BODY FAT DETERMINED BY DXA AND ANTHROPOMETRIC EQUATIONS IN PROFESSIONAL SOCCER PLAYERS

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INTRODUCTION

Several anthropometric equations have been developed to predict body fat in athletes and in the general population (Lohman, 1981). These equations show a wide variability among the results when using the same data (Katch, 1980; Sinning, 1985). The above mentioned leads to uncertainty about which equation is more appropriate to be applied in athletes, specifically in professional football soccer players. Although some of them have been tested against hydrostatic weighting, a more accurate criterion method is needed (Prior, 1997). The purpose of this study is to compare different anthropometric equations to predict body fat with Dual-energy X-ray Absorptiometry (DXA) as the reference method.

METHODS

Anthropometric measurements and whole-body DXA (Hologic QDR) scanning values of 75 professional male football soccer players (2009 to 2013) from the University of Guadalajara, México, mean age 23.7 ±4.3 (17 to 37 years), were used to compare fifteen equations to predict body fat. Only equations calculating body fat from skinfold thickness (Harpenden caliper) and body weight (Tanita TBF-410) were used. The ANOVA test was applied to find differences and Dunnett's test as post hoc with DXA as the reference method, both with a significance of $p<0.05$. Those equations without statistical differences were analyzed with Bland-Altman's plot modified according to O'Connor (2011).

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RESULTS

The values obtained with each equation are shown in table 1. Seven equations had statistical differences when compared with DXA. The equations that had shorter limits of agreement with DXA were the one proposed by Oliver (2012) and Wilmore (1969) (Figure 1), followed by Civar (2003).

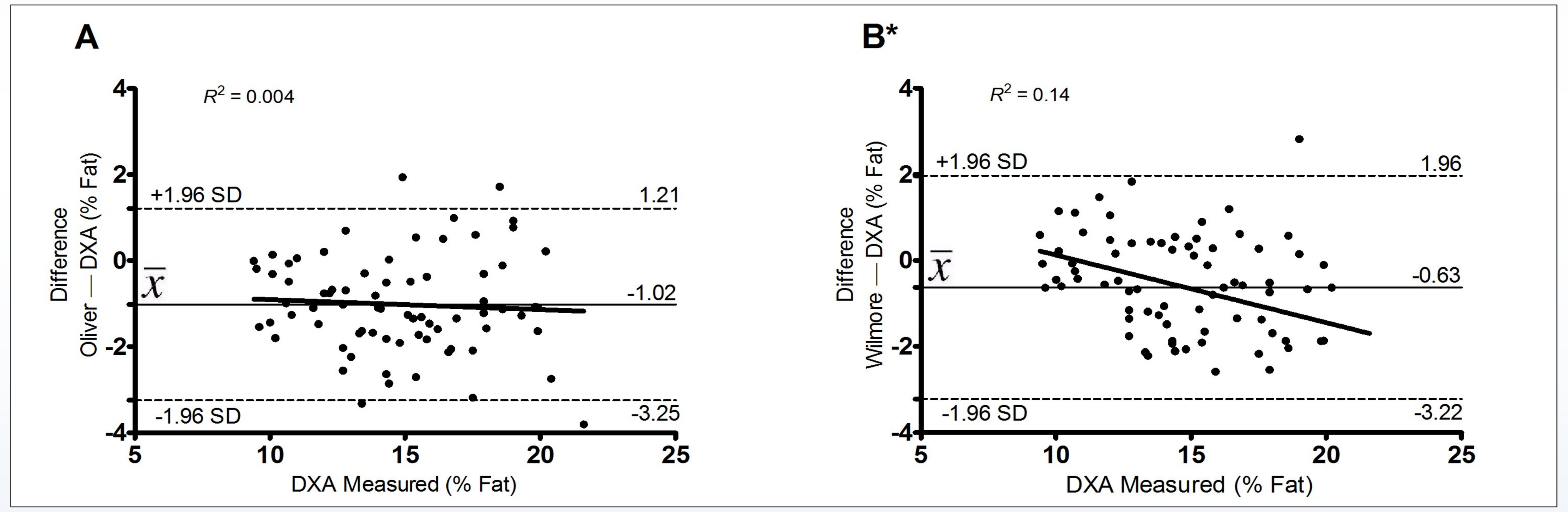

Figure 1. Bland-Altman´s plots for the reported equations by (A) Oliver and (B) Wilmore. Dashed, straight and gross lines are limits of agreement at 95%, mean difference and tendency respectively. *Two values are hidden because of the scale adjustment (-4.6, -4.9).

CONCLUSION

Despite that Wilmore's equation was not developed in athletes, results of this study shows one of the best agreements with DXA, but since it only measures two skinfolds we are not sure if it is the most appropriate way to monitor the changes in body fat of soccer players. In our sample, Oliver's equation was the best to predict body fat percentage. Because this equation was developed in American football players, where the morphological variety of subjects is wider, this equation may provide more reliable results in other sports disciplines, including football soccer.

Moreover, Oliver's equation may be more sensitive to body fat changes because it employs seven skinfolds and monitoring could be more accurate. Because of the wide range of results found in this study, there is a need to continue this type of research evaluating different samples of soccer players.

Table 1. Values obtained for the anthropometric equations compared with DXA.

Author/equation	Body fat (%)	Differences (%) ‡§	
DXA	14.8 ±3.1	-	
Oliver (2012)	13.8 ±3.2	-1.02 ±1.14	(-3.25 to 1.21)
Wilmore (1969) *	14.2 ±2.9	-0.63 ±1.32	(-3.22 to 1.96)
Civar (2003)	13.8 ±2.8	-0.95 ±1.32	(-3.53 to 1.63)
Durnin (1967) *	15.8 ±3.8	1.01 ±1.66	(-2.25 to 4.26)
Durnin (1974) *	15.1 ±3.9	0.36 ±1.90	(-3.37 to 4.10)
Withers (1987) *	11.3 ±3.1†	-3.53 ±1.43	(-6.34 to -0.72)
Katch (1973) *	11.0 ±3.0†	-3.77 ±1.24	(-6.20 to -1.33)
Stewart (2000)	10.9 ±3.9†	-3.88 ±1.93	(-7.66 to -0.10)
Jackson-2 (1978) *	10.5 ±3.8†	-4.32 ±1.47	(-7.20 to -1.43)
Thorland-1 (1984) *	9.9 ±4.4†	-4.87 ±2.12	(-9.02 to -0.73)
Jackson-1 (1978) *	9.8 ±3.4†	-5.03 ±1.47	(-7.90 to -2.16)
Thorland-2 (1984) *	13.5 ±5.6	-1.33 ±2.93	(-7.07 to 4.41)
Forsyth-2 (1973) *	14.4 ±5.7	-0.42 ±3.15	(-6.58 to 5.74)
Forsyth-1 (1973) *	15.0 ±5.6	0.24 ±3.07	(-5.78 to 6.27)
Sloan (1967) *	8.8 ±2.7†	-5.97 ±2.30	(-10.48 to -1.46)

Expressed as $\bar{x}$ ±SD.

Civar: 3 skinfolds + body weight; *Durnin*: ∑4 skinfolds; *Forsyth-1*: 2 skinfolds; *Forsyth-2*: 4 skinfolds; *Jackson-1*: ∑3 skinfolds; *Jackson-2*: ∑7 skinfolds; *Katch*: 3 skinfolds; *Oliver:* ∑7 skinfolds; *Sloan*: 2 skinfolds; *Stewart*: 2 skinfolds + body weight; *Thorland-1*: ∑3 skinfolds; *Thorland-2*: ∑7 skinfolds; *Wilmore*: 2 skinfolds; *Withers*: ∑7 skinfolds.

*Body density equation converted to body fat % with Siri's equation (1956).

†Statistical differences ($p < 0.05$) compared with DXA.

‡Predicted value with equation – measured with DXA.

§ Limits of agreement at 95% [$\bar{x} \pm (1.96 * SD)$] are shown in parentheses.