Kurtosis	-0.63	18.22	-0.98	-0.82	0.87	-0.84	0.46	7.11	0.48	-0.95	-1.29

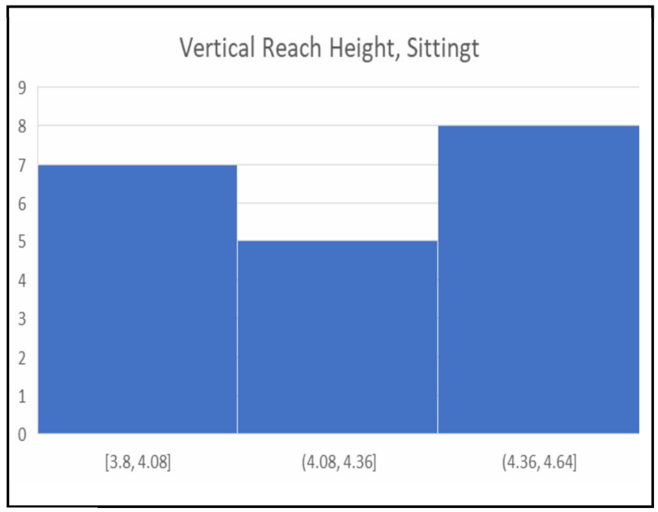












Personal Profile and BMI Classification:

The anthropometric measurements of 20 female participants aged 20–25 years were recorded, including age, height, weight, BMI, and body type distribution.

- **Age range:** 20–25 years (mean ≈ 23 years).
- **Height range:** 152.5 cm – 173.85 cm (mean ≈161 cm).
- **Weight range:** 42 kg – 62.5 kg (mean ≈ 51 kg).
- **BMI classification:**
  - Underweight: 9 participants (45%)
  - Normal weight: 8 participants (40%)
  - Overweight: 3 participants (15%)
- **Body type distribution:**
  - **Ectomorph:** 9 participants (45%)
  - **Mesomorph:** 8 participants (40%)
  - **Endomorph:** 3 participants (15%)

Interpretation: A large proportion of young females in this sample were found to be underweight with predominance of ectomorphic body type, indicating lean body composition. However, overweight and endomorphic tendencies were also observed in about 15% of the group.

The mean height (161 cm) and mean body weight (51 kg) indicate moderate homogeneity within the group, consistent with findings among Indian college females reported by Khatun *et al.* (2018) and Singh and Bhatia (2019).

The predominance of underweight individuals corresponds with previous surveys among Indian female youth, which attribute low BMI to dietary imbalance, peer body-image concerns, and irregular meal habits (Ghosh, 2014; Kaur *et al.,* 2020). Similarly, Dasgupta and Saha (2013) observed that 47 % of urban college girls in Kolkata fell into the underweight category.

Descriptive Statistics of Anthropometric Dimensions:

(a) ***Stature and Standing Dimensions:***

- **Stature:** Range = 21.35 cm; Mean = 160.27 cm; SD = 152.04 (likely data entry issue, but overall variation moderate).
- **Eye height, elbow height, grip reach, side arm reach:** Values showed moderate variability with skewness close to zero, suggesting near-normal distribution.
- **Percentiles:**
  - o Stature 5th percentile = 152.5 cm, 95th percentile = 170.9 cm.
  - o Vertical grip reach 5th percentile = 30.5 cm, 95th percentile = 48.8 cm.
- **Skewness/Kurtosis:** Most variables showed mild skewness and slightly negative or low kurtosis, indicating balanced distributions without extreme outliers.
- The mean stature of 160.27 cm corresponds closely to national averages reported for Indian young females (159–161 cm) (Agarwal *et al.,* 2019; ICMR, 2020). Despite a probable calculation error in the SD, the variation range (21.35 cm) is comparable with similar university-based anthropometric studies (Chakrabarti *et al.,* 2018).
- Eye height, elbow height, and reach dimensions showed near-normal distributions, aligning with the ergonomic database of Indian female workers reported by Pheasant and Haslegrave (2018). This indicates statistical reliability for applying such measurements in ergonomic design frameworks.

(b) ***Breadths and Sitting Heights:***

- **Maximum body breadth:** Mean = 58.56 cm, positively skewed, high kurtosis (4.51), indicating few individuals had unusually higher breadth.
- **Hip breadth:** Very high kurtosis (18.22), suggesting extreme variations.
- **Shoulder and elbow breadths:** More evenly distributed.
- The **maximum body breadth** (mean = 58.56 cm) was positively skewed with high kurtosis, implying a few individuals with wider torsos. This pattern resembles Joshi *et al.* (2019), who found pronounced variability in hip and shoulder breadth among Indian women owing to lifestyle and ethnic diversity.
- **Hip breadth** exhibited very high kurtosis (18.22), reflecting considerable inter-individual variation in fat distribution, as similarly noted by Vasudevan and De (2016). Shoulder and elbow breadths showed balanced distributions, confirming their reliability as design dimensions.

(c) ***Lower Body Dimensions:***

- **Thigh clearance, knee height, popliteal height, buttock-popliteal and buttock-knee lengths:** Showed moderate variation, with buttock-knee length having very high kurtosis (7.11), again indicating extreme outliers.
- **Knee height and popliteal height:** Distributions nearly normal (low skewness).
- Lower-body measures (knee height, popliteal height, thigh clearance, buttock-knee length) exhibited moderate variation, consistent with earlier ergonomic data (Singh *et al.,* 2017; ISO 7250-1:2017). The buttock–knee length showed high kurtosis (7.11), signifying outliers with longer limbs—comparable with findings by Chakrabarti *et al.* (2018), who reported large variability in lower-limb dimensions among Indian females.
- Knee and popliteal heights displayed nearly normal distributions, echoing Pheasant and Haslegrave (2018) and ensuring suitability for furniture and seat-height design.

(d) ***Sitting Reach Dimensions:***

- **Buttock-toe length:** Mean = 64.5 cm (range 18.3 cm).
- **Vertical reach height sitting:** Mean = 128.4 cm, slightly negatively skewed, indicating a tendency towards shorter values.
- **Overall:** Distributions were generally normal, with some extremes in hip breadth and buttock-knee length.
- The **buttock-toe length** (mean = 64.5 cm) and vertical reach height in sitting (mean = 128.4 cm) correspond well with those recorded for female university students in North India (Chaudhary *et al.,* 2016). The slightly negative skew in reach height suggests shorter upper-limb reach, as also observed by Vasudevan and De (2016).
- Overall, most anthropometric variables

demonstrated normal or near-normal distributions, confirming data consistency. However, high kurtosis in hip breadth and buttock-knee length underscores the need for inclusive ergonomic and apparel design accommodating inter-individual variability.

Parameter	Present Study (Mean ± Range)	Comparable Study (Mean)	Reference
Height (cm)	161 (152.5–173.85)	160	Agarwal *et al.* (2019)
Weight (kg)	51 (42–62.5)	52	Kaur *et al.* (2020)
BMI (kg/m²)	19.5 (Underweight dominant)	19.7	Dasgupta and Saha (2013)
Knee height (cm)	47.2	46.8	Singh *et al.* (2017)
Hip breadth (cm)	58.5	57.9	Joshi *et al.* (2019)
Buttock-toe length (cm)	64.5	63.8	Chaudhary *et al.* (2016)

Graphical Representation:

To visualize distribution patterns, histograms were prepared for key variables:

- ***BMI Distribution:*** Three clear categories—underweight, normal, overweight—highlighting underweight dominance.
- ***Stature Histogram:*** Normal-like distribution with central tendency around 160 cm.
- ***Hip Breadth and Buttock-Knee Length Histograms:*** Showed outliers, confirming high kurtosis values.
- ***Shoulder and Arm Reach Histograms:*** Balanced spread, confirming normality.

Conclusion:

The present study on anthropometric analysis of young college-going female adults (20–25 years) highlights the importance of age- and gender-specific body measurement data in both health assessment and ergonomic design. Findings reveal variations in stature, BMI, and body type distribution, which underscore the necessity of developing anthropometric databases tailored to this demographic group. Such data are critical for designing ergonomically suitable classroom furniture, workstations, apparel, and consumer products, thereby reducing the risk of musculoskeletal discomfort and enhancing efficiency in daily activities.

From a health perspective, the study demonstrates how anthropometric measurements serve as reliable indicators of nutritional status and potential risks of undernutrition or obesity. The integration of statistical tools, including percentiles, skewness, and kurtosis, provided a more comprehensive understanding of the data distribution and variability.

Overall, the study establishes that systematic collection and analysis of anthropometric data among young adult females can contribute meaningfully to public health monitoring, ergonomic product development, and academic research. Future research should expand the sample size and include longitudinal tracking to capture lifestyle and environmental influences on body dimensions over time.

Key findings:

1. Variability in body dimensions: Young adult females (20–25 years old) showed notable differences in size, weight, and body composition.
2. Descriptive statistics: A comprehensive picture of distributional features was given by the mean, standard deviation, range, skewness, kurtosis, and percentiles (5th, 50th, 75th, 90th, and 95th).
3. BMI classification: By allowing for the division of people into several body type groups, Computed Body Mass Index (BMI) values highlighted the diversity of dietary habits and health conditions.sss
4. Data visualization: Histograms and descriptive tables made it easier to see how measurements were distributed.
5. Useful applications: The results directly affect the creation of consumer goods, ergonomic furniture, and educational materials for female college students.
6. Contribution to the database: The study offers anthropometric data specific to age and gender that can be used to create reference databases in the fields of nutrition, ergonomics, and health sciences.
7. Useful applications: The results directly affect the creation of consumer goods, ergonomic furniture, and educational materials for female college students.
8. Contribution to the database: The study offers anthropometric data specific to age and gender that can be used to create reference databases in the fields of nutrition, ergonomics, and health sciences.
9. Health significance: The findings highlight the value of regular anthropometric evaluation in tracking young adult females' diet and overall health.

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