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Original / *Deporte y ejercicio*

Inter-methods agreement for the assessment of percentage of body fat between two laboratory methods in male adolescent cyclists

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Abstract

Objective: **To examine inter-methods agreement between dual energy X-ray absorptiometry (DXA) and air displacement plethysmography (ADP) in male adolescent cyclists for assessing percentage of body fat (PBF).**

Methods: **PBF of 24 male adolescent cyclists was assessed by DXA and ADP. Agreement between ADP and DXA was determined according to a Bland–Altman plot; validity and lack of agreement was assessed by calculating inter-methods difference. The limits of agreement and differences between methods were also calculated by paired t-tests. Heteroscedasticity was also examined.**

Results: **The values obtained by DXA were higher than those obtained by ADP, and the graph presented heteroscedasticity (both $p < 0.05$; $r = 0.74$).**

Conclusion: **DXA and ADP methods were not comparable in terms of PBF assessment in our sample of male adolescent cyclists; it needs to be taken into account when evaluating longitudinal changes in this determined population.**

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Key words: *Body composition. Body fat. Cycling. Adolescents.*

VALIDEZ INTER-MÉTODO PARA LA VALORACIÓN DEL PORCENTAJE DE GRASA ENTRE DOS METODOS DE LABORATORIO EN CICLISTAS VARONES ADOLESCENTES

Resumen

Objetivo: **Examinar la validez inter-métodos entre la absorciometría rayos X (DXA) y la pletismografía por desplazamiento de aire (PDA) en ciclistas varones adolescentes, para la evaluación del porcentaje de grasa corporal.**

Métodos: **Se evaluó el porcentaje de grasa corporal de 24 ciclistas varones adolescentes mediante DXA y PDA. La validez inter-métodos se determinó mediante un gráfico de Bland-Altman; se calculó la diferencia inter-método y los límites de concordancia mediante test t de Student. Se examinó también la heteroscedasticidad ente ambos métodos.**

Resultados: **Los valores de porcentaje de grasa corporal obtenidos por el DXA fueron más elevados que los obtenidos por PDA, y el gráfico presentó heteroscedasticidad (ambos $p < 0,05$; $r = 0,74$).**

Conclusión: **El DXA y la PDA no son métodos comparables para la evaluación del porcentaje de grasa en nuestra muestra de ciclistas varones adolescentes; esto debería ser tenido en cuenta a la hora de evaluar cambios longitudinales en esta determinada población.**

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Palabras clave: *Composición corporal. Grasa corporal. Ciclismo. Adolescentes.*

Introduction

Several factors influence performance in long-distance competitions such as road cycling. Apart from physiological aspects, other variables have also an influence: height, weight, body mass index (BMI), percentage of body fat (PBF) or limbs length, among others.[1,2] In addition, maximal oxygen uptake has been related with fat free mass;[3] therefore, an excess of fat represents unnecessary weight loaded while practising sports, without providing any benefit.

During adolescence, changes in body composition occur continuously;[4] it is, therefore, important to control PBF in adolescent athletes not only for health reasons during the growth period,[5] but also looking for performance.

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Several methods such as underwater weighing, air displacement plethysmography (ADP) or dual energy X-ray absorptiometry (DXA) have been used to evaluate PBF in adolescents because of their accuracy at the individual level.[6] ADP, as a substitute of hydrostatic weighing, has become the 'gold standard' for assessing total body density (TBD), and then PBF.[7] DXA, for its part, has been suggested as one of the most appropriate methods for studying body composition because it does not only provide values of fat, but also lean and bone masses. Some efforts have been made in order to compare different assessment methods in sports[8] and non-sports people.[9]

As it is known, cycling might not be a good sport for improving bone mass,[10] specially throughout adolescence;[11] this aspect needs, therefore, to be controlled. It could be interesting to clarify whether the device used for assessing bone health (DXA) does also provide reliable values for assessing PBF in adolescent cyclists, compared with the 'gold standard' method (ADP).

To the best of our knowledge, no studies have been performed until the date in adolescent cyclists in order to assess the agreement between DXA and ADP for assessing PBF.

Therefore, the main objective of this study was to examine the inter-methods agreement between DXA and ADP in male adolescent cyclists for PBF.

Materials and methods

Participants

Twenty-four male adolescent cyclists between 14 and 20 years of the region of Aragon (Spain) participated. All of them had at least 2 years of cycling practice.

The study was performed in accordance with Helsinki Declaration of 1961 (revision Edinburgh 2000) and the study was approved by the Research Ethics Committee of the Government of Aragón (Spain).Writing informed consents were obtained from the adolescents and parents.

Anthropometry

Participants were measured without shoes and the minimum clothes to the nearest 0.1 cm (SECA 225, SECA, Hamburg, Germany), and weighted to the nearest 0.1 kg (SECA 861, SECA, Hamburg, Germany). BMI was calculated as weight (kg) divided by height squared (m^2).

Fat mass measurement

Air displacement plethysmography

TBD was assessed by ADP with a Bod-Pod® device (Body Composition System; Life Measurement, Concord, CA; Software V.2.3). All studies were performed by the same technician. After calibration, participants were measured with minimum clothes and a swimming cap. The pulmonary capacity was calculated with the software of the device based on physical characteristics of participants. PBF was calculated by introducing TBD (g/cm^3) in the equation of Siri.

Dual energy X-ray absorptiometry

Total fat mass (kg) was determined from a whole body scan by DXA using a paediatric version of the software QDR-Explorer (Hologic Corp., V.12.4, Waltham, MA). DXA equipment was calibrated using a lumbar spine and a step densities phantom. Participants were scanned in supine. PBF was calculated as total body fat divided by body mass and multiplied by 100.

Statistics

Statistical analyses were performed with the Statistical Package for the Social Sciences (V.15.0, SPSS Inc., Chicago, IL). Results were presented as mean ± standard deviation, otherwise stated. Normal distribution of the variables was assessed with Kolmogorov-Smirnov tests. Agreement between ADP and DXA was determined according to a Bland–Altman plot.[12] Differences were plotted against 'gold standard' (in this case ADP) instead of the mean value because 'gold standard' was expected to be closer to the *"true value"* than the mean.[13] Validity and lack of agreement between ADP and DXA was assessed by calculating inter-methods difference and sd of the differences. The 95% limits of agreement (inter-methods difference ± 1.96 sd) were also calculated. Differences between methods were analysed by paired *t*-test. Heteroscedasticity was examined by linear regression to determine whether the absolute inter-methods difference was associated with the magnitude of the measurement. Statistical significance was set at $p < 0.05$.

Results

Descriptive characteristics of the sample are summarized in table I.

Tabla I
Physical characteristics of the participants

	N = 24
Age (yr)	17,3 ± 2,4
Weight (kg)	63,4 ± 9,7
Height (cm)	174,1 ± 6,9
BMI (kg/m^2)	20,8 ± 2,1
PBF by DXA	16,0 ± 4,1
PBF by ADP	13,3 ± 5,5

BMI: Body Mass Index; PBF: Percentage of body fat; DXA: Dual energy X-ray.

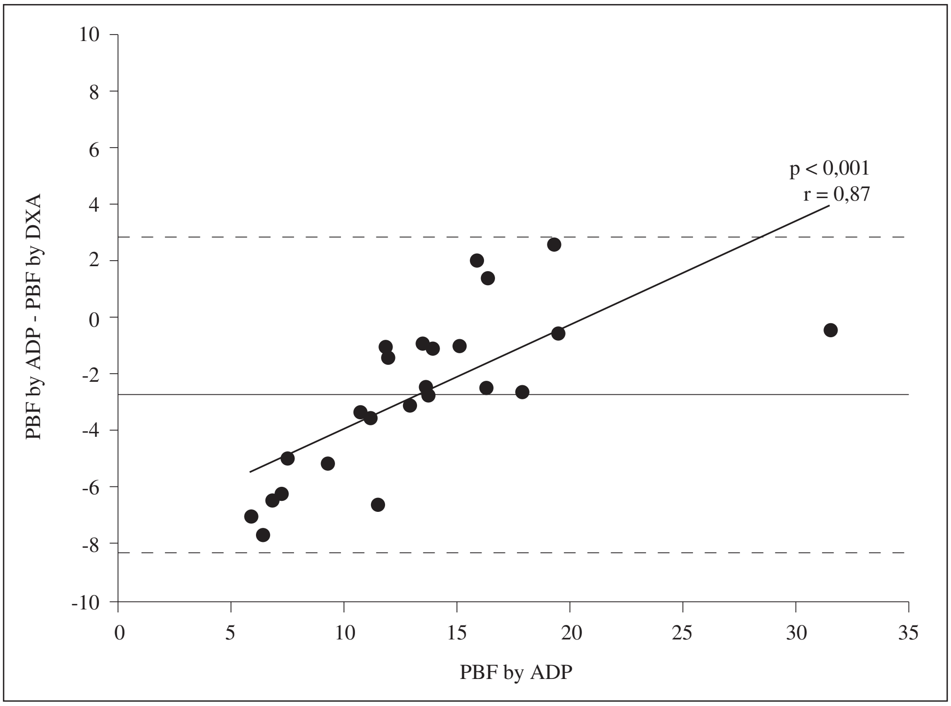

Fig. 1.—Comparison of PBF obtained with DXA and ADP by Bland-Altman plots. Central line represents the inter-methods difference. Upper and lower broken lines represent the 95% limits of agreement (inter-methods difference ± 1.96 sd of the differences). The solid line represents the linear regression between PBF by ADP and differences between methods, its correlation(r) and significance (p). Note: ADP: air displacement plethysmography; DXA: dual energy X-ray absorptiometry; PBF: percentage of body fat.

Bland-Altman plot showed significant inter-methods difference for PBF; the values of PBF measured with DXA were higher than the measured with ADP ($p < 0.001$). In addition, heteroscedasticity was present in the graph ($p < 0.001$, $r = 0.87$).

Discussion

The main finding of the present study was that DXA and ADP were not in agreement when evaluating PBF in our sample of adolescent cyclists.

Inter-methods agreement for PBF has been studied in different athletic adolescent populations.[6,14,15] Our results are in line with previous studies that reported higher values for PBF measured with DXA compared with ADP performed in young athletes and football players.[16,17] These differences could be partially explained because of Siri equation might not be the most accurate to calculate PBF in young athletes. As previously mentioned, ADP is the 'gold standard' for measuring PBF, it could be hypothesized that DXA is not valid for measuring PBF in adolescent cyclists. However, the additional information about bone mass that DXA provides is a very important issue to be taken into account assessing body composition in this population characterised by low mineral content.[11]

The small sample size represents a limitation to this study and, therefore our findings needs to be confirmed in further studies.

Conclusion

The assessment of PBF by DXA and ADP in male adolescent cyclists does not present the same results; therefore these two methods cannot be interchangeably used to evaluate longitudinal changes or to compare data from different studies within this population. This finding emphasizes the relevance of standardization and harmonization when conducting body composition measurements in specific population samples.

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