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Assessment of body composition and nutritional risks in young ballet dancers – the bioelectrical impedance analysis

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Abstract

Background: Young ballet dancers are at risk of health issues associated with altered nutritional status and of relative energy deficiency in sport compared to the general population.

Aim: To evaluate the nutritional status and body composition in ballet dancers.

Materials and methods: The study group consisted of 40 young ballet dancers (mean age 19.97 years). Height and weight were measured and body mass index was calculated in all subjects (mean BMI value 19.79 kg/m^2, SD: 2.051). Body composition was estimated using the bioelectrical impedance method.

Results: The dancers' fat-free mass was 47.33 kg (SD: 5.064) and, on the average, body fat represented the 15.92% (SD: 16.91) of their body weight.

Conclusions: Ballet dancers, who usually show significantly lower BMI values compared to the general population, also displayed body fat values under the suggested range. Some screening for altered nutritional status should be performed. In addition, education programs should be recommended in young ballet dancers, in order to inform about energy and nutrition requirements for health and training and to prevent malnutrition-related problems.

Keywords: Bioimpedance; nutrition; leanness, body composition, ballet dancers.

Introduction

For dancers, being a particular group of athletes, the optimal body composition serves as the means for achieving both the physiological needs of a healthy body and the esthetic goal of thinness to obtain maximum on-stage performance. Previous studies investigated the body composition of female dancers aiming either to provide descriptive characteristics of dancers or to determine the optimal body composition, which would maintain the best standards of health and improve training techniques [1,2]. The above studies indicated that even though dancers constitute a very lean group of athletes, their mean levels of fatness ranged widely, from 14 to 22 % of body weight, depending on the study. The aim of this study was to estimate the body composition in dancers using the bioimpedentiometry as a method of assessment in this lean and well-trained young female population.

The bioelectrical impedance analysis or bioimpedentiometry (BIA) displays many advantages over other methods: it is safe, rapid, portable, easy to perform, and requires minimal operator training [3].

This technique allows the assessment of individual body composition including total body water (TBW), intracellular water (ICW), extracellular water (ECW), fat free mass (FFM), body cell mass (BCM), and body fat (BF). This non-invasive instrument exploits the electrical impedance, representing the opposition force to the flow of an alternating current through body tissues. BIA is based on the principle that human body impedance is inversely proportional to body water and electrolytes content, when the body receives an alternating current: this current runs through extracellular fluids at low frequencies, while overcomes cellular membranes penetrating intracellular fluids at high frequencies. The clinical use of bioimpedentiometry allows the monitoring in individual nutritional state and it was proved a valid instrument in order to improve compliance to dietetic prescriptions. The more recent scientific evidence shows how body compartment evaluation at the moment of diagnosis, is the most valid therapy to prevent malnutrition in inflammatory diseases [4]. In biological systems, electrical conduction is linked to water distribution: as body FFM contains the greatest part of water and electrolytes, the conductivity is greater that in fat mass. Adipose tissue contains little water and electrolytes making it a poor conductor with a high resistance to current flow.

Materials and methods

a) Subjects: 40 European young female ballet dancers (mean age: 19.97 years, age interval: 16-24 years, SD: 2.07). During recruitment, the dancers were asked to fill out a simple questionnaire on their general health status and daily exercise habits. On average, they started dancing at the age of 7.5 years and they typically used to dance on average 28.22 hours per week (SD: 1.21, range 26-32) because of their daily training.

b) Anthropometric data: Weight and height were measured using a professional weighting scale (SECA 711 Mechanical Column Scale, medical class III) with stadiometer. BMI was calculated as weight (kg) / height^2 (m^2). Waist (WC), hip (HC), and arm circumferences were measured using a plastic tape measure. All measurements were done by a single, well-trained researcher from the research team.

c) Body composition: Body composition was assessed through bioimpedentiometry. Resistance and reactance were measured with a single frequency (50 kHz), four-terminal impedance analyzer (Model: Human-IM II Plus DS Medica Dietosystem, mode MFBIA total body multi-frequency analysis; measuring range: 0 to 2000 ohm, 5 to 250 kHz; resolution measurement: 1 ohm; impedance precision, 499 ohm sample: ±0.2 %; phase angle resolution 0.1 degrees), with the subject lying in a standardized supine position.

Previous research has shown that impedance is affected by factors that produce changes in body fluids or electrolytes. In order to control for fluid shifts and improve the accuracy of measurement, specific pre-testing guidelines were respected before using BIA technology. This analysis was performed with empty bladder, after an overnight fast, abstaining from medicaments, caffeine, tea or other drinks (that can induce dehydration) in the previous 12 hours, as described in previous studies [4,5,6]. Each athlete abstained from strenuous exercise the day before the measurement. In addition, they were tested in follicular/early luteal phase of their ovaric cycle: in fact, it is recommended that women should not be tested when they perceive to be retaining water, such as during the pre-menstrual phase and the menstrual period.

The technique is based on this principle: when an electric current is applied to a cylinder filled with a saline solution, the fluid opposes to the current, the higher is its electrical resistance (expressed in ohm). Considering the human body like a series of cylinders mutually connected, the measured resistance across the whole body will reflect body composition. Four disposable pre-gelled electrodes (PG500) are placed on the skin: a couple on the back of the hand and a couple over the instep (hand and feet belonging to the same side). The subject lies supine with his legs slightly apart and upper limb away from the body. The device generates a low intensity alternate current, which flows into the patient's tissues.

The FFM and the percentage of BF were estimated through the internal equation of the impedance analyzer. Resulting data are expressed in kilograms and in percent of total body weight.

Statistical Analysis

The descriptive characteristics of the group variables were expressed as mean values, standard deviation (SD, which measures the amount of variation or dispersion of the values set: when low it indicates that the values tend to be close to the mean, while a high SD indicates that the values are spread out over a wider range), and intervals.

Informed consent

Informed consent was obtained from all individuals included in this study.

Ethical approval

The research related to human use has been complied with all relevant national regulations, institutional policies and in accordance with the tenets of the Helsinki Declaration, and has been approved by the authors' institutional review board or equivalent committee.

Results

Age, anthropometric characteristics, main body composition parameters and other descriptive characteristics are shown in Table 1.

Table 1. Antropometric, bioimpedentiometric and descriptive characteristics of our young female dancers (N= 40)

	Mean	SD	Range
Age (years)	19.9	2.1	16-24
Dancing (h/week)	28.2	1.2	26-32
Heigh (cm)	162.6	4.9	151-171
Weight (kg)	46.8	3.5	42-56
BMI (kg/m^2)	19.8	2.1	15.9-22.0
WC (cm)	64.6	3.7	58-72
HC (cm)	91.4	39.5	83-102
FFM (kg)	47.33	5.1	36.5-55.4
BF (%)	15.9	1.7	13.2–20.4

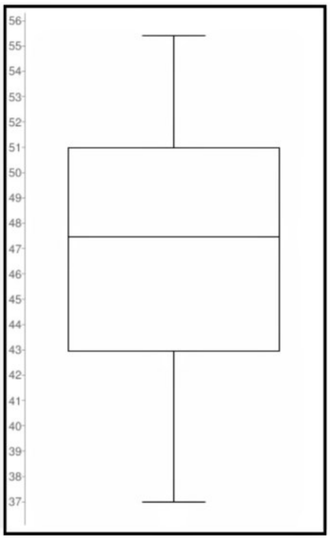
Figure 1. Fat-free mass (FFM, kg) box plot

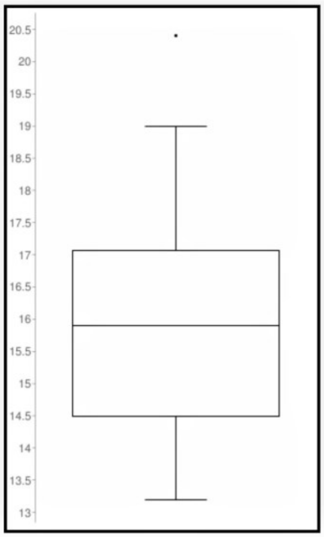
Figure 2. Body fat (BF, %) box plot

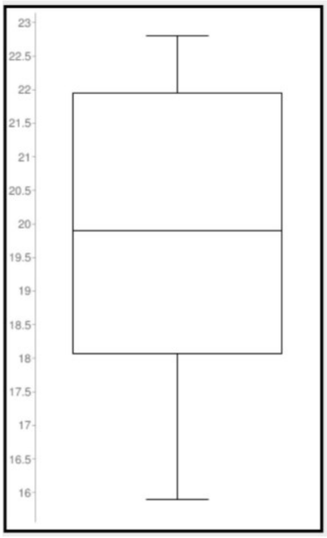
Figure 3. BMI (kg/m^2) box plot

The group's mean FFM (Figure 1) was 47.33 kg (SD: 5.06, range: 37–55.4) and, on the average, BF (Figure 2) represented the 15.92% (SD: 1.69 range: 13.2–20.4) of their body weight. The mean BMI (Figure 3) resulted to be 19.79 kg/m^2 (SD: 2.05, range 15.9-22.8).

Discussion

The present study is among the few in Europe, which investigated body composition of young ballet dancers. The results indicate that the studied subjects constitute a group of lean women with mean body fat of 15.92%. This value is not only outside the BF normal range of 18-25% proposed for young females [7], but also lower than the BF range (17–23%) which was proposed as an optimum body composition for female dancers [8] and, dangerously, very close to the well-known amount of essential fat (10-14%). These guide-lines were based on several studies using various methods of body composition in university adult female dancers.

Our study's subjects had the same characteristics (age, sex and racial, health and leanness status) with previous similar studies [2,9,10] and our results show analogue [11] and even lower [2] BF% values compared to dancers who were studied elsewhere.

Other studies also cite dual energy X-ray absorptiometry (DXA) as one of the reference standards for the body composition researches, measuring both bone and soft tissue composition, even with several limitations: when DXA was compared with the four-compartment model, it was found less accurate in estimating body fat and fat-free mass in healthy adults and in dancers [12,15].

For example, the dancers in Yannakoulia's study [2] constituted a lean population group with a mean FFM of 42.6 kg and a mean BF of 19.4%, as estimated by the dual-energy X-ray absorptiometry (DXA): these levels of fatness were close to the upper range of the BF values reported for dancers elsewhere, but these subjects were students in professional dance schools and not professional dancers. This study evidenced that the BIA can accurately estimate the body composition of young female dancers and elaborated the first dancer-specific equation for the estimation of body composition with the use of BIA, even if further studies are needed for the cross-validation of the equation in various groups of dancers.

In another study [12], dancers had a lower body mass index (BMI 18.9 kg/m^2) compared to both our dancers and their controls (21.3 kg/m^2), a comparable mean FFM, and a mean BF of 17.4%: this value was higher compared to our study, but significantly lower than the control group (24.4%). This research also evaluated mean bone mineral density, which resulted to be significantly higher (6%) compared with that of a reference population. These high values could be attributed to the high bone mineral density of legs and pelvis, the weight-bearing sites of the dancer's body.

The measurement of skinfolds has also been used in previous studies for the body composition assessment of ballet dancers [10,12,13]. It represents an indirect method for estimating the degree of body fatness easily, quickly, and inexpensively [14]. However, it was found to be the least accurate, because it can overestimate the %BF in very lean dancers: in this particular group of young lean females, it does not predict accurately body fatness. Anyways this trend results to be attenuated in higher levels of body fatness [2].

Conclusion

In conclusion, the dancers in the present study constitute a lean population group with a mean %BF under the suggested range for good health, as estimated by BIA analysis, which can accurately be used for the estimation of the body composition of young female dancers.

Ballet dancing is a complex activity requiring muscular power, endurance, flexibility, and agility with demanding training schedules. Dancers are often under aesthetic pressure to maintain a lean physique; at the same time, adolescent dancers require extra-nutrients not only for sport performance but also for growth and development. For these reasons, dancers can be at increased risk of poor micronutrient status due to their restricted energy intake.

In particular, female adolescent ballet dancers are at risk for iron/vitamin deficiency [16], and possibly inadequate nutrient intakes. Leanness is certainly necessary in dance schools; its importance is often exaggerated by dance companies, especially those focused on the ballet dance. Because of this essential prerequisite, the dancers have to maintain a low-calories diet (which may significantly influence their future health, especially in the case of women) in order to achieve and maintain a desired, low body weight. These altered eating habits mainly mean a reduced consumption of particular products; this can determine a failure to provide the body with a sufficient amount of nutrients [17,18]. In addition, sometimes such diets are not prescribed by an expert and can become dangerous for health, especially when they may lead to destructive behaviors, eating disorders (anorexia, bulimia), menstrual disturbances and low bone mineral density [19].

Rigorous exercise undertaken by young girls, combined with a negative energetic balance, is related to substantial physiological changes in a competitor's body, often leading to hormonal imbalance manifested by: delayed puberty, delayed menstruation, menstrual disorders, and even long-term secondary amenorrhoea (cessation of regular menses for three months or the cessation of irregular menses for six months).

According to sport-specific recent guidelines, dancers should consume at least 30 kcal/kg fat-free mass/day, plus the training energy expenditure, in order to diminish the risk of energy imbalance and associated disorders. For macronutrients, a daily intake of 3 to 5 g carbohydrates/kg, 1.2 to 1.7 g protein/kg, and 20 to 35% of energy intake from fat can be recommended [20]. In addition, nutritional supplements (that may help in achieving specific nutritional goals when dietary intake is inadequate) could include multivitamins, antioxidants, such as carotenoids [21-27] and polyphenols [28,29], polyunsaturated fatty acids [30] and minerals.

Common nutritional concerns for the female athlete include low energy availability (i.e., energy intake from food remaining for metabolic processes after accounting for energy expended during exercise) and inadequate dietary intakes (i.e., not meeting sports nutrition guidelines) of carbohydrates, protein, essential fatty acids, B-vitamins, calcium, iron, and vitamin D.

Low energy availability and the associated nutrient deficiencies are more common in athletes who compete in weight-sensitive sports, such as aesthetic, gravitational, and weight category sports, because low body fat and mass often confer a competitive advantage [31].

It is important that athletes seek dietary advice from qualified specialists, since the pressure to maintain a low body weight and low body fat levels is high, especially in styles as ballet, and this can lead to an unbalanced diet and health problems if not correctly supervised. Both screening for altered nutritional status and education programs are recommended in order to inform about energy and nutrition requirements and to prevent malnutrition-related problems in high-risk group, such as young female ballet dancers.

Conflict of interest

Authors state no conflict of interest.

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