

# SOMATOTYPE AND BODY COMPOSITION OF ELITE BRAZILIAN GYMNASTS

**Andrea Ferreira João, José Fernandes Filho**

Universidade Federal do Rio de Janeiro - Escola de Educação Física e Desporto  
Rio de Janeiro, Brazil

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## **Abstract**

*The main objective of this study was to analyze the somatotype and body composition of elite athletes in Brazilian artistic gymnastics, belonging to the junior and senior categories. Forty-six athletes were assessed, whereby 21 were from Male Artistic Gymnastics and 25 from Female Artistic Gymnastics. To determine the somatotype, the Heath & Carter's anthropometric method was used (1990). The body composition was assessed by electrical bioimpedance on the InBody R20 scale, and variables of skeletal muscle mass (MM), fat mass (MG), fat-free mass (MLG) and fat percentage (%G) were measured. Descriptive statistics was used. Results show that the dominant somatotype within the group of male gymnasts was the Balanced mesomorph while among the females, the prevalent classification was Ectomorphic mesomorph. The body composition of the male gymnasts presented the average values of  $33.08 \pm 3.53$  kg for lean muscle mass,  $7.44 \pm 1.57$  kg for fat mass,  $57.74 \pm 5.78$  kg for fat-free mass and a fat percentage of  $11.39 \pm 2.08$ , while the female gymnasts showed values of  $21.7 \pm 3.38$  kg for lean body mass,  $7.55 \pm 2.73$  kg for fat mass,  $38.12 \pm 5.77$  kg for fat-free mass and a fat percentage of  $15.84 \pm 3.79$ . These results corroborate with the existing profiles for the modality of artistic gymnastics found in literature.*

**Keywords:** *Artistic gymnastics, Anthropometry, Somatotype, Elite Gymnasts, Body composition.*

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## **INTRODUCTION**

There are many factors that determine success in elite sport. Among them, having anthropometric characteristics specific to one's chosen sport brings various advantages to the athlete. The process by which the physical demands of a sport determine the most adequate morphology and body composition for said sport is known as "morphological optimization" (Norton & Olds, 2000).

The somatotype and body

composition has great influence on the performance of various sports in high level. In artistic gymnastics these variables also play an important role. In general, the morphological characteristics of elite gymnasts are basic in competitions, due to the new demands of gymnastics code of points, and the creation of new exercises that are increasingly difficult, as those who need more rotation about the axis vertical and horizontal. There are few studies that

address the influence of somatotype and body composition in the performance of gymnasts (Poblano-Alcalá & Braum-Zawosnik, 2014).

The somatotype is a method used to assess the morphological characteristics of an individual. It is defined as the quantification of the current form and composition of the human body. It is expressed in a classification of three numbers which represent the endomorph, mesomorph and ectomorph components respectively, and always appear in this same order. Endomorph refers to the state of relative fatness, mesomorph represents relative musculoskeletal robustness, and ectomorph is the relative linearity or leanness of a body. Results within each of the aforementioned categories of  $\frac{1}{2}$  to  $2\frac{1}{2}$  are considered low, from 3 to 5 are moderate,  $5\frac{1}{2}$  to 7 are high, and  $7\frac{1}{2}$  or more are very high. This classification is phenotypic, i.e. it is subject to change with growth, exercise, nutrition and ageing, and is applicable to both genders from childhood to old age. (Carter & Heath, 1990).

Heath and Carter's anthropometric somatotype system has been the most commonly used to identify the somatotype profile of athletes from various sports, including Men's (MAG) and Women's (WAG) Artistic Gymnastics respectively (Claessens, Beunen, Stijnen, Maes, & Veer, 1991; João & Fernandes Filho, 2002; Čuk, et al., 2007; Arkaev & Suchilin, 2009; Kvetoslava, Vadasová, & Sousková, 2013; Massidda, Toselli, Brasili, & Calò, 2013; Hedbávný, Cacek, & Svobodová, 2014; Mosqueira, et al., 2014; Rodrigues, Castillo, Tejo, & Rozowski, 2014). A review of the somatotype of female gymnasts shows the predominance of mesomorphism, while the rate of ectomorphism is higher than endomorphism. This classification is known as "Ectomorphic mesomorph" and differentiates the gymnasts from non-athletic women, who tend to be more endomorphic and less mesomorphic (Sands, Caine, & Borms, 2003).

Furthermore, artistic gymnastics is an

example of a sport in which the body is pushed against gravity, and because of this, the gymnast should be light. For gymnasts, the advantages of being lighter and shorter can be proven by biomechanics and also by the ratio of absolute force to relative force and the relation between height and weight.

Body composition plays an important role when leading programs that control body weight and in the prescription of exercises. It is normally used to describe the percentage of fat, bones and muscles in the human body. It encompasses predetermined genetic factors, but ones that can be enhanced and are approximate to the reference values of the chosen sport (Fernandes Filho, 2010).

A case study in China reports the difficulty faced by a gymnast from the male national team to reduce his body weight just before the 2012 Olympic Games.

The authors reported that one aspect of the gymnast's successful weight-loss program was the use of the "true" body weight indicator to record the gymnast's emotions and encourage the athlete. The gymnast's body composition was assessed so that he could clearly understand the difference between body weight and body fat. As well as motivating the gymnast to follow the program, this made it possible to control his weight effectively, yielding excellent results in the competition. (Haitao Chen, 2013). This assessment of the athletes' body composition allowed for the measurement of the ideal body weight for a competition and the monitoring of changes in the lean and fat components of the body, used as a way of monitoring athletes preparing for competitions (Rodrigues C. et al., 2013).

Various studies found in literature note the use of electrical bioimpedance to assess the body composition of gymnasts (Perecinská, Vadasová, & Sousková, 2013; Hedbávný, Cacek, & Svobodová, 2014). The method of bioimpedance involves passing a low-intensity electrical current through two electrodes and into the hands and feet of the individual under assessment.

Cellular fluids act as conductors and the cellular membranes as condensers. The difference of current caused by the impedance is detected by two receptors. Knowing a person's height and impedance makes it possible to calculate the volume of water in the body (Fernandes Filho, 2010).

There are many studies on the somatotype and body composition of gymnasts but none directed towards both male and female Brazilian artistic gymnasts, thus leaving a gap in literature on the topic.

The main objective of this study was to analyze the somatotype and the body composition of elite Brazilian artistic gymnasts belonging to the junior and senior categories.

## METHODS

This study analyzed the somatotype and body composition of 46 elite Brazilian Artistic Gymnasts belonging to the junior and senior categories, where 21 gymnasts were from Male Artistic Gymnastics and aged  $20.3 \pm 3.41$  years and 25 were from Female Artistic Gymnastics and aged  $17 \pm 4.66$  years. The criterion of inclusion was to have been selected at least once to represent the Brazilian Team in an International Championship since 2012. The study was presented to the Brazilian Gymnastics Federation and the coaches responsible for the gymnasts, who were informed about the research and its objectives. Then the coaches and gymnasts voluntarily signed the Consent Form to participate in the study.

All the anthropometric measurements follow the protocol of the norms and techniques of measurement recommended by the "International Society for the Advancement of Kinanthropometry" (ISAK). To calculate the somatotype, the Heath & Carter's anthropometric method was used (1990).

Ten anthropometric variables were analyzed: Subscapular Cutaneous Fold, Triceps Cutaneous Fold, Supraspinal Cutaneous Fold, Cutaneous Fold of the Calf, Humerus Bi-epicondylar Diameter, Femur Bi-epicondylar Diameter, Perimeter

of the Contracted Arm, Perimeter of the Calf, Height and Weight.

In order to determine body composition, the method of electrical bioimpedance was used in conjunction with the Inbody R20 scale. The muscle mass (MM), fat mass (MG), fat percentage (%G) and fat-free mass (MLG) were assessed. All the gymnasts were informed of the standard necessary conditions before measurement of body composition using the Inbody R20 took place: 1. To conduct the test with an empty stomach and bladder; 2. To not conduct exercise before the test nor have a shower, dry or steam sauna, as the heat provokes a temporary change in conductivity inside the body;

3. That their arms needed to be by their sides and away from the body.

The cutaneous folds were measured using the Prime Digita compass (Terra Azul); the diameters using the Cescorf pachymeter and perimeters with the Sanny measuring tape (precision 1.0 mm). For body composition, the Inbody R20 model scale of Biospace was used, based on the principle of electrical bioimpedance (BIA).

The current study was developed within a model of descriptive and transversal research. The statistical analysis was conducted by describing the data obtained for the somatotype and body composition, using the measurements of central trend (average) and standard deviation, as well as the minimum and maximum values.

## RESULTS

The objective of this study was to analyze the somatotype and body composition of elite Brazilian Artistic Gymnasts, belonging to the junior and senior categories.

The average age, weight and height of the groups of male and female gymnasts are presented in tables 1 and 2, respectively. The minimum age for a gymnast to compete in the junior category in Brazil is 14 for boys and 12 for girls with birthdays in the same year as the competition. For this

reason, the authors observed younger female gymnasts. On the other hand, men tend to remain in the sport longer, so the average age of men is higher than that of women.

Assessment of the male gymnasts shows that the predominant somatotype is the Balanced mesomorph, as demonstrated in Table 3. According to Heath & Carter (1990), this classification corresponds to dominant mesomorphism, while endomorphism and ectomorphism are the same (or do not differ by more than 0.5).

Graph 1 shows the percentage distribution of the somatotype in which 3 classifications were observed. The first was found in 48% of the gymnasts assessed with Balanced mesomorph, the second in 33% of the Endomorphic mesomorph and the third, Ectomorphic mesomorph in 19%. It is worth noting that in 33% of gymnasts classified as Endomorphic mesomorph, mesomorphism was dominant, however endomorphism was greater than ectomorphism.

Table 1

*Average values and their derivatives for Age, Weight and Height of the athletes in Male Artistic Gymnastics.*

<i>Variables</i>	<i>Age/year</i>	<i>Weight/kg</i>	<i>Height/cm</i>
Average	20.14	65.06	165.38
Standard Deviation	2.94	6.37	5.91
Minimum	15	53.90	156
Maximum	27	77.3	177

Table 2

*Average values and their derivatives for Age, Weight and Height of the athletes in Female Artistic Gymnastics.*

<i>Variables</i>	<i>Age/year</i>	<i>Weight/kg</i>	<i>Height/cm</i>
Average	14.3	43.7	148.7
Standard Deviation	2.30	8.68	8.61
Minimum	12	29.50	131
Maximum	22	57.30	160

Table 3

*Components of the Male Artistic Gymnasts' somatotype.*

<i>Variables</i>	<i>Endo</i>	<i>Meso</i>	<i>Ecto</i>
Average	1.82	7.06	1.60
Standard deviation	0.53	1.15	0.58
Minimum	1.05	4.33	0.54
Maximum	2.87	9.38	3.04

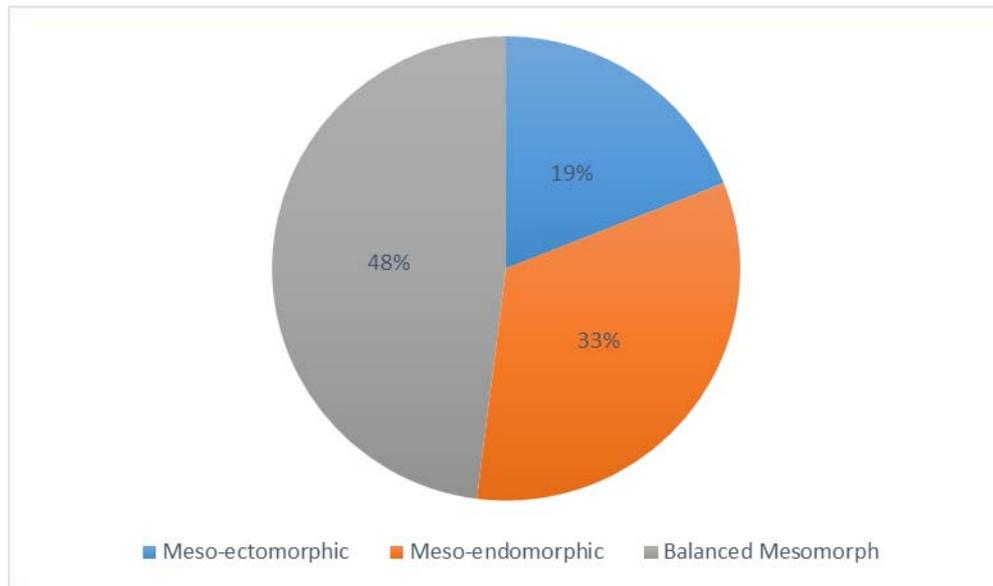


Figure 1. Percentage distribution of the Male Artistic Gymnasts' somatypes.

Table 4

Components of the somatotype of Female Artistic Gymnasts.

Variables	Endo	Meso	Ecto
Average	1.84	5.20	2.52
Standard Deviation	0.67	0.63	1.04
Minimum	0.96	3.92	0.86
Maximum	3.09	6.12	4.44

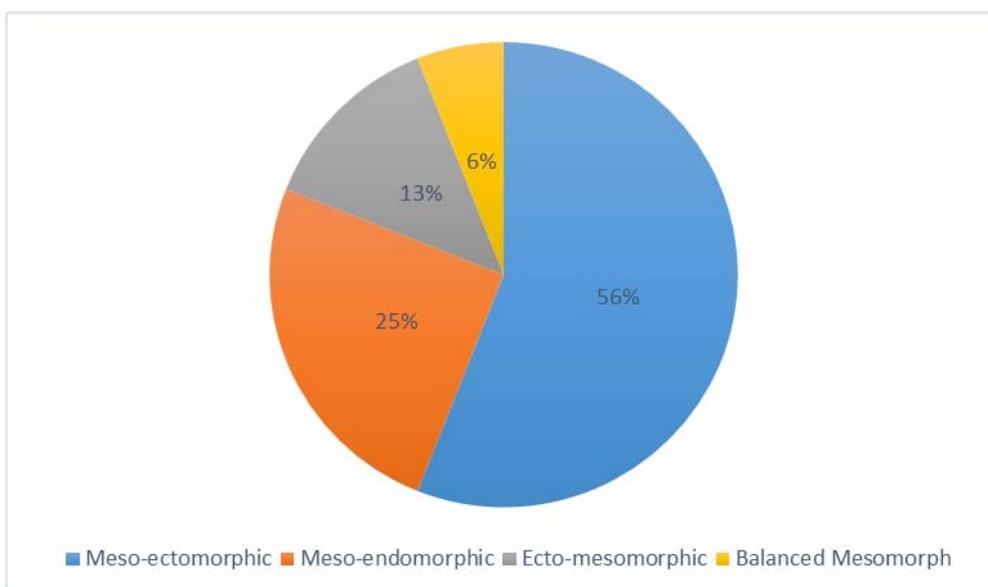


Figure 2. Percentage distribution of the somatypes present in Female Artistic Gymnasts.

Table 5  
*Body composition of Male Artistic Gymnasts.*

	Muscle Mass (kg)	Fat mass (kg)	Fat-free mass (kg)	Fat (%)
Average	33.08	7.44	57.74	11.39
Standard Deviation	3.53	1.57	5.78	2.08

Table 6  
*Body composition of Female Artistic Gymnasts.*

	Muscle Mass (kg)	Fat mass (kg)	Fat-free mass (kg)	Fat (%)
Average	21,07	7.55	38.12	15.84
Standard Deviation	3.38	2.73	5.77	3.79

As shown in table 4, assessment of the female gymnasts showed that the predominant somatotype is the Ectomorphic mesomorph, whereby mesomorphism is dominant and ectomorphism is greater than endomorphism (Heath & Carter, 1990).

This study showed that 56% of the gymnasts assessed were classified as Ectomorphic mesomorph, 25% Endomorphic mesomorph, 13% Mesomorph-ectomorph and 6% Ectomorphic mesomorph. This distribution can be seen in Graph 2.

The body composition of the male gymnasts showed the average values of  $33.08 \pm 3.53$  kg for lean muscle mass,  $7.44 \pm 1.57$  kg of fat mass,  $57.74 \pm 5.78$  kg for fat-free mass and a fat percentage of  $11.39 \pm 2.08$ . Meanwhile, the female gymnasts exhibited values of  $21.7 \pm 3.38$  kg for lean body mass,  $7.55 \pm 2.73$  kg of fat mass,  $38.12 \pm 5.77$  kg for fat-free mass and a fat percentage of  $15.84 \pm 3.79$ , as shown in Table 6.

## DISCUSSION

Analysis of the somatotype's basic parameters and the body composition of both male and female artistic gymnasts will allow coaches to create training programs that are adequate for the needs of the

gymnasts, as well as assist in sports selection and guidance, examining and monitoring young people that best fit the required elite profile (João, Fernandes Filho, & Dantas, 1999; João & Fernandes Filho, 2002).

Arkaev & Suchilin (2009), presented the height and weight of the Russian gymnasts as 160-170 cm and 56 to 70 kg respectively for men and 150-160 cm and 38-50 kg for women. The results of this study verified that male Brazilian gymnasts showed similar values to the male Russian group, while the female group's were slightly inferior. This reinforces the idea that gymnasts are getting smaller and lighter. However, these same authors highlight that it is possible to find real "Gullivers" at an elite level, such as Alexander Dityatin (178 cm in height, weighing 72 kg), Eberhard Ginger (176 cm, 70 kg), Alexei Nemov (174 cm and 74 kg), Elvira Saade (166 cm and 52.5 kg), and Svetlana Khorkina (165 cm and 47 kg).

A study conducted in Chile assessed the somatotype of various sports, in which the male elite gymnasts presented a predominantly mesomorphic profile, as well as age values of  $27 \pm 2.38$ , a weight of  $74.1 \pm 4.5$  kg and height of  $173.8 \pm 7.3$  cm. This classification presents an average level of fat and the predominance of muscle mass,

which is favorable for the performance of these athletes (Rodríguez, Castillo, Tejo, & Rozowski, 2014). The Chilean gymnasts' results are similar to those of the Brazilian gymnasts and of other nationalities found in literature.

In this study, the somatotypic profile of the Female Artistic Gymnasts was characterized as Ectomorphic mesomorph, whereby mesomorphism is dominant and ectomorphism is greater than endomorphism. This result differs from the somatotype found in the study conducted in 2002, conducted with 25 highly-qualified Brazilian gymnasts (João & Fernandes Filho, 2002). These athletes were classified as Mesomorph-ectomorph, whereby ectomorphism is dominant and mesomorphism is greater than endomorphism. This demonstrates that the mesomorph component, where the low relative adiposity and low subcutaneous fat, with muscular visible contours were maintained, while the characteristic of increased relative linearity was substituted by the high development and volume of skeletal musculature, bone diameters and large articulations. This can be explained by the influence of the phenotype, a change in the methods of training and new requirements of the code of points.

Sands, Slater, McNeal, Murray, & Stone (2012) conducted a study that assessed the changes in size and age of 106 gymnasts from 14 Olympic teams between 1956 and 2008 at two levels: height, weight, age, and body-mass index (BMI). They concluded that since 1956, the height, weight, age, and body-mass index (BMI) of the athletes have been reducing. They attributed this to the changes in the rule of minimum age during this period. Low values can also be observed in the data for female Brazilian gymnasts, presented in this study. However, they verified that in the last four Olympic Games, the gymnasts of the United States team, on the other hand, have been getting bigger. The changes observed within the American team are important, as the United States' team was runner up in the

2008 Olympics and champions in 2012.

The National Health Institute of the United States of America recommends that the body of a healthy male adult should be between 6% - 24% fat and between 14%-31% for females. This study found values below the reference values in both the male and female groups of Brazilian gymnasts. This corroborates with the study of Poblano- Alcalá & Braum-Zawosnik (2014), which says that athletes such as gymnasts, slimmer individuals, and more muscular individuals present a body fat percentage lower than these levels. In general, most athletes manage to perform with a body fat percentage of between 7% - 19% for men, and 10% - 25% for women depending on their sport. (Poblano-Alcalá & Braum-Zawosnik, 2014)

The average amount of subcutaneous fat ( $13.33\% \pm 2.81$ ), assessed by electrical bioimpedance using the Inbody 720, was found in a study of eight female gymnasts from the Czech Republic that took part in the World Championship of 2010 (Hedbávný, Cacek, & Svobodová, 2014). This result is lower than the  $15.84\% \pm 3.79$  found in Brazilian gymnasts. However, the gymnasts from Brazil have a result similar to the  $16.4\% \pm 4.99$  found in 113 participants of European and World Championships in the last 15 years (Georgopoulos et al. cited by Hedbávný, Cacek, & Svobodová, 2014).

Another study of somatotype and body composition (assessed by electrical bioimpedance using the Inbody 720) was conducted on 13 female gymnasts from Slovakia between the ages of 7 and 13 and at different levels of performance (Perecinská, Vadasová, & Sousková, 2013). The results from the group of elite gymnasts of a higher average age (13.3) show that the fat percentage of 14.1%, and muscle mass of 23.4 kg are in line with the values obtained in this study, but with a difference in the variables of weight (50.5 kg) and height (161.2 cm), whereby the Brazilian gymnasts showed lower values.

## CONCLUSION

The somatotype is phenotypic, and is therefore susceptible to change with growth, training, nutrition and ageing. This is a transversal study, so a long term follow-up of young gymnasts ranging up to the adult category is advisable.

These results can be seen as trends, considering that with the constant changes of the code of points, technology, equipment and the evolution of the sport, they can undergo changes. Therefore, the authors strongly recommend the study of the dynamics of the morphological indexes and body composition of the gymnasts, seeing as these are bodily properties that change under the effect of training, growth and development.

It is important to highlight that the results reflect the current time and should be constantly updated in order to guarantee their reliability and, whenever possible, seek to increase the size of the sample.

Finally, it is important to highlight that Brazilian gymnastics has seen improved results in international events. Conducting a follow-up study of the athletes' somatotype and body composition is of major importance and may assist in the maintenance or improvement of these results.

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**Corresponding author:**

Andréa Ferreira João  
Universidade Federal do Rio de Janeiro  
Escola de Educação Física e Desporto  
Tel: + 55-21-9-9801-0232  
E-mail: andreaaj@domain.com.br

