

RESEARCH ARTICLE

Acute Physiological and Metabolic Responses
for 40-minutes of Samba Dance

Paulo R. Santos-Silva¹, Cicera C. Duarte¹, Bruna B. Osorio¹, Julia Maria D.A. Greve¹, Guilherme V. Guimaraes²

¹Institute of Orthopedics and Traumatology, University of Sao Paulo, Brazil

²Heart Institute, University of Sao Paulo, Brazil

*Corresponding author: Paulo Santos Silva: fisiologistahc@usp.br



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Abstract:

Dance is an enjoyable health-promoting physical activity that many people worldwide incorporate into their lifestyles today. Dancing can aid in improving your heart health, overall muscle strength, balance, coordination, and reduce depression. Dance has been considered a safe alternative form of physical activity to reduce fat mass, decrease triglycerides, and improve cardiovascular fitness. The advantage of samba dancing is that it is a simple activity in which you aren't necessarily required to invest a lot financially to receive the benefits of this activity. We aim to gain insights into the effects of samba dance on the cardiorespiratory and metabolic response during an acute session of this dance style for 40-minutes. The study was carried out on 20 female samba dancers. All of them performed two procedures: (1) a cardiopulmonary exercise test (CPX) on a treadmill for physical fitness aptitude verification and (2) a 40-minutes of samba dancing monitored by analysis of expired gases. The results were: At peak exercise: oxygen uptake (VO_2) = 32.7 mL/kg/min; heart rate (HR) = 183 bpm; pulse of oxygen (PO_2) = 10.9 mL/HR, energy expenditure (EE) = 9.9 kcal/min and metabolic equivalent (METs) = 13.5. Overall, each session of the dance of 40-minutes was performed at a mean VO_2 of 22.8 mL/kg/min (70% $\text{VO}_{2\text{max}}$), heart rate of 162 bpm (89% HR_{max}), energy expenditure (EE) of 6.5 kcal/min (66% max), metabolic equivalent (METs) of 6.3 (62% max), and the rate of perceived exertion (RPE) of 11.8/20. In conclusion: The findings of the current investigation might suggest that the moderate and vigorous-intensity of the exercise verified in an acute samba dance session is enough to induce a chronic training effect

recommended by the criteria established by the American College of Sports Medicine (ACSM) for improving cardiorespiratory fitness. This information may lead to a better understanding of the energy expenditure of samba dance and add to the compendium of physical activity.

Keywords: Metabolic responses, energy expenditure, exercise, oxygen uptake, women, carnival

Introduction

The samba dance is considered one of the most valued cultural expressions for Brazil to the point of having its day; it has become part of his identity and is considered "the heartbeat" of the Rio de Janeiro carnival. The question in this study is to know, how much exercise samba as physical activity is enough for developing ways to improve physical performance and consequently contribute to the health of people. Although samba is known around the globe, no studies have been done looking into the physiological effects on the body from this particular form of exercise. In Latin America, Brazil is the country with the highest rate of a sedentary lifestyle, 47% of the Brazilian population do not practice enough physical activity to stay healthy [Cruz et al. 2018; Silva et al. 2020]. Part of the mission of exercise and sport scientists is to bring alternative methods that can help alleviate physical inactivity throughout the world [Dimondstein, 1985; McCabe et al. 2013]. A sedentary lifestyle is one of the main global health challenges, as it is associated with adverse effects related to aging, weight control, physical function, longevity, and quality of life [Dimondstein, 1985; McCabe et al. 2013].

The role of dance in the context of preventive health is aggregated in many situations. A sedentary lifestyle is one of the main global health challenges, as it is associated with adverse effects related to aging, weight control, physical function, longevity, and quality of life. The contribution of dance is enormous, as it is a form of physical activity associated with health benefits throughout life, even at levels of amateur participation. In the present study, samba dance is another genre that joins others in an attempt to show its effectiveness as other forms of physical activity [Yan et al. 2018]. One of the most important aspects of participating in dance programs is membership. It has been considered reliable, similar, and even higher to conventional exercise programs with rates over 80% [Hackney et al. 2007; Hackney et al. 2007; Barene et al. 2014; Barene et al. 2014; Barene et al. 2016].

Several studies have shown that those who dance when compared to those who do not have numerous benefits such as increased cardiovascular fitness, bone mineral density, motor balance, reduced body mass index (BMI), and quality of life [Baldari and Guidetti, 2001; Matthews et al. 2006; Huang et al. 2012; Donath et al. 2014]. All ages and sexes in the most different conditions have a positive effect on dance [Delextrat et al. 2016; Yan et al. 2018; Pereira et al. 2019]. Especially the elderly significantly improve cardiovascular health when practicing dance at moderate intensity [Merom et al. 2016; Mattle et al. 2020].

Aerobic fitness shows the bodies ability to uptake, transfer, and consume oxygen for the use of energy release during muscular contraction. A large number of authors have investigated aerobic fitness levels of dancers from different skill levels of all ages, while performing a variety of dance styles [McIlroy et al. 1989; Kremenitzer, 1990; Ignico and Mahon, 1995; Bartholomew and Miller, 2002]. Dance can improve the physiological homeostasis of the body through metabolic process endurance, muscular endurance, muscle strength, body composition, balance, joint quality, and coordination [McIlroy et al. 1989; Kremenitzer, 1990; Ignico and Mahon, 1995; Bartholomew and Miller, 2002; Yan et al. 2018]. Among influencing these factors dance has also been shown to aid in the psychological and emotional development in children (Lobo and Winsler, 2006) while also improving motor and kinetic skills (Hufferd, 2007)

In certain cases, exercise has been said to be as powerful as medication (Garber et al. 2011). When healthy there is not much debate that any quantity of exercise is better than none. The minimum amount of exercise performed is still positive (Garber et al. 2011). Exercise similar to medication can reduce the risk for several diseases, extended life expectancy, and help with overall physical as well as mental health [Berryman, 2010; Vina et al. 2011; Pedersen and Saltin, 2015]. The potential wealth of dance has additionally served as medical care and should provide its intrinsic potential as a complementary treatment related to drug medical care in varied forms of diseases with physical and psychological issues, bodily disorders, anxiety, depression, heart, and respiratory organ illness, and even cancer [Serlin, 2010; Earhart, 2009]. Thus, to study samba dancers in an acute design was the first step we found to contextualize and to prospect through some variables of cardiorespiratory and metabolic performance the potential of this dance style taking it out of the scientific darkness [Braga et al. 2015]. Although there are several publications on various dance styles showing their potentials of use and effects, little is known about the effects from samba [Toji, 2006; Braga et al. 2015]. In order to study more the first step was to contextualize and hypothesize some variables of cardiorespiratory and metabolic performance of this dance style. With more information on samba, it can be better recommended and used as a recreational and sporting choice while allowing people of all age groups enjoy this activity. Therefore, given the lack of available data and the importance of establishing the magnitude of samba dance as exercise, we felt the need to carry out this investigation. We hypothesized that performing samba dance-specific intermittent exercise would induce increases in the cardiorespiratory and metabolic parameters sufficient to increase the physical fitness of practitioners. Hence, this study aimed to verify whether 40 minutes of samba provoked sufficient motor stimuli to improve the physical fitness of samba dancers in the future, accepting as a model and stimulus for supporters of this dance style.

Methods

Study design, participants and ethics statement

This study was acute, prospective, and cross-sectional. Studies with acute designs have their value since they envisage their effects in chronic drawings [Pallmann et al. 2018]. The present experimental study was conducted in the Exercise Physiology Laboratory of Instituto de Ortopedia e Traumatologia,

Hospital das Clínicas, Faculdade de Medicina da Universidade de São Paulo. This study was approved by the University of São Paulo, School Medicine Ethics Committee for Research on Human subjects (case # 281/12) and followed the recommendations of the Declaration of Helsinki (1975) for the study in humans being. All participants were informed of possible risks and benefits of their participation before signing an approved consent document. All information, both from the dancers and from the schools, were kept confidential. A systematic search of the literature on dance using the terms "dance, exercise, training, fitness in health, and disease" was carried out as a support in the data parts of PubMed / MEDLINE, Lilacs, Scielo, academic Google, Embase, Cochrane Library, and Web of Science and included studies published until October 2020.

Twenty active recreationally females samba dancers participated in the study. The dancers had great experience in samba dancing, but were not involved in any supervised training program during assessment and did not have samba as a profession. They danced samba recreational and for pleasure, a cultural tradition in our country. The families take the children to practice samba at samba schools very early [Toji, 2006]. Individuals were eligible according to the following inclusion criteria: (i) age between 17 and 40 years old; (ii) no professional female samba dancers (iii) apparently healthy individuals carried out by medical staff, (iv) without history of disease, (v) no cardiovascular or orthopedic abnormalities, (vi) no pregnancy, (vii) non-obese dancers [BMI <29.9 kg/m²], and (viii) sign the consent form for participation in the study. Exclusion criteria: (i) known history of any disease, or (ii) any abnormality detected during the physical examination that might have adversely affected the participant's health or study results were the exclusion criteria. After screening, they were healthy free from injury and illness at the time of their individual assessment by physician and did not take any kind of medicine. The samba dancers were in the preparatory period rehearsals dancing on the weekends. They were recruited from various samba schools in the city of São Paulo. The dancers visited our physiology laboratory twice. At the first visit, they were submitted to the maximum cardiopulmonary exercise test to assess the physical fitness level and during the second visit were submitted to samba dance testing. The difference in temperature, humidity, and atmospheric pressure within the Physiology Laboratory was: 20-24°C, 40-60%, and 689-696 mmHg, respectively.

Anthropometric assessment

Weight was measured with the subjects wearing light clothing and no shoes to the nearest 0.05 kg by digital weighing scale (Welmy[®], 200/5, Santa Barbara d' Oeste, São Paulo, Brazil). Height was measured without shoes to the nearest 0.1 cm by rigid stadiometer (Welmy[®], 200/5, Santa Barbara d' Oeste, São Paulo, Brazil), and body mass index (BMI, kg/m²) was calculated as weight (kg) divided by the square of height (m) and, samba experience (yrs) are listed in Table 1.

Cardiorespiratory fitness testing

Cardiopulmonary exercise testing, to assess maximum cardiorespiratory capacity was carried out at the Laboratory of Movement Studies of the

HCFMUSP Institute of Orthopedics and Traumatology. ($RQ/RER = VCO_2/VO_2$) were variables continuously monitored and calculated from the measured values using an on-line gas analysis system (Medgraphics®, CPX/D, Saint Paul, Minnesota, USA). The pneumotachograph was calibrated before each test using a syringe (Hans Rudolph®, 5530, Kansas City, MO, USA) with a 3-liters capacity. The equipment calibration was performed before each test against gases of known concentrations ($O_2 = 12.1\%$ and 20.9%), ($CO_2 = 4.96\%$) and were balanced with nitrogen (N_2) (Air Products and Chemicals®, Inc, USA) in addition to using the atmospheric air composition. In order to verify if the flow of air drawn by the vacuum pump of the equipment, that gives the adequate pressure to capture the gases, and if it was adequate, we used the equipment Fluke 922-Pressure Calibrator (Fluke®, Everett, Washington, USA). During the test, the dancers had a rubber mouthpiece and nose clip. The loss of verbal communication with a samba dancer during the test was overcome with prearranged hand signals. The heart rate was monitored continuously using a 12-lead electrocardiogram (HeartWare®, Belo Horizonte, MG, Brasil). The usual ECG parameters (heart rate, PR interval, QRS duration, QT and QTc intervals, and P, QRS and T axes) were analyzed in rest, during exercise, and cooldown period. The blood pressure (BP) was measured using the auscultatory method based on Korotkoff sound on every 2 min, using an aneroid sphygmomanometer (Welch Allyn Tycos® 767, USA) and a stethoscope (Littman®, St. Paul, Minnesota, USA) while at rest after 5 min in the sitting position, at every 2 min of exercise, and at the first, second, fourth, and sixth minutes of the cool-down period. The stress test was conducted on a medical-grade treadmill (h/p/cosmos®, pulsar, Nussdorf-Traunstein, Germany) with variable speed (km/h) and slope (%). A modified version of the Heck stress test protocol was used with fixed speed and increasing slope increments at the rate of 2% (1.15°) per minute. The speed was selected from those available (4.8, 6.0, 6.5 and 7.2 km/h) based on the limit of individual conditions after two pilot tests with different speeds [Muotri and Bernik, 2014]. Once a speed had been selected, individuals remained for a one-minute period at rest and shortly thereafter began the protocol at the previously chosen and tested speed. Guidelines recommending short duration treadmill-based tests for dance populations were used in the present study [Wyon, 2006]. The test was discontinued at the request of the participant or when signs of tiredness were perceived. During the 3-minute recovery phase, beginning immediately after the end of the test proper, speed was decreased and maintained for one minute at every step of decrement.

Maximal oxygen uptake (VO_{2max}) was achieved in two of the subsequent criteria occurred: (a) plateau in VO_2 (≤ 2.1 mL/kg/min) with an increased work rate of over the final 2 stages of test [Taylor et al. 1955]; (b) the respiratory exchange rate cutoff values higher 1.10 [Edwardsen et al. 2014]; (c) predicted maximal heart rate at 90% was calculated using Tanaka's formula ($208 - [0.7 * \text{age}]$) [Tanaka et al. 2001]; (d) Perceived exertion was evaluated by the subject at each stage of the exercise test on a 15-point linear scale (6 to 20) as described by Borg [Borg, 1982]. All subjects met the primary two criteria. Additionally, information from the VO_{2max} tests was time-averaged at 30-s intervals.

Ventilatory threshold 2, VT_2 , (i.e., respiratory compensation point), was determined as the point where minute ventilation (VE), ventilatory equivalent of oxygen (VE/VO_2), ventilatory equivalent of carbon dioxide (VE/VCO_2) and end-tidal oxygen pressure (PET_{O_2}) concomitantly increased and end-tidal carbon dioxide pressure (PET_{CO_2}) decreased (second inflection of curves in progressive

exercise). This is the transition between “steady” and “heavy” paces [Skinner and McLellan, 1980; Bhambhani and Singh, 1985].

Ventilatory threshold 1, VT_1 , was determined by the lower value of VE/VO_2 and PET_{O_2} before its continuous increase associated with the beginning of abrupt and continuous increase of respiratory quotient ($RQ=VCO_2/VO_2$) (first inflection of the curve in progressive exercise). VT_1 pace is termed as "steady" [Skinner and McLellan, 1980; Bhambhani and Singh, 1985].

Economy of movement determination

The experimental procedure was expressed as a function of the VT_1 and VT_2 as previously suggested [Saunders et al. 2004]. The economy of movement (EM) was determined by interpolation measuring the rate of oxygen consumption (VO_2) and the displacement speed between ventilatory thresholds 1 and 2 (VT_1 and VT_2) by cardiopulmonary exercise testing. This is the transition between “steady” and “heavy” paces. EM, which is required to assess, was defined as oxygen uptake was $\leq 85\%$ of VO_{2max} for all samba dancers. The VO_2 and walking speed at the VT_1 and VT_2 were determined. Based on these walking speeds, VO_2 at VT_1 and VT_2 was expressed in mL/kg/KM and averaged between these two intensities.

Samba dance monitoring

A cross-sectional design was employed for this study, where samba dancers were measured at a one-time point only. The 40-minutes time was used as an acute strategy and future prediction of the capacity of response to physiological changes of samba dance performed chronically. In the test "concrete drawing of the movement", the dancers danced the samba in the foot listening to the samba music plot by a microcomputer of the respective samba school. The samba dancers were linked with monitoring by analysis of the expired lung gases online without interval. A total of more 1400 ventilatory and metabolic parameter repeats in real-time (VE , ventilation; VO_2 , oxygen consumption; RQ , respiratory quotient; MET , metabolic equivalent, and EE , energy expenditure) were recorded breath by breath at each samba dancer and then averaged over 30 seconds to eliminate the variability of these data. Heart rate (HR) was recorded by a heart rate monitor (Polar[®], T31, Kempele, Finland) placed on the left wrist and the HR transmitter was placed on the xiphoid process in direct contact with the skin. HR was recorded every minute. The women wore sandals and were dressed in the appropriate dance costume (Figure 1). The samba dance was repeated in a cycle of foot-leg movements, accentuating the hips and arms extended until a new cycle was initiated. This is the pattern of this dance. They danced in an area equivalent to 2.25 square meters. The choreography sequences were free, without cadence marked and the samba dancer executed a variety of movements that combined, in different fashions, the movement in small space to provoke the physiological response of the samba dance in the foot. To verify any anomaly in the physiological data, they were cross-referenced with video footage. Therefore, participants were also filmed while performing the sequence of samba movements to allow visual analyzes of consistency in these movements across participants and time-points. During the samba dance session inside of the laboratory, the

perception of effort was recorded at intervals of 5-minutes utilizing Borg's subjective perception of effort scale [Borg, 1982]. The time of the samba school on the official day of the parade is relatively short, only 17 minutes, but the rehearsals last from 20 to 75-minutes. In brief, the acute samba dance session recreated the physiological and metabolic demands imposed on dancers during the samba.

Statistical analyzes

The Gaussian distribution (normality) was verified by the Kolmogorov-Smirnov test (Z value <1.0). Descriptive data were presented as mean \pm standard deviation (SD), minimum and maximum values and median. The median was also used to avoid that a small number of discrepant values distorted the average since the mean has the disadvantage of being influenced by individual values. The measured and predicted VO_2max , HRmax , PO_2max and METmax values of the samba dancers were compared by student t test. Each bout of 5-minutes and to verify the variability of the parameters measured directly at the end of the 40-minutes of samba dance we used One-way (ANOVA) for repeated measures to evaluate the effect of time and if we identified differences between the means was used post hoc analysis of Bonferroni. The statistical analyses were performed using (Sigma Stat 3.5 Software, Inc., Point Richmond, CA, USA) with significance set at $P < 0.05$.

Results

In the analysis of the 20 dancers, the BMI classification in relation to the height and the weight presented by them was within values compatible with the normality, they were not obese, and had considerable experience as demonstrated by the median in Table 1.

Table 1. Baseline Characteristics of the 20 women samba dancers and experience status.

| Variables | Mean | Standard Deviation | Median |
|--------------------------|-------------|--------------------|--------|
| Age (years) | 29.9 | 5.3 | 30 |
| range | (17-40) | | |
| Weight (kg) | 61.0 | 5.8 | 61 |
| range | (51-77.5) | | |
| Height (cm) | 164 | 5.2 | 164 |
| range | (156.5-175) | | |
| BMI (kg/m ²) | 22.7 | 1.7 | 22.6 |
| range | (20.2-27.1) | | |
| Samba experience (years) | 11.6 | 5.2 | 11 |
| range | (3-29) | | |

Values are presented as mean, standard deviation and median. The values between parentheses represent minimum and maximum

To verify the baseline level of physical fitness of the participants, we compared the predicted values and those measured at exercise peak for VO₂, HR, PO₂, and METs according to age, weight, and height (Table 2). There was no significant difference (P=0.485, P = 0.333, P = 0.461, P = 1,000, P=0.382) among them, respectively (Table 2).

Table 2. Comparison between predicted and measured values at peak exercise testing

| Variables at peak exercise stress testing | Predicted values | Measured values | Diff | % of predicted | P value | 95% IC |
|---|------------------|-----------------|------|----------------|---------|---------------------|
| VO ₂ (mL/min) | 2027 | 1972 | 55 | 97 | 0.485 | -104,547 to 215,915 |
| VO ₂ (mL/kg/min) | 33.7 | 32.7 | 1 | 97 | 0.333 | -1.07 to 3.07 |
| HR (bpm) | 188 | 183 | 5 | 97 | 0.461 | -3.44 to 7.44 |
| PO ₂ (mL/HR) | 10.6 | 10.6 | 0 | 100 | 1.000 | -0.75 to 0.75 |
| METs (VO ₂ /3.5) | 9.6 | 10.2 | 0.6 | 106 | 0.382 | -13,042 to 5,116 |

Predicted vs. measured for each variable. VO₂, oxygen consumption; HR, heart rate; PO₂, pulse of oxygen; MET, metabolic equivalent

As the results showed the samba dancers were not professional and had values comparable to the population mean. The fitness level was within the expected range. At the peak of the exercise, the maximum values, the standard deviation, the median and intensity level for VO₂, HR, RQ, EE, MET, RPE Borg scale and time test are listed in Table 3. As demonstrate in Table 3 and Figure 2 the

relationship between physical activity intensity and the physiological stress on the body is categorized as light, moderate, vigorous or high. These are aligned to physiological or metabolic parameters that indicate the relative stress at these intensities. In this study, the samba dance style was characterized by intensity predominantly between moderate to vigorous. The ramp style stress test protocol had a maximum duration of 15 minutes. Sixty percent (12) in 20 of the evaluated ones reached 100% (Table 3).

Table 3. Intensity of samba exercise determined by VO₂, HR, PO₂, RQ, EE, MET and RPE Borg scale at exercise peak testing and during the samba dancing session (n=20)

| Variables at peak exercise stress testing | Maximal value at peak exercise | Mean value (samba dance) at 40 min | Percentage of maximal values | Median | Intensity level of samba dance |
|---|--------------------------------|------------------------------------|------------------------------|--------|--------------------------------|
| VO ₂ (mL/kg/min) | 32.7± 3.5 | 22.8± 0.9 | 70 | 23 | Vigorous |
| range | (25.4-40.9) | (21.2-32.4) | | | |
| HR (bpm) | 183±12 | 162±3 | 89 | 162 | Vigorous |
| range | (165-208) | (150-188) | | | |
| PO ₂ (mL/HR) | 10.6±1.5 | 8.2±0.9 | 77 | 8.2 | Vigorous |
| range | (8.7-14.0) | (7.1-8.3) | | | |
| RQ (VCO ₂ /VO ₂) | 1.12 ±0.06 | 0.94±0.01 | 84 | 0.94 | Vigorous |
| range | (1.03-1.28) | (0.85-1.00) | | | |
| EE (kcal/min) | 9.9 ±1.4 | 6.5±0.3 | 66 | 6.6 | Vigorous |
| range | (7.3-13.1) | (6.0-7.2) | | | |
| METs (VO ₂ /3.5) | 10.2±4.6 | 6.3±0.2 | 62 | 6.3 | Vigorous |
| range | (7.2-11.6) | (5.9-9.0) | | | |
| RPE Borg scale (6-20) | 19.2±1.7 | 11.8±1.5 | 61 | 12 | Moderate |
| range | (18.9-20) | (11-15) | | | |
| Time test (min) | 14.1±1.2 | - | - | 15 | - |
| range | (11-15) | | | | |

Data are expressed as mean ± standard deviation (SD), median and between parentheses minimum and maximum values. VO₂, oxygen consumption; HR, heart rate; PO₂, pulse of oxygen; RQ, respiratory quotient; EE, energy expenditure; MET, metabolic equivalent; RPE, rated perceived exertion by Borg scale. Intensity level according to the Classification of Physical Activity Intensity (ACSM Guidelines 8th edition 2009). Pescatello L and Riebe D. ACSM's Guidelines for Exercise Testing and Prescription the Ninth Edition-A Preview.

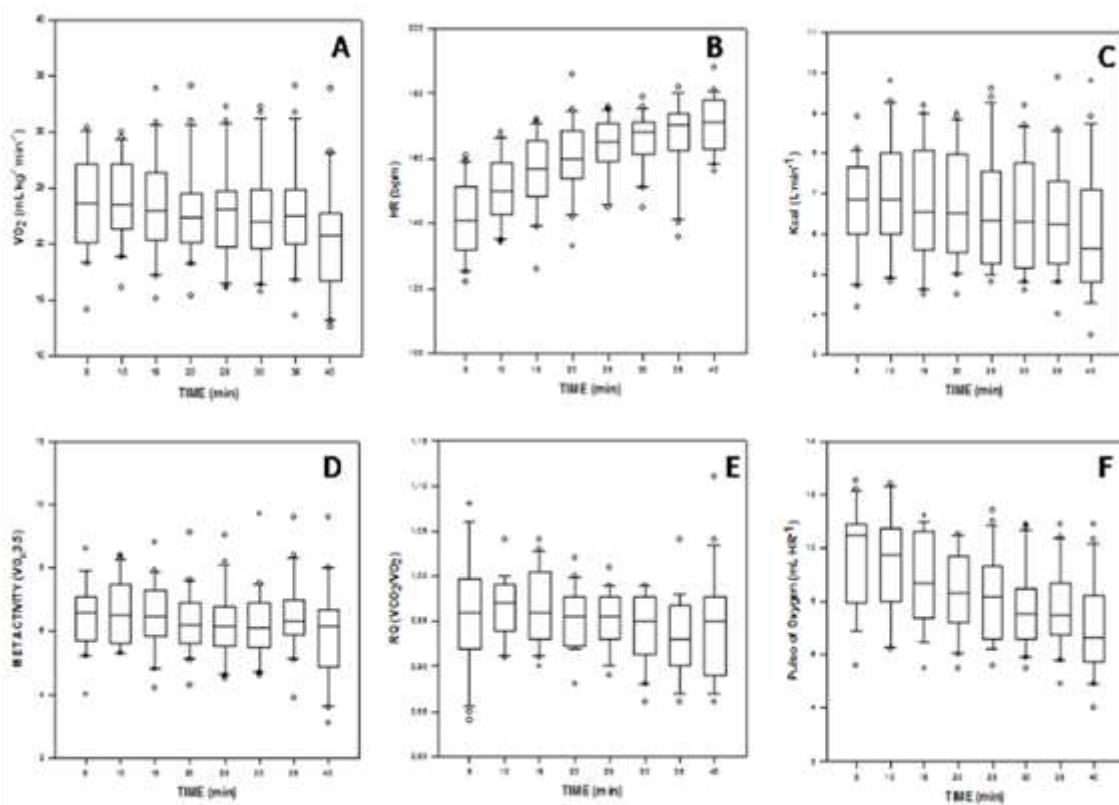


Figure 2: Mean values for oxygen consumption VO_2 (A), heart rate, HR (B) energy expenditure, kcal (C), metabolic equivalent, MET (D), respiratory quotient, RQ (E), PO_2 , Pulse of oxygen (F) during acute samba dance session for 40 minutes

Mean values of cardiorespiratory and metabolic as VO_2 , HR, PO_2 , RQ, EE, MET and Borg scale during the samba dance exercise are shown in Table 4.

Table 4. Mean values of parameters every 5-minutes for a total period of 40-minutes during samba dance (n = 20)

| Samba Dancing (min) | VO_2 (mL/kg/mi n) | HR (bpm) | PO_2 (mL/H R) | RQ (VCO ₂ /VO ₂) | CHO/FA T (%) | EE (Kcal/m in) | METs (VO ₂ /3.5) | RPE Borg scale (6-20) |
|---------------------|---------------------|-----------|-----------------|---|--------------|----------------|-----------------------------|-----------------------|
| 5 | 23.3 | 156 | 9.6 | 0.96 | 87.2/12.8 | 6.7 | 6.4 | 9.3 |
| 10 | 23.7 | 161 | 9.3 | 0.96 | 87.2/12.8 | 6.9 | 6.6 | 10.3 |
| 15 | 23.3 | 161 | 8.7 | 0.96 | 87.2/12.8 | 6.7 | 6.4 | 11.0 |
| 20 | 23.1 | 163 | 8.3* | 0.95 | 84.0/16.0 | 6.6 | 6.2 | 11.8 |
| 25 | 22.9 | 164 | 8.1* | 0.94 | 80.7/19.3 | 6.6 | 6.2 | 12.5 |
| 30 | 22.6 | 164 | 7.8* | 0.94 | 80.7/19.3 | 6.4 | 6.2 | 12.8 |
| 35 | 22.7 | 162 | 7.7* | 0.93* | 77.4/22.6 | 6.4 | 6.4 | 13.3 |
| 40 | 20.7 | 166 | 6.8* | 0.93* | 77.4/22.6 | 5.9* | 5.9 | 13.6 |

| | | | | | | | | |
|--------|----------|------|--------|-----------|----------|---------|--------|----------|
| Mean±S | 22.8±0.9 | 162± | 8.2±0. | 0.94±0.01 | 82.7±4.2 | 6.5±0.3 | 6.3±0. | 11.8±1.5 |
| D | | 3 | 9 | | 17.2±4.2 | | 2 | |
| | 23 | | | 0.94 | 82.3 – | 6.6 | | 12 |
| median | | 162 | 8.2 | | 17.6 | | 6.3 | |

VO₂, oxygen consumption; HR, heart rate; PO₂, Pulse of oxygen; RQ, respiratory quotient; CHO/FAT, percentage ratio of carbohydrate and fat utilization during dance by RQ; EE, energy expenditure; MET, metabolic equivalent; RPE, ratings of perceived exertion. ANOVA, post hoc Holm-Sidak test * significant (P <0.05).



Figure 1 shows the monitoring of the samba dance by 40-minutes.

The Average heart rate values every five minutes in 20 dancers during samba dancing for the 40-minutes duration without pause are demonstrated in Figure 3.

The VO₂ at samba dance ranged 8.9 to 38 mL/kg/min (mean = 22.8 mL/kg/min ; 70% of max value used). There is not a statistically significant difference among mean values to VO₂ (P= 0.597, F= 0.790). The HR ranged from 135 to 187 bpm (mean =162 bpm; 89% of max value used). There is not a statistically significant difference among mean values to HR (P = 1.000, F= 0.0326). The PO₂ ranged 8.7-14.0 mL/HR (mean = 8.2; 77% of max value used). There is a statistically significant difference at PO₂ (P < 0.001, F= 5.595) from the twentieth minute we observe a reduction of PO₂. The RQ ranged 0.88 to 1.10 (mean = 0.94; 84% of max value used). There is a statistically significant difference at RQ (P = 0.006, F=3.210) at bout time 35 minutes. As shown by the percentage proportion of substrate utilization by RQ, the predominant carbohydrate consumption is evident, but it is important to highlight that from the 35 min of samba dance the fat ratio increases reaching almost 20%. The EE ranged 4.2 to 6.8 (mean = 6.5 kcal/min; 66% of max value used). There is a statistically significant difference at EE (P= 0.003, F=3.268) at bout time 40 minutes. The MET ranged 5.8 to 9.0 (mean= 6.3; 62% of max value used). There is not a statistically significant difference among mean values to MET (P= 0.812, F= 0.451). The RPE session ranged 9 to 14 (mean = 11.8; 61% of max value used). There is a statistically significant difference at RPE (P = 0.001, F=86.537) at bout time 40 minutes. Considering all the studied variables, all

values presented fluctuation as expected for an intermittent activity such as dance. The economy of movement (EM) 196 ± 10 mL/kg/KM (median = 194.5) founded in the dancers after exercise testing was considered above average demonstrating that samba dance style produced low energy cost.

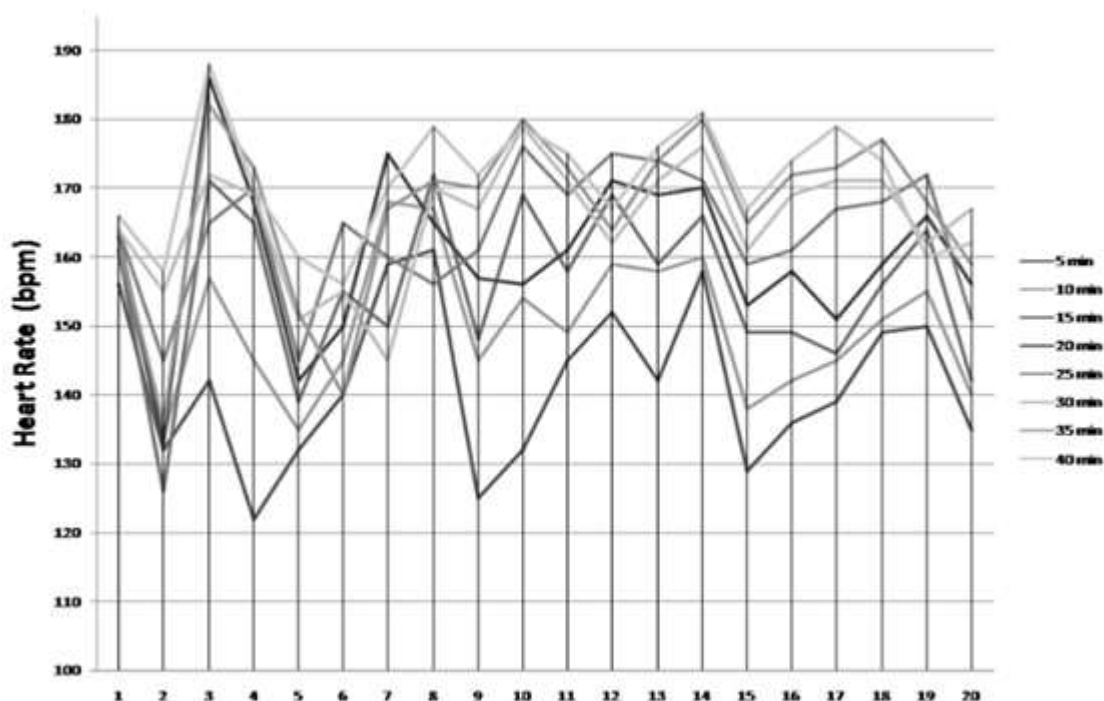


Figure 3: Average heard rate values every five minutes in 20 dancers during samba dancing for 40 minutes duration without a break

Discussion

The main highlight of this study was to demonstrate the potential impact of Brazilian samba dance with great perspectives to be a tool used to improve physical fitness. Furthermore, we are unaware of other studies that analyzed the exercise intensity during samba dance sessions in our country for a period of 40 consecutive minutes. The results of our study allow us to develop this discussion about the relevance of this style for cardiorespiratory enhancement with potential implications of both scientific researchers and dance educators' perspectives. According to Yan et al. [2018] structured dance lasting at least 4 weeks can significantly improve physical health outcomes equivalent to other forms of structured exercise.

Physical inactivity rates in developed as well as underdeveloped countries are great [Kohl et al. 2012]. Discovering strategies to increase people's participation and engagement in exercise is the first step in the challenge to combat physical inactivity. The adoption of the Exercise is Medicine® brand, an initiative of the AHA and ACSM institutions, had immediate sympathy and interest reaching several countries [Neville, 2013]. This brand appeals to those who advocate exercise/physical activity as a form of disease prevention and/or symptom management for chronic conditions (e.g., hypertension), and mental health (e.g., depression, anxiety). The samba dance and the results of this study incorporate

the idea of combining medicine with exercise as a method to gain credibility with practitioners. The first step of this study was to verify the extent to which the samba dance performed acutely could predict a chronic effect [Åstrand, 1967; Tillmann et al. 2020; Delabary et al. 2020]. This response is very likely due to the results of the samba dancers. Physiological responses fit the profile of the exercise guidelines such as AHA and ACSM, respectively.

Unquestionably, the proficiency, the coordination of the movements, and the learning of this dance are fundamental for the physiological effects of the motor movements to have their respective effects [Braga et al. 2015]. There is a difference in the samba dance between professional dancers and that of ordinary people. Not really in dance. However, what changes are the intensity of the dance, it is greater for the professionals, because they constantly participate in shows, championships, and presentation on television. The greater difference is that they live off the dance, they earn money to dance [Toji, 2006]. The purpose of this study was not to show differences between professionals and ordinary people, but rather to show that any ordinary person can benefit from the samba movements [Braga et al. 2015]. The physical demands placed on professional dancers by choreography and performance schedules make their physiology and fitness as important as the development of technical skills. At the professional level, dancing as a professional sport would need additional training [Koutedakis and Jamurtas, 2004].

The cardiorespiratory and metabolic variables obtained at the peak of the cardiopulmonary exercise test, when compared with predicted values were classified as normal fitness confirming that they were untrained [Wasserman et al. 2011]. The test time ranged between 8 and 15-minutes as recommended [Buchfuhrer et al. 1983].

The minimum threshold of exercise intensity to increase the aerobic level according to ACSM is 50% of the VO_{2max} , in the present study the dancers reached 70% considered fit for this purpose [Swain and Franklin, 2002; ACSM, 2013]. According to Åstrand and Rodahl [1986] and Yan et al. [2018] dancing in the intensity of moderate to vigorous is enough to trigger the physiological effect of training. Among the dancers studied during the samba dance session, they exercised at 70% of the VO_{2max} , 89% of the HR_{max} and 77% of the PO_{2max} with an RPE median of score 12 enough to improve the aerobic profile [Åstrand, 1967]. Here, the PO_2 provides an estimated index for stroke volume/cardiac efficacy since it is related to increased cardiac output and consequently to VO_{2max} [Wasserman et al. 1987]. Similar results were observed by Blanksby and Reidy [1988], who showed in female dances HR values between 74% and 95% of HR_{max} and consuming oxygen corresponding to 76% of VO_{2max} . On contrary, previous studies [Spelman et al. 1993] with dance research have shown in young populations, such as ours, that dancers exercise in a percentage of VO_2 equivalent to 67% of VO_{2max} value inferior to that found by Grant et al. [1998] 65% in university students.

In the present study, the intensity at which the dancers performed samba dancing according to several researchers [Ehsani et al. 1982; Malfatto et al. 1996], this intensity during a chronic program will result in physiological adaptations that will contribute to the reduction of the submaximal heart rate [Myers et al. 2014], improvement in the autonomic balance between parasympathetic and sympathetic nervous activity and increasing myocardial performance [Ehsani et al. 1982; Malfatto et al. 1996]. Besides, these adaptations, already known, will allow longer ventricular filling time, improved coronary perfusion and lower rate pressure product [Redwood et al. 1972; May et al. 1984; Belardinelli et al. 1995].

Another aspect postulated by Eston and Williams [Eston and Williams, 2001] and ACSM [2013] is that a higher metabolic cost results in an increased RPE confirm previous research. In the present study, the RPE median value of 12 for the samba dance sessions is slightly lower than would be expected for relative intensities of 89% of VO_2max attained by dancers when compared with the guidelines of Birk and Birk [Birk and Birk, 1987]. The researches indicate that RPE values of 12 to 15 correspond in general to 58 and 89% of VO_2max , respectively. The truth is that our results converge with those of Zeni et al. [1996] that reported RPE levels from 13 to 15 resulted in % VO_2max values within the recommended intensity range for several modes of exercise.

The quantification and the effect of the exercise on the aerobic metabolism can be evaluated basically by three dependent variables (a) VO_2max , (b) ventilatory threshold in % fraction (% VO_2max) and (c) EM [Ramos-Jimenez et al. 2008]. Research indicates that individuals with low cardiovascular fitness ($\text{VO}_2\text{max} < 30 \text{ mL/kg/min}$) and also high cardiovascular fitness ($\text{VO}_2\text{max} 40\text{-}51 \text{ mL/kg/min}$) may improve VO_2max (up to 16% and 8%, respectively) when a moderate-intensity aerobic exercise stimulus is realized [Redwood et al. 1972; Swain and Franklin, 2002]. In this sense, our dancers are in a range of VO_2 that can benefit from the chronic training of samba as showed previously [Åstrand, 1967].

Another very important aspect observed was the metabolic activity observed in a samba dance session with mean values of 6.5 kcal/min and 6.3 METs, if performed 4 times a week lasting 40-minutes is sufficient to spend 1,000 kcal/week or 1,000 MET/min/week as recommended by ACSM to improve physical fitness and reduces the risk of all causes of mortality by 20-30% [Garber et al. 2011; ACSM, 2013]. Metabolically the proportion of carbohydrates and fatty acids as energy sources during endurance exercise depends on the intensity and duration of the exercise [Romijn et al. 1993]. In the present study, for 40 minutes the RQ value indicated that the carbohydrate was the dominant metabolic substrate. It is known that if exercise performed over a long period at a mild to moderate intensity it is normal for RQ to gradually decrease due to a reduction in the number of carbohydrates stored in muscles [Ahlborg et al. 1974]. Although samba is an intermittent dance on average, the RQ recorded for 40-minutes after the beginning of the exercise remained below the maximum aerobic capacity, and therefore a mean RQ of 0.94 ± 0.02 corresponded to a metabolic substrate ratio of 84% for carbohydrates and 16% for fatty acids [Åstrand, 1967; Hawley et al. 2000]. However, from the 35 minutes of dance exercise, the participation of fatty acids increased to 22.6% (RQ = 0.88) indicating higher aerobic participation. Therefore, an RQ below 1.0 found in the dancers indicated adequate aerobic exercise intensity and consequently no compensatory hyperventilation for metabolic acidosis [Ramos-Jimenez et al. 2008]. In this sense, RQ can be considered an additional indicator in exercises of mild to moderate intensity [Ramos-Jimenez et al. 2008].

The association of energy and metabolic expenditure and cardiovascular response express the importance of dance in the context of preventive health. Lankford et al. [2014] using the MET indicator, demonstrated in some Latin dances, the average metabolic demand by MET and verified in Waltz = 5.3, Foxtrot = 5.3, Cha-Cha = 6.4, Swing = 7.1 and recreational ballroom dance 6.9, respectively. In the present study, samba presented 6.3 METs and as above they were classified as moderate to vigorous intensity. Based on the assumption that our population is mostly sedentary, 3 out of 10 people practice some type of physical activity, samba is a good alternative to fight the epidemic of

sedentarism. Our results also were similar to those found by Massidda et al. [2011] that verified in samba 6.2 METs and 6.5 kcal, respectively. These values were very close when compared to the present study. These activities are considered moderate to vigorous by ACSM [2013]. Reliable quantification of METs and EE for samba dance gives a deeper understanding of its physiological demands and how it cooperates with metabolic and cardiorespiratory fitness.

The literature argues that dance causes improve the economy of movement (EM), but we do not found studies quantifying this variable in dancers. In the present study, this variable of aerobic function showed relative values equivalent to female runners of a high-level at a long distance [Jones, 2006]. Therefore, it seems that the physiological adaptations of samba dance allow reducing the cost of the submaximal exercise condition for improvement of performance in endurance exercises [Coyle, 2005]. In addition, the good EM reduces the use of muscle glycogen and potentially less dependence on anaerobic metabolism resulting in the reduction of metabolic acidosis early and consequently muscle fatigue [Harris et al. 2018; Hargreaves and Spriet, 2020].

An interesting study was carried out by Maddigan et al. [2019] that presented results that reinforce the notion that music can alter the association between the central motor impulse, the central cardiovascular command and the perceived effort, in addition to contributing to the prolonged duration of exercise at higher intensities, together with a greater HR recovery. In the present study, what we saw was that the dancers adjusted the intensity according to the feeling of tiredness and did not remain in the anaerobic zone of effort for a long time which prevented peripheral fatigue. Music seems to have a certain fatigue dampening power [Brohmer and Becker, 2006; Haluk et al. 2009]. However, Table 3 shows minimum values of low and high-intensity and it seems that at certain times the tempo of the music is a stimulus for a more intense motor drive accelerating the cardiovascular command of the dancers. However, the dancers did not exceed 15 (tiring) on the Borg Scale. It seems that in this sense the feelings of well-being and pleasure would positively affect the common physiological measures of fatigue. As stated by Karageorghis et al. [2011], the effect of the distraction theory could be applied to the attenuating effect of music when it exceeds 70% of VO₂max, due to the domination of internal feedback on the capacity of the afferent nervous system. However, this theory is not yet consistent. According to Vasilev et al. [2018] intelligent speech and lyrical music resulted in the greatest distraction. Although the latter result is consistent with the semantic distraction theories, there was also a reliable noise distraction. It is argued that new theoretical models are needed to explain the distraction caused by speech and background noise [Vasilev et al. 2018].

When we analyze the behavior of the physiological variables studied during the samba dance it is evident that the moderate to vigorous values give the peripheral component a greater importance than the maximum values reached at peak exercise test, which reflects the ability of the muscles to use the oxygen to break down fuel to release energy.

Perspectives and future directions

In summary, the results of this study are potentially interesting and should attract the interest of sports scientists, coaches of dance, readers, physicians, and samba lovers demonstrating that samba dancing can make a promising contribution towards physiological changes for many people with lower physical fitness. More studies are certainly needed, to reach a definitive conclusion as well as learn more on this topic. We understand that this dance modality has enormous potential as a tool to be used in rehabilitation programs and/or to fight the chronic sedentarism that affects the majority of the Brazilian population. One of the advantages of this work is that it was performed in an indoor environment when we think of using this type of dance as a tool to improve physical fitness indoors (residence, gym, schools, clinics, etc). It is important to critically evaluate the results of the study as a whole. Despite its contribution, the study has some limitations that need to be considered. Although the results present good prospects with this type of exercise, the sample size evaluated was small. However, if the study had achieved larger sample sizes, this would have allowed a more thorough examination of the noted individual variations and/or trends of similarity. Only adult women were evaluated, excluding men and children, who also samba dance. Besides, this study did not evaluate the chronic effects of samba dancing exercise, only the acute cardiorespiratory and metabolic response. However, acute exercise can predict positive chronic effects if repeated regularly (Dawson et al. 2018). Thus, further research is recommended, with other types of study design and greater depth, to prove its effectiveness. However, the results provide an initial indication as to the positive benefits of samba dancing. The field is open, and some of these limitations may prove to be fruitful. One of the most important advantages of dancing is the pleasure that people feel in dancing with music, alone or accompanied. Imagining massive application, we cannot forget the financial aspect of dance compared to other methods of therapeutic intervention, because samba dance, already learned, may be less expensive than other means used for the same purpose. Domains for future research on this theme should be explored the chronic effect. Further scientific research on all forms of samba dance is required.

Conclusion

We provide data samba dance by demonstrating that this style as other types of dance has the potential to improve metabolic and cardiorespiratory dependent variables. The present study allowed us to verify that the mean intensity of the exercise verified in an acute samba dance session is enough to induce a chronic training effect, assuming that the dance is predominantly moderate to vigorous-intensity if performed with the frequency and duration. The pleasure of dancing has a highly positive psychological effect as shown in the various synthesized studies. This response showed that structured dance has a similar, if not even greater, power in terms of physical health metrics compared to known structured methods. Therefore, samba dance represents true training and will confer similar benefits to other styles if performed long-term. These results support the use of samba dance supporting the proposition as a physical activity intervention tool in future studies, as well as a means of meeting the guidelines for prescribed weekly exercise recommended by the ACSM.

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