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# Anthropometric and Kinanthropometric Distinctive Profile of a Sedentary Population Compared with an Amateur Athlete Population

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**Abstract:** Anthropometry and kinanthropometry are sciences that measure variations in the physical dimensions and composition of the human body. There are studies that analyze these parameters individually, but we believe that it is much better to analyze them globally. We realized a multivariate analysis, to determine which variables could explain the profiles of the subjects depending on sex, lifestyle, and type of sports modality. We analyzed 25 variables in a population of 574 people aged between 18 and 42 years. A multivariate statistical analysis was performed using exploratory factor analysis, and then we obtained five differentiating variables: fat mass, muscle mass, bone mass, skinfolds, and robustness. We classified the population into sedentary lifestyle, amateur athletes with predominance of the upper and lower train, and amateur athletes with predominance mainly of the lower train, in an attempt to analyze the existence of statistical significance between them. Amateur athletes with a predominance of the upper and lower train have a higher Body Mass Index and a lower Relative Index of the Lower Limbs, in addition to greater muscle mass and robustness than those athletes with a predominance mainly of the lower train. The sedentary control group presented higher values in terms of skinfolds and fat mass. This work could help people to choose the best sport according to their morphotype, and also could be used to plan sports training to potentiate different body regions, injury recovery, selection of talented athletes, etc.

**Keywords:** anthropometry; kinanthropometry; multivariate analysis; lower train; upper train; fat mass; muscle mass; bone mass; skinfolds; robustness

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## 1. Introduction

Sedentary lifestyle is often related to poor physical–emotional health [1], while there is no doubt that regular exercise favors physical [2] and emotional [3] health and it can help prevent all kind of diseases. The evidence is overwhelming with risk reductions of at least 20–30% for more than 25 chronic medical conditions and premature mortality [4].

The International Society for the Advancement of Kinanthropometry (ISAK) is the entity concerned with the measurement of human body composition. The methodology proposed by ISAK for the collection and analysis of anthropometric and kinanthropometric values [5] is the most widely used today. Each person has morphological characteristics that define them, which can be beneficial to practice a certain sport or another. That is why, in the recent years there has been an increase in scientific studies focusing on professional athletes [6] or specific sports [7].

We hardly find papers that compare athletes of one sport with another [8] and there is even less literature that compares sports where practitioners use the upper and lower body with practitioners who mainly use the lower body [9]. In general, all these papers completed an univariable analysis [6–9], which could not explain or define the existence of possible differentiating profiles in amateur athletes that use the upper and lower body [6–9], to perform a specific sport versus those who mainly use the lower body [9–13]. We believe that it would be interesting to establish a profile to advise each person what sport suits their morphological conditions better.

There are studies that relate, for example, height with sports performance (for example, in basketball or handball [14]), but we intend to go further. We look to define a complete profile considering more morphological aspects.

The Exploratory Factor Analysis (EFA) [15] and Principal Components Analysis (PCA), also known as Varimax rotation, could be an efficient and precise method to use to conduct a multivariate analysis [16] to find out the differences between population groups and establish if they have differentiating profiles.

Obtaining this individualized profile can be useful for multiple tasks, such as establishing personal training plans, injury prevention, recruiting young sports talent, etc. Our objective in this work is trying to demonstrate that the regular practice of physical exercise favors the improvement of the anthropometric and kinanthropometric profile of a person, which can be beneficial for their health.

## 2. Materials and Methods

### *2.1. Legal Documents*

The sample of our study was obtained voluntarily through classes or advertisement in different kind of sports centers in Malaga and in the University Podiatry Clinic facilities of the University of Extremadura, which are both located in Spain. We received the approval of The Bioethics Committee of the University of Extremadura before we started our investigation (reference 169/2019). All the participants were informed of the procedure and had to sign the corresponding informed consent form before taking the measurements.

### *2.2. Inclusion Criteria*

All participants had no pathologies and a similar diet (Mediterranean diet without supplements). The inclusion criteria for a subject to be classified as amateur athlete were the same as what Piercy used [17]. In other words, people should perform at least 150 min of moderate-intensity aerobic exercise and/or 90 min of high-intensity aerobic exercise per week. When these considerations were not met, we classified people as sedentary. In addition, people we measure should not suffer from any injury or pathology and should not take any type of food supplement.

The criteria for the selection of the participants are included in the flow chart of Figure 1.

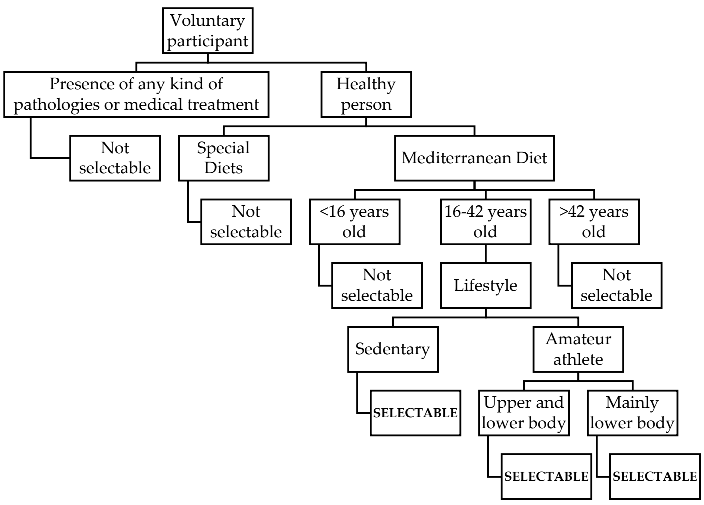


**Figure 1.** Flow chart showing the selection of participants.

### 2.3. Exclusion Criteria

All participants that had any pathologies, metabolism diseases, non-Mediterranean diet, alimentary supplements, thyroid disease, inborn errors of metabolism, chronic drug use of steroids, smoking, and/or alcohol use were discarded from the study.

### 2.4. Study Sample

We analyzed 574 individuals between 16 and 42 years. The sample was divided into groups based on their physical activity.

Sedentary = people that did not practice any sport. We found 73 participants, 24 were men and 49 women, with an average age of 23.96 ± 4.08 years.

Amateur athletes = people that practice sport regularly (according to inclusion criteria). We found 501 participants, 336 were men and 165 women, with an average age of 25.17 ± 4.69 years. Additionally, we divided this group into another two based on whether they support any weight or resistance in the up extremity:

- Upper and lower body = The sports observed in this group were as follows: airsoft, basketball, handball, canoeing, capoeira, cross fit, American football, gym, swimming, rugby, and volleyball. This group comprised 307 people, 200 were men and 107 women, with an average age of 24.10 ± 4.25 years.
- Mainly lower body = The sports observed in this group were as follows: walking, cycling, football, and running. Our principal criteria to classify that the sports in this category was that players did not support weights and resistance in the up extremity unlike players in upper and lower body sports. This group comprised 193 people, 135 were men and 58 women, with an average age of 26.83 ± 4.87 years.

All the categories of studied subjects are included Table 1.

**Table 1.** Categories of subjects studied according to sex.

| | Total | Male | Female |
|---|---|---|---|
| Football | 12.0% (69) | 14.4% (52) | 7.9% (17) |
| Walking | 11.1% (64) | 8.9% (32) | 15.0% (32) |
| Basketball | 9.2% (53) | 7.5% (27) | 12.1% (26) |
| Crossfit | 8.5% (49) | 10.6% (38) | 5.1% (11) |
| Running | 8.5% (49) | 11.1% (40) | 4.2% (9) |
| Handball | 8.4% (49) | 7.2% (26) | 10.3% 22) |
| Volleyball | 7.0% (40) | 4.4% (16) | 11.2% (24) |
| Gym | 5.4% (31) | 4.4% (16) | 7.0% (15) |
| Airsoft | 3.1% (18) | 5.0% (18) | 0.0% (0) |
| Rugby | 4.4% (25) | 6.9% (25) | 0.0% (0) |
| Canoe | 3.0% (17) | 4.4% (16) | 0.5% (1) |
| American football | 2.6% (15) | 4.2% (15) | 0.0% (0) |
| Cycling | 2.1% (12) | 3.3% (12) | 0.0% (0) |
| Swimming | 1.0% (6) | 0.0% (0) | 2.8% (6) |
| Capoeria | 0.9% (5) | 0.8% (3) | 0.9% (2) |
| Sedentary lifestyle | 12.7% (73) | 6.7% (24) | 22.9% (49) |
| | 574 (100%) | 360 (100%) | 214 (100%) |

### 2.5. Study Variables

Following the ISAK considerations and protocols [5], we decided to measure the following: weight (kg), height (cm) in standing and sitting position, armspan (cm), perimeter (cm) of the contracted arm, waist, hip, thigh, and calf, size (cm) of styloid diameter of the wrist and bicondylar of the femur, and the fold (mm) of biceps, triceps, male pectoral, subscapular, abdominal, suprailiac, thigh, and calf. With all these measures we calculated the following [18–20]:

$$\text{Body Mass Index (BMI)} = \frac{\text{weight}}{\text{height}^2}$$

$$\text{Ponderal Index (PI)} = \frac{\text{height}}{\sqrt[3]{\text{weight}}} \cdot 100$$

$$\text{Cormic Index (CI)} = \frac{\text{sitting height}}{\text{standing height}} \cdot 100$$

$$\text{Relative Index of Lower Limbs (RILL)} = \frac{\text{stanging height} - \text{sitting height}}{\text{sitting height}} \cdot 100$$

$$\text{Body Density Index in men (BDI)} = \frac{4.95}{1.10938 - (0.0008267 \cdot \sum \text{pectoral, abdominal and thigh fold}) \pm (0.0000016 \cdot \sum \text{pectoral, abdominal and thigh fold})^2 - (0.0002574 \cdot \text{Age})} - 4.5$$

$$\text{Body Density Index in women (BDI)} = \frac{4.95}{1.0994921 - (0.0009929 \cdot \sum \text{triceps, suprailiac and thigh fold}) \pm (0.0000016 \cdot \text{tricpes, suprailiac and thigh fold})^2 - (00.0001392 \cdot \text{Age})} - 4.5$$

$$\text{Fat percentage (F\%)} = \sum_{(\text{triceps fold, subescapular fold, suprailiaca fold, abdominal fold})} \cdot 0.153 \pm 5.783$$

$$\text{Muscle percentage in men (M\%)} = \frac{\text{stanging height}}{100} \cdot (0.00744 \cdot \left(\text{arm perimeter} - \pi \frac{\text{biceps fold}}{10}\right)^2 \pm (0.000888 \cdot \left(\text{thigh perimeter} - \pi \frac{\text{thigh fold}}{10}\right)^2 \pm \left(0.00447 \cdot \left(\text{calf perimeter} - \pi \frac{\text{calf fold}}{10}\right)^2\right) \pm 2.4 - (0.0048 \cdot \text{Age}) \pm \text{Ethnicity} \pm 7.8$$

$$\text{Muscle percentage in women (M\%)} = \frac{\text{stanging height}}{100} \cdot (0.00744 \cdot \left(\text{arm perimeter} - \pi \frac{\text{biceps fold}}{10}\right)^2 \pm (0.000888 \cdot \left(\text{thigh perimeter} - \pi \frac{\text{thigh fold}}{10}\right)^2 \pm \left(0.00447 \cdot \left(\text{calf perimeter} - \pi \frac{\text{calf fold}}{10}\right)^2\right) \pm 0.048 - (0.0048 \cdot \text{Age}) \pm \text{Ethnicity} \pm 7.8$$

$$\text{Bone tissue percentage (\%B)} = \frac{3.02 \cdot (\text{Height}^2 \cdot \text{wrist diameter} * \text{bicondylar of the femur diameter} \cdot 400)^{0.712}}{100}$$

$$\text{Residual percentage in men (R\%)} = \frac{\text{Weight} * 24.1}{100}$$

$$\text{Residual percentage in women (R\%)} = \frac{\text{Weight} * 20,9}{100}$$

We would like to highlight that the pectoral fold was only analyzed in men, not in women, because we did not want to create any uncomfortable situation and it was not necessary for our study. The way we obtain this variable was drawing a horizontal line between the right anterior axillary line and the right nipple. The intermediate point of this line was where the fold value was obtained [5].

### 2.6. Methodology

Following the ISAK considerations [5], each measurement was performed three times to minimize a possible measurement mistake, always using instruments that are homologated: electronic scale (model SECA704®), height rod (model SECA 213®), tape measure (model Premax 19394®), and digital caliper (Cescorf®) with steel tape measure.

### 2.7. Statistical Analysis

We used the IBM-SPSS Statistics 25.0® software, with a confidence interval of 5% ($p < 0.05$) and a high level of significance with 1% ($p < 0.001$). We realized an Exploratory Factor Analysis (EFA) to find underlying factors that are common in empirically measured variables. Previously, the KMO and Bartlett tests were used to ensure compliance with the conditions that allowed the use of EFA [18]. The ANOVA test of 1 factor was also carried out in a univariate and multivariate way to study the significance of the differences between the measurements of the numerical variables together with a Discriminant Analysis as a multivariate method to study the differences between the different groups of sports. We also used the Principal Components Analysis (PCA) method, which is known as Varimax rotation [19], because we wanted to associate each variable to, at most, one factor. Additionally, we calculated the size of the effect on the Cohen's d scale to know the magnitude of the changes observed in the measured variables, which are expressed as R2 on a 0–1 scale, but, when we expressed it, we conveyed it as a percentage of variance. Therefore, the following factors were differentiated:

F-Fat mass: composed of various skinfolds (abdominal, suprailiac, subscapular, triceps, and pectoral), mass fat, and Body Density Index, as they all relate to the body's fat tissue.

F-Muscle mass: composed of various circumferences (arm, hip, waist, thigh, and calf), total mass, muscle mass, residual mass, and Body Mass Index, as they all relate to the body's muscle tissue.

F-Bone mass: composed of several diameters (bicondylar of the femur and bistyloid of the wrist) in addition to the percentage of bone tissue, as they all relate to the bone tissue of the organism.

F-Skinfolds: composed of several skinfolds, namely, the thigh, calf, and biceps.

F-Robustness: composed of several measurements, namely, standing height, sitting height, and armspan.

In all multivariate procedures, only one missing data item excludes the subject from the analysis. That is why, in our research, we went from a total sample of 574 participants to one of 375, which divided groups based on their physical activity:

- Sedentary = composed of 24 individuals of the 73 initial participants.
- Amateur athletes = composed of 351 individuals of the 501 initial participants. Additionally, we divided this group into another two based on which body area they use:
  - Upper and lower body = composed of 135 individuals of the 194 initial participants.
  - Mainly lower body = composed of 216 individuals of the 307 initial participants.

## 3. Results

### *3.1. Variable Reduction*

We grouped the twenty-five anthropometric kinanthropometric variables five 5 factors that contained all of them (Table 2):

F-Fat mass: It reflected 21.7% of explained variability.

F-Muscle mass: It reflected 20.5% of explained variability.

F-Bone mass: It reflected 12.6% of explained variability.

F-Skinfolds: It reflected 11.9% of explained variability.

F-Robustness: It reflected 11.9% of explained variability.

The results obtained through the EFA validate the use of these five factors instead of the twenty-five anthropometric and kinanthropometric variables, as these imply 78.6% of all the variables. From the assignment of coefficients, we also calculated the factorial and standardized scores of the participants in our sample (Table 3).

**Table 2.** Exploratory Factor Analysis. Grouping of empirical variables into common dimensional factors using Varimax rotation.

| | | Factors | | | | |
|---|---|---|---|---|---|---|
| Variable | Communality | Fat Mass | Muscle Mass | Bone Mass | Skinfolds | Robustness |
| Abdominal fold | 0.854 | 0.894 | - | - | - | - |
| Suprailiac fold | 0.814 | 0.883 | - | - | - | - |
| Subscapular fold | 0.764 | 0.826 | - | - | - | - |
| Triceps fold | 0.609 | 0.743 | - | - | - | - |
| Pectoral fold | 0.626 | 0.747 | - | - | - | - |
| Fat mass | 0.975 | 0.792 | - | - | - | - |
| Body Density Index | 0.889 | 0.684 | - | - | - | - |
| Muscular mass | 0.970 | - | 0.911 | - | - | - |
| Weight | 0.987 | - | 0.730 | - | - | - |
| Residual mass | 0.960 | - | 0.716 | - | - | - |
| Body Mass Index | 0.954 | - | 0.761 | - | - | - |
| Arm circumference | 0.838 | - | 0.867 | - | - | - |
| Hip circumference | 0.727 | - | 0.662 | - | - | - |
| Waist circumference | 0.651 | - | 0.597 | - | - | - |
| Thigh circumference | 0.627 | - | 0.553 | - | - | - |
| Calf circumference | 0.570 | - | 0.547 | - | - | - |
| Bone mass | 0.985 | - | - | 0.858 | - | - |
| Bistyloid of the wrist diameter | 0.664 | - | - | 0.800 | - | - |
| Bicondylar of the femur diameter | 0.709 | - | - | 0.776 | - | - |
| Tight fold | 0.810 | - | - | - | 0.874 | - |
| Calf fold | 0.748 | - | - | - | 0.805 | - |
| Biceps fold | 0.501 | - | - | - | 0.586 | - |
| Standing height | 0.919 | - | - | - | - | 0.914 |
| Armspan | 0.850 | - | - | - | - | 0.874 |
| Sitting height | 0.647 | - | - | - | - | 0.771 |
| % Explained variance | - | 21.7% | 20.5% | 12.6% | 11.9% | 11.9% |
| % Accumulated | - | 21.7% | 42.2% | 54.8% | 66.7% | 78.6% |

**Table 3.** Exploratory Factor Analysis. Coefficients of the empirical variables in each factor, which are used to generate the standardized factor scores.

| | Factors | | | | |
|---|---|---|---|---|---|
| **Variable** | **F-Fat Mass** | **F-Muscle Mass** | **F-Bone Mass** | **F-Skinfolds** | **F-Robustness** |
| Abdominal fold | **0.23** | −0.03 | −0.04 | −0.09 | −0.02 |
| Suprailiac fold | **0.24** | −0.07 | −0.02 | −0.11 | 0.04 |
| Subscapular fold | **0.19** | −0.02 | −0.05 | −0.05 | −0.01 |
| Triceps fold | **0.18** | −0.04 | −0.01 | −0.06 | 0.00 |
| Pectoral fold | **0.15** | −0.12 | −0.07 | 0.11 | 0.15 |
| Fat mass | **0.16** | 0.02 | 0.02 | −0.07 | 0.00 |
| Body Density Index | 0.10 | −0.06 | −0.07 | 0.19 | 0.03 |
| Muscular mass | −0.08 | **0.27** | −0.15 | −0.01 | 0.04 |
| Weight | 0.02 | **0.10** | 0.06 | −0.05 | 0.04 |
| Residual mass | 0.01 | **0.10** | 0.06 | −0.03 | 0.05 |
| Body Mass Index | 0.01 | **0.18** | 0.09 | −0.06 | −0.18 |
| Arm circumference | −0.05 | **0.27** | −0.22 | 0.03 | 0.04 |
| Hip circumference | 0.00 | **0.13** | 0.04 | 0.00 | −0.06 |
| Waist circumference | 0.08 | **0.12** | 0.00 | −0.10 | −0.07 |
| Thigh circumference | −0.12 | **0.13** | 0.02 | 0.19 | −0.04 |
| Calf circumference | −0.11 | **0.14** | −0.01 | 0.18 | −0.06 |
| Bone mass | −0.03 | −0.10 | **0.35** | −0.04 | 0.06 |
| Bistyloid of the wrist diameter | −0.03 | −0.08 | **0.36** | −0.04 | −0.08 |
| Bicondylar of the femur diameter | −0.04 | −0.07 | **0.37** | −0.05 | −0.08 |
| Tight fold | −0.11 | −0.01 | 0–03 | **0.39** | 0.00 |
| Calf fold | −0.08 | 0.02 | −0.04 | **0.34** | 0.01 |
| Biceps fold | 0.03 | −0.03 | −0.11 | **0.23** | 0.09 |
| Standing height | 0.02 | −0.08 | −0.02 | 0.01 | **0.36** |
| Armspan | 0.00 | −0.09 | 0.01 | 0.04 | **0.34** |
| Sitting height | 0.02 | −0.01 | −0.16 | 0.05 | **0.33** |

### 3.2. *Relationship of Explanatory Variables Based on Lifestyle and Type of Sport Practiced*

Using the univariate ANOVA test, we analyzed if there were statistically significant differences based on lifestyle and the type of sport practiced (Table 4):

**Table 4.** M-ANOVA test. Differences in the factors and explanatory variables between the groups established according to the type of sport and depending on the training used.

| | **Upper and Lower Body** | | **Mainly Lower Body** | | **Sedentary** | | **M-ANOVA Test** | | |
|---|---|---|---|---|---|---|---|---|---|
| | **N** | **M and SD** | **N** | **M and SD** | **N** | **M and SD** | **F** | ***p*-Value** | **$R^2$** |
| F-Fat mass | 135 | −0.02 ± 1.01 | 216 | −0.04 ± 1.00 | 24 | 0.48 ± 0.87 | 2.97 | 0.053 | 0.016 |
| F-Muscle mass | 135 | −0.37 ± 0.82 | 216 | 0.26 ± 1.03 | 24 | −0.28 ± 0.88 | 19.36 | <0.001 * | 0.094 |
| F-Bone mass | 135 | −0.04 ± 0.89 | 216 | 0.01 ± 1.09 | 24 | 0.16 ± 0.73 | 0.46 | 0.629 | 0.002 |
| F-Skinfolds | 135 | −0.01 ± 0.97 | 216 | −0.05 ± 1.03 | 24 | 0.51 ± 0.73 | 3.44 | 0.033 * | 0.021 |
| F-Robustness | 135 | −0.22 ± 0.86 | 216 | 0.14 ± 1.07 | 24 | −0.02 ± 0.88 | 5.35 | 0.005 * | 0.028 |
| Cormic Index | 194 | 51.53 ± 2.37 | 307 | 52.48 ± 2.12 | 73 | 52.4 ± 2.82 | 11.05 | <0.001 * | 0.037 |
| Relative Index of the Lower Limbs | 194 | 94.52 ± 9.65 | 307 | 90.88 ± 8.15 | 73 | 91.0 ± 11.04 | 10.12 | <0.001 * | 0.034 |

N = sample size; M = arithmetic mean; and SD = standard deviation. * = significant.

Fat mass: The statistical significance ($p < 0.10$) had a small effect (1.6%). Using Tukey's post hoc test, a statistical significance was detected ($p < 0.05$), which reflected a higher value in the control group compared to the rest of the groups.

Muscle mass: Highly significant differences were observed ($p < 0.001$) with a moderate–high effect size (9.4%). Using Tukey's post hoc test, it was detected that the upper and lower body group ($p < 0.01$) presented higher values than the rest of the groups. Furthermore, no differences were observed between the control group and the group that mainly used the lower body ($p > 0.05$).

Bone mass: No statistically significant results were observed when comparing the groups with each other ($p > 0.05$), despite the mean values being generally higher among people in the control group.

Skinfolds: Statistically significant differences were observed ($p < 0.05$) with a slight effect size (2.1%). Using Tukey's post hoc test, it was detected that the control group presented the highest values in the population, being statistically significant when compared with the upper and lower body group ($p < 0.05$) and the group that mainly used the lower body ($p < 0.05$). No statistically significant differences were observed between these last two groups ($p > 0.05$). It should be noted that this analysis could not be carried out based on sex, since the pectoral fold was not collected in women, so they were discarded when doing the analysis.

Robustness: Statistically significant differences were observed ($p < 0.01$) with a moderate–mild effect size (2.8%). Using Tukey's post hoc test, it was detected that those in the upper and lower body group had values above the average, while those in the control group and the group that mainly used the lower body had values below the average ($p < 0.05$). It should be noted that the members of this last group presented a certain tendency toward statistical significance ($p < 0.10$), which reflects that they would tend to be less corpulent than the rest of the population.

Cormic Index: Highly significant statistical differences were observed ($p < 0.001$) with a moderate–mild effect size (3.7%). Using Tukey's post hoc test, it was detected that the subjects in the group that mainly used the lower body had lower values ($p < 0.01$) than the rest of the individuals in the upper and lower body group and in the group control. While between these last two groups no differences were observed between them ($p > 0.05$).

Lower Relative Index of the Lower Limbs: Highly significant statistical differences were observed ($p < 0.001$) with a moderate–mild effect size (3.4%), with the lower body group being the one that differs from the other two (in this case with a higher index to be inverse to the Cormic Index).

The existence of highly significant global differences ($p < 0.001$) between groups was proven through the results of the Multivariate Analysis of Variance test (M-ANOVA), since the joint effect of the linear combination of all the variables when behaving differently in the groups is moderate–high (9.7%) (Table 4).

To confirm the veracity of the profiles detected, we performed a Discriminant Analysis to find out which variables are most associated with each of the three groups studied. We tried to minimize the errors that could be made when we classified the subjects into one of these three categories.

The variables that we considered are muscle mass, robustness, and the Cormic Index, since all of them present a high statistical significance ($p < 0.001$). Other ones, such as fat mass and skinfolds were excluded in this model, because their discriminatory capacities to ($p > 0.05$) are not enough (Table 5).

**Table 5.** Stepwise Discriminant Analysis. Variables included and excluded from the discriminant function. Standardized coefficients and classification coefficients (N = 375). * = significant.

| Included | Λ Wilks | F Exact | *p*-Value | Standardized Coefficients Functions | | Classification Function Coefficients | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 1 ($p < 0.001$) | 2 ($p > 0.05$) | Mainly Lower Body | Upper and Lower Body | Sedentary |
| F-Muscular mass | 0.91 | 19.36 | <0.001 * | 0.767 | 0.002 | −2.13 | −1.45 | −2.04 |
| Cormic Index | 0.87 | 13.26 | <0.001 * | 0.540 | 0.221 | 8.90 | 9.06 | 8.98 |
| F-Robustness | 0.85 | 10.30 | <0.001 * | 0.394 | 0.194 | −3.10 | −2.75 | −2.92 |

The efficiency of this model to classify people can be evaluated by comparing the predicted group of each individual with their finally assigned group, thus establishing the percentage of success. In this case, 245 of the 375 people were correctly cataloged, which represents a 65.3% correctness, which is practically two-thirds of the population.

The degree of partial efficacy is much higher within the upper and lower body group, since 184 of the 216 members were correctly catalogued, which represents 85.2%, while in the mainly lower body group, it was 61 of 135, which represents 45.2%. In the case of the members of the control group, 16 were classified within the category of upper and lower body and 8 in the category of mainly lower body, which represents 66.7% and 33.3%, respectively (Figure 2).

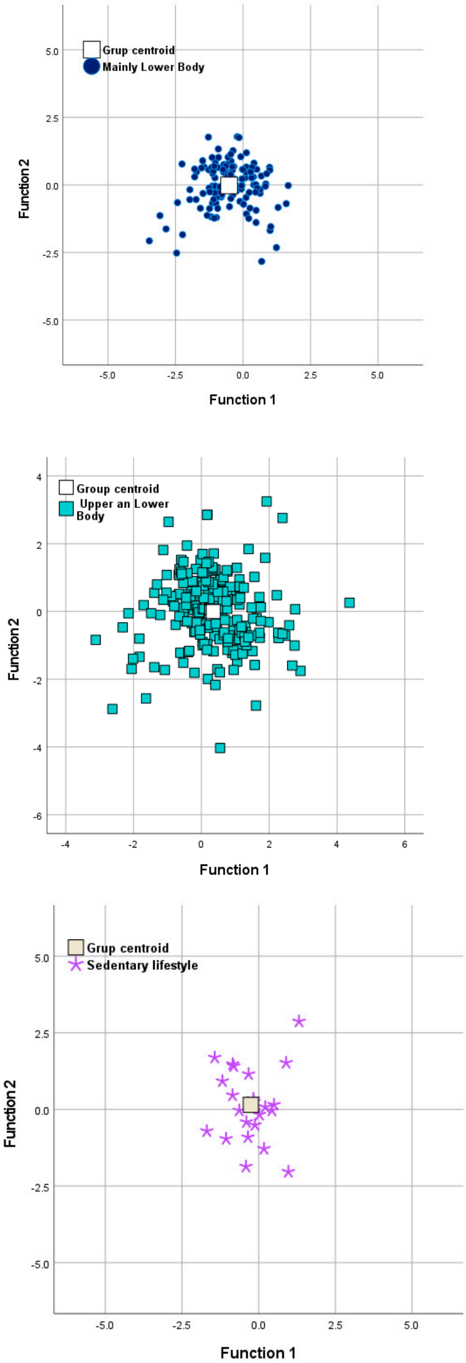


**Figure 2.** Separate group graphs. Variability of the subjects with respect to the centroid of the group.

Although technically they were erroneously classified in all cases, since the sedentary individuals were not amateur athletes, it is true that if they had been amateur athletes, they would have been classified that way (Figure 2).

We can appreciate how the variability of the cases of the upper and lower body group is much higher than in the other groups. Most of the cases are located to the right of the central axis of the discriminant function, while those that mainly use lower body tend to be rather to the left of the same axis (Figure 3).

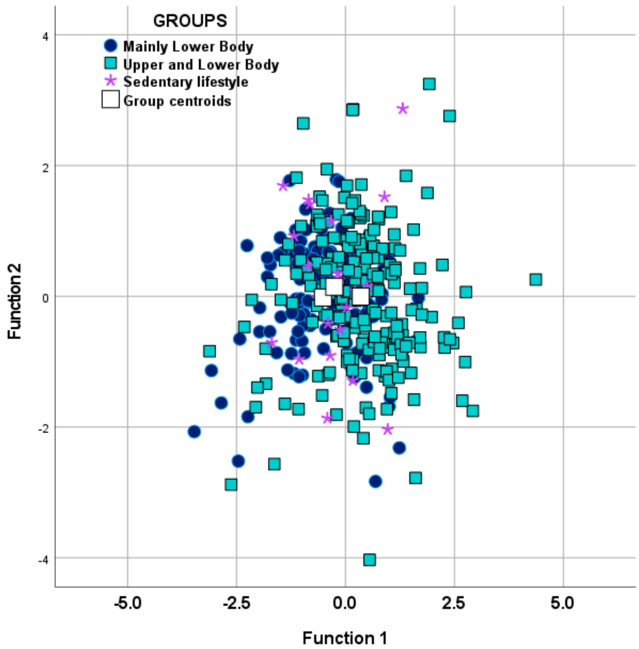


**Figure 3.** Scatter plot of all groups.

### 3.3. Relationship of Explanatory Variables According to the Practiced Sport

Analyzing the five EFA factors in each of the sports disciplines, we observed no statistically significant differences in American football, gym, capoeira, and swimming, but we have observed them in Table 6.

**Table 6.** Comparative analysis: ANOVA repeated measures. Differences in the factors and explanatory variables between each sport modality.

| Sport | N | F-Fat Mass | F-MuscleMass | F-Bone Mass | F-Skinfolds | F-Robustness | ANOVA Repeated Measures | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | F | *p*-Value | $R^2$ |
| Airsoft | 18 | −0.53 | 0.65 | −0.15 | 0.74 | 0.09 | 4.48 ** | 0.003 * | 0.208 |
| Basketball | 27 | 0.52 | −0.09 | 0.57 | −0.35 | 0.65 | 6.08 ** | <0.001 ** | 0.190 |
| Handball | 33 | 0.06 | 0.04 | −0.07 | −0.35 | 0.76 | 5.92 ** | <0.001 ** | 0.156 |
| Walking | 32 | 1.16 | 0.06 | −0.56 | 0.14 | −0.45 | 16.56 ** | <0.001 ** | 0.348 |
| Canoe | 17 | −0.76 | 0.77 | 0.17 | −0.72 | −0.25 | 10.20 ** | <0.001 ** | 0.389 |
| Cycling | 11 | −0.69 | −0.96 | 0.01 | 0.03 | −0.13 | 7.00 ** | <0.001** | 0.412 |
| Football | 52 | −0.44 | −0.20 | 0.05 | −0.31 | 0.02 | 2.96 * | 0.021 * | 0.055 |
| American football | 15 | 0.65 | 0.37 | 0.87 | 1.40 | 0.06 | 1.97 NS | 0.111 | 0.123 |
| Gym | 16 | −0.07 | −0.04 | −0.27 | −0.11 | 0.03 | 0.34 NS | 0.848 | 0.022 |
| Rugby | 24 | 0.34 | −0.15 | 0.26 | 1.16 | 0.55 | 6.05 ** | <0.001 ** | 0.208 |
| Running | 40 | −0.23 | −0.77 | 0.22 | 0.25 | −0.37 | 12.12 ** | <0.001 ** | 0.237 |
| Volleyball | 16 | 0.30 | −0.31 | −0.51 | −0.94 | 0.02 | 7.44 ** | <0.001 ** | 0.332 |
| Sedentary lifestyle | 24 | 0.49 | −0.27 | 0.13 | 0.60 | −0.10 | 5.97 ** | <0.001 ** | 0.206 |

NS = not significant; * = significant; and ** = highly significant.

The results showed that the sedentary group has high values in fat mass and skinfolds ($p < 0.020$ and a large effect of 20.6%). Among the sports, those with high values in fat mass were as follows: walking, which also had with low values in bone mass and robustness ($p < 0.001$ and a very large effect of 34.8%); rugby, which had high values in fat mass, skinfolds, and robustness. ($p < 0.001$ and a large effect of 20.8%); volleyball, which also had low values in muscle mass, in addition to bone mass and skinfolds ($p < 0.001$ and a very large effect of 33.2%); and basketball, which showed high values in fat mass, bone mass, and robustness and low values in fat mass ($p < 0.001$ and a large effect of 19%).

On the other hand, football had low values in fat mass and skinfolds ($p < 0.030$ and a moderate effect of 5.5%) and cycling also had low values in fat mass and muscle mass ($p < 0.001$ and very large effect of 41.2%).

Airsoft had high values in muscle mass and skinfolds and low values in fat mass ($p < 0.01$ and a large effect of 20.8%). Canoe showed high values in muscle mass and low values in fat mass and skinfolds ($p < 0.001$ and a very large effect of 38.9%).

CrossFit also showed high values in muscle mass and low values in fat mass, bone mass, skinfolds, and robustness. ($p < 0.001$ and a very large effect of 30.1%).

The sports that showed differences in robustness were running, which had low values in muscle mass and robustness. ($p < 0.001$ and a large effect of 23.7%) and handball, which had high values in robustness and low values in skinfolds ($p < 0.001$ and a large effect of 15.6%).

## 4. Discussion

Due to the large number of variables studied, we tried to simplify the interpretation of the results to obtain a differentiating profile. We have chosen those that were correlated with each other. Thanks to the EFA [15] and the Varimax rotation [16], we went from twenty-five variables to only five: F-Fat mass, F-Muscle mass, F-Bone mass, F-Skinfolds, and F-Robustness. As usually happens in multivariate procedures, the initial sample was reduced from 574 to 375 people, because the lack of a single piece of datum in one of the variables means that the results of that person cannot be counted.

The population that we have analyzed is made up of young people with sedentary behavior and amateur athletes who are not professionals, which allows us to assess the differences in body measurements between these groups.

Some sports are difficult to classify, for example, football. We decided to classify it as a sport that mainly uses the lower extremity because, ignoring the goalkeeper, in the rest of the positions the upper extremities are not used. Obviously, they are important, but you tend to mainly develop the lower extremities.

After performing the univariate ANOVA, we observed that sedentary people tend to present higher values in the variables related to fat and lower values in terms of skinfolds. These results support the ideas of many authors that the regular practice of physical exercise, regardless of the sports modality chosen, favors the general health of an individual [1–3]. As Campa [7] and Masanovic [8] found, we observed that people who practice sports that use the upper and lower body tend to present higher values in the factors of muscle mass and robustness. The difference between our research and that of our colleagues was that in our case, the sample was made up of amateur level athletes, while in theirs, the population was composed of athletes at the federation and even professional level. However, we observed the same thing, and that is that the regular practice of physical exercise favors values related to muscle mass and robustness, regardless of whether the person who practices it does so recreationally or for competitive purposes.

Other authors, such as Acero [21], observed that athletes who practice sports in which the lower body is mainly used tend to have a lower Cormic Index and a higher Relative Index of the Lower Limbs than those who use the upper and lower body. We observed the same thing, but again, with the caveat that in our case, the population that we analyzed was not professional.

Based on our results, we can affirm that there are differences between the morphotypes of athletes depending on the type of sport that they perform on a regular basis, always for recreational purposes.

The previous studies that we have been able to review usually analyze the anthropometric characteristics of an individual separately [9,22,23], while in our case, we analyze them all together. This could be the starting point for future research and may also be useful for recruiting sports talent at an early age. In this way, we could try to recognize possible future elite athletes earlier, to enhance their own anthropometric characteristics and make them achieve their highest sports performance quickly and continuously over time [24–27]. Although this hypothesis can be very controversial, regardless of whether an individual has good aptitudes to perform a certain sport, if they do not have the correct attitude, it is very likely that they will never be able to develop their full potential. Obtaining the morphological profiles of the different study groups could be useful for anyone who wants to start practicing sports, since this allows us to have an overview of the common characteristics of athletes who perform different disciplines and even of people who do not exercise.

## 5. Conclusions

The existence of five factors that encompass the twenty-five variables that were initially analyzed has been determined, although of those five, only three of them were highlighted as discriminatory: muscle mass, robustness, and Cormic Index.

The profile of sedentary people reflected higher values in terms of fat mass, bone mass, and skinfolds.

The profile of amateur athletes who use the upper and lower body showed that they presented the highest values in terms of muscle mass and robustness.

The profile of amateur athletes who mainly use the lower body showed that the robustness values were below average and that there was a tendency toward statistical significance. In addition, they presented lower values in the Cormic Index and higher values in terms of the Relative Index of the Lower Limbs.

## 6. Strengths and Limitations of Study

Our study is focused on a young population (18–42 years) that is made up of people with a sedentary lifestyle and people with an active lifestyle. Other research has focused on elite athletes, while our research focuses on a broader spectrum of society. By obtaining these profiles, we can help all these people lead a healthier lifestyle.

It would have been interesting to incorporate sex as another factor in these models, but in our study, we chose not to measure the pectoral fold since, in several cases, the women refused to partake it because it was too invasive (in fact, ISAK has withdrawn it from the profiles required for the different levels of accreditation). To avoid uncomfortable situations or data collection being incomplete due to the abandonment of the participants, we chose not to measure the pectoral fold in women. As this measurement was not collected, it was not possible to have the data of said person for the EFA. It would have been interesting to incorporate sex as a factor in these models, but the absence of the measurement of this fold prevented it. This may be a limitation of this work. Although it should be noted that by performing the analysis of the variables only by sex, it has allowed us to intuit that it is not determinant; even so, we consider that it would be convenient to measure it in other future studies.

As a result of these limitations, the choice of the population for the study is considered acceptable in this case, but it is not random. Our results can be considered of great interest as they are so indicative. In addition, another limitation was that we did not pick up the pectoral skinfold to avoid possible uncomfortable situations. This can be considered a limiting factor in a multivariate study, although our results show that gender does not really influence the results.

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