Correlation between body composition data obtained by DXA and skinfold predictive protocols in sprinters

Correlação entre dados de composição corporal obtidos pelo DXA e protocolos preditivos de dobras cutâneas em velocistas

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Abstract - The aim of this study was to describe the correlation between body composition data obtained through DXA and through skinfolds strategy, with some of their respective formulas, in sprinters. The sample consisted of 15 male sprinters (23.81 years ± 3.11; 70.06 Kg ± 4.38; and 179.13 CM ± 5.16) all high performance runners of speed and barriers events (100m, 200m, 400m, 110m with barriers and 400m with barriers). The athletes were submitted to DXA evaluation procedure and to skinfolds collection (triceps, biceps, subscapular, supra iliac, abdominal, medial thigh and calf) and the results were calculated through four distinct equations: Slaughter, Faulkner, Lázari and Boileau. The respective DXA correlations (0.60; 0.81; 0.23 and 0.48) and the equations predicted by skinfold strategy were calculated using Pearson correlation. Among the equations used, Faulkner's was the one presenting highest correlation value when compared to DXA protocol, although all of them aimed to estimate values for BF%.

Key words: Absorptiometry photon; Anthropometry; Body composition; Sports.

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Resumo - *O objetivo deste estudo foi descrever a correlação entre dados de composição corporal obtidos através de DEXA, e pela estratégia de dobras cutâneas, com algumas de suas respectivas fórmulas, em velocistas. A amostra foi composta por 15 velocistas do sexo masculino (23,81 anos ± 3,11; 70,06 Kg ± 4,38; e 179,13 cm ± 5,16) todos corredores de alto desempenho das provas de velocidade e barreiras (100m, 200m, 400m, 110m com barreiras e 400m com barreiras). Os atletas foram submetidos ao procedimento de avaliação do DEXA e a coleta de dobras cutâneas (tricipital, bicipital, subescapular, supra ilíaca, abdominal, coxa medial e panturrilha) e os resultados calculados através de quatros distintas equações Slaughter, Faulkner, Lázari e Boileau. As respectivas correlações (0,60; 0,81; 0,23 e 0,48) de DEXA e as equações previstas pela estratégia de dobras cutâneas foram calculadas através da correlação de Pearson. Dentre as equações utilizadas, a de Faulkner foi a que apresentou maior valor de correlação quando comparada ao protocolo do DEXA, apesar de todas terem por objetivo estimar valores para o %G.*

Palavras-chave: *Absorciometria de fóton; Antropometria; Composição corporal; Esportes.*

INTRODUCTION

The maximum speed performance in athletics is a multifactorial phenomenon. It requires an interrelation of some determining factors, such as strength development rate, muscle power, maximum dynamic strength and anaerobic power[1].

Changes in body composition during athletes preparation period for the most varied modalities are part of a variables set that must be taken into account during physical abilities preparation and development[2,3]. Some studies have addressed the body composition variables, regarding lean and fat mass compartments, and their possible relations with sports performance.

For such, dual-energy X-ray absorptiometry (DXA), considered the gold standard for assessing body composition, is a fast and non-invasive method. It is based on 3 components indirect measurement: mineral bone density, fat-free mass and fat mass[2,4].

DXA collected results may also be combined with anthropometric parameters for development of more data on body composition[5].

Reference tables, with DXA values differentiated by sports modalities and sex, may be a good measure to help understanding athletes specific needs and comparing evaluation methods[5].

Among the most used methods for measuring body composition, skinfolds stands out. For having a lower cost compared to DXA, coaches involved with most varied sports modalities have been using it. In this sense, several studies show athletes morphological data obtained via this method[6-8].

A longitudinal study with female sprinter athletes found a correlation between performance improvements in 100-meter dash and fat mass percentage reduction[3]. Another study with 98 professional sprinters pointed out that athletes who achieved the best 100-meter dash marks had higher lean mass and lower fat mass amounts[2].

Based on these considerations, this study sought to describe the correlation between DXA obtained body composition data, considered gold standard for this purpose, and skinfolds measuring strategy, with some of their respective formulas, in sprinters.

METHOD

Sample

The sample (Table 1) consisted of 15 male sprinter athletes, with an average of 23.81 ± 3.11 years for age, 70.06 ± 4.38 kilograms for weight and 179.13 ± 5.16 centimeters for height, all high-performance runners of speed and barriers events (100m, 200m, 400m, 110m with barriers and 400m with barriers). The individuals come from an athletics club in Campinas (SP) and have as best results average (Personal Best – PB) 91.9 ± 1.56% in relation to World Records, in official competitions in their respective races.

Of the studied group, 12 athletes (80% of the sample) have already been part of national teams, representing Brazil in international competitions; besides, 4 of them took part in Rio 2016 Olympic Games, 3 of these reaching finals.

All athletes in the study were duly registered in Brazilian Athletics Confederation, participating in national and international competitions. The selection was intentionally made (non-probabilistic). All individuals participated in systematic training for at least three years and performed their practices five to six times a week.

Table 1. Descriptive statistical values in mean and standard deviation for sample characterization through the variables age, experience, weight, height, fat mass, lean mass and body mass index (BMI).

	Mean	Standard Deviation
Age (years)	23.81	3.21
Experience (years)	7.73	3.02
Weight (kg)	70.06	4.53
Height (cm)	179.13	5.35
Fat mass (kg)	7.86	1.52
Lean mass (kg)	59.34	3.57
BMI	21.85	1.45

Anthropometry assessment procedures

Both DXA and skinfolds evaluations were conducted in the morning, always at rest. For skinfolds evaluation, we used the suggestions described by Ross and MarfellL-Jones[9] and by Harrison et al.[10]. The skinfolds (mm) measured were: triceps, biceps, subscapular, supra iliac, abdominal, medial thigh and calf. Then results were calculated in four distinct protocols (Table 2): Boileau et al.[11], Faulkner[12], Lázari[13] and Slaughter et al.[14].

Table 2. Predictive equations description by skinfolds method, population intended in its original article, folds quantity and author.

Equation	Population	skinfolds Quantity	Author (res)
BF% = 5.783 + 0.153 (TR + SB + SI + AB)	Swimming, Water Polo and Triathlon	4	Faulkner[12]
BF% = 0.735 (TR + PA) + 1	Black and white children	2	Slaughter et al.[14]
BF% =1.35 (TR+SE) - 0.012 (TR + SE)2 - 4.4	Young male	2	Boileau et al.[11]
FM = -5051.087 + 134.581 * weight + 117.540 * Σ7D + 44.846 * C.P	Athletics	7	Lázari[13]

For body composition analysis by the above method, a scientific adipometer of the Harpenden brand was used, all data were collected by the same evaluator, and three measurements were made for each of the folds. A fractionation of two components was carried out: fat mass (FM) and muscle mass (MM).

For body composition analyzed through DXA, an iDXA model equipment was used (GE Health care Lunar, Madison, WI, USA) with *fan beam* detectors, enCore™ 2011 software, version 13.6. The whole body (including head) was measured, the body composition was analyzed and three components were determined: lean mass (LM), bone mass (BM), fat mass (FM).

The procedure consisted in lying the subjects on the scanning platform at supine position, with arms and legs extended (in pronated position). The ankles were secured with a velcro strap to ensure standard positioning. The subjects

were instructed not to use jewelry or any other metal accessory that prevented analysis.

All protocols and evaluations carried out by the study were duly submitted to analysis of the Research Ethics Committee of UNICAMP – Campinas Campus, and obtained its approval through the opinion 1,511,796.

Statistical analysis

For data statistical treatment, the softwares Biostat (version 5.3) and Microsoft Excel 365 were used. Descriptive statistical data analysis was performed, correlations were established through Pearson correlation test and linear regression analysis (Simple Linear Regression). Through these data it was possible to develop a linear equation. For significance index, a value of $p<0.05$ was established.

RESULTS

Table 3 shows the values referring to each athlete BF% and the differences found in their values (%) by changing the protocols used for calculation.

Table 3. Descriptive statistical values (Minimum, Maximum, Mean and Standard Deviation) for the different prediction methods and equations: DXA, Slaugther, Faulkner, Lázari and Boileau.

|	Minimum	Maximum	Mean	Standard Deviation
DXA	7.90	14.29	11.20	1.91
Slaughter	5.85	10.11	7.33	1.24
Faulkner	8.67	11.15	9.99	0.76
Lázari	8.63	10.51	9.42	0.59
Boileau	7.34	13.25	10.71	1.78

Table 4 shows the correlation results obtained between BF% values collected through DXA and other protocols. The results indicate a strong correlation between the data presented by Faulkner protocol and DXA, unlike other protocols. Figure 1 displays the graphs indicating the dispersion of each protocol calculated together with the DXA. By simple linear regression calculus, it was possible to generate a linear equation and its respective R^2 (Table 5).

Table 4. Values for correlation strength and p value corresponding to the predictive equations of Salughter, Faulkner, Lázari and Boileau.

Protocol	Pearson Correlation (r)	Value (p)
Slaughter	0.60	0.0170
Faulkner	0.81	0.0002
Lázari	0.23	0.4079
Boileau	0.48	0.0667

Table 5. Determination of Linear Equation and respective R^2 for predictive equations of Slaughter, Faulkner, Lazari and Boileau from DXA.

Protocol	Linear Equation	R^2
Slaughter	y = 0.9247x + 4.4240	0.364
Faulkner	y = 2.0468x - 9.2547	0.664
Lázari	y = 7468x + 4.1636	0.053
Boileau	y = 0.518x + 5.6478	0.235
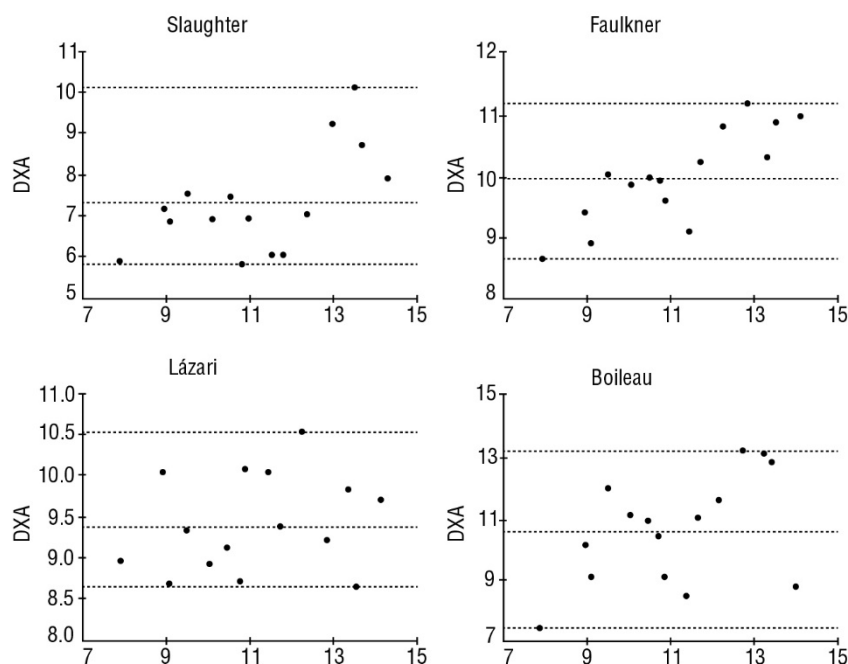
Figure 1. Scatter plots with indication of maximum, mean and minimum value of predictive equations of Slaughter, Faulkner, Lázari and Boileau.

DISCUSSION

This study sought to describe the correlation between data obtained through DXA and other fat percentage evaluation protocols by skinfold strategy in sprinters.

The results found bring to athletics practice and training more reliability regarding elite athletes body composition analysis. The findings were able to show a strong correlation between data obtained through DXA and Faulkner's predictive equation. The other equations used in this study could have their results interpreted as: moderate correlation (Boileau and Slaughter) and weak correlation (Lázari).

According to a study by Martins et al.[15] countless researches have been comparing body composition methods such as anthropometry, bioimpedance and DXA. The results found in this study corroborate those presented by Deutz et al.[16], which compared gymnastic athletes and runners body composition values through DXA and Jackson's equation anthropometry. In both, a strong correlation was found between the adopted methods, and also that DXA values were higher in relation to fold method. These convergences show evidence of

a greater proportionality between some equations and DXA values, upon a given population.

This effect can also be described in the study by Moreira et al.[17], since when comparing the BF% values found in Taekwondo athletes, through DXA and six distinct prediction equations, it was possible to verify a greater correlation of one above the others. This same behavior is also evidenced in the study of Lozano-Berges et al.[18], which also compared six different folds to DXA, in teenage football players.

It is important to note that certain equations were developed for specific populations, which would explain the differences found between the protocols used. In this study, we noted that the equation closest to DXA results in terms of proportionality, Faulkner's, is not meant for athletics, the modality tested by us. It is important saying there are divergences in what is understood as the origin and author of such equation. According to Pires Neto and Glaner[19], the formula up to then attributed to Faulkner, in reality, would have been created from the adaptation of two equations developed by Yuhasz. However, this strong correlation is understandable, given that both samples fit within the profile determined by the formula, that is, well-trained young men.

Once we had an equation showing a strong correlation with the values obtained by an evaluation considered gold standard, it was also possible, through a linear equation, to correct its values in order to reproduce DXA values, being R2 the determination coefficient whose function is to explain the results obtained. Thus, we interpret that such data is able to explain 66% of the results, while other data and variables would be needed to explain the remaining 34%.

We suggest for the next study a greater variables range to be analyzed from the statistical scope, as well as a greater number of protocols to be compared. Greater sampling could bring more comprehensive results. However, we believe that athletes with expressive results at national and international level, such as those in this study, are sufficient to obtain relevant results for sport science.

CONCLUSION

Although all the formulas in our study aim to estimate fat percentage, we could identify that, among the equations used, Faulkner's was the one showing the highest correlation value when compared to DXA protocol. This fact indicates proportionality with the gold standard method, in order to ascertain the body composition and the aforementioned formula.

Absolute mean values of fat percentage were also observed as higher than DXA, regarding anthropometry. Finally, new studies are needed, including exploring new protocols, formulas and sampling in order to provide a greater understanding of the body composition from different populations and modalities.

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COMPLIANCE WITH ETHICAL STANDARDS

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Ethical approval

Ethical approval was obtained from the local Human Research Ethics Committee – Universidade Estadual de Campinas and the protocol no. 1.511.796 was written in accordance with the standards set by the Declaration of Helsinki.

Conflict of interest statement

The authors have no conflict of interests to declare.

Author Contributions

Conceived and designed the experiments: EL. Performed the experiments: EL; Analyzed the data: EL, AM, RA, RO, RG; Contributed reagents/materials/ analysis tools: EL, RA, RO, RG; Wrote the paper: EL, AM, RA, RO, RG.

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