Validation of anthropometric equations for the estimation of body density in professional soccer players

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ABSTRACT

The objective of this study was to validate equations which estimate the body density in professional soccer players. Twenty-five soccer players were evaluated, aged 22.7 ± 4.4 years, body mass 73.9 ± 6.6 kg, and height 177.8 ± 5.5 cm, who played in the state championship of the Federação Gaúcha de Futebol in 2004. The validity of 11 anthropometric equations were analyzed by the process: Pearson correlation (r), dependent t test, constant error (EC), total error (ET) and estimated standard error (EPE), using hydrostatic weight as the “gold standard”. In the present study of 11 equations, only the equations proposed by Jackson and Pollock (1978) are valid for estimating the body density of professional soccer players, since the other equations analyzed in this study present considerable errors in their estimation.

INTRODUCTION

High performance sports demand constant improvement of knowledge level on their intervenient variables (morphological, physiological, psychological, biomechanical, and cognitive among others). Soccer, due to its specific condition, involves a high number of athletes and is played in different climate conditions, with technical, tactical and physical varied alternatives, becoming hence a sport of high complexity of interpretation and study.

Under the perspective of this set of variables, body composition assessment represents one of the important identification elements of the soccer player profile.

Works published in journals which describe morphological characteristics of soccer athletes in its majority make use of a method called anthropometry. Such method uses measurement quantification in the study of size, shape, proportionality, composition and maturation of the human body(1). After obtaining the measurement values, these are applied in equations and, via calculations, it is possible to fractionate the human body composition in fat, muscular, bone and residual mass through the analysis of the relative values, these are applied in equations and, via calculations, it is possible to fractionate the human body composition in fat, muscular, bone and residual mass through the analysis of the relative value in percentage with the total body fat value. Such outcome is usually analyzed by technicians.

In order to make use of an equation in a given population, it is necessary that this equation has reached scientific criteria in the evaluated population, that is, it should be valid to measure what it is proposed to measure, or else, it can underestimate or hyper estimate values, adding an assessment error, which leads to misleading diagnosis, prescription and training control(2,4,6).

It is observed that in Brazil, both in professional soccer practice and in the academic field, equations coming from samples of foreign athletes or national generalized equations have been systematized used. In other words, equations which have used a wider sample for elaboration, which probably will imply in an evaluation error(2,4,6). Thus, soccer coaches should have as reference a specific equation which considers these athletes’ characteristics.

Once this methodological issue has been identified, the study had as aim to analyze the validation of the anthropometric equations for body density estimation in professional soccer athletes.

METHODS

The studied group consisted of professional soccer athletes (n = 25) mean age 22.7 ± 4.4 years and between 18 and 32 years, with a minimum of 2 months of training and 4 hours of daily training, comprised in the competition season promoted by the Soccer Federation of Rio grande do Sul State, year of 2004.

The anthropometric measurements were taken(7) with adaptations, respecting the measurement procedure concerning validation of the original equation, in which the analyzed measurements were: body mass (BM) and height (H), with the use of a scale and stadiometers (RIW 200, Welmy, Brazil). The measured perimeters were the ones from the forearm (FA P.), abdomen (AB P.), with a measuring tape (Cescorf Científico, Cescorf, Brazil). For the skinfolds, the chosen registers were: triceps (TR. SF), biceps (BI. SF), subscapular (SS. SF), chest (C.SF), media underarm (MUA SF), supra- iliac (SI. SF), horizontal abdominal (ABh. SF), vertical abdominal (ABv SF), medium thigh (MT SF) and medium leg (ML SF), measured with the skinfold dividers (Cescorf Científico, Cescorf, Brazil).

The anthropometric procedures adopted were the following: a) for all measurements, the right side of the athlete was adopted; b) the measurement was conducted in a rotation system with three measurements, being the mean taken as final measurement. These measurements were taken by a single evaluator, c) the non-performance of training physical activities at least for 4 hours prior to the data collection, d) checking of the used instruments as well as the room temperature where collection would take place, which was standardized between 24°C and 26°C for all assessments. In addition to the previous procedures, e) the trustworthiness in the measurements of the single evaluator involved in the data collection was also tested.

The value of the hydrostatic weighing (HW), gold standard method, was obtained with the use of a 1 meter and 50 centimeters high tank and had the aid of two evaluators: on inside the tank, who helped and explained to the volunteer the testing methodology, and another who performed the scale reading (Filizola L, Filizola, Brazil) which had 5 grams resolution and 6 kg capacity. The volunteer was wearing a bathing suit during the measuring. Grouped position(8) was used as submersion position of the individual in water, and he was motivated to eliminate all the air kept in the lungs and air ways through expiration.

Breathing was kept blocked for approximately 5 to 10 seconds, for scale’s stabilization, when the weighing reading was then recorded. This same procedure was repeated 6 to 10 times. The mean of the three last highest readings was used as hydrostatic

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The outcomes obtained in this study are presented in tables. Table 2 presents the descriptive characteristics of the group of athletes studied, including the data on the hydrostatic weighing, skinfolds, and perimeter data. Table 3 presents the outcomes of the validation criteria of the 11 equations.

The test and re-test values showed high reliability from the part of the evaluator, both for the Pearson correlation and the dependent “t” test, being all values statistically significant (p < 0.05). These results guarantee the trustworthiness of the values obtained through anthropometry and densitometry, allowing hence the evaluation of the group of athletes studied.
The found results for body mass and height are normal when compared with the results of other national[6,19-23] and international athletes[4,26-33], being lower than in the study with athletes from Yugoslavia[34] and professional athletes from Iceland[28] and Germany[29].

Comparing the skinfold values with studies involving national athletes, these do not present remarkable difference when compared with athletes from Paraíba[6] and Santa Catarina states, and athletes similar to the athletes from Rio Grande do Sul state[20]. Such similarity is probably due to the fact that the group studied is from the same region.

Body density values in most of the equations studied presented higher results than the ones from their original validation studies, except for the EQ2 and EQ5 equations, which presented similar values, and for EQ1, which obtained result below the results found in its original study.

When analyzing validation criteria, they reveal that the EQ6 equation hyper estimates body density of the subjects below the mean and underestimates body density of the subjects above the mean, once its values of standard deviation are lower than the ones of the hydrostatic weighing, an outcome similar to the one found in a study with soccer athletes from the sub-20 category[36]. In the EQ1, 2, 3, 4, 5, 7, 8, 9, 10 and 11 equations the opposite fact occurs; they underestimate body density of the subjects below the mean and hyper estimate body density of the subjects above the mean, since its values of standard deviation are higher than the body density measured by hydrostatic weighing.

The second validation criterion, the “t” test, showed that only the EQ6, 10 and 11 equations do not differentiate from the standard measurement, while all the remaining presented statistical differences. The equations have reached moderate correlations and the highest value was obtained by an equation (EQ3) which had as validation group athletic individuals.

The correlation values behaved fairly around 0.0098 g/cm³ was chosen in relation to the mean, which corresponds approximately to 4% of body fat, as an accuracy threshold with which the body density values would be predicted through anthropometric variables[12]. In the present study, all used equations presented measurements lower than this cutting point and it had its values lower than the values from original studies. A hypothesis for this result would be a small number of analyzed individuals as well as by the homogeneity of their measurements.

CONCLUSION AND RECOMMENDATION

In an attempt to answer the aim of this study to analyze the validation of anthropometric equations in the estimation of body density in professional soccer athletes, it is concluded that:

In the present study, from the 11 equations analyzed, only the equations proposed by Jackson e Pollock (1978), EQ10 and EQ11, respectively from seven and three skinfolds, responded to the validation criteria, having moderate correlation with the hydrostatic weighing used as gold standard measurement, though.

The preference over the equation of three skinfolds is recommended in the performance of the body density assessment in professional soccer athletes, once it is practical and maximizes the evaluators’ time.

All the authors declared there is not any potential conflict of interests regarding this article.

REFERENCES


