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Acute Hemodynamic Changes Associated with Zumba and ZOCA Dance Exercises among Females of Selected Gyms in Lusaka, Zambia

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Abstract

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Background: Dynamic exercises are known to elicit hemodynamic changes such as an increase in arterial blood pressure and heart rate. Zumba and ZOCA are part of a fast growing group of dance fitness programmes designed to provide a cardiovascular dynamic workout. Despite their growing popularity, very few studies have been done to provide knowledge regarding the hemodynamic changes associated with these exercises.
Methods: Case study in which 27 females took part in either a Zumba or ZOCA class. Using digital blood pressure monitors, recordings of blood pressure and heart rate were taken, firstly, before commencement of the exercise, secondly, after 30 minutes after exercise and thirdly, at the end of the class.
Results: Mean baseline blood pressures were 118 (SD = 14) mmHg and 77 (SD = 7) mmHg, systolic and diastolic blood pressures, respectively. After 30 minutes of dancing, mean systolic blood pressure increased to 130 (SD = 19) mmHg ($p< 0.05$) while diastolic blood pressure only rose to an average of 80 (SD = 8) mmHg ($p> 0.05$). At the end of the class (after the cool down phase) mean systolic blood pressure reduced to 109 (SD = 13) mmHg ($p<0.05$) while diastolic blood pressure reduced to 74 (SD = 12) mmHg ($p< 0.05$).
Conclusions: Zumba and ZOCA elicited significant hemodynamic changes that can be attributed to these exercises stimulating the cardiovascular regulatory mechanisms (e.g central command and exercise-pressor) sufficiently and hence resulting in autonomic adjustments that were concurrent with effective dynamic exercise.

Keywords: *Blood Pressure, Heart Rate, Aerobic, Dance Exercise*

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Introduction

Dynamic, isotonic or aerobic exercises result in changes in certain hemodynamic parameters [1]. These include; increased heart rate (up to 200beats/min), increased stroke volume and cardiac output (up to 100ml/beat and 20lt/min respectively, increased systolic blood pressure (up to 160-220mmHg) and slight increase or no change in diastolic blood pressure [2].

Zumba Fitness and Zambia's Own Caribbean and African dance fever (ZOCA) are aerobic dances. Zumba uses mainly Latin music [3] while ZOCA uses mainly Zambian and Caribbean music [4]. The aim is to offer fun and a high energy cardiovascular workout. Both offer the social aspects of group fitness and support as well as a certified instructor to lead the class. The typical format of a class begins with a warm up dance of 3 to 5 minutes. The dance choreography then gradually increases in speed for the next 30 to 45 minutes. Heart rate elevates to the target as one performs the dance based movements during this aerobic phase of the class. The class ends with a 3 to 4 minutes of slow music in order to gradually restore the body to resting levels, this is referred to as the cool down phase and is then followed by stretches [5]. A typical class lasts for approximately 60 minutes [6].

Although non-communicable diseases (NCDs) such as cardiovascular disease, diabetes mellitus, chronic obstructive pulmonary diseases (COPD) and cancers are among the leading causes of morbidity and mortality in the world, with higher rates in developing countries including Zambia [7], and with the scientific knowledge that the risk of these diseases is significantly reduced by appropriate lifestyle modifications such as increased physical activity [8], investigations into physiological components of dance as an aerobic exercise has mainly concentrated on classical forms such as ballet dancing [9]. Relatively little has been published in relation to these modern dance exercises despite their growing popularity [10]. If proven to be an effective exercise based on the tested parameters, the two dances could be recommended for prevention and control of non-communicable diseases that are among the leading causes of morbidity and mortality in the world, with higher rates in developing countries. Therefore, this study sought to determine the hemodynamic changes associated with Zumba and ZOCA dance exercises among females of selected gyms in Lusaka, Zambia.

In this study, blood pressure and heart rate changes (and its derivatives) were assessed in clients taking part in either of two fairly new dance exercises, Zumba Fitness or ZOCA (Zambia's Own Caribbean and African dance) in order to generate knowledge about the acute effects of dance exercises on hemodynamic parameters in females of Lusaka, Zambia.

Materials and Methods

The total sample consisted of 27 adult females. In this study, blood pressure and heart rate changes (and its derivatives) were assessed in clients taking part in either of two dance exercises, Zumba or ZOCA. The research design was a case study. The study was conducted at three study sites; Chez Nthemba Sports Club (nine), Intercontinental Hotel Gym (eight) and Olympia Fitness Centre (10 respondents).

The study population included all female members of the selected study sites attending dance exercise classes between the ages of 18 and 56 years. Twenty seven dance exercise clients were conveniently sampled and took part in this study.

The inclusion criterion was all dance exercise class members above the age of 18 who had normal measures of blood pressure and heart rate at rest, had attended at least one dance exercise class prior to the day of data collection and gave consent to taking part in the study. Baseline measures of blood pressure and heart rate were done in order to exclude clients who might have had unknown underlying cardiovascular disease. The changes in the cardiovascular parameters could then be attributed to dance exercise session.

The exclusion criterion was dance exercise class members who were below the age of 18 and those who did not have normal measures of blood pressure and heart rate at baseline.

During data collection, demographic information (date of birth, age, gender & how long one had been practicing the dance) were collected before the start of the dance exercise

session. Blood pressure and heart rate measurements were collected using a Digital Wrist Blood Pressure Monitor (Brand: Citizen Micro HumanTech, Model; CH- 618). The client was asked to sit down and rest their hand on a table so that their hand was approximately at the level of the heart. The sphygmomanometer was then strapped at the wrist and the measurement taken.

The first measurements were taken before the start of the exercise session which was the baseline measurement. The second measurement was taken after 30 minutes of exercise that is during the aerobic phase of the exercise. The third measurement was taken after 60 minutes, that is, at the end of the session, after the cool down choreography.

Continuous variables (such as age, systolic blood pressure, diastolic blood pressure and heart rate) were summarized using means, medians and standard deviations. Paired t-tests were used to determine statistical significance of the change in the means of the variables between baseline and 30 minutes, between 30 minutes and 60 minutes and between baseline and 60 minutes. Data analyses were done using STATA version 12. During statistical analyses, the significance threshold was set at 0.05. Each session in which data were collected lasted approximately 60 minutes and all participants in a particular session started the exercise at the same time. Data were presented in tables and graphs for clearer display of the results.

Results

All hemodynamic parameters are presented as raw data (giving values at baseline, values during the aerobic and cool down phases of the dance exercises). Baseline mean systolic blood pressure was 118 (SD = 14) mmHg. After 30 minutes of exercise (during aerobic phase), mean systolic blood pressure increased to 130 (SD = 19) mmHg (p=0.0052). 60 minutes after exercise (cool down phase), mean systolic blood pressure reduced to 109 (SD = 13) mmHg (p=0.005). See table 1.

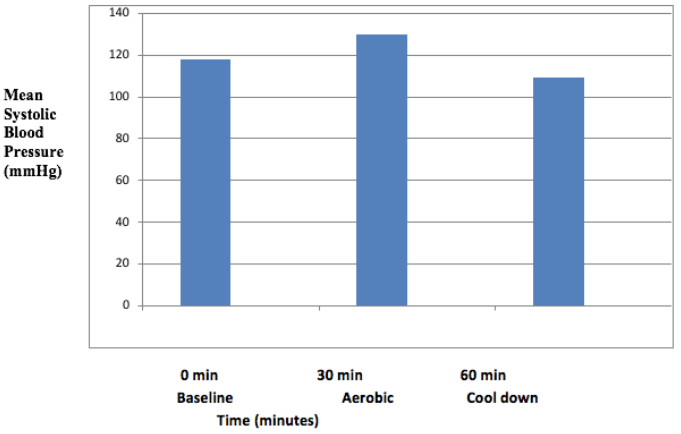

Figure 1: Mean systolic blood pressures at baseline (0min), during the aerobic (30 min) and cool down phases (60 min) of the dance exercise.

Diastolic Blood Pressure

The mean diastolic blood pressure at baseline was 77 (SD = 7) mmHg and showed no significant change after 30 minutes of dance exercise as it only rose to 80 (SD = 8) mmHg (p=0.1237) at 0.05 level of significance. At the end of the class, diastolic blood pressure reduced to 74 (SD 12) mmHg (p= 0.1123) at 0.05 level of significance. See table 2.

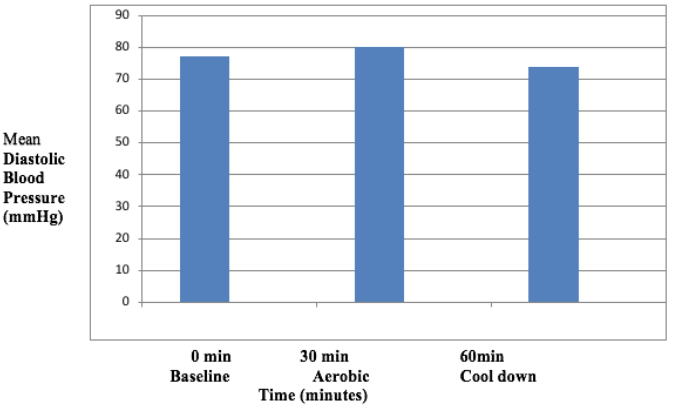

Figure 2: Mean diastolic blood pressures at baseline (0min), during the aerobic (30 min) and cool down phases (60 min) of the dance exercise.

Heart rate (HR), maximum heart rate (HRmax) and percentage of maximum heart rate (%HRmax)

The means for heart rate were 83 (SD = 16), 124 (SD = 25) and 110 (SD = 17) beats per minute (bpm) at baseline, 30 minutes after exercise and 60 minutes after exercise respectively. The changes from baseline mean heart rate's that

were recorded 30 minutes after exercise and also 60 minutes after exercise were highly significant ($p<0.0001$). Using the age-predicted formula for women (i.e., 226- age), the maximum heart rate was calculated first for each participant and then the mean maximum heart rate for the participants was calculated and found to be 190 bpm. Furthermore, using the heart rates measured at 30 minutes after exercise, and the maximum heart rates of the individual participants, the percentage of maximum heart rate during the aerobic phase of exercise was calculated for each participant using the formula, $X = \frac{HR(30min)}{HR(max)} \times 100\%$

The average percentage of maximum heart rate was 65% in this study. See table 3.

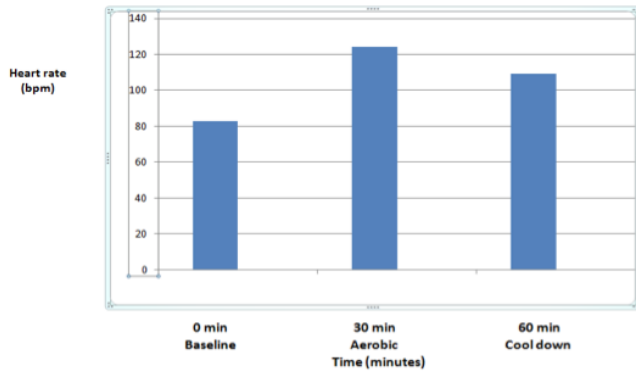

Figure 3: Mean Heart rates at baseline (0min), during the aerobic (30 min) and cool down (60 min) phases of the dance exercises.

Discussion

Systolic blood pressure changes

In healthy adults, during acute aerobic exercise, systolic blood pressure increases linearly in relation to the exercise intensity [11]. The systolic blood pressure of the participants in this study showed a significant increase between baseline and the aerobic phase of exercise and also between the aerobic phase and the cool down phase of the exercise session. The findings agree with those of [12] in which they evaluated, among other things, the physiological effects of Zumba on cardiovascular risk factors and inflammatory biomarkers in overweight and physically inactive women. Participants were randomly assigned to either engaging in one or two one hour classes of Zumba fitness weekly. Laboratory assessments were conducted pre (week 0) and post- intervention (week 8). In the intervention group, maximal oxygen uptake significantly increased, percentage of body fat significantly decreased and interleukin 6 and white blood cell count both significantly decreased. They concluded that Zumba fitness was an efficacious health-enhancing activity for adults.

In this study, the significant increase in systolic blood pressure during the aerobic phase of dance exercise demonstrates that the exercise intensity of Zumba and ZOCA was sufficient to elicit cardiovascular reflex activity that influenced the autonomic nervous system to increase cardiovascular activity. This is because the neural regulatory mechanism's (central command) response of the cardiovascular system to acute exercise is a result of an integration of information from the metaboreflex of the exercising muscles and the arterial baroreflex [13]. The neural regulation of the cardiovascular system responds to acute exercise by parasympathetic withdrawal and sympathetic activation. Both the increased cardiac output and increased vascular resistance contribute to the increased arterial blood pressure observed during dynamic exercise [14]. In order to promote and integrate scientific research and practical application of sport and exercise science for the maintenance and enhancement of physical performance, fitness, health and quality of life, certain membership organizations formulate guidelines for professionals and individuals to adhere to.

The American College of Sports Medicine is one such organization and in its guidelines, healthy adults should get at least 150 minutes of moderate-intensity exercise per week for the maintenance and improvement of cardiorespiratory health. In this study, Zumba and ZOCA sessions were routinely offered for 60 minutes per session, three times per week. With the significant increase in mean systolic blood pressure recorded during the aerobic phase of exercise, it can be said that the guidelines of Zumba and ZOCA comply with the guidelines for the duration and intensity of exercise for healthy adults.

Diastolic blood pressure changes

The means of diastolic blood pressure before the dance exercises and during the aerobic phase of exercise were not statistically different, showing that diastolic blood pressure

did not change significantly during this period of exercise. This finding is in agreement with [15] who stated that in healthy individuals, diastolic blood pressure does not change significantly during dynamic exercise in spite of the increase in systolic blood pressure.

Together with cardiac output, one of the important determinants of arterial blood pressure is total peripheral resistance. During diastole, the heart is relaxed, not ejecting a stroke volume and hence during this part of the cardiac cycle, the blood pressure is mainly affected by the peripheral resistance [16]. However, during dynamic exercise, local metabolites (such as adenosine, potassium, nitric oxide) produced in the exercising muscles cause vasodilation which then lowers peripheral resistance and therefore maintains a low diastolic blood pressure [17]. In addition to vasodilator metabolites, local mechanisms maintaining vasodilation and hence a high blood flow in exercising muscle include a fall in partial pressure of oxygen, a rise in tissue partial pressure of carbondioxide, a decreased pH and an increased temperature [18].

These autoregulatory mechanisms maintain vasodilation and hence a low vascular resistance. A marked increase in diastolic blood pressure during dynamic exercise could therefore result from an inappropriately high cardiac output or impaired vasodilation of resistance vessels within skeletal musculature [19].

Acute heart rate changes of participants during dance exercise

Baseline heart rate: The intrinsic electrical automaticity of the SA node determines the heart rate [20]. At rest, the SA nodal myocytes depolarize at a regular rate between 60 and 100 impulses/minute which is considered the normal resting heart rate [21]. In this study, participants had an average baseline heart rate of 83 beats per minute which was within the physiological limits. It was important that all participants have heart rate within the normal range at baseline so that changes measured during the course of the exercise session could be attributed to the physiological effects of the dance exercises.

Aerobic phase heart rate: The mean heart rate of the study participants during the aerobic phase of the exercise (at 30 min) was significantly higher than the baseline (0 min) value. During aerobic exercise, heart rate increases primarily due to reduced cardiac parasympathetic neural activity (cPNA), i.e. parasympathetic withdrawal. Central command and rapid feedback from muscle mechanoreceptors contributes to initial parasympathetic withdrawal, while loading of the cardiopulmonary baroreceptors (due to an increase in venous return secondary to muscle pump action) likely also elicits parasympathetic withdrawal as well cardiac sympathetic neural activation (cSNA). The sinuatrial node has both sympathetic and parasympathetic innervations. As exercise intensity increases further, progressive baroreceptor resetting as well as afferent feedback from muscle metaboreceptors trigger further cardiac parasympathetic withdrawal and sympathetic activation, the latter of which is increasingly augmented from moderate to maximal intensity by systemic-adrenal activation. This is because as intensity increases, the augmented activity of the adrenergic neurons stimulates increased adrenal gland release of epinephrine (and to a lesser extent norepinephrine) into the bloodstream [22]. Therefore, a significant increase in heart rate during Zumba and ZOCA suggest that the intensity of the dance participants was adequate to elicit the above mentioned mechanisms of aerobic exercise.

Findings of [23] recommended that individuals should exercise between 64 and 94% of the HRmax to improve cardiovascular fitness. The average percentage of maximum heart rate during the aerobic phase (at 30 minutes) of the study participants was 65 ± 12%, therefore, the intensity of the Zumba and ZOCA dance classes undertaken by these female participants was sufficient to meet the guidelines of the ACSM regarding the intensity of aerobic exercise that should be engaged in by healthy adults for improvement of cardiovascular health. The findings of this study were comparable with those of [24] in which they found that the average percentage of heart rate maximum of their study subjects was 79±7.0%. This was also within the stipulated guidelines.

Cool down heart rate: Upon cessation of exercise, the removal of central command together with abolished feedback from muscle mechanoreceptors causes an initial heart rate decrease. The heart rate decrease is also caused by increase in cardiac parasympathetic neural activity (cPNA). As recovery continues, cardio-deceleration is likely mediated by both progressive parasympathetic reactivation and sympathetic withdrawal. These slower

autonomic adjustments are believed to be elicited primarily by an intensity-dependent combination of gradual metabolite clearance (i.e., reduced metaboreflex input) and a reduction in circulating catecholamines, while thermoregulatory factors (direct thermoreceptor afferents and/or blood flow redistribution) may also be involved [25]. A review of studies done by [25] demonstrated that this removal of lactate, accumulated in the body after exhausting exercise, is enhanced if, during recovery, the subject continues to exercise, but at a lower intensity which normally does not produce any lactate. This lower intensity exercise is what is termed as the cool down phase of exercise. During this study, the last measurement of heart rate was taken after the cool down choreography of the dance exercises. The mean heart rate after the 60 minutes was lower than the mean heart rate during the aerobic phase of the exercise, that is to say mean heart rate reduced after the cool down choreography. Therefore, the cool down choreography of Zumba and ZOCA effectively lowered the heart rate in the participants of this study.

Conclusions

In this study, hemodynamic changes occurred during Zumba and ZOCA dance exercises. The change was reflected by significant increases in systolic blood pressure and heart rate between baseline and peak exercise. The increase in systolic blood pressure also indicated that the participants exhibited baroreflex resetting to sustain the increase in systolic blood pressure due to sympathetic activation. However, there was no significant change in diastolic blood pressure during exercise from which it can be concluded that the vasodilators produced during Zumba and ZOCA counteracted the vasoconstriction due to sympathetic activation and therefore the total vascular resistance could have been maintained or reduced. In addition, because the change in hemodynamic parameters from rest and during aerobic exercise are directly proportional to the exercise intensity, the percentage of heart rate maximum, systolic blood pressure and heart rate change measured during the aerobic phase demonstrate that the exercise intensity of the Zumba and ZOCA classes that respondents were engaged in was sufficient to meet the guidelines for aerobic exercise for the improvement of cardiovascular health in healthy adults.

The study was characterised by a limitation of a small sample, which could affected the generalisability of the findings. Further studies should include a large sample as well as including male respondents.

Declaration

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