Kineanthropometric study of male athletes according to track speciality

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Summary

The aim of the present work was to conduct an anthropometric study of amateur male athletes and compare the results with those obtained in a group of the same sex and age and with those published in the literature concerning professional athletes and athletes involved in other sports. A further aim was to see whether there is a given anthropometric pattern as a function of the athletic speciality involved.

Sixty male athletes belonging to the Sports Association of the University of Salamanca (ADUS) and participating in national and, occasionally, international competitions in the specialities of long, —medium— and short-distance running ("athlete" group) were studied. The following anthropometric measurements were taken from all those included: height, weight, six skin folds (triceps, subscapular, supraspinal, abdominal, anterior thigh and medial of leg) and two diameters (bistyloid and bicondyloid) and the percentage of fat (Carter) and body composition (four components). As controls, the same number of students from the Physiotherapy School of the Nursing and Physiotherapy School of the University of Salamanca ("student" group) were studied, obtaining the same anthropometric measurements on these as in the previous group.

The results pointed to significant differences in weight, height and the body mass index between the students (70.7±3.26 Kg; 174.9±3.3 cm, 23.2±0.94 Kg/m^2, respectively) and the athletes (64.4±6.06 Kg; 171.9±10.7 cm; 21.5±2.22 Kg/m^2, respectively). The same was the case for all the values of the fat folds. Analysis of body composition revealed similar values for the bone (11.21±0.89 in athletes; 11.25±0.5 Kg in students) and muscle compartments (32.81±3.09 Kg in athletes; 34.58±1.58 Kg in students), while fat weight and residual weight were greater in the students (4.81±1.21 Kg; 15.52±1.48 Kg in athletes, respectively, and 7.833± 1.11 Kg and 17.03±0.79 Kg in students).

Upon analysing the group of athletes as a function of the speciality involved, the short-distance (henceforth "fast") runners were found to be taller and heavier, their values for weight being significantly different from those of the other two groups (medium- and long distance). Concerning the fat fold values, differences were seen for the triceps and abdominal folds between the fast and long-distance runners. Body composition was found to have higher values for fat and residual weight in the case of the fast runners together with greater muscular weight, with significant differences between the fast and long-distance runners.

Key Words: Anthropometry – Athletics – Body composition

Introduction

Although it has received considerable criticism by some, who consider it an invalid method, kineanthropometry is for others a method that provides useful, reliable and reproducible information that permits assessment of the differences in size and body form that occur as a result of physical activity and nutrition. The validity of kineanthropometry only appears when investigations follow certain recommendations as

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regards data collection and analysis (Weiner and Lourie, 1969).

The existence of a kineanthropometric pattern seems to be clearly documented in individual sports in which the ideal body, with respect to size and form, is expressed as a characteristic of each modality, although this is not a sufficiently important factor when attempting to obtain maximum yield in the final performance (Kohsla, 1983). For team sports, however, in which studies are fewer and have sometimes reported conflicting results, this does not seem to be the case.

The availability today of more advanced methods, other than kineanthropometry, for the calculation of body composition should not be forgotten, although such methods generally have their own drawbacks, such as cost or the use of extremely complicated equipment. We agree with Pacheco and Canda (1999) that the anthropometric technique allows a rapid and sufficiently reliable assessment of body composition for it to be preferred over other methods —which are undoubtedly useful— although we are aware that the results obtained with the method (kineanthropometric) should be taken with caution.

The aim of the present study was to conduct an anthropometric study of young amateur Spanish athletes from the ADUS (Sports Association of the University of Salamanca), which is very demanding (competitions at national level), involved in different track specialities. Another objective was to determine whether there is a given anthropometric pattern for the practice of each speciality and to compare the results obtained with those of a control group, used as reference, of similar chronological age composed of students since most works have been carried out with a somewhat restrictive measurement protocol or have used calculations made in the adult population, which are of debateable use when applied to the younger population. The present study also differs from previous ones in two main characteristics: the study explores a population that, on the one hand, is most active in physical terms and, on the other, these individuals undergo important changes in their body composition, height and arm-span throughout their period of growth and maturation. In this sense, regular training has been reported to have no manifest effect on height, although this is debatable. However, regular training is an important factor that affects the growth and integrity of specific tissues such as bone, muscle and fat. Physical exercise enhances mineralisation and skeletal density and stimulates width-wise bone growth as well as producing muscular hypertrophy. However, in growing subjects, it is necessary to separate the effects of the variations related to maturation from those attributed to a physical training program. This is difficult to accomplish because growth is a continual process and it is hard to separate the effects on it of development from those of training (Malina et al., 1982). With this in mind, it can be concluded that it is never possible to know with any degree of accuracy which part of the transformation undergone by the human body from birth to adulthood corresponds to the action of hormones, to heredity, to nutrition or to the psychophysical status of the individual and which part can be attributed to the environment of the individual (Berral, 1992). Likewise, we contrast our results with those of other authors who have studied similar populations, both of athletes and individuals practising individual and team sports.

Materials and Methods

The study sample comprised 60 male athletes from the Sports Association of the University of Salamanca (ADUS) who periodically participate in different track events. The sample was further subdivided into three different groups: one of them contained 22 athletes participating in races of 100, 200 and 400 metres flat; 110 and 400 metres hurdles and a small number of long-jumpers. The second group (n=18) comprised athletes participating in middle-distance races —800 and 1500 metres— while the third group contained individuals (n=20) participating in races of 5,000 and 10,000 metres, marathon runners and walkers. All measurements were made by the first two authors of the work, who followed the ISAK (International Society for the Advance of Kineanthropometry) measurement criteria.

After marking (always on the right side) the anatomical points of reference, the following anthropometric measurements were recorded:

- — Height and weight.
- — Skin folds: triceps, subscapular, supraspinal, abdominal, anterior thigh, and medial of leg.
- — Diameters: bistyloid and bicondyloid of femur.

The measuring instruments used were as follows: a digital Soehnle balance with a precision of 0.1 Kg, a Slimguide fold-meter, a Stanley Powerlock sesmometer, Harpenden anthropometric tape and compass and a Berfer Pachymeter.

As well as being analysed individually, the measurements also served to perform the corresponding study of body composition, following the strategy of De Rose and Guimaraes (modified). In this sense, the Carter formula was used to calculate fat weight; the Von Döebeln method (modified by Rocha) was used for bone weight; the basic proposal of Matiegka was employed for muscle weight and the constants proposed by Würch were used to calculate residual weight.

The mean and standard deviations are given for each group considered. The results obtained for the sample of athletes were compared statistically with those recorded in a control group comprising 60 students chosen at random from all the students enrolled at the Department of Physiotherapy of the School of Nursing and Physiotherapy of the University of Salamanca, with homogeneous characteristics but different degrees of physical activity.

For data analysis, Student's t test for independent data when two groups are compared was used. When the data from both groups were heteroscedastic, the Welch approach was applied for the degrees of freedom. When comparing more than two groups, Analysis of Variance (ANOVA) was used to detect the differences among groups, using the Scheffé test. A significance level of 5% was established.

Computerised data treatment was carried out using a Macintosh LC III, a Macintosh Performa 5260 and a PC Pentium III at 450 MHz. Apart from this hardware, the following software was used: Claris Works (Macintosh) as text processor, Filemaker Pro from Claris (Macintosh) for the data base; Statview 512+ (Macintosh) as the statistical program, Statgraphics (PV) and Deltagraph Professional (Macintosh) for graphic data distribution and Excel 4.0 from Office (PC) for numerical data distribution.

Results

The overall characteristics of the groups studied as regards age, weight, height and Body Mass Index (BMI) are shown in Table 1. Table 2 shows the division of these parameters according to the sports speciality followed.

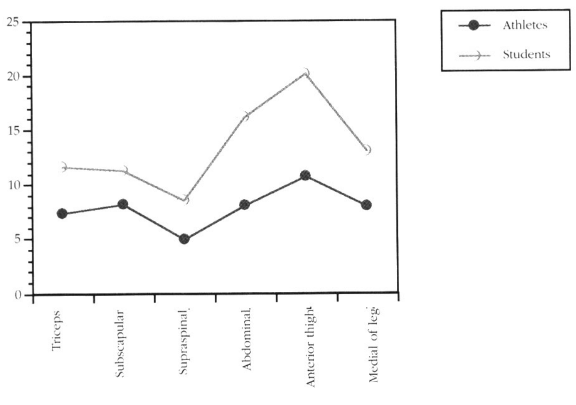
The athletes were found to have a lower weight, with statistically significant differences, and a shorter height than the student controls. Likewise, the BMI had lower values in the group of athletes, although the values of both groups (students and athletes) lay within those considered to be normal (22-25 kg/m²).

By track speciality, no significant differences were observed in the height of any of the three groups, although there were differences in weight between the fast runners and the rest.

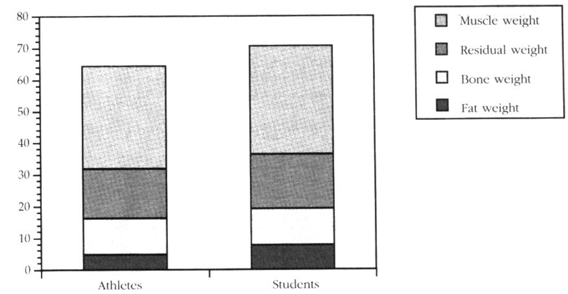
As regards skin folds (Table 3 and Graphic 1), in the athletes the values of this parameter were clearly lower than those found in the students, which in some cases were double. By track speciality, the highest skin fold values were found in the fast runners; in this regard there were significant differences in triceps and abdominal folds between the fast and long-distance runners (Table 4 and Graphic 3).

Bistyloid diameter was significantly different between athletes and students (Table 5). By track speciality, the only diameter showing significant differences was that of the femur, which was greater in the fast runners than in the other two groups (Table 6).

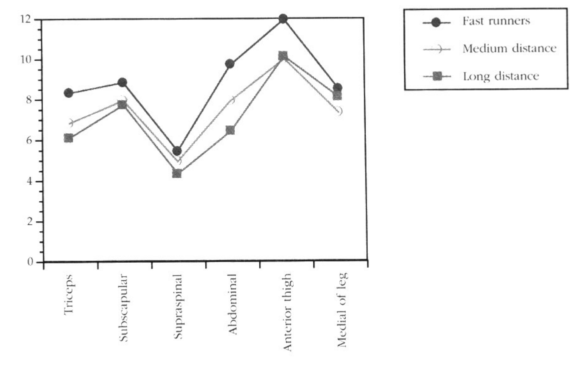
Graphic 1.- Profile of fat folds of the groups studied.



Graphic 2.- Four-compartment division of the two groups studied.



Graphic 3.- Profile of fat folds of the groups studied.



Graphic 4.- Four-compartment division of groups of athletes according to specialities.

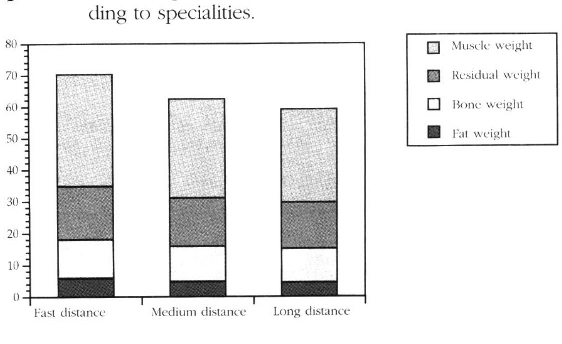


Table 1.- General data of the sample of athletes and university students.

	ATHLETES n=60	STUDENTS n=60
Age (years)	19.2 ± 2.24	18.9 ± 0.4
Weight (Kg) *	64.4 ± 6.06	70.7 ± 3.26
Height (cm)*	171.9 ± 10.7	174.9 ± 3.3
BMI *	21.5 ± 2.22	23.2 ± 0.94

* ($p < 0.05$)

Table 2.- General data of the group of athletes by track speciality.

	FAST RUNNERS n=22	MEDIUM DISTANCE n=18	LONG DISTANCE n=20
Age (years)	19.5 ± 2.25	19.4 ± 1.85	18.9 ± 2.01
Weight (Kg) *	70.1 ± 6.89	62.6 ± 8.54	59.2 ± 4.23
Height (cm)	176.2 ± 4.5	174.8 ± 5.6	170.3 ± 5.3
BMI *	22.6 ± 2.22	20.4 ± 2.21	20.4 ± 1

* significant differences between fast runners and rest of groups studied. ($p < 0.05$)

Table 3.- Skin folds of the different groups studied.

	ATHLETES n=60	STUDENTS n=60
Triceps *	7.4 ± 1.65	11.7 ± 0.88
Subscapular *	8.2 ± 1.51	11.3 ± 1.26
Supraspinal *	4.9 ± 0.94	8.5 ± 1.52
Abdominal *	8.1 ± 2.04	16.2 ± 2.93
Anterior thigh *	10.7 ± 3.05	20.1 ± 2.69
Medial of leg *	7.9 ± 3.34	13 ± 2.43

Values are expressed in mm.
* ($p < 0.05$)

Table 4.- Skin folds of the athletes by track speciality.

	FAST RUNNERS n=22	MEDIUM DISTANCE n=18	LONG DISTANCE n=20
Triceps *	8.3 ± 3.03	6.8 ± 1.21	6.1 ± 1.13
Subscapular	8.8 ± 2.03	7.9 ± 2.58	7.7 ± 1.1
Supraspinal	5.4 ± 1.74	4.9 ± 0.78	4.3 ± 0.75
Abdominal *	9.7 ± 3.59	7.9 ± 1.76	6.4 ± 1.24
Anterior thigh	11.9 ± 5.67	10 ± 2.22	10.1 ± 3.42
Medial of leg	8.5 ± 4.09	7.3 ± 2	8.1 ± 3

Values are expressed in mm.
* significant differences between fast and long-distance runners ($p < 0.05$)

Table 5.- Bone diameters of the groups studied.

	ATHLETES n=60	STUDENTS n=60
Bistyloid * (cm)	5.5 ± 0.34	5.4 ± 0.16
Bicondyloid of femur (cm)	9.7 ± 0.39	9.6 ± 0.23

* significant differences between fast and long-distance runners ($p < 0.05$)

Table 6.- Bone diameters of the three groups of athletes.

	FAST RUNNERS n=22	MEDIUM DISTANCE n=18	LONG DISTANCE n=20
Bistyloid	5.7 ± 03.	5.5 ± 0.51	5.5 ± 0.44
Bicondyloid femur *	10.1 ± 0.28	9.4 ± 0.6	9.6 ± 0.36

Values are expressed in cm.
* significant differences between fast runners and other two groups (p < 0.05)

Table 7.- Percentage of fat after Carter and body composition of the two groups studied.

	ATHLETES n=60	STUDENTS n=60
Fat % (Carter) *	7.55 ± 1.26	11.08 ± 1.07
Fat weight *	4.86 ± 1.21	7.83 ± 1.11
Bone weight	11.21 ± 0.89	11.25 ± 0.5
Residual weight *	15.52 ± 1.48	17.03 ± 0.79
Muscle weight	32.81 ± 3.09	34.58 ± 1.58

Weight values are expressed in Kg.
* (p < 0.05)

Table 8.- Percentage of fat after Carter and body composition of the athletes.

	FAST RUNNERS n=22	MEDIUM DISTANCE n=18	LONG DISTANCE n=20
Fat % (Carter)	8.11 ± 2.26	7.29 ± 1.15	7.07 ± 0.95
Fat weight *	5.69 ± 2.08	4.57 ± 1.1	4.18 ± 0.55
Bone weight	12.25 ± 0.53	11.22 ± 1.42	10.97 ± 1.14
Residual weight *	16.89 ± 1.72	15.08 ± 2.06	14.26 ± 1.02
Muscle weight ≠	35.26 ± 3.23	31.72 ± 4.83	29.77 ± 2.33

Weight values are expressed in Kg.
* Significant differences between fast runners and rest of groups (p < 0.05)
≠ Significant differences between fast and long-distance runners(p < 0.05)

Body composition (Table 7 and Graphic 2) revealed greater weight and fat percentages in the students as compared with the athletes, the differences being significant. The bone and muscle weight values were similar in both groups (athletes and students) and residual weight was clearly lower in the athletes.

The percentage of fat according to the Carter criterion was higher in the fast runner group with respect to the medium-distance and long-distance runners, although the differences were not significant. Fat weight showed the same characteristics, although in this case statistically significant differences were seen between the fast runners and the other groups. Bone weight, despite the fact that the anthropometric characteristics were similar to those of the above variables, did not show significant differences among the groups. Residual weight followed the same trend as fat weight, statistically significant differences being observed between the fast runners and the other two groups. As regards muscle weight, it should be noted that although the numerical values of the fast runners continued to be higher than those of the remaining groups, significant differences were only observed between the fast runners and the long-distance runners (Table 8 and Graphic 4).

Discussion

Many anthropometric studies have been carried out on athletes participating in different sports activities and different assessments have been made as a function of the individuality or team nature of the sport involved. It has been reported that individual sports activities tend to lead to a given anthropometric profile, which is not the case of team sports. What is clear, however, is that the practice of physical exercise within the age group of the individuals studied by us is a good way to perfect body composition: hence our observation of lower fat percentages in the group of subjects practising sports on a regular basis.

The values concerning the height and weight of the group athletes studied lie within those reported in the international literature (Reilly, 1996). Our attention is drawn to the similarity between the heights of the three groups of athletes, in contrast with the observed differences in weight, where the fast runners were found to have significantly higher values than the rest of the individuals participating in track events. The same trend was seen for skin folds, which were largest in the fast runners and clearly lower in the long-distance runners. This leads us to consider the importance of a low fat compartment in athletes dedicated to activities that demand resistance. This can be seen on comparing the percentage of fat on the basis of the Carter index, which is also lower in this group of long-distance runners. Although no significant differences were observed with the rest of the groups, such differences did appear in the determinations of fat weight, which was markedly different in the long- and medium distance runners from that of the fast runners.

Muscle weight was higher in the fast runners than in the other two groups, although differences were only found between the fast and long-distance runners. A striking observation was the higher muscle weight shown by the control group.

The anthropometric characteristics of the athletes studied here are similar to those reported by other authors. We observed great similarity as regards the heights of their athletes and those studied by us (Sady and Freedson, 1994; Pacheco and Canda, 1999). Regarding weight, there are similar analogies, although the weights of the fast running athletes studied by Pacheco and Canda were appreciably lower than those of our own athletes.

Study of body composition did not reveal pronounced differences between our subjects and those studied by others. We did note differences in the fat percentages of the athletes studied by Sady and Freedson (1994), whose subjects had clearly higher values. The group analysed by Pacheco and Canda show very similar values to those of our own subjects, although we are unable to make any valid comparison because we did not employ the same protocol for dividing up body weight, those authors using the model described by Drinwater et al. (1986) based on the theoretical "Phantom" concept.

On comparing the data collected in our series with those reported by other authors for other sports, it is striking that, overall, their values for weight, height and the BMI lie above those found by us for our athletes. In this sense, Casajús and Aragones (1997), studying elite Spanish footballers (national team, first division, second division A and second division B), reported values that are much higher than those observed by us here; only players from the second division B had values close to those of our own athletes and even then they were consistently higher. Generally, however, the values of the fat folds of athletes and all the categories of football players are fairly similar.

On assessing body composition, the fat percentages have very similar values for both athletes and football players, although fat weight is much lower in the athletes. Bone and residual weights are also quite similar, whereas there are large differences in muscle weights.

With the foregoing in mind, and taking into account that despite their dedication our athletes cannot be considered as top ranking sportsmen (at least most of them), we observed that in spite of the above differences-which are the most significant findings of our research- there are also analogies between our athletes and footballers from different categories that seem to be interesting (percentage of fat, bone and residual weights, skin folds and sum of all of them).

When we analysed footballers according to their place on the field, we observed a large difference, in anthropometric terms, between all the footballers and the athletes. Only athletes devoted to short-distance running are close to the footballer forwards in their anthropometric parameters.

In 1996, Palomino et al. conducted a study on swimmers from the Canary Islands and swimmers from Peninsular Spain. In this case, the swimmers' ages were similar to those of our own athletes. As is the case of the footballers, most of the swimmers' parameters were above those of the athletes studied by us; only the parameters relating to bone and residual weight proved to be similar, as regards both weight and percentage. On comparing the swimmers by speciality (butterfly, crawl, backstroke and breast stroke) and athletic specialities, an observation that drew our attention was that with the exception of fat percentage and weight, the latter of which was much higher in all the swimming specialities with respect to the athletes, the values of the rest of the variables of the fast runners are close to those of the swimmers, regardless of their style. It is even possible to make a further distinction and state that the values of our fast runners are closer to the values of the Peninsular than to those of the Canary Islands swimmers (the latter with more pronounced values for fat). Accordingly, it could be speculated that some of the conditions required for both sports are very similar, as is part of the training, although swimming requires a larger fat compartment owing to the necessary demand of flotation. Both the medium-distance and long-distance runners differed from the anthropometric profiles of these swimmers.

Rubio et al. (1994) conducted a study of Spanish roller hockey players from different competition categories (honours division, first national division and junior division). Height and weight proved to be the same as described above; that is, overall the athletes had lower values. Also here, the fast runners are those with the values closest to the hockey players, although the latter were shorter and heavier.

Finally, Romero et al. (1994) studied a group of amateur cyclists. In this case, the analogies that were most striking were those observed with our group of middle-distance runners. We believe these to be due to the demands of resistance and occasional exertion shown by both sports specialities, although we are unable to determine which compartments would be involved in the appearance of such analogies. In any case, this sports activity is the one that most resembles that practiced by our own athletes.

It may be concluded that there are clear and significant differences in body composition between groups of the population of the same age subjected to a specific training program based on the sports activity practised. In the same way, the differences are also seen between those who do sports activities and those who live a sedentary existence. Similarly, we observed the existence of a close relationship between physical exercise, the level of training and the level of competition, especially as regards the fat and muscle compartments. The anthropometric profiles of the long- and medium-distance runners studied here are very similar but are very different from that observed for the fast runners, such that, at least in the speed mode, well defined anthropometric characteristics are required.

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