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Cardiorespiratory responses of a dance session designed for older women: A cross sectional study

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ABSTRACT

Background: Dancing has been increasingly used as a type of exercise intervention to improve cardiovascular fitness of older people. However, it is unclear which may be the exercise intensity of the dance sessions.
Objective: To describe cardiorespiratory responses of a dance session for older women, and to identify intensity zones in relation to peak oxygen consumption (VO_2peak), first and second ventilatory thresholds (VT1 and VT2).
Methods: Ten women (66 ± 5 yrs., BMI 27 ± 4) were examined on three occasions: Familiarization, maximum effort and dance sessions. Incremental treadmill test: 5 km/h, 2% slope each min, until maximum effort. Dance class (60 min): warm-up (20 min), across-the-floor (10 min), choreography (15 min), show (10 min) and cool-down (5 min). Ventilatory parameters were measured continuously (breath-by-breath).
Results: VO_2 ($mL\cdot kg^{-1}\cdot min^{-1}$): Maximum effort: VO_2peak (23.3 ± 4.3), VT1 (17.2 ± 3.5) and VT2 (20.9 ± 3.4). Dancing: warm-up (12.8 ± 2.4, ~55%VO_2peak), across-the-floor (14.2 ± 2.4 ~62%VO_2peak), choreography (14.6 ± 3.2 ~63%VO_2peak) and show (16.1 ± 3.3, ~69% VO_2peak). Show was similar to VT1.
Conclusions: Cardiorespiratory demands of a dance class for older women are at low aerobic intensity. Show was similar to VT1, indicating that a dance class may be modulated to improve aerobic fitness, at least at initial stages of training.

1. Introduction

Longevity rates have been progressively increasing worldwide, with significant reductions in rates of mortality and fecundity indicating that the population over 60 years old will jump from 18 million (2010) to 65 million (2050) (WHO, 2001). However, health complications associated with the aging process, such as the development of chronic diseases (obesity and type 2 diabetes mellitus), functional and cognitive limitations, have been reported as the major source of health costs with this population (WHO, 2001). In fact, deteriorations on the neuromuscular system, such as loss atrophy of type II muscle fibers, together with deteriorations in the cardiovascular system (reduced maximal cardiac output, systolic volume, arteriovenous oxygen difference) have been connected to early fatigue onset, reduced levels of physical activity, difficulty in performing daily activities and eventually loss of physical independence (Cadore & Izquierdo, 2013).

Particularly, reduced levels of physical activity have been related to a reduction in peak oxygen consumption (VO_2peak) (Myers et al., 2015), which can dramatically decrease 5 $mL\cdot kg^{-1}\cdot min^{-1}$ per decade of life from the 30's, reaching critical thresholds for physical independence (VO_2 peak lower than 18 $mL\cdot kg^{-1}\cdot min^{-1}$) (Shephard, 2009). On the other hand, increases in the level of physical activity suggest an attenuation of age-associated declines in VO_2peak with habitual endurance training (Kohrt et al., 1991). Indeed, the elderly undergo cardiovascular adaptations to exercise, although in lower magnitude than middle-age individuals (Evans et al., 2005). The capacity of older individuals to adapt to endurance exercise training may be limited by biological aging effects on oxidative capacity, such as reduced capillary bed, mitochondrial density and slower VO_2 kinetics (Babcock et al., 1994; Safdar et al., 2010). Regarding the last one, it is true that older individuals present increased O_2 deficit and debit compared to the youngest (Babcock et al., 1994), as well as the impaired older compared

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to the healthy ones (Alexander et al., 2003). It means that the older take longer to adjust to a new workload in sub maximum efforts, which impacts the performance in daily activities (Alexander et al., 2003). Along with that, the ability to withstand physiological overload due to orthopedic and morbidity-related limitations may refrain the elderly to engage in structured exercise training programs (Evans et al., 2005).

Thus, alternative forms of exercise have been suggested in order to optimize cardiorespiratory, metabolic and functional adaptations, while reducing early fatigue onset and orthopedic overload. For example, circuit training (Romero-Arenas et al., 2013), multicomponent training (Forte et al., 2013a), tai chi (Wolf et al., 1996) and yoga (Chu et al., 2016) have been studied. Particularly, dancing has been increasingly suggested because it can be widely adjusted to a population's age and physical limitations (Hwang & Braun, 2015). Higher levels of tolerance to intermittent exercise bouts, consequent greater perception of success, and higher levels of motivation also favor dance practicing at old ages (Rodrigues-Krause et al., 2016). There is evidence that dancing improves functionality and reduces fall-risk related factors by improvements in balance and gate ability (Fernandez-Arguelles et al., 2015). Dancing has been also suggested as potential intervention for improving the elderly maximum aerobic capacity and reduce cardiovascular risk (CVR) associated factors, when compared to the sedentary older (Rodrigues-Krause et al., 2016).

Actually, no matter the dance style, recently reviewed metabolic and functional adaptations of dance practice have been generally linked to exercise program adherence, rather than to objective results of cardiorespiratory and neuromuscular adaptations from the exercise training itself (Rodrigues-Krause et al., 2018). Primary studies evaluating functional or metabolic outcomes usually focus on the description of the pedagogic process of the dance lessons, poorly describing intensity of work, which limits its reproducibility in terms of exercise prescription. This regards to direct measures of exercise intensity, such as oxygen consumption (VO_2) and heart rate (HR), as well as simple and practically useful indicators of intensity, such as the beats per minute (bpm) of the songs used during the dance classes (Rodrigues-Krause et al., 2018).

Therefore, the main goal of this study was to evaluate the cardiorespiratory responses of a dance class, especially designed to develop aspects that deteriorate with the aging processes, such as functionality and aerobic conditioning. Specifically, VO_2 and HR were measured during a whole dance session and analyzed separately in different parts of the class: warm up, across-the-floor, choreography and show (each of them performed in different music *tempos*, it means, the songs' bpm). We also aimed to verify the zones of intensities of the whole class and its different parts in relation to the participants' first and second ventilatory thresholds (VT1 and VT2) and VO_2peak, determined during a maximum effort test. Energy expenditure and lactate responses were also measured after the whole dance session.

2. Materials and methods

2.1. Participants

Ten women from 60 to 75 years old, body mass index (BMI) lower than 35 kg/m^2, and independent for performing daily activities volunteered for this study. They provided informed consent after being informed about the study protocol, approved by the local Research Ethical Committee. Participants were previously familiarized with the class structure and choreography routines. They did not engage in any other type of regular exercise practice for at least 6 months. All participants underwent a medical evaluation during a maximum effort test, simultaneously to an electrocardiogram (ECG) assessment. Exclusion criteria were: not controlled-hypertension, type 2 diabetes mellitus (T2DM), mobility limitations, not being able to perform the maximum effort test, alteration in the ECG or any other condition that could limit the exercise practice.

2.2. Study design

Participants were examined on three occasions: Familiarization session, maximum effort test session and dance session. At the familiarization session, participants were familiarized with the maximum effort test protocol, including the use of the facial mask and the treadmill. They were also introduced to the dance class structure, basic dance steps and choreography routines. At the maximum effort test session, body composition and a maximum effort test on treadmill, simultaneously to an ECG and medical evaluation were performed. At the dance session, the dance class was performed. Two weeks separated sessions 1 and 2, during which participants learned and practiced the dance routines in group, 3 × /wk for 60 min, with a specialized dance instructor. Participants were instructed to refrain from any unusual physical activity 48 h before the exercise sessions, in order to avoid effects of fatigue and muscle soreness on the selected performance. They were also instructed to maintain their usual food intake.

Ventilatory parameters, such as VO_2 and carbonic dioxide production (VCO_2) were measured continuously during the dance and the maximum effort sessions, by the breath-by-breath method, using an open-circuit spirometry system (Quark CPET, Cosmed, Italy). HR was also measured continuously using a chest belt telemetry (Polar Electro Oy, Kempele, Finland). Fingertip blood samples for lactate analyses (Accusport-portable-analyser, Roche-Diagnostics-GmbH, D-68298, Mannheim/Germany) were collected before and after both exercise sessions.

2.3. Protocols of assessment

2.3.1. Body composition

Height and weight (Urano, Canoas, Brazil) were measured with the participants wearing light clothing. Waist and hip circumferences and skin folds were also measured, and body composition was calculated using a 5-component method, following the standards of the International Society for the Advancement of Kinanthropometry (ISAK) (Marfell-Jones et al., 2006).

2.3.2. Maximum effort test

Participants' VO_2peak and maximum heart rate (HRmax) were determined through an incremental exercise test on a treadmill (Inbramed, Porto Alegre/Brazil). The test started with a 5-min warm-up (from 3 to 5 km/h, increasing 0.5 km/h each min, until 5 min), followed by 2% increases in slope every 1 min, while maintaining a constant speed of 5 km/h throughout the entire test (Flo et al., 2012). In order to be considered a maximum effort test, participants must have attained at least two of the following criteria: (1) age-predicted HRmax, (2) respiratory exchange ratio (RER) ≥ 1.1, (3) subjective perception of effort ≥ 17 (Borg scale 6–20), (4) signals of muscle fatigue, such as loss of motor coordination (Cadore et al., 2012).

VO_2peak was identified as the highest VO_2 value in a line of tendency plotted against the time. Criteria to determine the ventilatory thresholds were: VT1: lowest workload at which the ventilatory equivalent of O_2 (VE/VO_2) increased without concomitant raises in the ventilatory equivalent of CO_2 (VE/VCO_2). VT2: lowest workload at which VE/VO_2 increased concomitantly, but disproportionally to VE/VCO_2. VT1 and VT2 were also associated with the first and second nonlinear increases in the ventilation's curve plotted against VO_2 (Cunha et al., 2011; Dekerle et al., 2003).

2.3.3. Dance class

The dance session duration was 60 min and included five parts: (1) Warm up (20 min), (2) Across-the-floor (10 min), (3) Choreography (15 min), (4) Show (10 min), and (5) Cool-down (5 min). Elements from different dance styles were used in selected parts of the class, specially designed to develop functional and fitness elements that tend to naturally deteriorate with the aging process, such as balance, flexibility,