

# DIFFERENCES IN ANTHROPOMETRIC CHARACTERISTICS, BODY COMPOSITION AND SOMATOTYPE COMPONENTS AMONG SENIOR AND CADET VOLLEYBALL GIRLS

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## **Abstract**

In this research, the problem of somatotypes will be treated components, body composition and anthropometric characteristics in volleyball players with different level of performance.

Namely, the research will be aimed at assessing the somatotype of the selected volleyball players, their body composition, anthropometric characteristics, as well as their mutual relations followed through the different level of performance. The main problem of this research is the differences in anthropometric characteristics, body composition and somatotype components between senior and cadet volleyball players. The subject of this research is certain anthropometric characteristics and body components, as well as determining the somatotype of the studied volleyball players with varying levels of success. The sample of respondents is drawn from a population of volleyball players from the volleyball clubs: "Shkendija", volleyball club "Bamikor", volleyball club "TE Volley" and volleyball club "Ljuboten" all from Tetovo aged 18 to 31 years  $\pm$  6 months. In the research are included 64 female volleyball cadets aged 18 and 19 and 126 senior female volleyball players aged 20 to 31 years  $\pm$  6 months.

A cross-sectional study was performed on the sample of respondents; the anthropometric, body and somatotype components in young volleyball players from this region of the Republic of North Macedonia. In this research, a total of 29 variables were applied, of which 18 were variables for assessment of anthropometric characteristics, 8 variables for assessment of the body composition and 3 variables for the assessment of somatotypicity in the chosen volleyball players.

*Key words: anthropometry, body composition, somatotype, volleyball, senior, cadets, ectomorph, mesomorph, endomorph.*

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## **1. Objectives of the research**

From the subject of the research and the general objective, the following arise special goals:

- to determine if there are differences in anthropometric characteristics between senior and female volleyball players,
- to determine if there are differences in body composition between senior and cadet volleyball players,
- to determine if there are differences in somatotype components between senior and cadet volleyball players.

## 2. Research hypotheses

X-0 There won't be a significant statistical difference in characteristics, body composition and somatotype components among female senior and cadet volleyball players,

X-1 There will be a significant statistical difference in anthropometric characteristics between senior and female volleyball players,

X-2 There will be a significant statistical difference in body composition between senior and cadet volleyball players,

X-3 There will be a significant statistical difference in somatotype components between senior and female volleyball players.

## 3. Results

For all applied variables in the research in both samples of respondents, the basic descriptive statistical parameters were calculated, namely arithmetic mean (X), standard deviation (SD), lower and upper limits of the range in which the results move (min-max), skewness - symmetry (skew), kurtosis - elongation or flattening of the distribution (kurt), as well as Kolmogorov Smyrna's test which tests the normality of the distribution. The results of these analyzes are shown in Tables 1 and 2.

**Table 1.** Basic descriptive statistical parameters and the normality of distribution among senior volleyball players.

|                               | N   | Minimum | Maximum | Mean   | SD    | Skewness | Kurtosis |
|-------------------------------|-----|---------|---------|--------|-------|----------|----------|
| Age (Years)                   | 126 | 20,00   | 31,00   | 23,18  | 2,96  | 0,93     | 0,00     |
| Endomorphic                   | 126 | 1,40    | 6,14    | 3,27   | 1,05  | 0,26     | -0,62    |
| Mesomorphic                   | 126 | 1,80    | 6,83    | 4,11   | 1,02  | 0,08     | -0,49    |
| Ectomorphic                   | 126 | 0,68    | 5,46    | 3,09   | 1,07  | -0,27    | -0,47    |
| Height (cm)                   | 126 | 160,50  | 187,00  | 176,58 | 7,05  | -0,60    | -0,12    |
| Wrist diameter                | 126 | 44,00   | 59,00   | 51,38  | 2,83  | -0,06    | -0,33    |
| Weight (kg)                   | 126 | 52,00   | 104,00  | 68,82  | 11,19 | 1,31     | 1,54     |
| Knee diameter                 | 126 | 87,00   | 113,00  | 97,04  | 4,55  | 0,94     | 1,07     |
| Elbow diameter                | 126 | 57,00   | 85,00   | 71,98  | 5,54  | -0,06    | 0,06     |
| Ankle diameter _              | 126 | 58,00   | 79,00   | 69,54  | 3,80  | -0,10    | 0,12     |
| Upper arm circumference       | 126 | 195,00  | 325,00  | 257,66 | 24,01 | 0,25     | 0,52     |
| Perimeter of upper arm flexed | 126 | 220,00  | 350,00  | 284,88 | 23,23 | 0,18     | 0,57     |
| Thigh circumference           | 126 | 480,00  | 710,00  | 573,73 | 47,82 | 0,71     | 0,39     |
| Forearm perimeter             | 126 | 190,00  | 315,00  | 240,87 | 17,76 | 0,57     | 2,39     |
| Skin fats on the upper arm    | 126 | 2,70    | 11,50   | 5,55   | 1,82  | 0,69     | 0,27     |
| Lower leg circumference       | 126 | 300,00  | 420,00  | 360,60 | 24,29 | 0,41     | 0,31     |

|                           |     |       |       |       |      |       |       |
|---------------------------|-----|-------|-------|-------|------|-------|-------|
| Skin fats above the elbow | 126 | 2,90  | 14,70 | 7,19  | 2,57 | 0,61  | -0,34 |
| Skin fats on the triceps  | 126 | 5,80  | 23,40 | 12,87 | 4,01 | 0,43  | -0,17 |
| Skin fats above the knee  | 126 | 10,60 | 38,40 | 21,19 | 6,32 | 0,40  | -0,48 |
| Subscapular skinfold      | 126 | 5,60  | 23,40 | 11,43 | 3,93 | 1,06  | 0,71  |
| Skin fats below the knee  | 126 | 4,00  | 26,30 | 11,32 | 4,35 | 0,40  | 0,08  |
| Supra-iliac skin fold     | 126 | 3,70  | 24,30 | 9,39  | 4,37 | 0,93  | 0,59  |
| MM kg (Muscle mass)       | 126 | 22,79 | 55,86 | 36,45 | 6,15 | 0,88  | 1,22  |
| KM kg                     | 126 | 8,29  | 14,43 | 11,18 | 1,28 | 0,06  | -0,53 |
| FM kg                     | 126 | 2,89  | 29,02 | 9,05  | 4,82 | 1,67  | 3,57  |
| MM% (% mus. mass)         | 126 | 40,70 | 62,48 | 53,01 | 3,62 | -1,08 | 3,12  |
| BMkg (Bone mass)          | 126 | 12,25 | 20,07 | 16,41 | 1,66 | -0,18 | -0,13 |
| FM% (% of body fat)       | 126 | 4,93  | 29,61 | 12,82 | 5,31 | 0,95  | 0,83  |
| BMI (body mass index)     | 126 | 17,85 | 30,06 | 21,98 | 2,50 | 1,30  | 1,36  |
| Fat-free component kg     | 126 | 45,63 | 95,48 | 59,77 | 8,78 | 1,06  | 1,89  |

From the review of (table 1.) it can be seen that the skewness values at most applied anthropometric measures and the measures for assessing the body composition and somatotype components in senior volleyball athletes move in the limits of the recommended values from -1 to +1 indicating that the distribution of the results is approximately symmetrical.

Positive asymmetry (a greater number of results are in the zone of the higher) is observed in the variables: body mass, subscapular skinfold, the body mass index (BMI) and the lean component.

Negative asymmetry (a greater number of results are in the zone of the lower) is observed in the variable: percentage of muscle mass (MM %). From kurtosis values (table 1.) it can be seen that all variables show flatness (platokurtic distribution). The results of the Kolmogorov Smirnova procedure showed that all anthropometric measures, derived measures for assessing body composition and somatotype components are normally distributed. From the review of (table 2.) it can be seen that the skewness values at most applied anthropometric measures and the measures for assessing the body

Composition and somatotype components in female cadet volleyball athletes move in the limits of the recommended values from -1 to +1 indicating that the distribution of the results is approximately symmetrical. [7]

Positive asymmetry (a greater number of results are in the zone of higher) is observed in the variables: wrist diameter, body mass, upper arm skinfold, subscapular skinfold, percentage of bone mass and percentage of adipose tissue.

From the kurtosis values (table 2.) it can be seen that most variables show flattening (platokurtic distribution). Leptocuric distribution is shown by the variables wrist diameter, body mass, skin upper arm circumference, bone mass expressed in kilograms (KM kg) and fat tissue expressed in kilograms (KS kg ). The results of the Kolmogorov Smirnova procedure showed that all anthropometric measures, derived measures for assessing body composition and somatotype components in cadet volleyball players are normally distributed. [19]

**Table 2.** Basic descriptive statistical parameters and the normality of the distribution among female volleyball cadets.

|                               | N  | Minimum | Maximum | Mean   | SD    | Skewness | Kurtosis |
|-------------------------------|----|---------|---------|--------|-------|----------|----------|
| Endomorphic                   | 64 | 1,86    | 6,11    | 3,86   | 0,98  | 0,36     | -0,24    |
| Mesomorphic                   | 64 | 0,51    | 5,69    | 3,65   | 1,24  | -0,53    | -0,49    |
| Ectomorphic                   | 64 | 0,88    | 5,36    | 3,06   | 1,17  | 0,39     | -0,72    |
| Height (cm)                   | 64 | 156,00  | 188,00  | 175,60 | 6,56  | -0,62    | 0,28     |
| Wrist diameter                | 64 | 44,00   | 64,00   | 50,48  | 3,11  | 1,14     | 4,45     |
| Weight (kg)                   | 64 | 54,00   | 104,00  | 67,50  | 8,11  | 1,47     | 5,14     |
| Knee diameter                 | 64 | 86,00   | 113,00  | 97,08  | 5,43  | 0,31     | 0,83     |
| Diameter of the elbow joint   | 64 | 57,00   | 85,00   | 71,98  | 4,95  | -0,52    | 1,34     |
| Diameter of the ankle joint   | 64 | 55,00   | 80,00   | 66,95  | 4,44  | -0,28    | 1,09     |
| Upper arm circumference       | 64 | 200,00  | 300,00  | 261,88 | 18,85 | -0,52    | 0,57     |
| Perimeter of upper arm flexed | 64 | 230,00  | 315,00  | 282,58 | 17,86 | -0,26    | -0,05    |
| Thigh circumference           | 64 | 495,00  | 665,00  | 576,09 | 37,47 | 0,08     | -0,20    |
| Forearm perimeter             | 64 | 190,00  | 290,00  | 238,28 | 15,64 | 0,07     | 1,88     |
| Skin fats on the upper arm    | 64 | 3,80    | 18,00   | 7,56   | 2,49  | 1,71     | 4,39     |
| Lower leg circumference       | 64 | 310,00  | 405,00  | 361,25 | 20,00 | -0,05    | -0,05    |
| Skin fats above the elbow     | 64 | 3,40    | 17,00   | 9,04   | 2,53  | 0,86     | 1,36     |
| Skin fats on the triceps      | 64 | 6,30    | 25,50   | 14,86  | 3,90  | 0,38     | 0,23     |
| Skin fats above the knee      | 64 | 12,70   | 45,60   | 25,79  | 5,71  | 0,66     | 1,43     |
| Subscapular skinfold          | 64 | 6,50    | 24,50   | 12,17  | 3,64  | 1,06     | 1,54     |
| Skin fats below the knee      | 64 | 7,50    | 26,30   | 15,42  | 4,53  | 0,73     | -0,22    |
| Fat mass suprailiac           | 64 | 4,60    | 26,40   | 12,22  | 4,41  | 0,83     | 1,23     |
| MM kg (muscle mass)           | 64 | 25,98   | 45,46   | 35,99  | 4,06  | 0,07     | -0,30    |
| KM kg                         | 64 | 4,87    | 16,40   | 10,81  | 1,43  | -0,23    | 6,69     |
| FM kg                         | 64 | 43,11   | 71,22   | 53,48  | 4,12  | 0,66     | 5,67     |
| MM% (% mus. mass)             | 63 | 13,73   | 19,95   | 16,16  | 1,12  | 0,81     | 1,46     |

|                       |    |       |       |       |      |      |      |
|-----------------------|----|-------|-------|-------|------|------|------|
| BM %                  | 64 | 3,77  | 27,33 | 10,48 | 4,48 | 1,47 | 2,74 |
| FM %                  | 64 | 5,38  | 34,59 | 15,42 | 5,70 | 1,04 | 1,50 |
| BMI (body mass index) | 64 | 18,10 | 29,43 | 21,88 | 2,19 | 0,53 | 0,99 |
| Fat-free component kg | 64 | 41,58 | 81,14 | 57,02 | 7,21 | 0,65 | 0,81 |

### Differences in anthropometric measures, derived measures for evaluation of body composition and somatotype components among senior and cadet volleyball girls

In order to determine whether there were differences in anthropometric measures, derived measures for assessing body composition and somatotype components among senior and cadet volleyball players, one-factor analysis was applied the variances. The results of the analysis are shown in table 3.

**Table 3.** Differences in anthropometric measures, derived measures for assessment of body composition and somatotype components among senior and cadet volleyball players.

|                               | Senior |       | Cadets |       | F     | P            |
|-------------------------------|--------|-------|--------|-------|-------|--------------|
|                               | Mean   | SD    | Mean   | SD    |       |              |
| Endomorphic                   | 3,27   | 1,05  | 3,86   | 0,98  | 13,91 | <b>0,000</b> |
| Mesomorphic                   | 4,11   | 1,02  | 3,65   | 1,24  | 7,67  | <b>0,006</b> |
| Ectomorphic                   | 3,09   | 1,07  | 3,06   | 1,17  | 0,02  | 0,884        |
| Height (cm)                   | 176,58 | 7,05  | 175,60 | 6,56  | 0,86  | 0,355        |
| Wrist diameter                | 51,38  | 2,83  | 50,48  | 3,11  | 3,99  | <b>0,047</b> |
| Weight (kg)                   | 68,82  | 11,19 | 67,50  | 8,11  | 0,70  | 0,403        |
| Knee diameter                 | 97,04  | 4,55  | 97,08  | 5,43  | 0,00  | 0,959        |
| Diameter of the elbow joint   | 71,98  | 5,54  | 71,98  | 4,95  | 0,00  | 1,000        |
| Diameter of the ankle joint   | 69,54  | 3,80  | 66,95  | 4,44  | 17,55 | <b>0,000</b> |
| Upper arm circumference       | 257,66 | 24,01 | 261,88 | 18,85 | 1,50  | 0,222        |
| Perimeter of upper arm flexed | 284,88 | 23,23 | 282,58 | 17,86 | 0,48  | 0,488        |
| Thigh circumference           | 573,73 | 47,82 | 576,09 | 37,47 | 0,12  | 0,730        |
| Forearm perimeter             | 240,87 | 17,75 | 238,28 | 15,64 | 0,98  | 0,324        |
| Skin fats on the upper arm    | 5,55   | 1,82  | 7,56   | 2,49  | 39,93 | <b>0,000</b> |
| Lower leg circumference       | 360,60 | 24,29 | 361,25 | 20,00 | 0,04  | 0,853        |
| Skin fats above the elbow     | 7,19   | 2,57  | 9,04   | 2,53  | 22,20 | <b>0,000</b> |
| Fat mass of triceps           | 12,87  | 4,01  | 14,86  | 3,90  | 10,58 | <b>0,001</b> |
| Skin fats above the knee      | 21,19  | 6,32  | 25,79  | 5,71  | 23,96 | <b>0,000</b> |
| Subscapular skinfold          | 11,43  | 3,93  | 12,17  | 3,64  | 1,59  | 0,209        |
| Skin fats below the knee      | 11,32  | 4,35  | 15,42  | 4,53  | 36,80 | <b>0,000</b> |
| Fat mass suprailiac           | 9,39   | 4,37  | 12,22  | 4,41  | 17,80 | <b>0,000</b> |
| MMkg (Muscle mass)            | 36,45  | 6,15  | 35,99  | 4,06  | 0,30  | 0,586        |
| KM kg                         | 11,18  | 1,28  | 10,81  | 1,43  | 3,32  | 0,070        |
| FM kg                         | 9,05   | 4,82  | 10,48  | 4,48  | 3,91  | <b>0,049</b> |
| MM% (% mus. mass)             | 53,01  | 3,62  | 53,48  | 4,12  | 0,65  | 0,421        |
| BM %                          | 16,41  | 1,66  | 16,16  | 1,12  | 1,22  | 0,271        |

|                       |       |      |       |      |      |              |
|-----------------------|-------|------|-------|------|------|--------------|
| FM %                  | 12,82 | 5,31 | 15,42 | 5,70 | 9,64 | <b>0,002</b> |
| BMI (body mass index) | 21,98 | 2,50 | 21,88 | 2,19 | 0,06 | 0,801        |
| Fat-free component kg | 59,77 | 8,78 | 57,02 | 7,21 | 4,67 | <b>0,032</b> |

From the review of table 3 it can be seen that statistically significant univariate between-group differences between senior and cadet volleyball players were determined in anthropometric measures: wrist diameter ( $F= 3.11, p=.047$ ), ankle ( $F= 17.55, p=.000$ ), upper arm skin fold ( $F= 39.93, p=.000$ ), skin forearm fat mass ( $F= 22.20, p=.000$ ), triceps skin fat tissue ( $F= 10.58, p=.001$ ), thigh skinfold ( $F= 23.96, p=.000$ ), lower leg skinfold ( $F=36.80, p=.000$ ) and skin fold suprailiac ( $F= 17.80, p=.000$ ). Statistically significant univariate between-group differences in body composition assessment variables among senior and cadet volleyball players are determined in: fat tissue, kilograms, FM% (% of body fat).

( $F= 3.91, p=.049$ ), adipose tissue percentage ( $F= 9.64, p=.002$ ) and fat-free component ( $F= 4.66, p=.032$ ). Also, the results of the table indicate that significant statistically significant differences between senior and cadet volleyball players were also determined in the somatotype components Endomorphic ( $F= 13.91, p=.001$ ) and Mesomorphic ( $F= 7.67, p=.006$ ). [1]

From the values of the arithmetic means and the level of statistical significance on, it is visible that the volleyball players who compete in the senior competition have larger elbow and ankle diameters, and show smaller average values of upper arm skin fold, forearm skin fold, skin fold on the triceps, the calf skin fold, and the calf skin fold fat tissue suprailiac. Also, the volleyball players who compete in the senior level competition have a statistically significant lower total mass of adipose tissue expressed in kilograms and percentage of adipose tissue and posed mesomorphic component, a less pronounced endomorphic component compared to volleyball players who are compete in cadet competition. The volleyball players who compete in senior competition also have higher values of the fat-free component in relation to the volleyball players competing in the cadet competition.

#### 4. Discussion of results

Current research indicates that the morphological characteristics and body composition can influence the selection of athletes in many sports (Hasan et al., 2007). To be successful in a certain sports discipline, it is important that the athlete has appropriate anthropometric characteristics – morphological construction (Ziv and Lidor, 2009). In the course of growing and maturing, there is an increase in all dimensions of the body; longitudinal (body height, length of limbs and trunk), transverse (the diameters of the joints, the width of the shoulders and hips), the circular ones (circumferences of trunk and limbs). It also increases muscle mass, as a result of an increase in fat and muscle components and enlargement of internal organs. In addition to the growth and physical development and style of life, the training process contributes to the increase of subcutaneous tissue. However among top volleyball players, these values should range from 7-14%. At the cadets the values of the thickness of the skin folds is somewhat higher on the upper arm and forearm, upper leg and lower leg, and suprailiac. Namely, the volleyball players with maturation and years they get the specific distribution of the body mass in the direction of increasing muscle mass, in addition to

other reasons increased strength training that leads to a change in the mesomorphic component (which is more pronounced in senior women). The circumferences of the lower leg and upper leg are somewhat higher among senior women, but without statistically significant differences. These differences are most likely as a result of the increased activity of the extensor system lower leg and upper leg as a result of prolonged jumping. [6]

Adipose tissue can be defined as excess weight in volleyball. The results of the research indicate that seniors have a lower estimate of fat tissue in relation to female cadets. When the average results of the percentage are compared of adipose tissue obtained in this study with other previous studies performed on volleyball players who are of the same age and level of competition can be states that our respondents have a generally similar or lower percentage of adipose tissue (Fleck et al., 1985; Geladas & Maridaki 1996; Hassapidou& Mastrantoni, 2001; Kovaleski et al., 1980; Papadopoulou et al., 2002; Puhl et al., 1982). Our results indicate that the selection of players in women's volleyball for individual playing positions must be based on the morphological characteristics of the players. Trainers should have a good knowledge of general and specific tasks to be performed by the player in the game. In top volleyball it is strict recommended for certain positions choose players who with their morphological characteristics are as compatible as possible with the requirements of that playground.

The obtained results can serve as normative anthropometric indicators of regular sports medical examinations of top female volleyball players in our country. The data can also be used as a template for comparison the anthropometric and somatotype data of top volleyball players from different countries.

## 5. Conclusions

Based on the obtained results, the following conclusions can be drawn: statistically significant univariate between group differences among senior and cadet volleyball players are determined in the anthropometric measures: diameter of the ankle, wrist, skin dowel on the upper arm, skin dowel on the forearm, skin dowel on triceps, hamstrings, calf hamstrings, and fat tissue skin suprailiac. Statistically significant univariate between-group differences in variables for assessment of body composition among senior and cadet volleyball players determined in: percentage of adipose tissue fat mass in kg. Statistically significant differences between senior and cadet volleyball players have been determinedand in the Endomorphic and Mesomorphic somatotype components.

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