

BODY COMPOSITION AND SOMATOTYPE OF CHILD AND ADOLESCENT ATHLETES FROM THE SPORTS SWIMMING SCHOOL, CAMPUS MALDONADO, URUGUAY

Meléndez-Gallardo, J.*¹, Plada-Delgado, D.¹, Cuevas-Palacios, A.¹, Stavrinakis-Calleja, Y.¹,
Hernández-García, F.¹, Pohoski-Ortiz, P.¹, Moyano-Polcaro, V.¹

¹Grupo de Investigación Biofísica y Bioquímica del Ejercicio. Instituto Superior de Educación Física, Centro Universitario Regional del Este, Universidad de la República, Maldonado, Uruguay.

*Correspondence address: jose.melendez@cure.edu.uy

<https://doi.org/10.52846/jskm/43.2024.1.2>

Abstract: Introduction: Sports performance is multifactorial, including body composition and somatotype. These factors can potentially influence the development of an athlete's biological potential and, more specifically, interfere with the technical execution of the sport.

Purpose: Determine the body composition and somatotype of swimmers from the Maldonado Sports School, Uruguay.

Materials and Methods: The sample size (n) consisted of 38 individuals aged between 10 and 18 years old. Body composition was determined using four-component method. Somatotype was determined by assessing the three components of somatotype separately (endomorph, mesomorph, ectomorph). All parameters were determined and classified by sex.

Results: The average values for fat tissue, bone tissue, muscle tissue, and residual weight for female athletes were 16.48, 17.20, 45.43, and 20.90, respectively. For male athletes, the average values were 9.88, 19.02, 50.22, and 20.90, respectively. The somatotype components for female athletes were 3.248 (endomorph), 4.787 (mesomorph), and 2.565 (ectomorph), while for male athletes, they were 1.773 (endomorph), 4.533 (mesomorph), and 3.373 (ectomorph).

Discussion and Conclusion: It was found that female athletes exhibited a predominance of adipose tissue, while male athletes showed a higher proportion of bone and muscle tissue. Regarding somatotype, there was a trend towards centrality with a predominance of the mesomorphic component for both sexes (female = mesoendomorphic, male = mesoectomorphic). A low endomorphic component and somatotype modifications apparently dependent on the time spent as an athlete were observed (both sexes).

Keywords: swimming athletes, anthropometry; body compositions; somatotype.

Introduction

The development of biological potential in sports performance is associated with a series of factors linked to highly systematized processes, often referred to as sports training theory and methodology. Evaluating and monitoring the effect of these aspects is of great importance for defining new criteria for biomedical control in athletes, especially in early stages such as childhood, puberty, and adolescence. Thus, determining the factors that influence athletes to improve or affect their adaptation process to training, their morphofunctional development, and their biological potential for sports performance will facilitate obtaining results. Sports training is a work plan whose main objective is the development of the biological potential of the athlete's physical sports performance. This plan must be systematically designed and scientifically supported in the short, medium, and long term to allow for the control, evaluation, and correction of the process (Williams & Reilly, 2000; Pieter &

Falco, 2011). Currently, the biomedical control of sports training development draws on contributions from different scientific areas of knowledge, leading to the rigorous and thorough application of this control defining the supremacy in sports performance observed among different countries, regions, and continents. In every sports training plan, the majority of elements that consider the individual characteristics of the subject must be introduced to influence their development (Kapczuk, 2017).

In this context, it is worth highlighting anthropometry, a branch of science that deals with measurements of the human body in areas such as health and sports. In the specific case of sports, it analyzes indicators of body composition using reference models, including the 4 component model, to study body fat, bone tissue, muscle tissue, and residual weight (Taboada-Iglesias et al., 2015). Different sports disciplines induce body compositions and somatotypes that are sometimes very particular. Regarding swimming,

male athletes generally have an ectomesomorphic somatotype, while female athletes mostly present an endomesomorphic somatotype (Ubago-Guisado et al., 2017).

To date, there is no anthropometric variable whose value guarantees sports success; rather, it is the combination of different indicators that make the difference and help improve the athlete's performance. Additionally, swimming exhibits marked sexual dimorphism, resulting in a notable anthropometric difference between the sexes (Martínez-Sanz et al., 2012). The objective of this work is to determine the body composition and somatotype of athletes who are part of the Swimming Sports School at the Maldonado Campus, Uruguay.

Methods

The study is descriptive and cross-sectional; it consists of the anthropometric evaluation of athletes from the Maldonado Sports School, Uruguay, specializing in Swimming, in the period from May to July 2023. The methods used were at the theoretical level, the Analytical-synthetic and the induction-deduction; both methods allowed analyzing the results obtained through the empirical measurement of the morphological variables studied in this research. The research complied with the precepts of the Helsinki Declaration. All subjects participated voluntarily, and given the type of study and techniques used therein, this research respected all ethical procedures for data collection and the Personal Data Protection Law No. 18331 of the Republic of Uruguay. The parents and/or guardians of the subjects under study signed the necessary informed consent to carry out the measurements.

Participants

The universe of study consisted of athletes from the Maldonado Sports School Swimming Campus, Uruguay. The study included 38 athletes aged between 10 and 18 years, of both sexes (23 females and 15 males). All athletes have a training frequency of 5 days per week and session durations of 3 hours. The time that the members of the group have been training is from 2 to 6 years. The athletes were grouped by sex and distributed among the categories defined by the governing body of swimming in Uruguay, based on the calendar age, 10 years old, Infant A1 (3 athletes); 11 years old, Infant A2 (8 athletes); 12 years old, Infant B1 (4 athletes); 13 years old, Infant B2 (10 athletes); 14 and 15, Juvenile A (8 athletes); from 16 to 18 years old, Juvenile B (5 athletes). All apparently healthy, verified through the athlete's valid health card.

Variables

For the morphological study, a group of anthropometric variables were measured, including weight and height, as well as the following circumferences: relaxed arm, contracted arm, mid-thigh, leg, waist, abdomen, and hip. Bone diameters were recorded, such as biestiloideal, biepicondylar of the humerus, and bicondyle of the femur. Regarding skinfold measurements, they were taken from the biceps brachii, triceps brachii, subscapular, supraspinal, umbilical, mid-thigh, and medial calf. The methodology proposed by the International Society for the Advancement of Kinanthropometry (ISAK) was used for the measurement of all these variables. All these data were used to determine body composition and somatotype.

Measurement Instruments

Skinfold measurements were taken with SLIMGUIDE calipers of 80 mm. Bone diameters were taken with 16 and 60 cm CESCORF calipers. Circumferences were determined with 150 cm PrimeMed anthropometric tapes. Height and weight were recorded with an RL-MPS mechanical scale with a resolution of 0.1 cm and 0.01 kg, respectively.

Data Collection, Processing, and Analysis

Measurements were taken in triplicate. All variables were statistically processed using the Scipy library of Python version 3.10. The data distribution analysis was performed using the Shapiro-Wilk normality test. To determine body composition, the 4 component method was used for each sex (Taboada-Iglesias et al., 2015), where the equation to determine the % of fat was proposed by Faulkner (1968), for athletes and different sexes. For the % of bone weight, the Von Döbereiner equation modified by Rocha, M., was used (López Cáceres et al., 2019). The Wurch equation for residual weight and % body mass is calculated from the values of the other 3 components. The somatotype was determined using the three components of the somatotype separately (endomorph, mesomorph, ectomorph) following the Heath-Carter method (Carter, 2002), and was reported the low, moderate, and high classification (Erazo et al., 2022). All parameters were determined and classified by sex.

Results

As mentioned earlier, the group of athletes studied comprises several age groups (from 10 to 18 years old). Considering that each subgroup has few subjects, the results are presented grouped by sex, and the values of the different studied body

components (fat tissue, bone tissue, muscle tissue, and residual weight) are shown as percentages.

Body Composition

Body composition of female athletes

The data on body composition of female athletes (Fig. 1) show a normal distribution, except for adipose tissue (values not shown). Regarding the average values for fat tissue, bone tissue, muscle

tissue, and residual weight, they were 16.48, 17.20, 45.43, and 20.90, respectively. In terms of standard deviation, it can be observed that it is relatively moderate for these variables, except for residual weight, which is very low. In general, the group of female athletes shows considerable homogeneity regarding the 4 components of body composition studied.

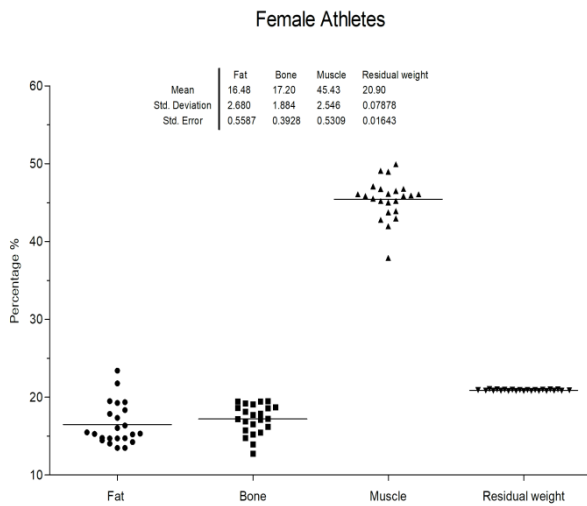


Fig. 1. This figure presents the percentages and descriptive statistics of four components (fat, bone, muscle, and residual weight) for a sample of female athletes ($n = 23$). The standard deviation is relatively moderate for these variables, with the exception of residual weight, which is very low. This suggests that the group of female athletes is homogeneous with respect to the four components of body composition studied. The development of muscle tissue is also evident.

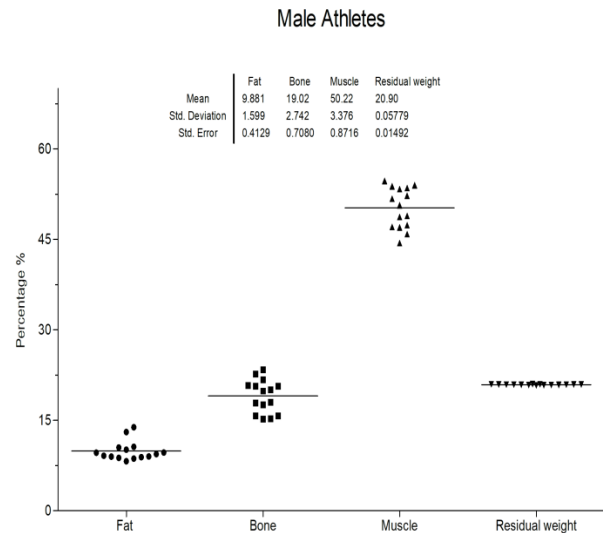


Fig. 2. This figure presents the percentages and descriptive statistics of four components (fat, bone, muscle, and residual weight) for a sample of male athletes ($n = 15$). The standard deviation is relatively moderate for these variables, with the exception of residual weight, which is very low. This suggests that the group of male athletes exhibits considerable homogeneity with respect to the four components of body composition studied. The significant development of muscle tissue is also evident.

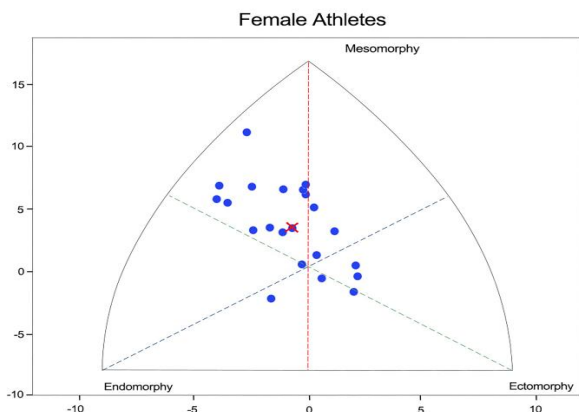


Fig. 3. The somatochart displays the somatotypes for each female athlete, represented by circles. The 'X' represents the average somatotype of the group ($x = -0.67$, $y = 3.77$). $n = 23$. The group of female athletes demonstrates a clear tendency towards mesoendomorphy and exhibits heterogeneity in somatotype.

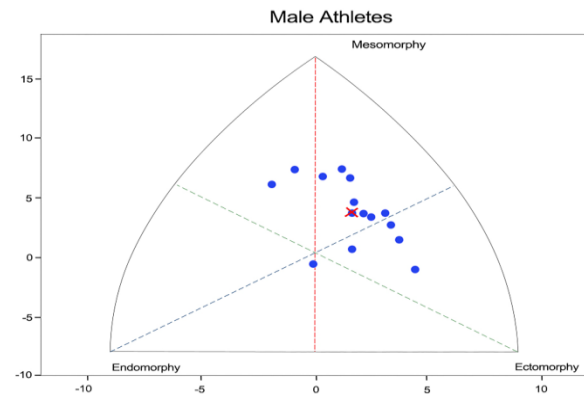


Fig. 4. The somatochart displays the somatotypes for each male athlete, represented by circles. The 'X' represents the average somatotype of the group ($x = 1.59$, $y = 3.95$). $n = 15$. The group of male athletes demonstrates a clear inclination towards mesoectomorphy and exhibits heterogeneity in somatotype.

Body composition of male athletes

The data on body composition of male athletes (Fig. 2) show a normal distribution, except for adipose tissue (values not shown). In the case of the average values for fat tissue, bone tissue, muscle tissue, and residual weight, they were 9.88, 19.02, 50.22, and 20.90, respectively. Regarding the standard deviation, it can be observed that it is relatively moderate for these variables, except for residual weight, which is very low. In general, the group of male athletes shows considerable homogeneity regarding the 4 components of body composition studied.

Table 1
Female athletes somatotype (n=23).

	Endomorphy	Mesomorphy	Ectomorphy
Mean	3,248	4,787	2,565
Std. Deviation	1,074	1,608	1,062
Std. Error	0,2239	0,3354	0,2214

*Somatotype**Somatotype of female athletes*

As can be seen in Table 1, the group of female athletes shows moderate values in the 3 components, with a clear tendency towards mesoendomorphy. On the other hand, the standard deviation values and the somatocharts (Fig. 3) show that the group of female athletes exhibits heterogeneity in somatotype.

Table 2
Male Athletes somatotype (n=15).

	Endomorphy	Mesomorphy	Ectomorphy
Mean	1,773	4,533	3,373
Std. Deviation	0,9362	0,9248	1,121
Std. Error	0,2417	0,2388	0,2894

Somatotype of male athletes

Table 2 shows that the group of male athletes has moderate values in the mesomorphic and ectomorphic component, while presenting a low value for the endomorphic component, resulting in a clear inclination towards mesoectomorphy. On the other hand, the standard deviation values and the somatocharts (Fig. 4) suggest that the male group exhibits heterogeneity in somatotype.

Somatotype and years of training

In the studied population, it is observed that as athletes' training years increase, the somatotype undergoes modifications and shows a trend toward positive values on the X-axis of the somatochart (Fig. 5 and 6).

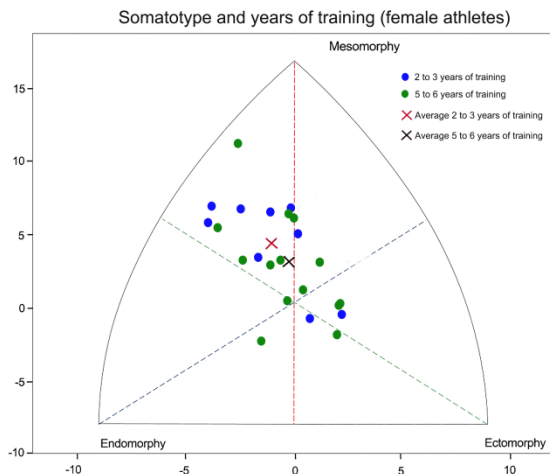


Fig. 5. The somatochart shows the difference in somatotypes between female swimming athletes who have been training for 2 to 3 years, represented by the blue dots ($n = 9$) and those who have been training for 5 to 6 years, represented by the green dots ($n = 14$). The red 'X' represents the average of 2 to 3 years ($x = -1.16$, $y = 4.75$). The black 'X' represents the average of 5 to 6 years ($x = -0.36$, $y = 3.14$). In the group with the longest training time, the average approaches centrality from the left (the endomorphic component decreases).

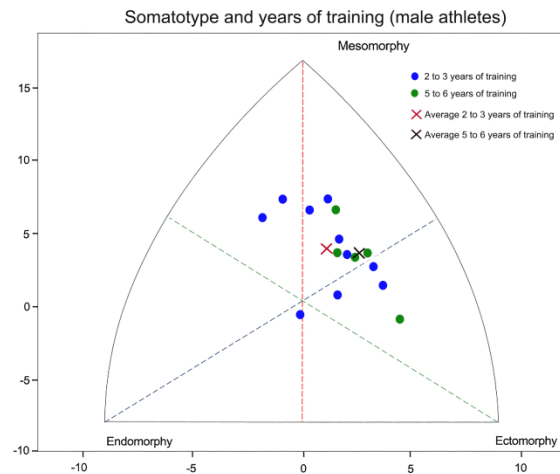


Fig. 6. The somatochart shows the difference in somatotypes between male swimming athletes who have been training for 2 to 3 years, represented by the blue dots ($n = 10$) and those who have been training for 5 to 6 years, represented by the green dots ($n = 5$). The red 'X' represents the average of 2 to 3 years ($x = 1.09$, $y = 4.19$). The black 'X' represents the average of 5 to 6 years ($x = 2.59$, $y = 3.45$). In the group with the longest training time, the average moves away from centrality to the right (the ectomorphic component tends to increase).

Discussion

Body composition has been fundamental in anthropometric studies. The combination of skinfold measurements and measurements of body circumferences and diameters provides the means to create models for a specific population. Additionally, anthropometric indices are used as a mechanism to assess health, guiding specialist interventions. On the other hand, determining somatotype is relevant for athletes as it allows for the combination and comparison of structural elements of the human body based on the specific sports specialty being performed. From the results obtained regarding the anthropometric characteristics of body composition and somatotype in the group of athletes studied, the following data and interpretations can be extracted.

As mentioned earlier, data grouping has been done by sex, which has meant that athletes with different chronological ages and different stages of maturity integrate the same category. This situation somewhat explains the standard deviation present in the data (Fig. 1 and 2), especially in the muscular and bone tissue of male athletes (Kraemer & Ratamess, 2005). In terms of body composition, it is observed that in female athletes, the percentage of fat component is predominant (Fig. 1), which is expected due to the physiological changes inherent to puberty and

adolescence, favoring the accumulation and distribution of adipose tissue in individuals of this sex as a result of increased estrogen and progesterone release (Torres Navarro, 2020). On the other hand, male athletes show a predominance in the osteomuscular components (Fig. 2), resulting in a higher percentage of muscle and bone mass compared to adipose tissue, probably as a result of increased testosterone and androgen levels experienced by this sex during puberty and adolescence (Tsolakakis et al., 2000). These findings are consistent with reports from studies conducted in similar populations (Martínez-Sanz et al., 2012). However, in the specific case of the muscular component, there are reports of higher percentages of muscle mass in swimmers of similar ages, which could be due to the use of different equations for its calculation. Another possibility could be attributed to different dietary habits or the genetic predisposition of the populations in question (Torres Navarro, 2020). Regarding somatotype, most evaluated female athletes are classified as mesoendomorphic, although there is a significant dispersion of data, the average tends towards centrality (Table 1 and Fig. 3). This finding differs from other studies conducted in groups of athletes of similar ages, where they report a balanced endomorphic somatotype in female athletes (Martínez-Sanz et al., 2012; Torres Navarro, 2020). Nevertheless, it

is very similar to the results of other research carried out in female swimming athletes of similar ages (Torres Navarro, 2020) and in adult swimming athletes, where the somatotype tends to be central or balanced mesomorphic (Fernandes et al., 2002). Furthermore, it can be observed that female athletes who have trained for a greater number of years within the team exhibit, on average, a greater centralization in the somatotype (balanced mesomorphic). This suggests that it could be an adaptation to the type of training they receive (Fig. 5).

On the other hand, the average somatotype of the male athletes' group is classified as mesoectomorphic, also with significant data dispersion but with a clear tendency towards centrality (Table 2 and Fig. 4). These results differ from those of other studies conducted in populations of similar ages and in adults, where the somatotype found was ectomesomorphic (Fernandes et al., 2002; Martínez-Sanz et al., 2012) and ectoendomorph (Martínez et al., 2011), respectively, but they approach a recent study conducted in athletes of the same age (Torres Navarro, 2020). In male athletes with more years of training in the team, it can be observed that the average somatotype, unlike female athletes, deviates from centrality and shifts to the right (ectomorpho-mesomorpho). Therefore, the ectomorphic component tends to increase. However, it also suggests that this could be due to an adaptation to the type of training they undergo (Fig. 6).

In general, the endomorphic component reported in this study for both sexes is lower (female < 3.3; male < 1.8) when compared to previous studies conducted in athletes of similar ages (Fernandes et al., 2002; Martínez et al., 2011; Martínez-Sanz et al., 2012; Torres Navarro, 2020). This might potentially be counterproductive due to hydrodynamic reasons, such as increase the contact area of the body surface and the metabolic cost of translation (Martínez-Sanz et al., 2012). Similarly, there are differences in the mesomorphic component found in this study (female > 4.7; male > 4.5) compared to previous studies that have reported much lower values (Fernandes et al., 2002; Martínez et al., 2011; Martínez-Sanz et al., 2012). However, these

values are similar to those reported by Torres Navarro (2020). Furthermore, it was observed that athletes in this group (both sexes) who have more years of training within the team exhibit a greater tendency toward decreasing the endomorphic component.

Conclusion

The present study provides a detailed insight into the body composition and somatotype of the athletes participating in the Sports Swimming School at the Maldonado Campus, Uruguay. Although not the primary focus of this study, heterogeneity was observed in the different components of body composition among female and male athletes, as well as within each group. Concerning body composition, it was found that in the studied group, female athletes exhibit a predominance of adipose tissue, while male athletes show a higher proportion of bone and muscle tissue. These findings align with results reported in the literature and are likely influenced by physiological factors such as sex hormones and differences in growth and developmental patterns. Regarding somatotype, a trend towards centrality with a predominance of the mesomorphic component was observed. A relevant observation is that the studied group of athletes (both sexes) present low levels of the endomorphic component compared to studies conducted in populations of similar and adult ages, which could be unfavorable for swimmers. It was also found that the somatotype of swimming athletes undergoes modifications, which are apparently dependent on the time the subject has been training (adaptations) and shows a tendency towards positive values on the X-axis of the somatotype (both sexes).

However, it is important to acknowledge the limitations of this study, such as the small sample size and the exclusion of other factors that could influence body composition and somatotype, such as diet, level of physical activity outside of training, and genetic factors. Therefore, it is suggested that future research address these limitations and further explore the relationships between anthropometry, athletic performance, and other aspects related to the health and well-being of athletes.

Acknowledgments

We thank the coaches, representatives and tutors of the athletes of the Maldonado Campus Swimming School, Uruguay.

Funding: This work was financed through the call for strengthening research groups of the Instituto Superior de Educación Física (ISEF), Universidad de la República (Udelar).

Competing interests

The authors declare that they have not competing interests.

References

- Carter, J. E. L. (2002). *THE HEATH-CARTER ANTHROPOMETRIC SOMATOTYPE-INSTRUCTION MANUAL - Somatotype Instruction Manual 2 Part 1: The Heath-Carter Anthropometric Somatotype-Instruction Manual*. www.tep2000.com
- Erazo, J. S., Gálvez Pardo, Á. Y., Castro Jiménez, L. E., Arguello Gutiérrez, Y. P., & Melo Buitrago, P. J. (2022). Body Composition, Dermatoglyphics and Aerobic Resistance in Sub-20 Category Footballers from Bogota, Colombia. *MHSalud*, 19(1). <https://doi.org/10.15359/mhs.19-1.10>
- Faulkner, J. A. (1968). Physiology of swimming and diving. *Exercise Physiology*, 24.
- Fernandes, R., Barbosa, T., & Vilas-Boas, J. P. (2002). Determinant kinantropometric factors in swimming. *Revista Brasileira de Cineantropometria e Desempenho Humano*, 4(1).
- Kapczuk, K. (2017). Elite athletes and pubertal delay. In *Minerva Pediatrica* (Vol. 69, Issue 5). <https://doi.org/10.23736/S0026-4946.17.05044-7>
- Kraemer, W. J., & Ratamess, N. A. (2005). Hormonal responses and adaptations to resistance exercise and training. In *Sports Medicine* (Vol. 35, Issue 4). <https://doi.org/10.2165/00007256-200535040-00004>
- López Cáceres, P. A., Chena Sinovas, M., Asín Izquierdo, I., Moreno Ortega, A., & Rojas, R. M. (2019). Effect of contextual factors on body composition in professional soccer players. A retrospective study. *Nutricion Hospitalaria*, 36(6), 1324–1331. <https://doi.org/10.20960/nh.02783>
- Martínez, S., Pasquarelli, B. N., Romaguera, D., Arasa, C., Tauler, P., & Aguiló, A. (2011). Anthropometric characteristics and nutritional profile of young amateur swimmers. *Journal of Strength and Conditioning Research*, 25(4). <https://doi.org/10.1519/JSC.0b013e3181d4d3df>
- Martínez-Sanz, J. M., Mielgo-Ayuso, J., & Urdampilleta, A. (2012). Body Composition and Somatotype in Adolescent Competition Swimmers | Composición corporal y somatotipo de nadadores adolescentes federados. *Revista Espanola de Nutricion Humana y Dietetica*, 16(4). [https://doi.org/10.1016/S2173-1292\(12\)70087-X](https://doi.org/10.1016/S2173-1292(12)70087-X)
- Pieter, W., & Falco, C. (2011). Skinfold patterning in elite spanish and american junior taekwondo-in. *Ido Movement for Culture. Journal of Martial Arts Anthropology*, 11(1).
- Taboada-Iglesias, Y., Gutiérrez-Sánchez, Á., & Vernetta, M. (2015). Proportionality Indices and Body Composition of Elite Acrobatic Gymnasts, Índices de proporcionalidad y composición corporal de la Élite de gimnasia acrobática. *International Journal of Morphology*. <https://doi.org/10.4067/S0717-95022015000300030>
- Torres Navarro, V. (2020). COMPOSICIÓN CORPORAL Y SOMATOTIPO DE JÓVENES DEPORTISTAS DE ALTO NIVEL DE ATLETISMO, NATACIÓN Y TRIATLÓN. *Revista Española de Educación Física y Deportes*, 429. <https://doi.org/10.55166/reefd.vi429.898>
- Tsolakis, C., Messinis, D., Stergioulas, A., & Dessypris, A. (2000). Hormonal Responses after Strength Training and Detraining in Prepubertal and Pubertal Boys. *Journal of Strength and Conditioning Research*, 14(4). <https://doi.org/10.1519/00124278-200011000-00006>
- Ubago-Guisado, E., Mata, E., Sánchez-Sánchez, J., Plaza-Carmona, M., Martín-García, M., & Gallardo, L. (2017). Influence of different sports on fat mass and lean mass in growing girls. *Journal of Sport and Health Science*, 6(2). <https://doi.org/10.1016/j.jshs.2015.06.001>
- Williams, A. M., & Reilly, T. (2000). Talent identification and development in soccer. *Journal of Sports Sciences*, 18(9). <https://doi.org/10.1080/02640410050120041>