Bioelectrical impedance vector analysis (BIVA) for monitoring hydration status in young competitive synchronized swimmers

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Introduction

A synchronized swimming (SS) training session typically includes specific drills, choreographies, and physical conditioning exercises, imposing complex physiological demands[1]. Training volume and intensity differs depending on the age and competitive level of the swimmers. Bioelectrical impedance vector analysis (BIVA) is a non-invasive and safe technique for assessing hydration and body composition changes[2].

Aim

This study applied BIVA to the assessment of hydration changes evoked by SS during a typical training session in swimmers of different age and competitive level.

Methods and Procedures

59 swimmers were divided into 1) pre-juniors (pre-JR) and juniors (JR) (Table 1). Height and body mass (BM) were assessed following the norms and procedures of the ISAK. BIVA was conducted PRE and POST a typical training session as shown in Figure 1. A multi-frequency wrist-to-ankle BIA meter device (Z-Metrix®, Bioparhom, France) was used and 50 kHz whole-body BIA vectors were analysed by the resistance (R) – reactance (Xc) graphic method, and Z mean values plotted[3] (Figure 2).

Statistical analysis

Pre-post differences were tested by paired t-test (Table 1). Hotelling's T^2 test determined differences in the complex localized vector through the 95% confidence and tolerance intervals (Figure 2).

Results

Compared to the reference population[4], significant differences were found in whole-body BIA vector in both pre-JR (T^2=25.6, p=0.003) and JR (T^2=25.8, p=0.001). Changes were observed between PRE and POST in BM (pre-JR: 47.0±7.2 kg vs. 46.7±7.3 kg, P<0.001; JR: 53.7±4.9 kg vs. 53.4±4.9 kg, P<0.001), R (pre-JR: 530±46 Ω vs. 548±45 Ω, P<0.001; JR: 503±33 Ω vs. 524 ±45 Ω, P=0.004), and Xc (pre-JR: 64.4±5.4 Ω vs. 66.6±4.8 Ω, P=0.002; JR: 66.0±2.9 Ω vs. 70.3±4.3 Ω, P<0.001). BIVA showed significant vector migration from PRE to POST (T^2=8.99; p<0.05) in JR, whereas no changes were noted (T^2=1.92; P>0.05) in pre-JR (Fig. 2).

Table 1. Characteristics of participants.

	Pre-junior (n=44)	Junior (n=15)	t-test (*t*)	*p*-value (*p*)
General				
Age (years)	13.9 ± 0.9	16.7 ± 0.9	-10.851	0.0001*
TV (h·week⁻¹)	15.6 ± 3.1	30.0 ± 3.8	-15.911	0.0001*
SSP (years)	6.0 ± 2.1	9.1 ± 1.0	-9.980	0.0001*
Anthropometric				
Height (cm)	161.9 ± 8.2	166.3 ± 4.8	-1.943	0.058
Body mass (kg)	47.2 ± 7.2	53.7 ± 4.9	-3.103	0.003*
Bioelectrical				
R (Ω)	530.0 ± 46.0	503.0 ± 33.0	3.286	0.002*
Xc (Ω)	64.4 ± 5.4	66.0 ± 2.9	0.395	0.695

Values are mean ± standard deviation; TV, training volume; SSP, synchronized swimming practice; R, resistance; Xc, reactance; * significant differences between Pre-junior and Junior swimmers (unpaired t-test, p<0.05).

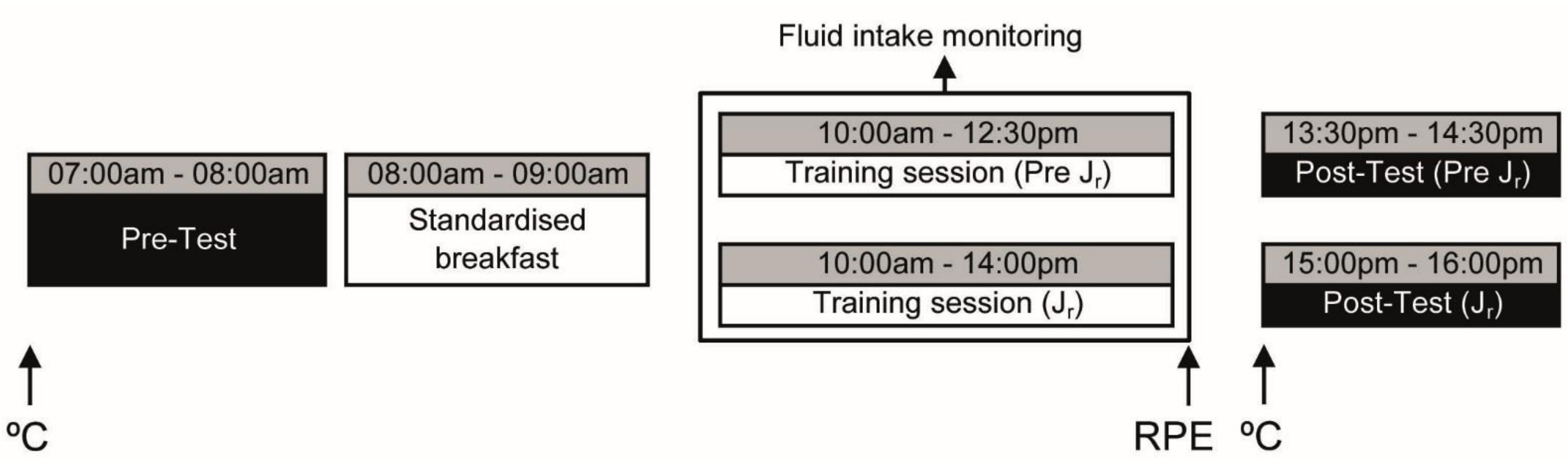

Figure 1. Study protocol. ºC, body and skin temperatures; RPE, rating of perceived exertion; Pre Jr: pre-junior; Jr: junior.

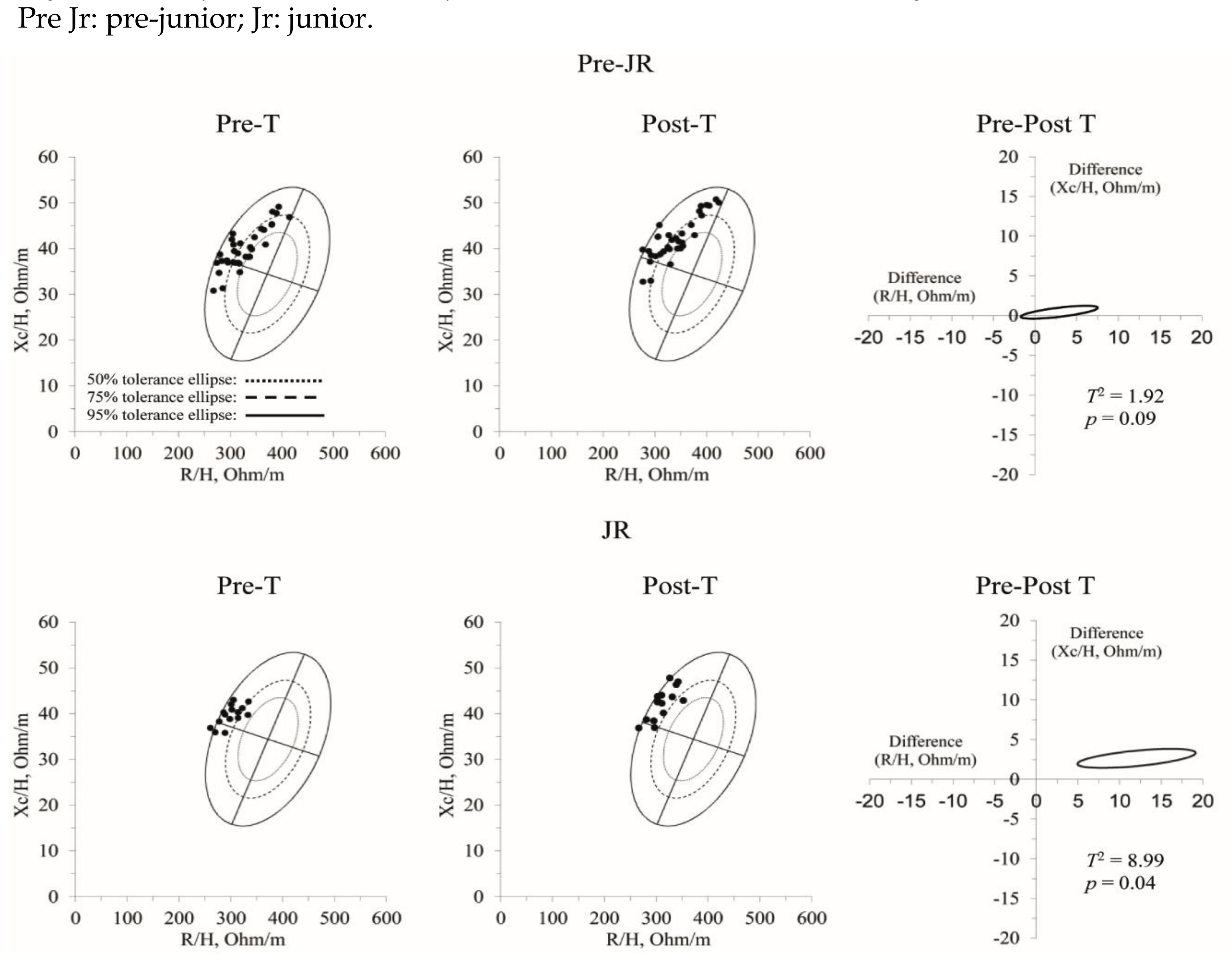

Figure 2. On the left side, scattergram of the 44 Pre-JR and 15 JR individual impedance vectors, plotted on the 50%, 75%, and 95% tolerance ellipses of the corresponding healthy female reference population[4]. Hotelling's T^2 test significance at p < 0.05.

Discussion & Conclusions

Both JR and pre-JR swimmers showed a migration of the BIA vector characterized by an increase in length (R) and height (Xc), likely as a result of moderate dehydration. Regardless of age and competitive level, a typical SS training session affects the homeostatic hydration level of the swimmers. BIVA analysis appears to be sensitive enough to detect these changes (mean diff.: 0.5–0.8 %BM).

References

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