Body Composition and Segmental Phase Angle in Physically Active Men

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Abstract: Body composition (BC) is strongly related to the overall health and fitness levels of athletes. The aim of this study was to evaluate BC and in particular phase angle for whole body and for the different body segments in males elite athletes compared with a normal-weight control group. 27 young men participated in the study: 9 ciclysts (age 28.8±3.5 years; weight 70.2±5.6kg; BMI 21.2±1.2 kg / m^2), 9 dancers (age 19.2±1.3 years; weight 63.3±5.8 kg; BMI 20.8±1.0kg /m^2) and 9 young normal-weight men (age 18.9±2.8years, weight 70.7±11.6 kg, BMI 22.9±3.3 kg / m$^{2.}$) Bioimpedance analysis (BIA) was performed at 50 kHz (DS Medica) early in the morning. Phase angle (a bioimpedance variable related to nutritional status) was used in order to evaluate differences in fat free mass (FFM) characteristics among the groups. As far as BC, cyclists showed the highest values of FFM whereas dancers and controls were similar. Fat mass (FM), both in absolute value and in percentage, is significantly lower in dancers and cyclists than controls. Total phase angle and leg phase angle were similar in Cyclist, dancers and controls. Regarding arm phase angle, there were no significantly differences between groups. This study shows that the sports activity, regardless of the type of sport, had a significant effect on BC variables respect non-athletic young men.

SCIENCE AND TECHNOLOGY PUBLICATIONS

1 INTRODUCTION

Body composition (BC) has been shown to strongly relate to the overall health and fitness levels of athletes (Esco et al 2008, Esco et al 2010) Generally, high ratios of fat-free mass (FFM) to fat mass (FM) and low body fat percentages (BF%) are advantageous. The presence of insufficient or excess body fat can result in performance reduction and possible deleterious effects on health.

Therefore, the accurate knowledge of body composition in athletes is strongly important.

The gold standard methods for body composition (Fields DA et al 2010) are not reproducible in individuals practicing sports because are invasive methods (hydrometry), not always applicable (densitometry) and they don't allow monitoring athletes because, being a radiological procedure, it should be performed not more than 2 times per year (DXA) (Fields DA et al 2012)

So, more user-friendly and simple techniques, such as skinfold thickness and Bioelectrical Impedance Analysis (BIA), are preferred.

Measurement of skinfold thickness (biceps, triceps, subscapular and iliac), performed by trained operators, could be appropriate to estimate body fat and its distribution in populations but not adequate for monitoring small changes in body composition at individual level. The accuracy of this method is related to the skill of the operators (Mei Z. et al 2007, Siri WE et al 1961).

BIA is a noninvasive, low cost, reliable and broadly applied method for body composition assessment in clinical and non-clinical settings.

Several predictive equations have been developed to estimate TBW and FFM by using Bioimpedance Index (H^2/R, cm^2/Ω).In addition to BIA data, these formulae include several parameters such as sex, age, body weight. Predictive equations are generally population-specific and can be useful only for individuals with characteristics of the reference population groups with a physiological hydration status (Kyle UG et al 2004).

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In particular, the use of BIA in athletes is less validated than other settings; also, BIA cannot be a reliable tool for evaluating FFM in athletes because hydration is not always normal (Matias CN et al 2012, Matias CN et al 2013).

Phase angle (PhA), which is a raw BIA variable, has been widely used as an objective indicator of cellular health, with higher values reflecting better cellularity, cell membrane integrity, and cell function (De Lorenzo et al 1985, Norman K. et al 2012). PhA has been suggested as a valuable proxy of body function (Beberashvili I et al 2014), nutritional status (Marra M et al 2005, Zhang G. et al 2014), disease prognosis (Stobaus et al 2012), and mortality risk (Norman K. et al 2014, Santarpia L. et al 2009).

In the literature, a few studies have so far evaluated PhA in elite as well as amateur athletes.

Therefore, the aim of this study was to evaluate body composition and in particular phase angle for the whole body and for the different body segments in males elite athletes of different sports compared with a normal-weight control group.

2 MATERIALS AND METHODS

27 young men, evaluated at the Clinical Nutritional Unit of the Department of Clinical Medicine and Surgery, Federico II University Hospital, Naples, participated in the study and were divided into three groups,: 9 cyclists (age 28.8±3.5 years; weight 70.2±5.6kg; BMI 21.2±1.2 kg / m^2), 9 dancers (age 19.2±1.3 years; weight 63.3±5.8 kg; BMI 20.8±1.0kg /m^2), 9 young normal-weight men as control group (age 18.9±2.8years, weight 70.7±11.6 kg, BMI 22.9±3.3 kg / m^2).

The data of a team of nine professional cyclists of the Pro Cycling Team Liquigas Cannondale were collected during the Giro D'Italia 2012, a three-week stage race.

The nine dancers attended dance school of the Teatro San Carlo in Naples. They train from Monday to Saturday for about 4 hours a day. The control group was selected among University students.

The same operator following standard procedures at the University "Federico II" of Naples performed all measurements.

Weight and height were measured with an approximation of 0.1 kg and 0.5 cm respectively. The BMI was calculated as weight (kg) / height² (m²). Body composition was estimated by skinfold thickness (biceps, triceps, subscapular and suprailiac sites) (Durnin JV. Et al 1974), measured on the left side of the body, in triplicate to the nearest 0.2 mm, using an appropriately calibrated HARPENDEN caliber.

PhA was measured with BIA (Human IM plus II-DS MEDICA) at 50 kHz in the post-absorptive state, at an ambient temperature of 22-24° C, after voiding and after being in the supine position for 10 min.

For the segmental BIA exam, the length of each segment was measured and the electrodes were properly positioned to obtain resistance and reactance values for each segment: arm and

leg. This evaluation was conducted according to the Organ method (Organ LW et al 1974).

The Medical Ethics Committee of the Federico II University approved the study and .all subjects give informant consent for routine diagnostic evaluation.

3 RESULTS

Anthropometric measurements of four groups are summarized in Table 1. Age and height were significantly different in cyclists versus other groups; the lowest was observed in dancers (63.3±5.8 kg), while BMI was similar between groups.

Table 1. Antropometric measurements for three sub-groups of 27 young men.

		Cyclists (n.9)	Dancers (n.9)	CTR (n.9)
Age	*y*	28.8±3.5*	19.2±1.3	18.9±2.8
Weight	*kg*	70.2±5.6	63.3±5.8	70.7±11.6
Height	*cm*	182±5°°	174±5	175±7
BMI	*kg/m^2*	21.2±1.2	20.8±1.0	22.9±3.3

* p< 0.05 vs all; °p<0.05 vs Dancers and CTR; °°p<0.05 vs Dancers;

In Table 2 are described the results of skinfold thickness measurements of athletes: except for biceps skinfold (significantly lower in dancers 2.72±0.12 mm), all skinfold values were significantly different in water polo and controls versus cyclists and dancers.

Table 2: skinfold thickness measurements of 27 young men.

		CYCLISTS (n.9)	DANCERS (n.9)	CTR (n.9)
Biceps	*mm*	3.89±0.54	2.72±0.12**	4.72±1.37
Triceps	*mm*	6.47±1.31	5.67±0.64	10.6±3.88*
Subscapular	*mm*	7.38±1.36	6.80±0.67	11.2±4.02*
Iliac	*mm*	6.82±2.59	5.98±0.75	12.9±5.34*
SUM	*mm*	24.5±4.74	21.2±1.22	39.4±13.3*

*p < 0.05 vs cyclists and dancers;** p< 0.05 vs all;

As far as body composition (Table 3), cyclists showed the highest values of FFM (62.1±5.5 kg) with no difference between dancers and controls (57.7±5.1 vs 58.0±8.3 kg). FM, both in absolute value and as percentage body weight, was significantly lowest in dancers (5.7±0.8 kg; 8.9±0.7 %) vs 15.1±3.6 kg); significant differences were observed between cyclists and controls.

Table 3: Body composition by skinfold thickness in different athletes.

		CYCLISTS (n.9)	DANCERS (n.9)	CTR (n.9)
FFM	*kg*	62.1±5.5	57.7±5.1	58.0±8.3
FAT	*kg*	8.0±1.7**	5.7±0.8**	12.7±4.5
FAT	*%*	11.5±2.4**	8.9±0.7**	17.6±4.5

* p< 0.05 vs ALL; **p<0.05 vs CTR;

In the Table 4 shows the mean values of PhA in the three groups.

Whole-body was significantly higher vs control group (6.91±0.68 degrees) and similar between cyclists (7.70±0.54 degrees) and dancers (7.74±0.57 degrees). The highest upper-limb PhA was observed in dancers with non-significantly differences between cyclists and controls. Regarding lower-limb PhA, there were no significant differences between athletes whereas it was clearly lower in the control group.

Table 4: Segmental Phase angle in different athletes.

		CYCLISTS (n.9)	DANCERS (n.9)	CTR (n.9)
PhA				
Total	°	7.70±0.54§	7.74±0.57§	6.91±0.68
Arms	°	5.89±0.53	6.29±0.64	5.74±1.03
Legs	°	9.28±0.52*	9.38±0.52*	8.13±0.32

* p< 0.05 vs CTR; § p< 0.05 vs CTR

4 DISCUSSION

This study shows that intense physical activity (sports and dancing) has a significant effect on body composition.

Dancers showed lower values of FM than cyclists and control group; the intense training in classical ballet dancers also markedly affects body composition. (Ferrari EP et al 2013)

Despite the elite status of all the examined athletes, significant differences in the selected BC variables were observed between sport groups.

Nowadays, many authors have studied body composition variables in elite athletes. Specifically, both longitudinal and cross-sectional studies showed a strong correlation between phase angle and sport activities. Several cross-sectional studies also have demonstrated that PhA was higher in athletes of different sports than in controls both in males and in females (Marra M. et al 2016, Meleleo D. 2017).

Marra M (Marra M. et al 2016) studied the body composition changes in cyclists during the Giro d'Italia 2012 and 2014 and found that total PhA was significantly reduced at the end of the competition. It is interesting that the segmental BIA measurements showed that upper-limb PhA did not significantly change during the competition whereas a significative reduction was reported for leg PhA. The present study shows that BIA is a useful method for both monitoring body composition and evaluating the quality of FFM, through the measurements of PhA. Segmental BIA analysis in different sports is might particularly be useful because gives more detailed information on different muscle groups. Interesting results emerged from segmental BIA exam because segmental PhA seems to differentiate between different type of sport, being an effective marker of qualitative changes in the different segment of body composition. Whole-body PhA was similar in cyclists and dancers. Regarding segmental PhA, it seems to change depending upon the muscle groups mainly involved in physical activity. Upper-limb PhA was higher in dancers than in cyclists whereas lower-limb PhA was higher in both dancers and cyclists than in control group.

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