Analysis of the physical condition, body composition and somatotype in colombian athletes

Análisis de la condición física, composición corporal y somatotipo en deportistas colombianos

Análise da condição física, composição corporal e somatotipo em atletas colombianos

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ABSTRACT

The objective of this study was to determine the physical condition, body composition, and somatotype in Colombian athletes. 618 athletes participated (Women 25.89%), from 14 to 22 years old. Cynanthropometric measurements were taken, and cardiovascular endurance tests were performed on treadmill, as well as squat jumps and counter movements, the sit and reach flexibility test and the amount of sit ups in 1 min. The athletes in the brand and precision sports group had the highest percentage of fat and bone mass, while the combat sports group had the highest body mass index, aerobic capacity, abdominal resistance strength, and jumping; in the ball sports group the highest percentage was the recovery time; and in the time and brand group, the percentage of muscle mass and flexibility stood out. The predominant somatotype was mesomorphic. The highest results in each variable depended on the sports discipline they practiced.

Key words: Athletes, Sport, Physical fitness, Body composition, Anthropometry.

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RESUMEN

El objetivo del estudio fue determinar la condición física, composición corporal y el somatotipo en deportistas colombianos. Participaron 618 deportistas (Mujeres 25,89%), con edad de 14 a 22 años. Se tomaron medidas cinantropométricas y se realizaron pruebas de resistencia cardiovascular en tapiz rodante, salto squat jump y contramovimiento, flexibilidad sit and reach y abdominales en 1min. Los deportistas del grupo de deportes de marca y precisión obtuvieron el porcentaje de grasa y porcentaje de masa ósea más altos, mientras el grupo de deportes de combate fue el índice de masa corporal, la capacidad aeróbica, la fuerza de resistencia abdominal y los saltos; en el grupo de deportes de pelota fue el porcentaje de recuperación, y en el grupo de tiempo y marca, sobresalió el porcentaje de masa muscular y la flexibilidad. El somatotipo predominante fue mesomórfico. Los resultados más altos en cada variable dependieron de la disciplina deportiva practicada.

Palabras clave: Deportista, Deporte, Aptitud física, Composición corporal, Antropometría.

RESUMO

O objetivo do estudo foi determinar a condição física, composição corporal e somatotipo em atletas colombianos. Participaram 618 atletas (Mulheres 25,89%), com idades entre 14 e 22 anos. Vinte medidas cineantropométricas foram realizadas e testes de resistência cardiovascular foram realizados em esteira, agachamento salto e contramovimento, sentar e alcançar flexibilidade e abdominais em 1 min. Atletas do grupo de esportes de marca e de precisão tiveram o maior percentual de gordura e massa óssea, enquanto o grupo de esportes de combate apresentou o maior índice de massa corporal, capacidade aeróbica, força de resistência abdominal e saltos; no grupo de esportes com bola foi o percentual de recuperação, e no grupo tempo e marca, o percentual de massa muscular e flexibilidade se destacaram. O somatotipo predominante foi o mesomórfico. Os maiores resultados em cada variável dependeram do esporte praticado.

Palavras chave: Atleta, Esporte, Aptidão física, Composição corporal, Antropometria.

INTRODUCTION

Professionals directly involved in physical exercise have realized the importance of assessing body composition and physical condition. In this sense, they have determined that low physical condition is associated with high adiposity, conditions that can predict cardiovascular and metabolic alterations (Lema et al., 2016). In the field of sports training, the direction of the preparation process will be more effective if the coach has control data, that is, information about the athlete regarding: the variation in his or her work capacity, the state of the body during training, the level of development of physical qualities, the degree of mastery of the technique of movements, the magnitude of the load and the change in sports results, among others (Absaliamov & Timakova, 1990).

In this sense, the study of anthropometry and physiological aspects, although they are not determining factors of optimal performance, are part of a complex of qualities that are related to it. The anthropometric study quantifies and provides information on the physical structure of an individual at a given time, and on the differences caused by growth and training (Iglesias-Sánchez et al., 2013). It is therefore important to mention that kinanthropometry allows the evaluation of the body composition, morphology, nutritional status and proportions of the athlete, data that make it possible to guide towards maximum performance parameters, compared with elite athletes. It also allows the verification of the symmetry of the body development of young athletes and the early detection of possible deviations in the locomotor system (Nahrstaedt et al., 2008).

In this regard, the Spanish Group of Kinanthropometry (GREC) has protocolized the technique that appears in the manual of kinanthropometry (Esparza, 1993) and the International Society for the Advancement of Kinanthropometry ([ISAK], 2006), developing international standards for anthropometric comparison. With this technique and reference values, fat folds, muscle perimeters and bone diameters can be measured, in order to establish the somatotype (graphic representation of body dimensions) of the athlete, from the training stages to maximum sports performance, which will allow each athlete to be compared with themselves (their evolution) and with the most successful athletes in their sport.

Accordingly, the knowledge and analysis of body shape is an important element in sport, since it is unquestionable that certain physical characteristics are linked to maximum sporting performance. Thus, the analysis of body composition is a reliable, practical and non-invasive way to know aspects that are modified by training, and other genetic aspects, not modifiable by it, which identify the ideal conditions of the good athlete (Esparza, 1993; Ramos-Parrací & Gómez, 2018), and which provide a basis for the morphological prototype of the elite player (Reilly et al., 2000).

In this order of ideas, it is proposed that the study of body composition is essential to understand the effect that diet, growth, physical exercise, illness and other environmental factors have on the body (Valtueña et al., 1996).

On the other hand, a significant number of studies suggest that athletes in each sport have specific morphological characteristics that favour reaching high performance (Monsma & Malina, 2005; Vila et al., 2015). Research whose main objective is the study of body composition and anthropometry tries to establish which aspects most influence the development and evolution of athletes. However, this must be addressed from a multifactorial perspective that establishes that, on an adequate genetic basis, the coincidence of numerous variables is necessary to reach high performance (Iglesias-Sánchez et al., 2013; Grijota et al., 2015; Sáenz-López et al., 2005).

In the Department of Huila, it has been established that there is no background that determines the functional and kinanthropometric characteristics of athletes from different Sports Leagues, leaving any investigative and/or pedagogical task incomplete towards improving the performance of athletes. In addition, it should be noted that growth during adolescence implies that talent detection programs in young athletes must be carefully examined, executed and must be carried out with rigorous monitoring, since at this stage the effect of growth and maturation can confuse future performance (Pearson et al., 2006). To this can be added the concern about physical inactivity during this stage, which is coupled with the increase in new leisure technologies that could limit the time that young people spend on other types of activities such as physical exercise (Ramos et al., 2016). On the other hand, it can be said that participation in a certain sport is associated with anthropometric characteristics and body composition (Duquet & Carter, 1996), and there has been a scientific interest for many years in trying to define the possible structural differences between athletes from different sports (Gualdi-Russo & Graziani, 1993). As described, the main objective of this study was to determine body composition, somatotype and physical condition in a sample of athletes from the Department of Huila (Colombia); the variables described were also compared based on the sport.

METHODS

Focus, type of study and participants

The study was conducted with a quantitative, descriptive and cross-sectional approach (Hernández et al., 2014). 100% of the population of Colombian athletes from the department of Huila was taken, in order to achieve greater reliability. 618 athletes without physical problems participated voluntarily, duly registered in 18 sports leagues; their ages ranged from 14 to 22 years, with an average of 18.04 ± 2.53 years, of which 74.1% were men (n = 458) and 25.9% were women (n = 160).

Instruments and procedure

Anthropometric and sociodemographic measurements and physical fitness tests were taken over a three-week period. The team consisted of three graduates in physical education and sports professionals, and two level I anthropometrists, certified by the International Society for the Advancement of Kinanthropometry (ISAK), who had 5 years of experience in the field. Each of the instruments used is described below.

Anthropometric and sociodemographic measurements

Age, sex and anthropometric measurements were recorded on a registration sheet designed for this purpose and following the protocols established by ISAK (2006). Weight (SECA 700 Scale), height (WCS Portable Stadiometer – WOOD Model – Brazil), skinfolds of the triceps, subscapular, suprailiac, abdominal, anterior thigh, medial leg (CESCORF Caliper – Scientific Model – Brazil) were measured; bone diameters of the biacromial, bicrestal, humerus, wrist, femur (Caliper for small diameters – FAGA S.R.L Model – Brazil); and muscle perimeters of the relaxed arm, contracted arm, forearm, wrist, waist, hip, upper thigh, calf (Anthropometric Tape – WISO model R88 – Brazil) were measured.

Body composition and somatotype. The body mass index (BMI) was obtained using the equation mass (kg)/height (m2) (Ramos-Parrací & Gómez, 2018). The remaining variables were then calculated using the following formulas:

- Fat percentage (%GC) (Mc Ardle et al., 1990, cited by Ramos-Parrací & Gómez, 2018):

Men: %GC = (0.5 x Tri) + (0.31 x Su) + 6.13.

Women: %GC = (0.43 x Tri) + (0.58 x Su) + 1.47.

Where: Tri = Triceps fold (mm); Su = Subscapular fold (mm).

- Muscle mass percentage (Heymsfield et al., 1982):

Muscle mass = Height (0.284 + 0.0029 x AMBc).

Where: AMBc Corrected arm muscle area = [(arm circumference – p Triceps fold/10)2 / p] -10

- Percentage of residual mass (Wurch, 1974, cited by Piñeda et al., 2017):

Residual mass = (Kg) BW x 24.1/100 (men).

Residual mass = (Kg) BW x 20.9 / 100 (women).

Where: BW Body weight (Kg).

- Bone mass percentage (Rocha, 1975):

Bone mass = 3.02 x (T2 * Styl. dia. * Bicond. dia. *400) 0.712.

Where: T Height (cm); Styl. dia. Styloid diameter (cm); Bicond. dia. Bicondyle diameter of femur (cm).

Somatotype. The components of each athlete's somatotype were determined according to the equations established by Rodríguez (2014, cited by Molina et al., 2021).

- Endomorphy: 0.7182 + 0.1451 * X + 0.00068 * X2 + 0.0000014 * X3. Where: X is the sum of the triceps, subscapularis and supraspinatus folds multiplied by 170.18 / subject's height (cm).
- Mesomorphy: 0.585 X biepicondylar diameter of the humerus + 0.601 X biepicondylar diameter of the femur + 0.188 X corrected arm circumference + 0.161 X corrected leg circumference -0.131 X height + 4.5.
- Ectomorphy: Ectomorph is the result of different equations based on the reciprocal ponderal index:

Weight Index = height (cm) / cubic root of weight (kg). After obtaining the weight index, the following equations are applied based on the result:

– If IP ≥ 40.75 Ectomorph = (IP. 0.732) –28.58

– If 38.25 < IP < 40.75 Ectomorph = (IP. 0.463) –17.63

– If IP ≤ 38.25 Ectomorph = 0.1

Physical condition. The following tests and measures were used:

For heart rate (HR), the subject, upon arriving at the assessment and during the process of filling out the registration form, was placed with the heart rate monitor (Polar F11 or Polar – FS1 E.U.), remaining for 10 min in a seated, relaxed, calm position and then the HR was taken. In the case of blood pressure, a semi-automatic electronic device (OMRON 75CP – E.U.) was used (Nieto et al., 2020).

For cardiovascular endurance, the subject ran on the treadmill until reaching his theoretical maximum heart rate, found using the Tanaka formula for athletes (Tanaka et al., 2001): HRmax = 205 – (0.6 x Age). The test was performed according to the protocol presented in Table 1.

Table 1

Treadmill test protocol.

Time (min)	Speed (Km/h)	Inclination	HR
1	6,0	0%	
2	6,0	2%	
3	7,0	2%	
4	7,0	4%	
5	8,0	4%	
6	8,0	6%	
7	9,0	6%	
8	9,0	8%	
9	10,0	8%	
10	10,0	10%	
11	11,0	10%	
12	11,0	12%	
13	12,0	12%	
14	12,0	14%	
15	13,0	14%	

Source. Ramos-Parrací & Gómez (2018); Roitman & Herridge (2001).

To find the VO_{2max} the following formula was used (Roitman & Herridge, 2001):

$$VO_{2max}\ (ml\ kg^{-1}\ min^{-1}) = (Vel \times 1000/60) \times 0.1 + 3.5 + (Vel \times 1000/60) \times 1.8 \times Incline)$$

At the end of the cardiovascular endurance test, the heart rate was taken 3 min post-test in order to estimate the recovery percentage using the following formula (Ramos-Parrací & Gómez, 2018; Roitman & Herridge, 2001):

%Recovery = (HRposttest – HR3m posttest) / (HRposttest – HRrest)

Regarding abdominal muscle strength, the 1-min Abdominal Test (Silva et al., 2006) was used. Regarding flexibility, it was determined using the Sit And Reach test, which aims to measure the flexibility of the lower back, hip extensors, knee flexor muscles and gastrocnemius (Wells & Dillon, 1952).

The Squat Jump (SJ) and Counter Movement Jump (CMJ) tests were performed on the AxonJump "T" brand contact platform - Axon Bioengineering Sports Software 4.02. The SJ consisted of performing a maximum vertical jump starting from a 90° leg position, without any type of bounce or countermovement. The hands remained on the hips from the initial position until the end of the jump. In the CMJ, the athlete started from a standing position with their hands held at their hips, where they remained from the initial position until the end of the jump. A flexion-extension movement of the knees was performed, forming a 90° knee angle during the descent, and immediately a maximum vertical jump was performed (Balsalobre et al., 2012).

Finally, the athletes and leagues were grouped according to the information provided by the Administrative Department of Sport, Recreation, Physical Activity and Use of Free Time (Zorro et al., 2015), as follows:

- Combat sports: wrestling, taekwondo.
- Ball sports: tennis, volleyball, basketball, football, indoor football.
- Time and marking sports: weightlifting, athletics (field), swimming, underwater activities, racing, skating, cycling, motorcycling (speed), canoeing.
- Art and precision sports: gymnastics, chess, shuffleboard.

Data analysis

The data were refined and analyzed in the IBM SPSS statistical program version 25.0. Descriptive statistics included the calculation of measures of central tendency such as the mean ($\bar{X}$) and variability such as the standard deviation (SD). Inferential statistics included parametric analyses, comparing the differences in the variables studied between the groups using the one-way analysis of variance test (ANOVA), and first checking the normality of the variables using the Kolmogorov-Smirnov test. A significance level of $p<0.05$ was used in all procedures.

Ethical considerations

Initially, all study participants were informed of the protocols and tests to be performed, and were familiarized with their execution in order to minimize technical errors and obtain more reliable values. Likewise, each one read and signed an informed consent.

The research was governed by Resolution 008430 issued by the Ministry of Health of Colombia (1993) and the ethical standards recognized by the Declaration of Helsinki, which regulates research conducted with humans (World Medical Association, 2017). The study was approved by the Ethics Committee of the University of Tolima.

RESULTS

Table 2 shows the results obtained from the means and standard deviations of the 618 athletes evaluated, in the basic measurements (age, height, weight and BMI) and in the 4 components of body composition expressed as a percentage. Also, the comparisons of these variables in groups differentiated by sport are presented, where combat athletes show significantly higher values in body weight, BMI and % of residual mass ($p < 0.05$); and art and precision athletes in age, % of bone mass and % of body fat, with significant differences in this last variable ($p < 0.05$). On the other hand, athletes in the ball sports group present significantly high figures in height ($p < 0.05$) and those in time and marking sports in % of muscle mass, without differing significantly ($p > 0.05$).

Table 2

Basic variables and body composition variables of athletes according to sport group.

Variable	Sport					p⍺
	All (n=618)	Combat (n=72)	Ball (n=190)	Time and marking (n=302)	Art and precision (n=54)	
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	
Age (years)	18,04±2,53	17,76±2,54	17,94±2,5	18,11±2,55	18,33±2,52	,560
Height (meters)	1,68±0,10	1,70±0,08	1,73±0,11	1,64±0,10	1,65±0,04	,000
Weight (kg)	62,56±13,2	66,67±11,6	65,86±13,2	59,06±12,7	65,09±12,4	,000
BMI (kg/m^2)	21,97±3,1	22,77±2,9	21,74±2,6	21,62±3,1	23,65±4,2	,000
% Body Fat	9,78±4,29	8,42±1,81	9,77±5,78	9,92±3,63	10,85±3,57	,012
% Muscle Mass	46,56±16,9	46,54±2,5	45,30±3,1	47,89±23,8	43,61±7,1	,210
% Residual Mass	23,28±1,4	23,87±0,8	23,81±0,9	22,90±1,5	22,72±1,6	,000
% Bone Mass	21,27±7,8	21,17±2,2	21,47±3,0	21,03±10,8	22±2,8	,831

[⍺] Level of significance.

Table 3 presents the components of the somatotype of athletes, differentiated by sport and then their classification. Significant differences were found in the endomorphic components in the ball sports group, and mesomorphic components in combat sports athletes.

Table 3

Somatotype of athletes evaluated according to the sport group.

Variable	Sport					p⟨
	All (n=618)	Combat (n=72)	Ball (n=190)	Time and marking (n=302)	Art and precision (n=54)	
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	
Endomorphy	2,55±1,26	2,24±0,71	2,68±1,01	2,60±1,51	2,20±0,99	,014
Mesomorphy	4,98±1,54	5,69±1,44	4,87±1,38	4,90±1,58	4,80±1,73	,000
Ectomorph	2,95±3,32	2,41±1,02	3,13±2,31	2,96±4,32	2,91±1,27	,486
Soma. Class. ^	Balanced mesomorphy	Balanced mesomorphy	Balanced mesomorphy	Balanced mesomorphy	Balanced mesomorphy	---

Ω Somatotype classification, α Level of significance.

Table 4 shows the results of the physical condition of the athletes, where the combat sports group obtained significantly higher figures in maximum oxygen consumption, SJ, CMJ and abdominal muscle resistance strength ($p < 0.05$), while the time and mark athletes had significantly higher flexibility ($p < 0.05$) and the ball athletes had a significantly higher recovery percentage, with no statistically significant differences ($p > 0.05$).

Table 4

Physical condition of athletes evaluated according to the sport group.

Variable	Sport					p⟨
	All (n=618)	Combat (n=72)	Ball (n=190)	Time and marking (n=302)	Art and precision (n=54)	
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	
VO_2 máx. (ml·kg-1 min-1)®	39,12±10,3	43,67±6,0	42,58±6,3	36,15±12,3	37,53±7,5	,000
% Recovery	54,62±29,8	51,03±8,9	55,19±44	55,18±23,5	54,31±12,7	,747
SJ (cm)ǀ	35,97±11,5	41,95±10,7	38,49±10,3	34,45±11,5	27,63±10,9	,000
CMJ (cm)□	39,99±11,6	45,95±10,6	42,57±10,3	38,44±11,5	31,61±10,9	,000
Flexibility (cm)	33,07±10,99	33,47±10,10	28,15±10,44	36,18±10,67	32,44±9,53	,000
AMR (Rep)ǀ	69,46±23,69	76,88±16,56	65,13±19,56	72,98±26,30	55,09±21,23	,000

β Maximum oxygen consumption, η Jump without countermovement in centimeters, ͻ Jump with countermovement in centimeters, τ Resistance force of abdominal muscles in repetitions per minute, α Level of significance.

DISCUSSION

The analysis of the results allowed us to determine the physical condition, body composition and somatotype in Colombian athletes, as well as to study differences by sport modality.

The results of the values in height and weight do not coincide, for example, with the study carried out on a group of Spanish athletes in handball, swimming and karate in the under-14 and under-16 categories (1.76m vs 58.78kg) where the height was higher and the weight lower in relation to the Colombian athletes (1.68m vs 62.56kg). It is worth mentioning that the sample consisted of 6 groups of 16 athletes n = 90 (Grijota et al., 2015; Iglesias-Sánchez et al., 2013).

However, in relation to the percentage of body fat, the Spanish obtained higher results (11.85% vs 9.78%), respectively, and in the percentage of muscle mass the results were similar (46.29% vs 46.56%) respectively (Iglesias-Sánchez et al., 2013). Likewise, high-level Spanish padel players revealed a higher percentage of fat (14.1%) than Colombian athletes (Pradas de la Fuente et al., 2019).

On the other hand, in a study carried out with 44 footballers classified as trained and untrained in the youth category from 16 to 18 years old, for which the data of weight (69.86kg vs 62.56kg), height (1.78m vs 1.68m), and muscle percentage (48.05% vs 46.56%) were analyzed, yielding higher data in relation to those carried out in this study. In the case of fat percentage, Spanish athletes used Yuhaz (9.3% vs 9.7%), with very similar BMI between Spaniards and Colombians (22.16kg/m2 vs 21.97kg/m2) (Iglesias-Sánchez et al., 2013).

Similarly, in a study conducted with 1037 adolescents (14 to 17 years) from the Murcia region in Spain, higher data were found in the variables of weight (77.67kg), height (1.71m) and BMI (22.95kg/m2) compared to Colombians (Nieto et al., 2020).

Regarding the study carried out on Chilean adolescents from the sports workshop of the Montesori school in Temuco (Araucaria Region) with an average age of 15 years (Cresp-Barria et al., 2019), they showed lower results in the variables of height (1.56m vs 1.68m), weight (58.2kg vs 62.56) and BMI (20.9kg/m2 vs 21.97kg/m2) respectively; in relation to the Colombians evaluated, taking into account that the average age was lower. Likewise, in another study, the results were lower in the variables mentioned above (1.62m vs 1.68m), (60.0kg vs 62.56kg), (19.9kg/m2 vs 21.97kg/m2) respectively. This study was conducted with 377 adolescents with an age range of 14 to 17 years from rural and urban areas in northern Brazil (Nunes et al., 2016). On the other hand, comparing the group of sports classified in time and mark, data below were found in 62 professional figure skating skaters, organized by continent, which were 28 European, 14 American and 20 South American, the variables evaluated were height (1.60m - 1.64m), weight (55.5kg vs 59.06kg), BMI (21.35kg/m2 vs 21.62kg/m2), but in the case of the percentage of fat that was calculated with Carter (10.6% - 9.92% Colombia) and the results were similar (Grijota et al., 2015). Within the same sports classification in time and mark, the study composed of 85 water rescue athletes from Alicante-Spain was found, where its results do not coincide with the present study since it showed higher data in the Spanish, in the following variables: height (1.72m vs 1.64m respectively) and percentage of fat calculated with Carter (14.67% vs 9.92%), taking into account that the sample was smaller than in Colombia (85 vs 302, respectively). In the case of the variables weight (60.65kg vs 59.06kg, respectively) and BMI (22.57kg/m2 vs 21.62kg/m2), the data were similar between Spaniards and Colombians. But in the muscle percentage the results were lower in the Spanish, although they worked with Lee's formula and possibly that is why they were so different (27.78% vs - 47.89%) (Abraldes et al., 2014). The results reported in 90 Spanish national and international elite runners with an age range of 17 to 23 years (Sánchez et al., 2020) are similar to those of Colombians in the variables of age (Ramos et al., 2017), weight (60.7 kg), BMI and percentage of fat calculated with the Wilmore and Behnke formula (10.4%) in the group of sports classified by time and mark; however, the height was higher in the Spanish (1.74 m) than in the Colombians.

On the other hand, Rodríguez et al. (2019) studied a group of Colombian soccer players, who presented lower values in body weight (58.7 kg) and BMI (20.5 kg/m2), and similar in % fat (10.2%), when compared to Colombian ball game players. Lower figures are also revealed in Macedonian footballers (Gontarev et al., 2016) for the case of % bone mass (18.21% vs 21.47%) and % fat mass (14.66% vs 9.77%).

On the contrary, a group of futsal players from the city of Pasto (Colombia), with an average age of 17 years, showed higher figures in height (1.78m), weight (69.36kg) and BMI (23.51 kg/m2) (Burgos, 2019).

The same is true for 486 young football players aged 14 to 18 from Macedonia in weight (66.80kg), height (1.75m), but a similar BMI (21.56kg/m2) (Gontarev et al., 2016); Likewise, the % of muscle mass in Macedonians was higher than in Colombian baseball athletes (52.47% vs 45.30%). 8.42. 46.54

When comparing the results of the body composition of Colombian athletes of art and precision with other research, it is observed that 53 Polish gymnasts of senior and junior categories (Sterkowicz-Przybycien et al., 2019) showed a lower BMI (21.2 kg/m2 vs 23.65 kg/m2) and percentage of body fat (9.8% vs 10.85%). On the other hand, Colombian athletes of ball sports showed a lower BMI when compared with a team of Brazilian basketball athletes (Setters: 24.06 kg/m2; laterals: 26.1 kg/m2; centers: 24.83 kg/m2) (Pinheiro et al., 2019). The research carried out by Sáez (2018) with Chilean taekwondo athletes showed higher levels of body fat (22.2%) and muscle mass (49.6%) compared to Colombian combat athletes.

When comparing the results of the present study with other research in Spaniards (Abraldes et al., 2014; Iglesias-Sánchez et al., 2013), Poles (Sterkowicz-Przybycien et al., 2019) and Macedonians (Gontarev et al., 2016), in the somatotype variable, similar results were found regarding the mesomorphic component, which is the predominant one. However, it contradicts the studies carried out with Mexicans (Caballero-Ruiz et al., 2019), Spanish (Sánchez et al., 2020) and Chilean rhythmic gymnasts (Mondaca et al., 2021), where the predominant component was endomorphy in Mexicans. In the case of the Spanish, they obtained equal values in mesomorphy and ectomorphy, and the Chileans showed a predominant somatotype of endomorph-mesomorph (3.88-3.60-1.78), the latter when compared with Colombian athletes in the art and precision modality.

The results presented in Table 4 made it possible to determine the physical condition of Colombian athletes. According to this, a group of Chilean adolescents obtained a better maximum oxygen consumption (53.12 ml/kg/min), clarifying that the test performed was the Course Navette Test (Cresp-Barria et al., 2019). Something similar occurs in the aerobic capacity of American youth with an average age of 21 years (Ronan & Shafer, 2019) and Colombians from the city of Pasto, assessed using the Cooper test.

Meanwhile, the results of the other variables of physical condition in Colombian athletes were higher in flexibility (33.07 cm vs 25.87 cm) and abdominal resistance strength (69.46 repetitions vs 21.86 repetitions) of 377 young Brazilians (Nunes et al., 2016).

Regarding the CMJ, Polish gymnasts (Sterkowicz-Przybycien et al., 2019) had better results compared to Colombians belonging to art and precision sports (33.9 cm vs 31.61 cm); the same happens with a group of Chilean professional soccer players for this variable (42.64 cm) (Molina et al., 2021).

Once the study was completed, it is important to indicate that there were no considerable difficulties that did not allow the proper development of the research stages and the objectives set. However, one of the limitations of the study was the failure to measure some variables related to nutrition and eating habits of athletes that can influence sports performance and high levels of some body composition variables, especially those related to adiposity.

CONCLUSION

The results obtained show that the group of athletes who participate in marking and precision sports had the highest age, percentage of fat and percentage of bone mass. In the case of combat athletes, they stood out in the data of body weight, body mass index and percentage of residual mass; in the group of ball sports the highest height was observed, and in time and mark the percentage of muscle mass stood out.

Regarding the somatotype, the mesomorphic component predominated in all the athletes examined. With respect to physical condition, the group of combat athletes showed greater results in aerobic capacity, abdominal resistance strength and in the SJ and CMJ jumps; the time and mark athletes had higher flexibility; and the recovery percentage was better in the ball athletes. Also, the results allowed comparisons with other research developed with athletes in different contexts, which established a reference point for the case of Colombia. Given the above, it is necessary to carry out intervention programs so that longitudinal studies can be carried out and the behaviors in the evaluated variables can be observed and thus better results can be achieved at a sporting level, taking as a reference the highest data in terms of classification of each variable. In addition, it is essential to carry out periodic assessments that allow the identification of the state and evolution of each athlete, in order to identify whether the training plan really generates improvement, stagnation or delay in the athlete's physical capacities.

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