Molecular and Cellular Body Composition Components Predict Sprint Performance in Adolescents

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Abstract

Body composition including hydration has been classically associated with aerobic performance. However, the relationships between anaerobic performance assessed by sprints and hydration have not been analyzed extensively in the literature, particularly among children and adolescents. This is a paradoxical situation because the child is primarily involved in short-term high intensity exercise in almost daily tasks, games or sports events. The analysis of these associations must be useful to describe the importance of hydration and lean mass for performance in healthy adolescents. **PURPOSE**: To analyze the association between 30m-sprint test and body composition (BC) variables in young athletes and non-athletes. **METHODS**: BC was assessed by anthropometric measures and total-body bioelectrical impedance analysis (BIA) in 159 adolescents between 12 and 18 years old (15.0 ± 1.5 yrs, BMI = 21.1 ± 3.5 kg/m^2). The volunteers were recruited from local high-schools and local sport clubs. Athletes (AT) and non-athletes (NAT) were identified using *ad hoc* questionnaire (NAT = 101, 41 boys, 60 girls, and AT = 58, 27 boys, 31 girls). Body fat (BF) and fat free mass (FFM) were calculated by anthropometric derived-equation. Total body water and intracellular water (ICW) were obtained from BIA. Photoelectrical cells were used to measure time spent in 30-m. Partial correlations were carried out to determine associations between BC variables and 30-m sprint values. The best-correlated variables with sprint performance were included in a stepwise regression analysis to determine BC predictors of sprint performance. **RESULTS:** As expected AT were faster than NAT in 30-m (5.07 ± 0.47 vs 5.52 ± 0.59 sec, *P<0.001*), but there were no significant differences in ICW (AT = 16.0 ± 5.1 vs NAT = 14.7 ± 6.1%, *P>0.05*). A significant correlation was found between ICW and 30m-sprint test after controlled by age and kg of BF (r = -0.732, *P<0.001*). When subjects were pooled together, %FFM, ICW, age and the athlete condition were predictors of the 30-m run (R^2 = 0.452, *P<0.001*). **CONCLUSIONS**: In accordance with studies conducted in adults, our results confirm that sprint performance in adolescents was partially dependent %FFM. The main finding was that ICW was a significant predictor of sprint in adolescents.
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Introduction

The relationships between anaerobic performance and hydration have not been analyzed extensively in the literature (Kraft et al, 2012), particularly among children and adolescents. This is a paradoxical situation because the child is primarily involved in short-term high intensity exercise in almost daily tasks, games or sports events. The analysis of these associations must be useful to describe the importance of hydration and lean mass for performance in healthy adolescents.

Purpose

To analyze the association between 30m-sprint test and body composition (BC) variables in young athletes and non-athletes.

Methods

Sample. One hundred and fifty-nine healthy adolescents between 12 and 18 years old (15.0 ± 1.5 yrs) were recruited from local high-schools and local sport clubs. Athletes (AT) and non-athletes (NAT) were identified using an *ad hoc* questionnaire (NAT = 101, 41 boys, 60 girls, and AT = 58, 27 boys, 31 girls).

Body Composition Assessment. Standard procedures for anthropometry were performed to measure circumferences and skinfolds variables. Body Fat (BF) was calculated using Slaughter's equation and FFM was derived from body weight. Validated age-specific models were applied to obtain Skeletal Muscle Mass (SMM) based on anthropometric variables (Poortmans' for <16 years and Lee's models). A classical BIA procedure (Lukaski, 1988) was used to obtain Total Body Water (TBW) by a multifrequencial impedanciometer (MediSystem®, Spain). Intracellular Water (ICW) was obtained by the equation TBW = ECW + ICW.

Sport Assessment. Photoelectrical cells were used to measure time spent in 30-m (SmartSpeed™, Fusion Sport®). AT and NAT were identified using an *ad hoc* questionnaire.

Design. A study advertisement during physical education classes and training sessions was carry out in order to recruit the sample. Parents and volunteers signed a written consent. Acute or chronic diseases were the only exclusion criteria.

Statistical analysis. Differences between groups were analyzed. Partial correlations were carried out to determine associations between BC variables and 30-m sprint values. The best-correlated variables with sprint performance were included in a stepwise regression analysis to determine BC predictors of sprint performance.

Results

As expected AT were faster than NAT in 30-m (5.1 ± 0.5 vs 5.5 ± 0.6), but there were no significant differences in ICW (AT = 16.0 ± 5.1 vs NAT = 14.7 ± 6.1). NAT had significantly more fat and less TBW than AT. No significant differences were found between groups for FFM (*P* = 0.150).

Table 1. Comparison of the characteristics of the sample.

	ALL		ATHLETES		NON-ATHLETES	
Variables	Mean	SD	Mean	SD	Mean	SD
Age *(years)*	15.0	1.5	14.8	1.3	15.1	1.6
Weight *(kg)*	57.1	11.9	54.2	10.3	58.8*	12.4
Height *(cm)*	163.9	9.0	164.5	9.0	163.6	9.0
BMI *(kg/m^2)*	21.1	3.5	19.9	2.6	21.9¥	3.8
BF *(%)*	23.2	8.3	19.3	6.6	25.5¥	8.4
FFM *(kg)*	43.5	8.3	43.6	8.7	43.4	8.1
SMM *(kg)*	20.9	5.6	20.2	5.7	21.3	5.5
Time 30-m *(s)*	5.4	0.6	5.1	0.5	5.5¥	0.6
TBW *(%)*	57.0	5.4	58.1	4.6	56.3*	5.8
ICW *(%)*	15.2	5.8	16.0	5.1	14.7	6.1

*P<0.05; ¥P<0.001

A significant correlation was found between ICW and 30-m sprint test after controlled by age and kg of BF (Table 2, Figure 1). The best association was found in AT when sprint performance was expressed as speed (m/s) and ICW in kg (r = 0.766, *P*<0.001).

Table 2. Partial correlations between ICW and 30-m sprint performance.

	ALL		ATHLETES		NON-ATHLETES	
Variables	ICW(%)	ICW(kg)	ICW (%)	ICW (kg)	ICW (%)	ICW (kg)
Time 30-m (s)	-0.422	-0.548	-0.665	-0.732	-0.405	-0.522
Speed 30-m (m/s)	0.446	0.579	0.692	0.766	0.418	0.542

In all cases *P* <0.001

When subjects were pooled together, %FFM, %ICW, age and the athlete condition were introduced in the initial model to predict time in 30-m (R^2 = 0.452, *P*<0.001).

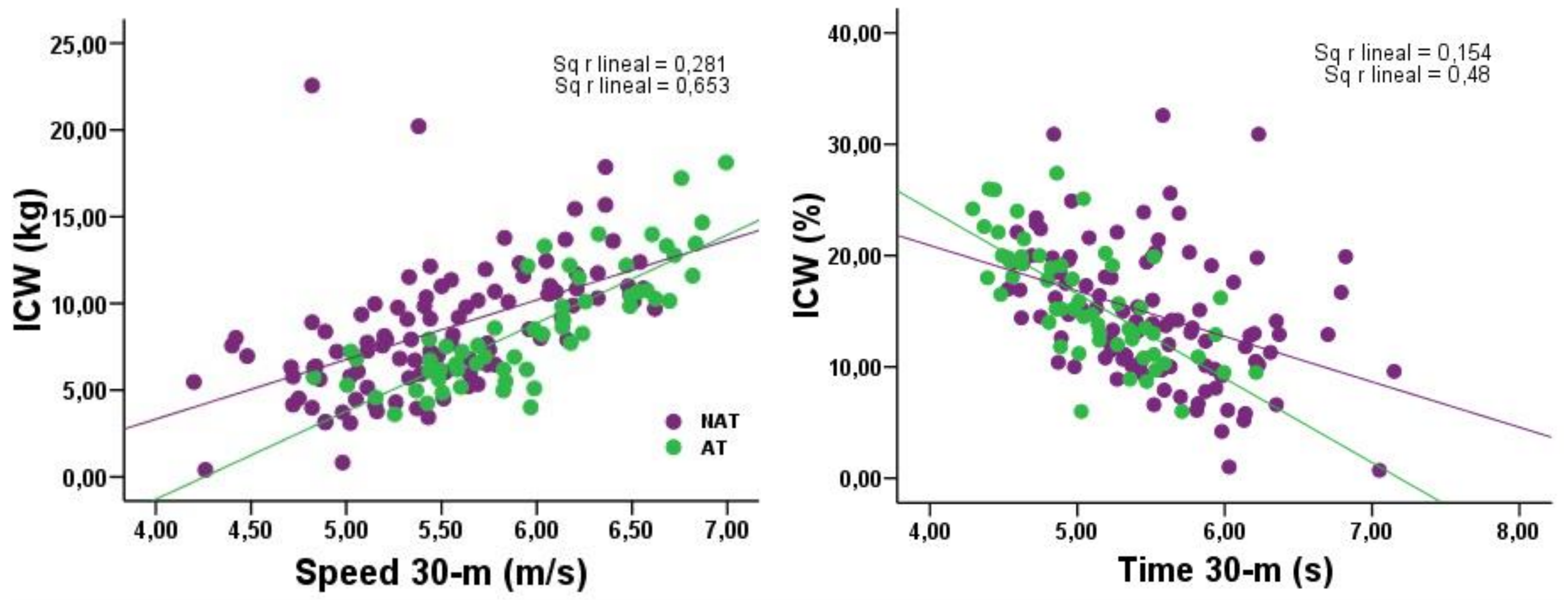

Figure 1. Graphs of intracellular hydration and sprint performance.

Stepwise regression analysis was performed again with speed in 30-m as dependent variable. With R = 0.793 and SEE = 0.371, SMM (kg), the athlete condition coded as yes or no, and %ICW were identified as predictors (*P*<0.001, R^2 = 0.629, adjusted R^2 = 0.622). The equation for the model was as follows:

$$\text{Speed 30-m (m/s)} = 3.7 + (0.058*\text{SMM}) + (0.485*\text{AT}) + (0.038*\text{ICW})$$

Summary & Conclusions

In accordance with studies conducted in adults, our results confirm that sprint performance in adolescents was partially dependent on muscle mass (Perez-Gomez, 2008). The main finding was that ICW was a significant predictor of sprint in adolescents. A classical study by Sjøgaard (1982) suggested that muscles with large fibers have a smaller ECW space than muscle with small fibers. So, a possible association between fiber size and ICW could be possible.

The multiple regression analysis applied in the present investigation indicates that other factors could play a role, such the athletic status. Training level had been shown before as influential factor in jump performance in children and adolescents (Keiner, 2013). Our body composition data are in accordance with the Battistini's study (1994), who reported significant differences among athletes of different training level.

More research with different samples is necessary to confirm our results. We suggest to use BIA in a clinical setting for the assessment of the ICW in order to have reference values to compare specifically among athletes.

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