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# A study of anthropometric measurements among volleyball players

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**Abstract**
The aim of the present investigation was to find out the significant differences of "Anthropometric Measurements", among different playing positions of university level volleyball players. Measurements were collected (N=163) from Guru Nanak Dev University, Amritsar ($N_1$=57), Punjabi University, Patiala ($N_2$=39), Panjab University, Chandigarh ($N_3$=37) and I.K. Gujral Punjab Technical University Jalandhar ($N_4$=30) with reference to playing position of inter-college volleyball players. This study's data analysis procedure was divided into two sections: Section-1: A descriptive analysis was used in the first section to describe the data distribution. Section-2: The hypothesis testing with ANOVA was included in the second section. The data was statistically analyzed using SPSS (Statistical Package for the Social Sciences) version 17 to draw conclusions. In addition, if the f-value was found to be significant, the Scheffe test for multiple comparison methods was used in this study. The level of significance was set at 0.05. Weight: The test statistic F equals 0.209389, is in the 95% critical value accepted range: [-∞: 3.0525]. Height: The test statistic F equals 0.397644, is in the 95% critical value accepted range: [-∞: 3.0977]. Biaccromial Diameter: The test statistic F equals 68.004707, is not in the 95% critical value accepted range: [-∞: 3.0525]. Biilliac Diameter: The test statistic F equals 21.939010, is not in the 95% critical value accepted range: [-∞: 3.0525]. Anterior Posterior Chest: The test statistic F equals 12.875806, is not in the 95% critical value accepted range: [-∞: 3.0525]. Transverse Chest: The test statistic F equals 22.609761, is not in the 95% critical value accepted range: [-∞: 3.0525]. Mid Upper Arm Circumference: The test statistic F equals 13.920474, is not in the 95% critical value accepted range: [-∞: 3.0525]. Chest Circumference Normal: The test statistic F equals 27.947329, is not in the 95% critical value accepted range: [-∞: 3.0525]. Waist Circumference: The test statistic F equals 2.599908, is in the 95% critical value accepted range: [-∞: 3.0525]. Calf Circumference: The test statistic F equals 12.573539, is not in the 95% critical value accepted range: [-∞: 3.0525]. Hip Circumference: The test statistic F equals 41.639098, is not in the 95% critical value accepted range: [-∞: 3.0525]. Biceps Skinfold: The test statistic F equals 11.916731, is not in the 95% critical value accepted range: [-∞: 3.0525]. Triceps Skinfold: The test statistic F equals 33.442666, is not in the 95% critical value accepted range: [-∞: 3.0525]. Subscapular Skinfold: The test statistic F equals 22.509007, is not in the 95% critical value accepted range: [-∞: 3.0525]. Abdominal Skinfold: The test statistic F equals 7.960778, is not in the 95% critical value accepted range: [-∞: 3.0525]. Calf Skinfold: The test statistic F equals 13.541014, is not in the 95% critical value accepted range: [-∞: 3.0525]. Fat Mass: The test statistic F equals 11.136638, is not in the 95% critical value accepted range: [-∞: 3.0525]. Fat Percentage: The test statistic F equals 84.414188, is not in the 95% critical value accepted range: [-∞: 3.0525]. Body Mass Index: The test statistic F equals 33.344641, is not in the 95% critical value accepted range: [-∞: 3.0525].

**Keywords:** Anthropometric measurements**,** volleyball players, setter, hitter, libero

## Introductions
Anthropomorphic measurement, the scientific study of human body dimensions and proportions, has significant implications in various fields, including ergonomics, product design, healthcare, and forensic science [1]. This review paper aims to provide a comprehensive overview of anthropomorphic measurement, exploring the various methods used to assess and quantify human body characteristics [2]. By examining a wide range of studies, this paper discusses the applications of anthropomorphic measurement in diverse domains, such as the clothing and apparel industry, automotive design, furniture design, and medical fields. Additionally, this review highlights the advancements in technology that have revolutionized anthropometric data collection, analysis, and visualization.

By synthesizing existing literature, this paper seeks to contribute to a better understanding of anthropomorphic measurement and its significance in improving human-centred designs and enhancing overall well-being [3-7]. Anthropomorphic measurement, also known as anthropometry, refers to the systematic measurement of human body dimensions and physical characteristics. This scientific approach plays a vital role in understanding human diversity, improving the design of products and environments, and enhancing human-machine interactions. Over the years, anthropometric data have been used in various fields, including ergonomics, fashion and apparel design, healthcare, and robotics, among others. This review paper aims to explore the advancements in anthropomorphic measurement, its applications, and the challenges faced in this field [8-10].

## Material and Methods

### Participants

Measurements were collected (N=163) from Guru Nanak Dev University, Amritsar ($N_1$=57), Punjabi University, Patiala ($N_2$=39), Panjab University, Chandigarh ($N_3$=37) and I.K. Gujral Punjab Technical University Jalandhar ($N_4$=30) with reference to playing position of inter-college volleyball players.

| Universities | Setter | Hitter | Libero | Total |
|---|---|---|---|---|
| Guru Nanak Dev University, Amritsar | 14 | 32 | 11 | 57 |
| Punjabi University, Patiala | 12 | 18 | 9 | 39 |
| Panjab University, Chandigarh | 10 | 20 | 7 | 37 |
| I.K. Gujral Punjab Technical University, Jalandhar | 8 | 16 | 6 | 30 |
| Sample Size | 44 | 86 | 33 | 163 |

### Statistical Analysis

This study's data analysis procedure was divided into two sections: Section-1: A descriptive analysis was used in the first section to describe the data distribution. Section-2: The hypothesis testing with ANOVA was included in the second section. The data was statistically analyzed using SPSS (Statistical Package for the Social Sciences) version 17 to draw conclusions. In addition, if the f-value was found to be significant, the Scheffe test for multiple comparison methods was used in this study. The level of significance was set at 0.05.

Anthropometric measurements

| Anthropometric Measurements | Tools |
|---|---|
| Weight (kg) | Weighing Machine |
| Height (cm) | Anthropometer |
| Biaccromial Diameter (cm) | Anthropometer |
| Biilliac Diameter (cm) | Anthropometer |
| Anterior Posterior Chest (cm) | Spreading Caliper (large) |
| Transverse Chest (cm) | Anthropometer |
| Mid Upper Arm Circumference (cm) | Steel Tape |
| Chest Circumference Normal (cm) | Steel Tape |
| Waist Circumference (cm) | Steel Tape |
| Calf Circumference (cm) | Steel Tape |
| Hip Circumference (cm) | Steel Tape |
| Biceps Skinfold (mm) | Holtain Skinfold Caliper |
| Triceps Skinfold (mm) | Holtain Skinfold Caliper |
| Subscapular Skinfold (mm) | Holtain Skinfold Caliper |
| Suprailiac Skinfold (mm) | Holtain Skinfold Caliper |
| Abdominal Skinfold (mm) | Holtain Skinfold Caliper |
| Calf Skinfold (mm) | Holtain Skinfold Caliper |
| Fat Mass (kg) | Omron Body Fat Monitor |
| Fat Percentage | Omron Body Fat Monitor |
| Body Mass Index | Calculated Term |

## Results

**Table 1:** ANOVA analysis of Weight (kg).

| Source | DF | Sum of Square | Mean Square | F Statistic | P-value |
|---|---|---|---|---|---|
| Groups (between groups) | 2 | 4.063844 | 2.031922 | 0.209389 | 0.811301 |
| Error (within groups) | 160 | 1552.647981 | 9.704050 | | |
| Total | 162 | 1556.711825 | 9.609332 | | |

That F value is 0.209389 and P value is 0.811301 at (alpha=0.05). The results revealed that groups are different significantly.

**Table 2:** ANOVA analysis of Height (cm).

| Source | DF | Sum of Square | Mean Square | F Statistic | P-value |
|---|---|---|---|---|---|
| Groups (between groups) | 2 | 31.367473 | 15.683737 | 0.397644 | 0.673076 |
| Error (within groups) | 90 | 3549.750625 | 39.441674 | | |
| Total | 92 | 3581.118098 | 38.925197 | | |

That F value is 0.397644 and P value is 0.673076 at (alpha=0.05). The results revealed that groups are different significantly.

**Table 3:** ANOVA analysis of Biaccromial Diameter (cm).

| Source | DF | Sum of Square | Mean Square | F Statistic | P-value |
|---|---|---|---|---|---|
| Groups (between groups) | 2 | 5086.362523 | 2543.181262 | 68.004707 | 0.00000 |
| Error (within groups) | 160 | 5983.541740 | 37.397136 | | |
| Total | 162 | 11069.90426 | 68.332742 | | |

That F value is 68.004707 and P value is 0.00000 at (alpha=0.05). The results revealed that groups are different significantly.

**Table 4:** ANOVA analysis of Biilliac Diameter (cm).

| Source | DF | Sum of Square | Mean Square | F Statistic | P-value |
|---|---|---|---|---|---|
| Groups (between groups) | 2 | 1487.873446 | 743.936723 | 21.939010 | 3.80160 |
| Error (within groups) | 160 | 5425.489712 | 33.909311 | | |
| Total | 162 | 6913.363159 | 42.675081 | | |

That F value is 21.939010 and P value is 3.80160e-9 at (alpha=0.05). The results revealed that groups are different significantly.

**Table 5:** ANOVA analysis of Anterior Posterior Chest (cm).

| Source | DF | Sum of Square | Mean Square | F Statistic | P-value |
|---|---|---|---|---|---|
| Groups (between groups) | 2 | 567.292761 | 283.646380 | 12.875806 | 0.00000653118 |
| Error (within groups) | 160 | 3524.705277 | 22.029408 | | |
| Total | 162 | 4091.998038 | 25.259247 | | |

That F value is 12.875806 and P value is 0.00000653118 at (alpha=0.05). The results revealed that groups are different significantly.

**Table 6:** ANOVA analysis of Transverse Chest (cm).

| Source | DF | Sum of Square | Mean Square | F Statistic | P-value |
|---|---|---|---|---|---|
| Groups (between groups) | 2 | 871.407608 | 435.703804 | 22.609761 | 2.24960 |
| Error (within groups) | 160 | 3083.297063 | 19.270607 | | |
| Total | 162 | 3954.704671 | 24.411757 | | |

That F value is 22.609761 and P value is 2.24960e-9 at (alpha=0.05). The results revealed that groups are different significantly.

**Table 7:** ANOVA analysis of Mid Upper Arm Circumference (cm).

| Source | DF | Sum of Square | Mean Square | F Statistic | P-value |
|---|---|---|---|---|---|
| Groups (between groups) | 2 | 868.053524 | 434.026762 | 13.920474 | 0.00000266917 |
| Error (within groups) | 160 | 4988.643512 | 31.179022 | | |
| Total | 162 | 5856.697037 | 36.152451 | | |

That F value is 13.920474 and P value is 0.00000266917 at (alpha=0.05). The results revealed that groups are different significantly.

**Table 8:** ANOVA analysis of Chest Circumference Normal (cm).

| Source | DF | Sum of Square | Mean Square | F Statistic | P-value |
|---|---|---|---|---|---|
| Groups (between groups) | 2 | 3799.509848 | 1899.754924 | 27.947329 | 3.89266 |
| Error (within groups) | 160 | 10876.20172 | 67.976261 | | |
| Total | 162 | 14675.71157 | 90.590812 | | |

That F value is 27.947329 and P value is 3.89266e-11 at (alpha=0.05). The results revealed that groups are different significantly.

**Table 9:** ANOVA analysis of Waist Circumference (cm).

| Source | DF | Sum of Square | Mean Square | F Statistic | P-value |
|---|---|---|---|---|---|
| Groups (between groups) | 2 | 1378.583619 | 689.291810 | 2.599908 | 0.0774165 |
| Error (within groups) | 160 | 42419.45566 | 265.121598 | | |
| Total | 162 | 43798.03928 | 270.358267 | | |

That F value is 2.599908 and P value is 0.0774165 at (alpha=0.05). The results revealed that groups are different significantly.

**Table 10: ANOVA analysis of Calf Circumference (cm).**

| Source | DF | Sum of Square | Mean Square | F Statistic | P-value |
|---|---|---|---|---|---|
| Groups (between groups) | 2 | 901.729743 | 450.864871 | 12.573539 | 0.00000847715 |
| Error (within groups) | 160 | 5737.317118 | 35.858232 | | |
| Total | 162 | 6639.046860 | 40.981771 | | |

That F value is 12.573539 and P value is 0.00000847715 at (alpha=0.05). The results revealed that groups are different significantly.

**Table 11:** ANOVA analysis of Hip Circumference (cm).

| Source | DF | Sum of Square | Mean Square | F Statistic | P-value |
|---|---|---|---|---|---|
| Groups (between groups) | 2 | 5755.003688 | 2877.501844 | 41.639098 | 2.77556 |
| Error (within groups) | 160 | 11056.92300 | 69.105769 | | |
| Total | 162 | 16811.92669 | 103.777325 | | |

That F value is 41.639098 and P value is 2.77556e-15 at (alpha=0.05). The results revealed that groups are different significantly.

**Table 12:** ANOVA analysis of Biceps Skinfold (mm).

| Source | DF | Sum of Square | Mean Square | F Statistic | P-value |
|---|---|---|---|---|---|
| Groups (between groups) | 2 | 470.698628 | 235.349314 | 11.916731 | 0.0000149842 |
| Error (within groups) | 160 | 3159.917662 | 19.749485 | | |
| Total | 162 | 3630.616290 | 22.411212 | | |

That F value is 11.916731 and P value is 0.0000149842 at (alpha=0.05). The results revealed that groups are different significantly.

**Table 13:** ANOVA analysis of Triceps Skinfold (mm).

| Source | DF | Sum of Square | Mean Square | F Statistic | P-value |
|---|---|---|---|---|---|
| Groups (between groups) | 2 | 2329.318555 | 1164.659278 | 33.442666 | 7.32969 |
| Error (within groups) | 160 | 5572.088150 | 34.825551 | | |
| Total | 162 | 7901.406705 | 48.774115 | | |

That F value is 33.442666 and P value is 7.32969e-13 at (alpha=0.05). The results revealed that groups are different significantly.

**Table 14:** ANOVA analysis of Subscapular Skinfold (mm).

| Source | DF | Sum of Square | Mean Square | F Statistic | P-value |
|---|---|---|---|---|---|
| Groups (between groups) | 2 | 1412.274915 | 706.137457 | 22.509007 | 2.43353 |
| Error (within groups) | 160 | 5019.412702 | 31.371329 | | |
| Total | 162 | 6431.687617 | 39.701775 | | |

That F value is 22.509007and P value is 2.43353e-9 at (alpha=0.05). The results revealed that groups are different significantly.

**Table 15:** ANOVA analysis of Abdominal Skinfold (mm).

| Source | DF | Sum of Square | Mean Square | F Statistic | P-value |
|---|---|---|---|---|---|
| Groups (between groups) | 2 | 357.271358 | 178.635679 | 7.960778 | 0.000505911 |
| Error (within groups) | 160 | 3590.315833 | 22.439474 | | |
| Total | 162 | 3947.587192 | 24.367822 | | |

That F value is 7.960778 and P value is 0.000505911 at (alpha=0.05). The results revealed that groups are different significantly.

**Table 16:** ANOVA analysis of Calf Skinfold (mm).

| Source | DF | Sum of Square | Mean Square | F Statistic | P-value |
|---|---|---|---|---|---|
| Groups (between groups) | 2 | 554.296387 | 277.148193 | 13.541014 | 0.00000369006 |
| Error (within groups) | 160 | 3274.770395 | 20.467315 | | |
| Total | 162 | 3829.066781 | 23.636215 | | |

That F value is 13.541014 and P value is 0.00000369006 at (alpha=0.05). The results revealed that groups are different significantly.

**Table 17:** ANOVA analysis of Fat Mass (kg).

| Source | DF | Sum of Square | Mean Square | F Statistic | P-value |
|---|---|---|---|---|---|
| Groups (between groups) | 2 | 669.373659 | 334.686829 | 11.136638 | 0.0000296318 |
| Error (within groups) | 160 | 4808.443415 | 30.052771 | | |
| Total | 162 | 5477.817073 | 33.813686 | | |

That F value is 11.136638 and P value is 0.0000296318 at (alpha=0.05). The results revealed that groups are different significantly.

**Table 18:** ANOVA analysis of Fat Percentage.

| Source | DF | Sum of Square | Mean Square | F Statistic | P-value |
|---|---|---|---|---|---|
| Groups (between groups) | 2 | 2440.527617 | 1220.263808 | 84.414188 | 0.00000 |
| Error (within groups) | 160 | 2312.907520 | 14.455672 | | |
| Total | 162 | 4753.435136 | 29.342192 | | |

That F value is 84.414188 and P value is 0.00000 at (alpha=0.05). The results revealed that groups are different significantly.

**Table 19:** ANOVA analysis of Body Mass Index.

| Source | DF | Sum of Square | Mean Square | F Statistic | P-value |
|---|---|---|---|---|---|
| Groups (between groups) | 2 | 612.296663 | 306.148331 | 33.344641 | 7.85483 |
| Error (within groups) | 160 | 1469.013655 | 9.181335 | | |
| Total | 162 | 2081.310318 | 12.847595 | | |

That F value is 33.344641 and P value is 7.85483e-13 at (alpha=0.05). The results revealed that groups are different significantly.

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