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Strength Capacity and Body Mass Index Evaluation of Swimmers

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Abstract
Purpose. Muscle strength is an important component of physical ability. In sports such as swimming, this physical capacity has been increasingly evident in training programs, thus becoming important for the performance of aquatic practices. In this context, the aim of this study was to evaluate the strength capacity and the body mass index (BMI) of swimmers. **Methods.** For this, 20 swimmers of both sexes with a mean age of 38 ± 2 years were evaluated. The handgrip strength (HS) was assessed using a dynamometer and weight and height for calculating BMI. **Results.** There were no differences in BMI be-

tween genders (men (M): 25±1 kg./cm2; women (W): 24±0.9.kg./cm2. Men had a higher HS (M: 42±2; W: 29 ± 2 kgf.) There was no correlation between the HS and the BMI of the swimmers (M: *r*: 0.44; *p*: 0.19; W: *r*: 0.34, *p*: 0.30). However, the behavior of the relation of the variables differs between the sexes, in men the HS is higher according to a lower BMI, and in women, the HS is higher according to a higher BMI. referring to HS (M: 8.0±0.2; W: 8.4±0.6). **Conclusions.** Thus, the results of the present study show that the handgrip strength in swimmers is greater in males and does not present correlation with BMI, however it is possible to observe a different behavior between HS and BMI between genders, in men the relationship behavior is negative and in women the relationship behavior is positive.

Keywords: Muscle strength; Body mass index; Swimming.

Introduction

Muscle strength is an important role in maintaining and performing daily activities, as well as in sports performance. Therefore, the practice of strength exercises has the function of promoting metabolic and structural changes in the skeletal muscle (Bacurau, et al., 2011). Accordingly, the same authors treated anaerobic breakdown of glucose and hydrolysis of high energy (creatine phosphate) as the metabolic pathway of the predominance mechanisms wrapped in adaptations and increase muscle strength. Other studies point out that such a change in the functionality of the metabolic pathways occurs due to the regular practice of exercises, as strength is the maximum vigor that a muscle or muscle group can generate (Robergs, et al., 2002). Thus, the evaluation of muscle strength becomes important, among other factors, due to the fact that the amount of strength exerted by the muscle directly reflects on motor performance, since muscle atrophy and weakness may be associated with deficits in balance and motor coordination, directly impacting physical performance (Carvalho, et al., 2004; Shumway, et al., 2003).

Muscle strength is understood as the muscle's ability to generate tension, it is one of the fundamental components for the assessment of physical fitness. Handgrip Strength (HS) is not simply a measure of hand strength or just a form of assessment of the upper limb. Studies have shown that it is an efficient indicator of health and general physical strength and in this sense it is used in physical fitness tests in the sports and rehabilitation programs (Balogum et al, 1991; Durward et al, 2001; Rantanen et al, 2003 ; Bertuzzi et al, 2005; Ikemoto et al, 2007).

HS is one of the basic elements in the analysis of manipulative abilities, strength and hand movements. The movements that the hand performs are controlled by the contralateral cerebral hemisphere and its innervation originates in the brachial plexus, in the roots from C5 to T1 (Machado, 2000). HS causes activity in the superficial flexor of the fingers and deep flexor of the fingers. Contraction of the deep flexor of the fingers exerts traction on the proximal fixation of the lumbrical. The simultaneous flexion of the interphalangeal joints places the intrinsic muscles under distal stretching, thus producing flexion of the phalangeal metacarpal joints (Smith et all, 1997).

According to Novo Jr. et al. (1998) the human hand produces apprehensive movements in different footprint patterns and they can be classified as: “Power Grip” (with inhibition of the action of the thumb); “Key Grip” (when the force is exerted by the thumb on the same side of the index finger) and the “Pinch Grip” (when the force of the thumb is opposite to the other fingers). The HS is normally measured using dynamometer devices, it is equipment that allows the measurement of the applied force, having its record measured in kilograms force or in pounds. They are divided into isometric and isokinetic types, and for HS measurements, traditionally, isometric dynamometers are used, with analog or digital characteristics (Massy-Westroop, 2011). Manual dynamometry is a reliable, accurate and validated measure in the literature, when the equipment is properly calibrated and the standardized collections, the tests are reliable even when performed by different evaluators (Mathiowetz, 2002; Shechtman et al., 2005).

There are different factors that can influence the HS values, among them, they are directly related: Age; Sex; Limb dominance (right and left), (Nicolay et al., 2005); Body positioning (Watanabe, et al., 2004; Su et al., 1994); Anthropometric characteristics (hand width, hand circumference and longitudinal length of fingers), (Neu, et al., 2002; Clerke, et al., 2005; Fernandes, et al., 2011) and the size of the handle used on the dynamometer , because there is a need to adjust the device to different hand sizes (España-Romero, et al., 2008; Blackwell, et al., 1999; Ruiz-Ruiz, et al., 2006).

Other factors may interact with strength gain, among them, it is worth mentioning the Body Mass Index (BMI), which by default is used in several countries by health professionals as a parameter to assess individuals with malnutrition, normal weight, overweight and grade I, II and III obesity (WORLD HEALTH ORGANIZATION, 2004). Thus, the regular practice of physical exercises and sports is at the center of numerous scientific investigations for its benefits associated with physical, psychosocial and health physical capacities.

Thus, the practice of swimming as an aerobic activity allows changes in body composition, such as the reduction of adipose tissue and increase in lean mass, as well as morph functional changes, promoting a better quality of life and an efficient option in improving cardiovascular conditions (Lazar, 2013).

In this context, this study guides the BMI as an interaction factor in the development of strength in swimmers. However, the aim of the present study was to verify the handgrip strength by dynamometry and its correlation with the body mass index of swimmers.

Method

The sample consisted of 20 individuals, 10 male subjects and 10 female subjects, aged between 18 and 60 years, who have been swimming for more than two years. The subjects trained 45 minutes a day, twice a week. All participants filled out the free and informed consent form, agreeing to voluntarily participate in the research. Among the procedures for data collection, all ethical research care was taken, following the ethical principles of Helsinki 2008.

At the beginning of the process, interviews were conducted with those evaluated and an anamnesis was carried out, containing information on the level of physical activity, health, food and objectives intended for the practice of physical activity (Cunha & Barros, 2005).

Afterwards, body mass evaluations were performed, which were measured using a mechanical scale (Welmy), with 100g precision and maximum capacity of 150kg. The subjects were instructed to remain standing, barefoot and wearing light clothing. Height was measured (in meters, m) with a stadiometer (Welmy), and the reference points were the vertex and the plantar region. The BMI was calculated using the formula: BMI (Kg/ m^2) = WEIGHT (Kg.) / $HEIGHT^2$ (meters) and the groups were classified as Eutrophic, Overweight and Obesity (Godoy-Matos et al., 2009).

For the evaluation of the handgrip strength (HS), the instrument used to measure was the JAMAR® analog hydraulic dynamometer (Asimow Engineering®, USA), with an accuracy of 0.5 Kg/force and a maximum capacity of 100 Kg/f. We followed the protocol proposed by Matsudo (2004) where the subject was instructed to put himself in the orthostatic position and after adjusting the dynamometer loops to the size of the hand and with the digital marker on the zero scale, the device was held comfortably, remaining parallel to the longitudinal axis of the body. During handgrip, the arm remained immobile, with only flexion of the interphalangeal and phalangeal metacarpal joints. Two measurements were taken in each hand, alternately, waiting 15 seconds between the limbs and the highest value was considered between attempts (Matsudo, 2004).

To correlate this protocol with body mass indexes, measurements of height (measured in centimeters) and body mass (measured in kilograms) were used. The measurements were performed with the students in the anatomical reference position: vertical position, with the gaze directed forward, upper limbs suspended and parallel to the trunk, palms oriented forward and lower limbs united and in extension. The height, or total height of the body, was measured, between the vertex and the plantar plane, being at the head with the Frankfurt plane parallel to the ground and the body in the anatomical position (Ribeiro, 2002). The Borg Scale (Borg and Noble in 1974) was applied to ascertain the effort perception index.

The results are presented as mean, standard deviation error of the mean. For comparison and correlation of results, Student's t test and pearson's correlation "*r*" were used. As well as the Kolmogorov-Smirnov normality test by Instat software, version 3.0 for Windows.

Results

The age, height, weight and BMI data, as well as their classification according to the Brazilian Obesity Guidelines (Godoy-Matos et al., 2009) can be seen in Table 01. There were no differences between genders in BMI. In addition, the mean among men showed BMI classified as overweight, and women had mean BMI with eutrophic classification (Table 01).

Table 01: Distribution of mean BMI values, age, height and weight of students separated by gender.

	Nº	AGE	HEIGHT	WEIGHT	BMI	CLASSIFICATION
M	10	44±3	1.74±0,02	77 ±4	25±1	Overweight
W	10	33±2	1.63±0,02	64±3	24±0.9	eutrophic

Data presented as mean ± standard error of the mean. M: men; W: women; BMI: body mass index.

The results of HS in both genders can be seen in Tables 02. It is important to note that all evaluated subjects reported high perception of effort during attempts through the subjective perception of effort (Borg Scale), referring to HS (men: 8.0±0.2; women: 8.4±0.6), demonstrating the effectiveness of the test. According to the handgrip tests of the dominant limb, men showed higher values of manual strength compared to the values observed in women.

Table 02: Manual pressure force of the dominant limb on the dynamometer (HS).

	N	HS 1	HS 2	HS 3	Mean (Kgf)
M	10	43±2	41±3	42±2	42±2
W	10	29±2	29±2	29±2	29±2*

Data presented as mean ± standard error of the mean. * $p \leq 0.05$. M: men; W: women; HS: Handgrip Strength; Kgf.: kilogram-force.

The tables below show the values of HS and BMI in men (Table 03) and women (Table 04). Analyzing the average among men, the table shows higher BMI values and lower HS values. The average among women, in turn, has a higher BMI index and a higher HS.

Table 03: Handgrip Strength (HS) and BMI in males.

Men	Nº	BMI (Kg/m^2)	HS (Kgf.)
eutrophic	05	22±0.9	43±3
Overweight	03	26±0.4	44±6
Class I Obesity	02	33±0.4	38±4

Data presented as mean ± standard error of the mean. BMI: body mass index; HS: handgrip strength; Kgf.: kilogram-force.

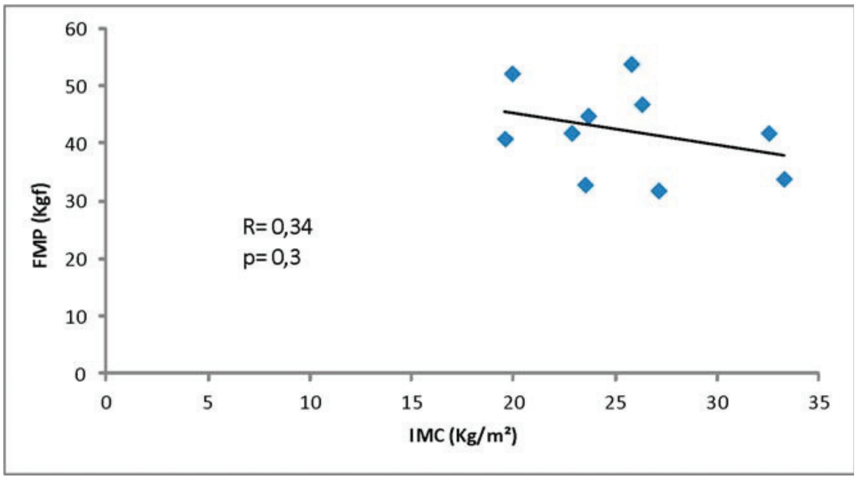
Tabela 04: Força de preensão manual e IMC no gênero feminino.

Women	Nº	BMI (Kg/m^2)	HS (Kgf)
eutrophic	06	22±0.9	25±1
Overweight	04	26±0.6	35±2

Data presented as mean ± standard error of the mean. BMI: body mass index; HS: handgrip strength; Kgf.: kilogram-force.

The correlations between HS and BMI in both genders did not show a value of *p*<0.05 to be considered significant (Figures 02 and 03). However, women had an *r*-value for the correlation between HS and BMI higher than men. Suggesting a better correlation between these variables in the female (Figure 03).

Figure 02: Correlation between KS and BMI in males.



BMI: body mass index; HS: handgrip strength; Kgf.: kilogram-force.

Discussion

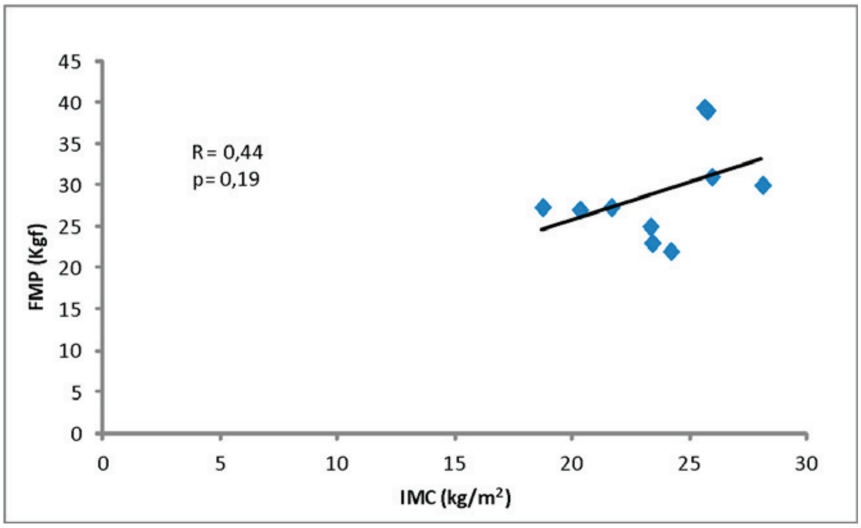


Figure 03: Correlation between HS and BMI in females.

BMI: body mass index; HS: handgrip strength; Kgf.: kilogram-force.

The aim of this study was to assess the possible correlations between BMI and HS using the dynamometer device. A total of 20 subjects were evaluated, 10 men and 10 women, being selected in the eutrophic, overweight and obese categories, with an average age of 44±3 and 33±2, with mean BMI values of 25±1 and 24±0.9 and classification of overweight and eutrophic respectively, where there was no difference in BMI values between them.

The body mass index (BMI) is a good indicator to determine the Nutritional Status (NS) of the population in general. It is a widely used instrument due to its ease of application, being of low cost, as it is not an invasive test and because there are several tables with values of reference standards allowing comparisons between populations (Anjos, 1992).

Several authors relate anthropometric characteristics such as height, weight, body mass, fat percentage, nutritional status and even anthropometric characteristics of the hand with handgrip forces (Sartório, et al., 2002).

In our results, men had higher HS rates when compared to those obtained by women (M = 4±2; W =29±2), corroborating the results presented in studies by Sasaki (2007) followed by Alexandre (2008) in which they consider that the mean HS in the elderly was higher in men when compared to women in all categories of BMI. This phenomenon can be explained by the physiological characteristics that differ between men and women. Men have higher levels of lean mass because they have higher concentrations of testosterone, growth hormones (GH), Dehydridropndrosterone (DHEA) and hormone insulin that helps increase growth hormone 1 (IGF-1) (Alexandre, 2008).

Kenjle et al (2005) evaluated the handgrip test with the nutritional status of 787 Indian children from six to ten years old. Grip strength was measured in the dominant hand and anthropometric factors, such as height, weight, arm circumference and skinfold triceps, were collected. The researchers observed that boys had greater handgrip strength than girls at all ages studied and that height, weight, arm circumference and skinfold, in addition to body fat mass, significantly interfered with handgrip strength.

In another study, there was no difference between genders in the handgrip of schoolchildren (12 to 15 years old). However, when children were separated by nutritional classification, underweight boys had higher strength values compared to girls who were also underweight. In addition, boys and girls who were overweight also had higher values of manual strength (Assis, et al., 2015), however, studies that did this correlation in swimmers have not been found.

Considering that HS can be associated with performance capacity in muscle strength (Kurakake et al., 1998; Vallejo et al., 2007), our HS values obtained in men's samples suggest that higher HS values are related to values lower BMI, while women have higher HS indexes related to higher BMI values, which leads us to believe that the lower the BMI value in men, the more muscular strength it will have, in women, the greater the BMI value, the more muscular strength it will have (Rolland, et al ,. 2004).

In a study that evaluated the HS and Flexibility of not trained women BMI classified as normal, as conclude that there was no correlation between this physical abilities in the group, considering that the sedentary group need to change the life style to improve force, so improving the quality of life (Hirota et al., 20015).

Studies show that men have higher HS than women, at all stages of human development. According to Alexandre et al. (2008) they describe that this fact is common, since the HS reflects the global muscular mass and strength, and men have greater amounts of lean mass and consequently have greater muscular strength. This is due to the fact that men have a higher concentration of hormones responsible for muscle protein synthesis, such as testosterone, growth hormone (GH), among other aspects.

A justification for our results may be due to the fact that the BMI assessment has some limitations, as it does not distinguish between adipose tissue and lean mass, or muscle hypertrophy. Thus, its applicability may be unreliable because it does not consider the loss and decrease of lean mass due to senescence and does not distribute body composition according to biological specificities in physically active adults (Mclaren, 1987).

Conclusion

The results of the present study show that the handgrip strength in swimmers is higher in males and has no correlation with BMI. However, it is possible to observe a different behavior between HS and BMI between genders. In men the relationship behavior is negative and in women the relationship behavior is positive.

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