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Full Length Research Paper

Street-dance: Physiological demands and effect of endurance training

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The aims of this study were (a) to describe the cardiovascular and metabolic demands and (b) to evaluate the effect of an endurance training on blood lactate (Lac) after street dance (SD). Nine female dancers (15.3 ± 1.2 years old) performed the following procedures, pre and post training: SD choreography (6 min), and 48 h later maximum incremental test (on treadmill) to obtain the lactate threshold (LT). Soon after the SD choreography the Lac and heart rate (HR) were registered. The training consisted of three running sessions per week on a treadmill (30 min, intensity 90 to 100% of LT) during eight weeks. The results showed that in post training, the values of Lac and HR_{peak} immediately after the SD choreography increased significantly ($p < 0.05$) when compared to the pre training Lac = 8.2 ± 2.4 to 10 ± 2 mmol.L^{-1}; HR_{peak} = 179.9 ± 10 to 188.4 ± 5.8 bpm^{-1}). In addition, training improved the LT from 8.4 ± 0.8 to 11.1 ± 1.4 km.h^{-1}. Therefore, we conclude that the SD has high metabolic and cardiovascular demand (~ 90% HR_{max}) and endurance training increases Lac after specific SD choreography.

Key words: Metabolism, lactate, dancers, exercise, aerobic conditioning.

INTRODUCTION

Street-dance (SD) is a physical activity that combines bouts of intense activity interspersed with lower-intensity periods of exercise. This dance is characterized by high motor coordination work of upper and lower limbs, choreographed acrobatic movements like jumps, and musicianship with strong beats. Due to these features, a high levels of muscular power combined with a well-developed aerobic capacity are required from dancers. Thus, if preparation to performance is well planned, it will help to prevent injuries as well as improve the dancer's readiness to perform (Wyon, 2010).

Generally, the SD training sessions last ~ 1 h and cover three distinct parts: preparatory, main and cool down. In the preparatory part, basically a warm up with low intensity exercises and general muscle and joint stretching are made. The main part includes exercises that consist of improving techniques through a variety of choreography and the last part (cool down) consists of relaxation exercises and stretching.

Despite the fact that the time of motor activity is relatively long in its training sessions (classes), curiously the SD competitive presentations are performed with intense physical pace and last only three to seven minutes. This usual practice could be considered as a physiological failure, because it probably infringes the specificity of training principle (Flouris et al., 2004).

Actually, other dance styles, like classic and contemporary ballet (Schantz and Astrand, 1984; Redding et al., 2009) have been studied in relation to the effect of physical training workouts isolated (not the

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classes about techniques), but little is known about the best ways to improve sport-specific performance in SD.Although, nowadays SD has been used as a form of physical exercise, including its practice in dance studios, for artistic expression, and in competitions, there are some studies about its social effects (Saito et al., 2006; Swami and Tovee, 2009) but there is no study regarding its physiological demands. In fact, there is no study about physical training effect on some of the SD parameters like cardiovascular and metabolic demands. Thus, the aims of this study were (a) To describe the cardiovascular and metabolic demands of SD choreography and (b) to evaluate the effect of 8 weeks of general endurance training on blood lactate (Lac) after SD choreography. Our hypotheses were that the SD choreography would have high cardiovascular and metabolic demands due to the performance time and intense rhythm of the movements, and that endurance training could improve aerobic capacity and generate more Lac just after the SD choreography.

MATERIALS AND METHODS

Ethical care

This study was approved by the local Ethics Committee and was performed in accordance with the international ethical standards. Besides, the volunteers' parents or guardians signed a free consent form.

Inclusion and exclusion criteria

To take part in this study, the volunteers had to attend the following criteria: Present medical clearance to practice the tests and proposed training; be aged between 14 and 17 years; have at least one year of SD experience in trainings (> 3 times/week) and competitions; do not take nutritional supplements or potential ergogenic aids of any kind (exogenous anabolic androgenic steroids); be non-smokers, hypertensive or diabetic; be familiarized with the exercises at least twice before the start of this research.

Volunteers

Convenience sampling technique was used to select participants. From thirty dancers of a SD group, 15 female volunteered to participate, but only 9 of them were selected because they met all the quoted above criteria. The selected girls were 15.3 ± 1.2 years old, had 59.9 ± 12.1 kg of body mass, were 1.66 ± 5.4 m high and had 2 ± 0.4 years of experience in SD activities. All the data were obtained in the beginning of the yearly season and they trained ~ 03 h per week (3 days/week) specifics SD activities in special movement techniques. None of the volunteers were trade professional dancers, and the SD was practiced only as a hobby.

Familiarization with tests and procedures

In order to make the results reliable (no influence of "learning"), the volunteers received theoretical instruction about all the procedures. One week before the initial tests, they undertook all tasks proposed (SD choreography and progressive test at treadmill) on different days, with an interval of 48 h to allow familiarization.

SD choreography

The participants were instructed to arrive at the laboratory in a rested and fully hydrated condition, at least 3 h post-prandial, and to avoid strenuous exercise in the 48 h preceding during the test session. Each participant was tested at the same time of the morning (0930 to 1200 h) to minimize the effects of diurnal biological variation (Denadai et al., 2004). The SD choreography was executed after a warm up (jogging and general stretching exercises). The volunteers started (by beep) the SD choreography with six-minute duration and maximum intensity with guidance from an instructor (familiar to the group). Additionally, all the dancers already knew the choreography and performed the same movements (speed = 148 BPM) and same song. In rest and immediately after SD choreography blood samples were collected for lactate analysis.

Progressive test to determine lactate threshold

Forty-eight hours after the SD choreography test, the volunteers performed the incremental test for determination of LT (treadmill inclination 1%; initial speed = 4 $km.h^{-1}$ with increments of 1 $km.h^{-1}$ every two minutes), until volitional exhaustion or inability to keep maximum speed imposed by electric treadmill (Moviment®, Brazil).
The LT was determined by visual inspection of the Lac curve in relation to the running speed. For this analysis, the inspection of the curve was performed individually and independently by two experienced evaluators. The LT was defined as the running speed immediately prior to the abrupt and sustained increase of Lac (Wasserman, 1984). Both tests (SD choreography and progressive treadmill test) occurred before and after eight weeks of endurance training.

Heart rate measurements

All participants used a heart rate (HR) monitor (POLAR® RS 400, Finland) and stayed in rest (supine position) during 20 min. HR was registered in rest (HR_{rest}) and immediately after the choreography (HR_{peak}).

Blood collection for lactate analysis

For the SD choreography blood samples were collected in rest (before the SD choreography) and immediately after for blood lactate analysis (25 µl from earlobe, in 1.5 ml microtubes (50 µl of NaF at 1%), and stored - 80°C). Analyses were performed 48 h later by electroenzymatic methods (YSI® 1500 Sport, USA). All these procedures were done in rest, immediately after SD choreography and after every two minutes stage at treadmill to determine LT through progressive test, 48 h later.

Endurance training program

The endurance training program was continuously performed on an electric treadmill. The sessions consisted in 10 min of warm up, 30 min of main part (Fontana et al., 2009) and 10 min of cool down. The sessions took place three times a week (alternate days) during eight weeks. The intensity of the running was 90 to 100% of the speed (in $km.h^{-1}$) from LT speed previously assessed by test (90% weeks 1 to 4; 95 to 100% weeks 5 to 8). Table 1 summarizes the design of this study.

Table 1. Design of the study.

Initial procedures	Pre-training	Post-training (after 08 weeks)
Recruitment of volunteers (N = 15)	Evaluations: HR and [Lac] at rest and after SD choreography;	Re-evaluation of all parameters and enclose of study
Volunteers selected according criteria (N = 09)	LT test; Start of endurance training;	

HR = heart rate; (Lac) = blood lactate concentration; LT = lactate threshold at treadmill; SD = street-dance.

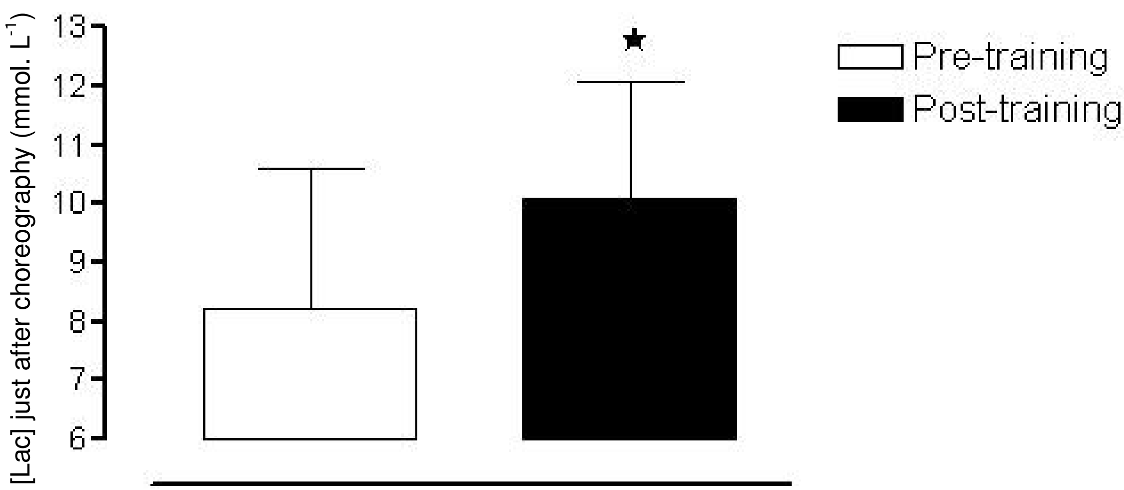

Figure 1. (Lac) post street-dance choreography increased after 8 weeks of endurance training. Data presented by mean ± standard deviation. * Significant difference from pre-training ($p < 0.05$).

Statistical analysis

Shapiro-Wilk test was used to test the normality of data. The means (pre and post-training) were compared by the paired Student *t*-test. Statistical significance was established at the $p < 0.05$ level.

RESULTS

The nine SD dancers that met the criteria established to participate in this study attended all evaluations and endurance training sessions. Their body mass and height did not change during the study period (see materials and methods for data and inclusion and exclusion criteria).

Absolute and relative Lac post choreography increased in relation to rest in both moments (pre and post endurance training). However, post-training analyses showed greater magnitude ($p < 0.05$) in both, relative (690 ± 284% pre-training versus 821 ± 212% post-training) and absolute terms (Figure 1).

Endurance training significantly ($p < 0.05$) increased the LT running speed of the dancers, both in absolute (Figure 2) and relative terms (± 32%). In the same way, the endurance training significantly ($p < 0.05$) changed HR parameters of the SD dancers. There were 13% of decrease for HR_{rest} (pre = 82.2 ± 12.7 bpm^{-1}; post = 71.3 ± 7.5 bpm^{-1}) and 4.7% of increased for HR_{peak} (pre = 179.9 ± 10 bpm^{-1}; post = 188.4 ± 5.8 bpm^{-1}).

DISCUSSION

The study major finding was that SD competitive choreography has high metabolic and cardiovascular demand and is supported by both anaerobic lactic and aerobic metabolisms. In fact, we show that both HR and Lac responses to SD choreography can be considered as a maximum effort, once several test protocols for maximum oxygen uptake needs to present the HR near the age-predicted maximum (HR_{max} = (220 - age) and Lac of 8 to 10 mmol.L^{-1} to be really maximum (Poole et al., 2008). Besides, a general (not specific) endurance training program of eight weeks increases both bloodlactate and HR_{peak} just after physical events of maximum intensity (SD choreography).

The absolute values of Lac reported here immediately after the choreography (8.2 ± 2.4 pre and 10 ± 2 mmol.L^{-1} post training) can not be compared with other similar

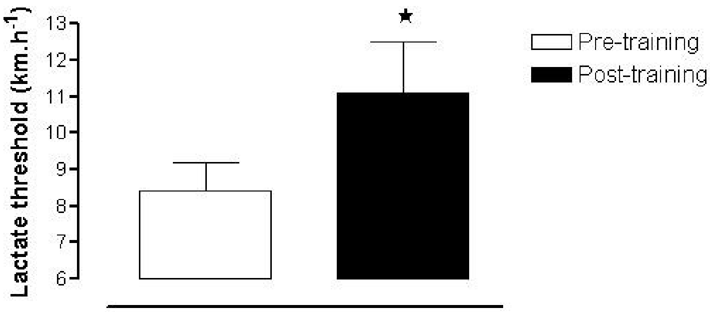

Figure 2. Lactate threshold speed improved after 8 weeks of endurance training. Data presented by mean ± standard deviation. * Significant difference from pre-training ($p < 0.05$).

work, since they were not found in the literature. Although specifically with SD there is not work of this nature, the values are similar to those reported in a study of classical ballet, in women immediately after ground choreography, which was up 10 ± mmol/ L (Schantz and Astrand, 1984). Additionally, considering that young have lower (Lac) than adults (Baxter-Jones and Maffulli, 2003), both in maximum or sub-maximum exercises, our results showed clearly that there was important participation of lactic anaerobic metabolism, because our participants were young (15.3 ± 1.2 years).

This higher Lac found here at post-training when compared to pre-training, both in relative (% alteration) and absolute values (Figure 1), is consistent with the literature (Green et al., 2002; Juel et al., 2004; Brooks et al., 2006; Gladden and Hogan, 2006; Messonnier et al., 2006). The probable explanations for the increase in Lac post peak exercise and after endurance training are the biggest intramuscular glycogen content and enzymatic activities of muscles training specifically (Burgomaster et al., 2008) and this was possibly due to the greatest capacity to generate work. Despite the intensity of training used here (aerobic stimulus near LT), anaerobic performance probably increased for the reason that the participants were untrained in running. Another mechanism for Lac increases is the raise in quantity, efficiency and activity of lactate transporters (Green et al., 2002) (MCT's 1 and 4) in the membranes of muscle fibers and mitochondrial accompanying improvement in LT. Although fitness training was running and predominantly aerobic, as the muscles used in this activity are also required in the SD choreography, we believe that such physiological changes may have contributed to the higher hyperlactataemia in the post-training. This effect should be considered positive for a better performance, since it enhances the capacity of skeletal muscles in controlling the disorder in intracellular pH during exercise, once more lactate and H^+ are released outside the cell into the bloodstream, delaying fatigue (Glaister, 2005).

The increase in Lac after the SD choreography, with six minutes' duration, in relation to rest, was already expected because its time is relatively short and the speed of movement is fast. It is classical knowledge in the literature that in intense physical activities there is higher demand for muscle fiber Type IIa and IIx in comparison with less intense activities (Henneman et al., 1965).

Furthermore, the IIa and IIx fibers have appropriate structures in large formation of lactate and hence this co-product release into the circulation, thus increasing the Lac. Although it could have been expected before this study, we did not find any scientific literature that has documented such metabolic profiling in practitioners of SD choreography during typical competition. Hence, our originals data contributes to the science of dance and encourages further research in this area.

The improvement in LT (Figure 2) of the dancers may have occurred because none of them performed a fitness program including running sessions before the intervention. As the values of Lac in classical ballet dancers resemble other sports, (Koutedakis and Jamurtas, 2004) it is interesting that the same occurs for the LT in SD dancers. Further, improvements in LT provide greater capacity for recovery among stimulus with a predominance of the ATP-CP system (Glaister, 2005) and glycolysis (Gladden, 2004) because during recovery from anaerobic efforts is the aerobic system that predominate. Considering that in a single specific training session and competitions therE are several execution, alternating short rests, a better aerobic conditioning could be important to improve the recovery between efforts and, consequently, performance.

Actually, in a recent study, 32 ballet dancers obtained an aerobic power (VO_{2max}) similar to some athletes after 12 weeks of aerobic and strength exercise training, suggesting that training programs may benefit dance performances (Koutedakis et al., 2007). Hence, the running training like this used in this study could be introduced in SD dancers routine for LT and performance improvements.

The values of HR_{peak} found here, in relative terms (~90% HR_{max}), is analogous with literature for the development of a high intensity dance performance fitness test (Redding et al., 2009). Nevertheless, it is higher than 27 min of Tap dance choreography (83.8 ± 6.2% HR_{max})

(Oliveira et al., 2010) and 60 min of body pump, body combat, step, and spinning (60.2 ± 6.5; 73.2 ± 7.3; 72.4 ± 5.7 and 74.3 ± 6.7% of HR_{max}, respectively) (Rixon et al., 2006). Evidently, the minor time of our SD choreography (6 min) contributed for the higher HR responses in comparison with others studies. On the other hand, relative intensity (~ 90% HR_{max}) during SD choreography is in agreement with the American College of Sport Medicine recommendations (ACSM, 2006) for exercise prescription aiming aerobic fitness improvement (continuous or interval exercises; between 64 and 94% of the HR_{max}; 3 to 5 times a week; 20 to 60 min). From a practical point of view, perhaps an interval approach would be interesting for future investigation to test SD choreography like a mean to increase fitness. Moreover, our study shows the importance of SD to enhance not only social aspects (Swami and Tovee, 2009), but fitness through an enjoyable activity, because dance, pace, and music, are important events to stimulate motivation and adherence (Oliveira et al., 2010). In addition, chronic increases in HR_{peak} after the SD choreography and reduction in HR_{rest} suggest an improvement in the aerobic capacity, as shown by others (Dixon et al., 1992; Chacon-Mikahil et al., 1998).

CONCLUSION

Considering the findings of this study, it was concluded that street-dance choreography has high metabolic and cardiovascular demands and is characterized by combining both the anaerobic lactic and aerobic systems. Furthermore, eight-week controlled endurance training program increases lactate threshold and contributes to higher blood lactate after maximal specific performance. Besides, the findings can help both the coach and the dancer to have a more scientific approach to their daily training, and thus improve performance.

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