Body composition, somatotype and proporcionality of elite bodybuilders in Brazil*

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ABSTRACT

Bodybuilding is a sport that mainly emphasizes physical appearance, body configuration and shape, trying to achieve aesthetics perfection. Kinanthropometry is a fundamental tool to lead training follow-up in bodybuilding. In spite of that, there are few scientific papers on the subject. The purpose of this paper is to describe body composition, somatotype and proportionality of 23 bodybuilders in the 2000 Brazilian Bodybuilding Championship. The subjects were evaluated moments before the competition according to the following specific variables: total weight, stature, nine skinfolds (tricipital, subscapular, bicipital, chest, medium axillary, suprailiac, abdominal, front thigh, medium calf), muscle girths (flexed biceps and calf-standing), and three bone breadths (elbow, ankle and knee), in accordance with ISAK methodology. The athletes were between 20 and 56 years old, with body weight between 57.4 kg and 105.8 kg. The sum of the nine skinfolds varied between 38.4 mm and 70.2 mm. The somatotype was 1.8-8.1-0.7, which can be classified as a balanced mesomorphic one. The average of body fat was 9.65%, using the Faulkner protocol, proposed by the Brazilian Group of Kinanthropometry. Fat weight was 7.29 kg. When compared to Phantom, the athletes showed higher body weight (Z = + 1.66), elbow girth (Z = + 5.26), and calf girth (Z = + 1.91). This group of Brazilian elite bodybuilders showed lower body fat percentage and bigger muscular weight when compared to the Ross and Wilson model (1974), with their body structure similar to the elite international bodybuilders.

Key words: Bodybuilding. Body composition. Kineanthropometry. Somatotyping. Proportionality. Z index. Faulkner. Phantom.

INTRODUCTION

Bodybuilding is a sport that stresses physical appearance, muscle shaping and body symmetry. By combining a highly selective diet and strength training, bodybuilders seek a better aesthetic performance. The purpose of their training is to achieve muscle maximization and physical symmetry with the lowest possible fluid and fat retention[1,2]. These are crucial factors at a competition, where a set of features will be considered: muscle mass, muscularity, muscle symmetry and shape[3]. Thus, body composition is certainly a decisive factor to guide bodybuilding training.

Ross *et al.*[4] described the expression "kinanthropometry" for the first time in 1972, and its most used definition is "the study of body size, shape, proportionality, composition, and biological maturation. Its purpose is to understand the growth process, training and sports performance".

The milestone for the development of kinanthropometry around the world was during the 1976 Montreal Olympic Games, where the unification of kinanthropometric measurements regulation was proposed for the first time[5].

Some investigators have used body composition and somatotype as tools to assess body and morphology features of bodybuilders, in order to quantify data for this population[1,2,6-9]. However, few studies so far, in Brazil and around the world, have addressed this issue[6,8,10,11].

With this in mind, this paper intends to describe body composition, somatotype and body proportionality of Brazilian elite bodybuilders in the year 2000.

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MATERIALS AND METHODS

Sample

Our sample included 23 male athletes from a total of 63 athletes classified for the finals of the Brazilian Bodybuilding and Fitness Championship, held in the city of São Paulo, in the year 2000. The athletes were assessed moments before the competition. This investigation was approved by the Ethics in Research Committee of the Rio Grande do Sul Catholic University (PUC-RS). The athletes agreed to take part in this investigation by signing an informed consent form.

Anthropometry

Measurements were taken according to the International Society for the Advancement of Kineanthropometry guidelines[12], and from each subject the following variables were assessed: total weight, total stature, nine skinfolds (tricipital, subscapular, bicipital, chest, medium axillary, suprailiac, abdominal, front thigh, and medium calf), two muscle girths (flexed biceps, calf standing), and three bone breadths (elbow, ankle and knee).

Weight was measured on a *Filizola* scale, with accuracy of 100 g; height with a vertical metric scale with a 1 mm accuracy; skinfold thickness was assess by a *Lange*-type caliper with a 0.2 mm accuracy; muscle girths were measured with a metallic *Rosscraft* 1 mm accuracy scale, and breadths with a 1 mm accuracy *Rosscraft Campbell*-type bone caliper.

To establish body composition, the following models were applied[13]: percentage of fat, with the use of Faulkner's formula (1968); bone weight, by means of Von Döbeln's model modified by Rocha; residual weight according to the percentages proposed by Würch, and muscle weight was measured according to De Rose's and Guimarães' strategy (1984). Somatotype was calculated according to the method proposed by Heath and Carter (1967)[7]. Proportionality was calculated through the Phantom model proposed by Ross and Wilson (1974)[14]. Z-index[14] was calculated for the following variables: total body weight, flexed biceps, calf standing, and femoral breadth.

Statistical analysis

The collected data are shown by means of descriptive statistics through minimum and maximum values, mean and standard deviation.

RESULTS

Mean, standard deviation, and the minimum and maximum values of variables age, height, weight, skinfolds, girths and breadths calculated in this study are presented in table 1.

TABLE 1
Mean, standard deviation, minimum and maximum values of each variable, assessed on the 23 study subjects

Variables	Mean	Standard deviation	Minimum	Maximum
Age (decimal)	33.43	11.42	20.00	56.00
Height (cm)	166	6.14	155	177
Total body weight (kg)	75.06	10.06	57.40	105.80
Tricipital skinfold (mm)	4.77	0.82	3.10	6.10
Bicipital skinfold (mm)	3.20	0.66	2.00	4.60
Subscapular skinfold (mm)	9.05	1.55	6.10	12.70
Chest skinfold (mm)	3.48	0.67	2.50	5.00
Medium axillary skinfold (mm)	5.74	1.02	4.40	7.80
Suprailiac skinfold (mm)	4.83	0.87	3.70	7.70
Abdominal skinfold (mm)	6.86	1.55	5.10	11.80
Front thigh skinfold (mm)	6.59	2.74	3.00	13.10
Medium calf skinfold (mm)	4.70	1.62	2.50	9.20
Σ9SF*	49.24	8.02	38.4	70.2
Flexed arm girth (cm)	41.12	3.38	36.00	50.50
Calf-standing girth (cm)	38.83	3.11	32.50	47.00
Humeral breadth (cm)	6.79	0.45	5.90	7.50
Wrist breadth (cm)	5.80	0.47	5.20	7.40
Bimalleolar breadth (cm)	7.13	0.79	4.50	9.10
Femoral breadth (cm)	9.26	0.51	8.40	10.00

* Summation of nine skinfolds (Σ9SF).

Table 2 presents the mean, standard deviation, minimum and maximum values of the four-weight components (fat, bone, residual and muscular) fat proportion, and of the somatotype (endomorphy, mesomorphy, and ectomorphy).

Somatotype values of this and other studies are presented in table 3.

Analysis of the somatogram from this and other studies is in figure 1.

The Z-index for the variables total body weight, flexed biceps, calf standing, and femur breadth is presented in table 4.

A comparative analysis of the Z-index from the subjects of this study and the one of American bodybuilders[1] is presented in figure 2.

DISCUSSION AND CONCLUSION

The bodybuilders of our study presented major ranges for age (20 to 56 years), body weight (57.4 kg to 105.8 kg) and skinfolds summation (38.4 mm to 70.2 mm) (table 1). Such major age and weight variation was due to the fact that the different bodybuilding categories were not taken into account[15]. The Brazilian sample presented lower height

TABLE 2
Mean, standard deviation, minimum and maximum values of the percentual of fat, four weight components (fat, bone, residual, muscle) and somatotype from subjects of this investigation

Variables	Mean	Standard deviation	Minimum	Maximum
% Faulkner fat	9.65	0.51	8.92	10.85
Fat weight (kg)	7.29	1.22	5.92	11.48
Bone weight (kg)	10.70	1.28	8.26	12.92
Residual weight (kg)	17.84	2.46	11.36	25.56
Muscle weight (kg)	39.10	5.92	30.04	56.34
Endomorphy	1.8	0.3	1.2	2.5
Mesomorphy	8.1	1.1	5.9	10.4
Ectomorphy	0.7	0.4	0.2	1.4

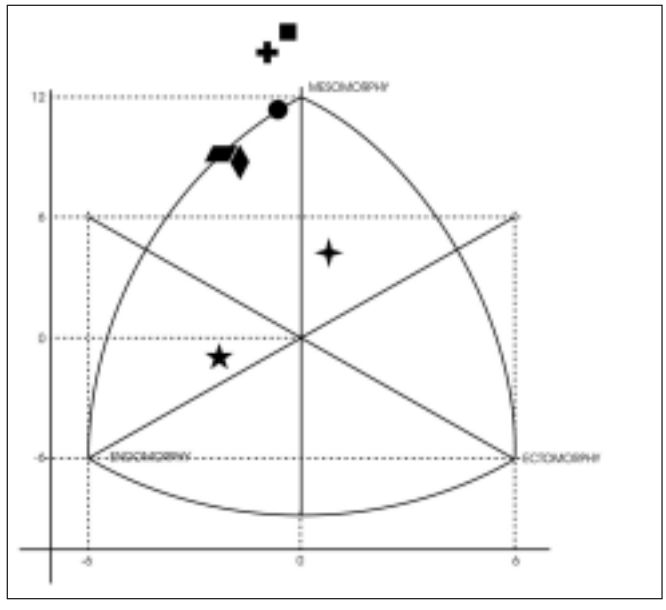

***Fig. 1** – Somatotype of bodybuilders investigated in this study and other power-exerting modalities: mean somatotype: ✚ Bodybuilders of this study (n = 23), ■ Bodybuilders contestants at the World Championship (n = 66) (Borms* et al.*, 1986* apud *Carter & Health, 1990) ◆ Belgian bodybuilders (n = 34) (Huygens* et al.*, 2002) ● Olympic weightlifters (n = 47) (Carter & Health, 1984), ◢ Weight and discus throwers (n = 28) (Carter, 1984), ✧ Olympic nigerian weightlifters (n = 18) (Igbokwe, 1991), and ★ Phantom (Ross & Wilson, 1974).*

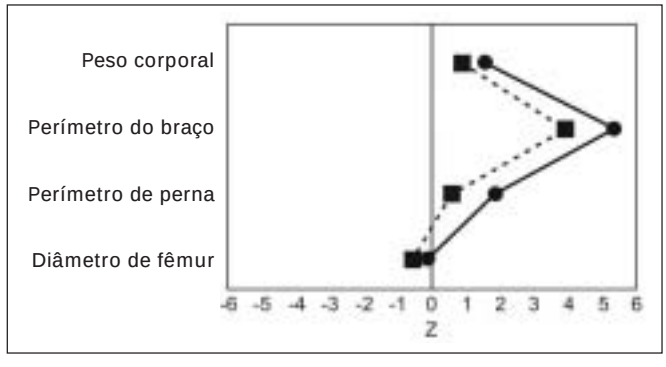

***Fig. 2** – Comparison between the Z index of Brazilian bodybuilders ● and the Z index of American bodybuilders ■*

TABLE 3
Mean somatotype values according to different authors in different groups of power-exerting athletes

Sources	Endomorphy	Mesomorphy	Ectomorphy
Bodybuilders, subjects of this study	1.8	8.1	0.7
World Bodybuilding Championship, males (Borms *et al.*, 1986)	1.6	8.7	1.2
Belgian bodybuilders (Huygens, 2002)	2.5	5.9	0.9
Olympic weightlifters (Carter & Health, 1990)	1.8	7.0	1.1
Olympic weight and discus throwers (Carter & Heallth, 1984)	3.2	7.1	1.1
Olympic nigerian weightlifters (Igbokwe, 1991)	2.6	5.1	3.4
Phantom (Ross & Wilson, 1974)	4.8	3.2	2.5

(mean = 165.7 cm; SD = 6.14) compared to the group studied by Maestá *et al.*[10] (mean = 170.6; SD = 0.82). Stature, skinfolds, girths and breadths had low variation, showing similarity among athletes (table 1).

The low skinfold values indicate a low amount of subcutaneous fat and fluids (table 1). The highest mean skinfold was the subscapular one (9.5 mm), and the lowest, the bicipital (3.2 mm); Bamman *et al.*[2] found similar results for a population of such athletes (means of 9.6 mm and 3.2 mm, respectively, for subscapular and bicipital skinfolds). Skinfold summation (ΣSF) is an excellent indicator of subcutaneous fat[9]. In their study, Belgian bodybuilders presented a Σ10SF = 64.1 mm, whereas in our study, Σ9SF = 49.24 mm. Even though comparison between the two studies is not possible due to differences in methodology, both presented a low ΣSF.

Brazilian bodybuilders presented, in average, a low proportion of fat (mean = 9.65%; SD = 0.51) (table 2). Results similar to these were found in another study with Brazilian bodybuilders[8], whose mean proportion of fat was of 6.9%. Other authors, in investigations with bodybuilders of different parts of the world, found similar results, ranging from 6.8% to 9.9%[6,9,10,11,16]. However, the biggest difficulty for comparing results of different authors is the doubly indirect form of calculating fat proportion. Another way to estimate fat is from its weight; in our study mean fat weight was of 7.29 kg. In other studies with foreign bodybuilders, mean ranged from 3.4 to 7.9 kg[1,2,6].

Brazilian bodybuilders, in addition to presenting a low proportion of fat (mean = 9.65; SD = 0.51), had a high muscle weight (mean = 39.10 kg; SD = 5.92) (table 2). These features were also evident from the somatotype analysis, which showed low endomorphism (1.8), high mesomorphism (8.1), and low ectomorphism (0.7) (table 2). Thus, according to somatotype classification (table 2), the athletes of the 2000 Brazilian Championship may be considered balanced mesomorphs (1.8-8.1-0.7).

In table 3 and in figure 1 different studies are compared as to the mean somatotype of bodybuilders, power-exerting athletes, and the Phantom. Brazilian bodybuilders, when compared to other power-exerting athletes, significantly differ ($p < 0.05$) from Belgian bodybuilders[9], Olympic weight and discus throwers, Olympic weightlifters[17], Olympic Nigerian weightlifters[18], and from Phantom[14]. There is no significant difference between subjects of this study and the male world bodybuilding championship contestants[19].

In spite of lower somatotype components of medal winners compared to those of other athletes, there was no significant differences between the two groups (medal winners n = 11, other athletes n = 12) as to endomorphy ($p = 0.5$), mesomorphy ($p = 0.8$), and ectomorphy ($p = 0.8$). Neither was there significant differences as to height ($p = 0.5$) and total body weight ($p = 0.9$).

In spite of the group under 40 years of age (n = 16) having presented lower endomorphy and ectomorphy, and higher mesomorphy values that the group aged 40 or older (n = 7), there was no significant age-related differences for endomorphy ($p = 0.4$), mesomorphy ($p = 0.1$) and ectomorphy ($p = 0.1$).

Our study showed that there are similarities between Brazilian and foreign athletes in terms of mesomorphy predominance, a crucial factor for success in both, power-exerting sports and bodybuilding. The somatotype did not differ between medal-winner and non-medal winner groups, thus there was no relationship between the somatotype and the outcome of the competition.

When compared to the Phantom model[14], the subjects of this study presented high body weight (Z = +1.66), flexed biceps (Z = +5.26) and calf standing (Z = +1.91). Such increment was also evident in the study with Brazilian bodybuilders[8], where high values for body weight (Z = +1.42) and flexed biceps (Z = +4.74) were found. In American bodybuilders[1], one sees lower values for body weight (Z = +0,95), flexed biceps (Z = +2.75), and calf standing (Z = +0.65). As for bone breadths, Brazilian and American bodybuilders[1] present negative values for the Z Index (Z = –0.16; Z = -0.62), as shown in figure 2. In spite of Brazilian athletes' measures being higher, they have similar behavior when compared to American athletes.

It is to be concluded that the investigated elite Brazilian bodybuilders present low proportion of fat and high muscle weight, as evidenced by the analysis of the different kinanthropometric methods used in this study. Moreover, flexed biceps was the higher proportional measure found (Z index). One can see a similarity among the kinanthropometric features of the different categories, when compared to age and championship rank. The elite Brazilian bodybuilders of year 2000 present quite similar features to elite international bodybuilders, thus showing the level of excellency of bodybuilding in Brazil.

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