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Original Article

Body composition and bioelectrical parameters in recreational CrossFit® practitioners

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Highlights

- Phase angle was positively correlated with lean mass index.
- A higher phase angle was associated with lower body fat percentage.
- Sex differences were observed in bioelectrical parameters.
- Phase angle was inversely correlated with body fat.

Abstract

Objective: To describe the raw bioelectrical and body composition parameters of CrossFit practitioners and to analyze the relationship between phase angle and body composition.

Methods: This was a cross-sectional observational study with 45 adult CrossFit practitioners (42.2% men and 57.8% women) from a gym in Porto Alegre, RS. Individuals who had been practicing the sport for at least three months, with a minimum frequency of three times a week, and who self-reported as healthy were included. Tetrapolar bioelectrical impedance (Biodynamics 450) was used to assess resistance, reactance, impedance, phase angle (PhA), lean mass, fat mass, total body water, intracellular and extracellular water, and lean mass index. The t-test for independent samples was used in SPSS 23.0 for comparison between sexes and Pearson's correlation for associations between variables. A significance level of 5% was adopted.

Results: Men had higher means of lean mass, total body water, and PhA; women presented higher values of body fat, resistance, and reactance. In the total sample, positive correlations were identified between PhA and lean mass ($r=0.518$; $p<0.001$), as well as with lean mass index ($r=0.482$; $p=0.001$). PhA also correlated inversely with body fat percentage ($r=-0.454$; $p=0.002$).

Conclusion: The findings corroborate PhA as a functional marker associated with lower body fat content and higher lean mass content, reinforcing the use of BIA as a viable tool for monitoring body composition in CrossFit practitioners.

Keywords: Bioelectrical impedance; Body composition; CrossFit; Athletes; Phase angle

Introduction

CrossFit® is a high-intensity functional training (HIFT) program that combines constantly varied exercises involving Olympic weightlifting, gymnastics, and cardiovascular activities, promoting relevant physiological adaptations in the cardiovascular, metabolic, and musculoskeletal systems [1]. This modality has gained increasing popularity among recreational practitioners and athletes due to its capacity to improve strength, power, endurance, and body composition—key components for physical performance and muscular health.

Body composition plays a central role in sports performance, as higher proportions of lean mass are associated with better functional capacity. In contrast, excess body fat may compromise mechanical efficiency, increase the energetic cost of movement, and elevate injury risk. In this context, accurate assessment of body compartments becomes essential for nutritional and training monitoring in high-intensity modalities such as CrossFit®.

Bioelectrical impedance analysis (BIA) stands out as a widely used method in clinical and sports settings due to its non-invasive nature, rapid application, and practical feasibility [2,3]. The technique is based on measuring resistance (R) and reactance (Xc) of tissues to the passage of a low-intensity electrical current [3,4], allowing estimation of body composition and fluid distribution parameters. From these variables, phase angle (PhA) can be derived, which is considered a marker of cellular membrane integrity and the relationship between intracellular and extracellular compartments [4–7].

Recent evidence indicates that higher PhA values are associated with better muscle quality, greater lean mass content, and improved physical performance in physically active individuals [6,8,9]. In athletes and individuals engaged in strength and power training, PhA has been proposed as a complementary functional indicator for nutritional status assessment and training adaptation. However, despite the growth of CrossFit® and its high physiological demands, studies describing raw bioelectrical parameters and their relationship with body composition in recreational practitioners remain limited [2,5].

Therefore, this study aimed to describe the bioelectrical and body composition parameters of recreational CrossFit® practitioners and to analyze the relationship between phase angle and body components, contributing to the understanding of the morpho-functional profile of this population and supporting the use of BIA as a monitoring tool in sports nutrition.

Methods

This was a cross-sectional observational study conducted through secondary analysis of data from the project entitled "Assessment of energy availability in CrossFit® practitioners," previously approved by the Research Ethics Committee of the Federal University of Health Sciences of Porto Alegre (UFCSPA) under protocol number 5.291.499, in accordance with Resolution No. 466/2012 of the Brazilian National Health Council. All participants signed an informed consent form. The sample consisted of 45 adult recreational CrossFit® practitioners recruited from a specialized gym in Porto Alegre, Brazil. Inclusion criteria were men and women (non-pregnant), aged ≥18 years, practicing CrossFit® for at least three months, with a minimum frequency of three weekly sessions, and self-reported healthy status. Individuals diagnosed with metabolic diseases or using medications that could significantly interfere with body composition or hydration status were excluded.

Assessments were preferably conducted in the morning to minimize diurnal variations. Body composition and bioelectrical parameters were evaluated using tetrapolar bioelectrical impedance (Biodynamics 450, 50 kHz). Participants remained in supine position for approximately 10 minutes before measurement, with electrodes placed on the right wrist and ankle according to standardized protocol [3,4]. Pre-assessment instructions included a minimum of four hours of fasting, abstinence from physical exercise for eight hours, and suspension of diuretics for 24 hours when applicable.
Raw bioelectrical parameters analyzed included resistance (R, Ω), reactance (Xc, Ω), impedance (Z, Ω), and phase angle (PhA, °), as well as total body water, intracellular water, and extracellular water. Body composition variables included total body mass, lean mass, fat mass (kg and %), height, and lean mass index (LMI), calculated as lean mass (kg) divided by height squared (m^2) [10].

Normality was assessed using the Shapiro–Wilk test. Results were expressed as mean ± standard deviation. Independent t-tests were used for comparisons between sexes. Associations between phase angle and body composition variables were analyzed using Pearson's correlation coefficient. Statistical analyses were performed using SPSS version 23.0, adopting a significance level of 5% ($p < 0.05$).

Results

The sample included 45 recreational CrossFit® practitioners (19 men and 26 women), with a mean age of 32.6 ± 7.9 years, without a significant difference between sexes.

Men presented significantly higher values of body mass, height, lean mass, lean mass index, total body water, and phase angle compared to women ($p < 0.05$, **Table 1**). Women showed higher body fat percentage and higher normalized resistance and reactance values ($p < 0.05$). No significant differences were observed for body mass index and absolute reactance.

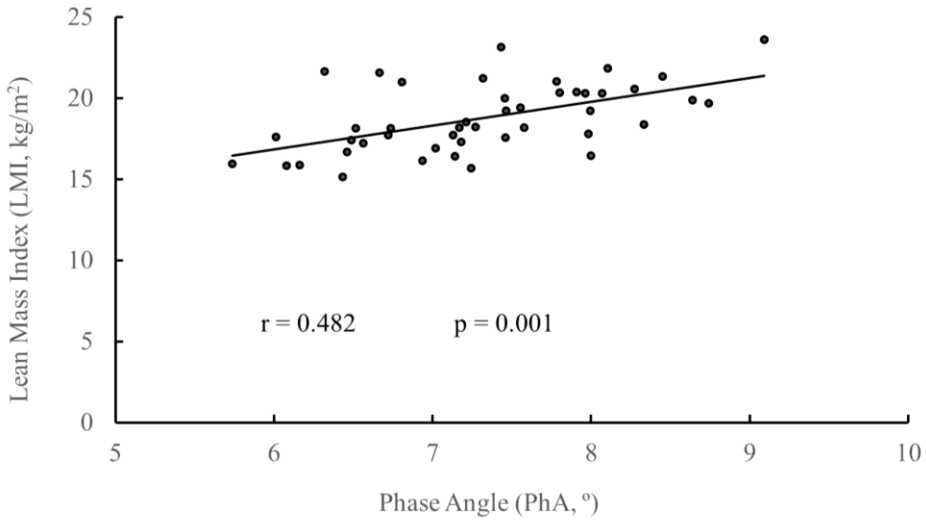
Table 1: Raw bioelectrical and body composition parameters of CrossFit® practitioners (mean ± SD).

	All (n=45)	Men (n=19)	Women (n=26)	p-value
Age (years)	32.6 ± 7.9	33.1 ± 8.6	32.2 ± 7.6	0.708
Body mass (kg)	74.8 ± 13.8	83.7 ± 11.2	68.3 ± 11.8	0.001
Height (cm)	169.1 ± 9.2	176.6 ± 7.8	163.6 ± 5.6	0.001
BMI (kg/m²)	25.9 ± 3.3	26.8 ± 2.1	25.4 ± 4.0	0.172
Phase angle (°)	7.3 ± 0.8	7.9 ± 0.7	6.9 ± 0.6	<0.001
LMI (kg/m²)	18.8 ± 2.1	20.5 ± 1.4	17.5 ± 1.5	<0.001
Resistance (Ω)	558.4 ± 76.2	497.4 ± 53.9	603.0 ± 56.9	<0.001
Reactance (Ω)	71.1 ± 8.4	69.0 ± 9.7	72.8 ± 7.0	0.121
RHm (Ω/m)	332.5 ± 56.1	282.3 ± 33.0	370.0 ± 38.0	<0.001
XcHm (Ω/m)	42.3 ± 5.9	39 ± 5.8	44.6 ± 4.7	0.001
Lean mass (kg)	54.2 ± 10.6	64 ± 7.3	47.0 ± 5.7	<0.001
Body fat (kg)	20.5 ± 6.5	19.7 ± 5	21.0 ± 7.5	0.527
Body fat (%)	27.3 ± 6.0	23.3 ± 3.6	30.1 ± 5.9	<0.001
Total body water (L)	39.0 ± 7.8	46.2 ± 5.9	33.6 ± 3.4	<0.001
Total body water (%)	70.9 ± 6.4	72.1 ± 1.2	70.0 ± 8.3	0.220
ICW (L)	23.2 ± 6.4	28.1 ± 3.2	19.7 ± 5.9	<0.001
ECW (L)	16.3 ± 2.9	18.1 ± 3.1	15.0 ± 2.0	0.001

Abbreviations: BMI: body mass index; LMI: lean mass index; RHm: resistance divided by height (Ω/m); XcHm: reactance divided by height (Ω/m); ICW: intracellular water; ECW: extracellular water. p-value: independent samples t-test for comparison between sexes.

In the total sample, phase angle showed a moderate positive correlation with lean mass ($r = 0.518$; $p < 0.001$) and lean mass index ($r = 0.482$; $p = 0.001$, **Figure 1**). An inverse correlation was observed between phase angle and body fat percentage ($r = -0.454$; $p = 0.002$). After stratification by sex, these associations did not remain statistically significant in men. Among women, however, the association between phase angle and lean mass index remained significant ($r = 0.421$; $p = 0.032$).

Figure 1: Correlation between phase angle and lean mass index (LMI) in recreational CrossFit® practitioners (n = 45).



Discussion

This study described bioelectrical and body composition parameters in recreational CrossFit® practitioners and investigated the relationship between phase angle and body components. Overall, findings indicate a profile consistent with physically active individuals, with expected sex differences, particularly regarding lean mass, body fat, and hydration-related parameters.

The phase angle values observed were similar to those reported in studies involving CrossFit® practitioners and high-intensity training modalities [5,6]. The positive association between phase angle and lean mass, as well as the inverse association with body fat percentage, reinforces the role of PhA as a functional marker of body composition, reflecting a higher proportion of metabolically active tissue and lower adiposity [6,8,9,11,12].

The positive correlation between phase angle and lean mass index in the total sample suggests that lean tissue adjusted for height is related to cellular quality. The persistence of this association only among women may be related to sample variability and physiological differences between sexes.

Raw bioelectrical parameters behaved consistently with literature findings, with lower resistance and higher phase angle values among men, reflecting greater intracellular water content and cellular integrity [4,5].

Among the study limitations, the cross-sectional design does not allow causal inference. The relatively small sample size, particularly in sex-stratified analyses, may have limited statistical power. Furthermore, although strict individual control of pre-assessment hydration and food intake was not performed, methodological precautions were adopted to standardize data collection. Considering that BIA is sensitive to acute variations in hydration status, food intake, and recent exercise [3,4], these factors may influence bioelectrical parameters. However, to minimize these effects, assessments were conducted in the morning, participants remained in a supine position for 10 minutes before measurement, and standardized pre-test instructions regarding fasting, exercise abstinence, and diuretic suspension were provided. These precautions aimed to reduce potential variability in bioelectrical measurements. Nevertheless, this study contributes by providing a detailed description of bioelectrical parameters in recreational CrossFit® practitioners, a population still underexplored in the literature

Conclusions

Recreational CrossFit® practitioners presented bioelectrical and body composition parameters compatible with physically active individuals. Phase angle was positively associated with lean mass and negatively associated with body fat percentage, supporting its potential as a complementary functional marker in body composition assessment. Bioelectrical impedance analysis proved to be a viable and applicable tool for nutritional and sports monitoring in this population.

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