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Effects of continous and interval trainings exercises on cardiovascular characteristics of pupils in Ibadan

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Abstract

Objective: The focus of the paper is to examine the effects of continuous and interval trainings exercises on cardiovascular characteristics of pupils in Ibadan, Nigeria, measured in terms heart rate, systolic blood pressure and diastolic blood pressure.

Methodology: A total of one hundred and eighty (180) volunteered pupils were conveniently drawn from four (two public and two private) primary schools in Ibadan based on type of school. The randomized classic experimental research design with two experimental and one control groups were employed in the study. Systematic random sampling technique was used to allocate sixty (60) participants to each of the three groups, namely: the continuous exercise (CE) and interval exercise (IE) and the control groups. The experimental groups participated in twelve weeks exercise trainings. The cardiovascular variables measured pre-post trainings were subjected to frequency counts, percentages, mean and standard deviation as well as analysis of covariance and scheffe post- hoc for analysis and discussions.

Results: Results show that the average age of the pupils was 9 years 8 months, 103 (57.2%) of the participants were male while 77 (42.8%) were female; the post-training mean height of the participants in the PRE group is 1.36±0.09m while that of weight is 29.52± 5.82kg. There was significant difference in the SBP of the primary school pupils exposed to each of the experimental groups and control group [($F_{3,176}$) =6.858, $p<0.05$]. The significant difference in SBP as indicated by scheffe post hoc was IE and control groups. There was no significant difference improvement in the DBP of the primary school pupils exposed to each of the experimental groups and control group [($F_{3,176}$) =1.319, $p>0.05$]. There was significant difference improvement in the heart rate of the primary school pupils that took part in each of the experimental groups and control group [($F_{3,176}$) =148.243, $p<0.05$]. The significant difference in the heart rate as indicated by scheffe post hoc was between CE and control ($P<0.05$).

Conclusion: Therefore, continuous and interval training exercises have positive effects on systolic blood pressure and heart rate functioning of the primary school pupils in Ibadan, Nigeria.

Vol: 3:3
DOI: 10.3823/508

Keywords: *Blood pressure, Heart rate, Continuous training, Interval training, Primary school pupils*

Introduction

Blood pressure (BP) refers to the arterial pressure as measured in the brachial artery of the arm. Din-Dzietham, Liu, Bielo and Shamsa (2007) reported that blood pressure is directly related to body size and larger people generally have higher blood pressure. Children have a greater blood flow to active muscle than adult due to there being less peripheral resistance (Muntner, He, Cutler, Wildman and Whelton, 2004). As the child ages, heart size and blood volume increase along with body size, and consequently stroke volume also increases as the body size increases, for the same amount of training (Chiolero, Bovet, Paradis and Paccaud, 2007). Moses, Onyezere, and Abass (In Press) are of the view that a child's smaller heart size and total blood volume result in a lower stroke volume both at rest and during exercise than in an adult. In an attempt to compensate for this, the child's heart rate response to a given rate of sub-maximal training where the absolute oxygen (O_2) requirement is the same is higher than in adults (Urbina, Alpert, Flynn, Hayman, Harshfield and Jacobson, 2008). However the child's higher sub-maximal heart rate cannot completely compensate for the lower stroke volume. Because of this the child's cardiac output is also lower than the adults for the same rate of exercise or oxygen consumption.

American Sports Medicine Institute (2008) declared that cardiovascular fitness represents the efficiency of the heart, lungs and vascular system in delivering oxygen to the working muscles so that prolonged physical work can be maintained. An individual with functional cardiovascular system is expected to have a decreased resting heart rate, lower blood pressure, increased stroke volume, increased cardiac output, and generally, increased heart function with an ability to pump more blood among other factors (Du, et al, 2005; Dimkpa, 2009). Ayenigbara (2010) submitted that regular participation in physical activity has been well established as an integral part of a healthy lifestyle in adults. It has been recognized that most diseases affected by exercise (such as coronary heart disease, hypertension, obesity, and osteoporosis) are a result of life-long processes, usually surfacing clinically in the older adult years (Corbin and Pangrazi, 1998; National Centre for Chronic Disease Prevention and Health Promotion, 2000). Clinical markers of hypokinetic disease have been observed in pupils (Boreham, Twisk, Savage, Cran and Strain, 1997; National Centre for Chronic Disease Prevention and Health Promotion, 2000). Magarey, Daniels and Boulton (2001) posited that the increased prevalence of overweight and obesity may be attributed to decreasing activity, increasing inactivity and a rising caloric intake of children. Morrow, Tucker, Jackson, Martin, Greenleaf and Petrie (2013) reported the guidelines for children and adolescents as daily physical activity behaviours of 60 minutes or more. They further reiterated that physical activity behaviours should include a minimum of 3 days per week of aerobic, muscle-strengthening and bone-strengthening activities.

Abass and Moses (2013) acknowledged that endurance capacity is an individual's ability to perform exercise at both submaximal and maximal intensities as demonstrated either by the ability to exercise longer at a similar workload or by increasing the workload attained at a given

Vol: 3:3
DOI: 10.3823/508

heart rate. Increased endurance capacity has been shown to be one of the indices of cardiovascular fitness (American Sports Medicine Institute, 2008). Studies have also demonstrated that exercise endurance capacity is linearly related to HRR (Ota, 2002; Singh, Rhodes, Gauvreau, 2008). Similarly, HRR is accelerated in endurance trained athletes (Otsuki, Maeda, Iemitsu, Saito, Tanimura and Sugawara, 2007). Increased cardiac output, increased stroke volume, decrease in resting blood pressure and resting heart rate are all evidences of cardiovascular fitness (American Sports Medicine Institute, 2008). After aerobic exercise training, it has been reported that stroke volume at rest increases due to increase in end diastolic volume; resting heart rate decreases due to greater venous return to the heart and increases in autonomic control; cardiac output increases primarily due to increase in stroke volume; blood flow increases through the cardiovascular system and both resting blood pressure and blood pressure during exercise are reduced (Adesola, 2008; Mahon, Anderson, Hipp and Hunt, 2003).
Adeyanju, Venkateswarlu and Dikki (2005) admitted that the results of better controlled experiments of interval exercise training support the fact that individual should expect at least 10% improvement in physiological components following an 'adult-like' fitness training programme. Earnest (2009) stated that contemporary exercise guidelines focus on aerobic exercise conditioning that uses exercise intensities from 40% to 85% of maximal aerobic capacity that centered on continuous training. Interval training began to emerge in the literature after a position statement from the American College of Sports Medicine challenged exercise practitioners to study exercise intensity. Interval training involves having participants exercise briefly at higher exercise intensities (90%–95% of maximum oxygen consumption) followed by a period of recovery. Although the net effect of interval training is aerobic, this style of training involves periodic excursions of exercise intensity into “anaerobic” metabolism and appears to better stimulate whole-body cardiorespiratory improvements as well as cellular signaling involved in metabolism and energy flux (Earnest, 2009). Studies have been conducted to find out the effects exercise training programmes have on fitness levels of children (Esan, 2011; Abass and Moses, 2011; Abass and Moses, 2013) with submission that if children follow a 3-5 times a week routine of at least 20 minutes continuous activity for 12 weeks, then improvements in VO_2max of 7-26% and body composition are possible without significant attention on interval exercise training. Oyeyemi and Adeyemi (2013) reported that the burden of chronic diseases including cardiovascular disease (CVD) is increasing rapidly in Nigeria, but fewer studies have examined the effects of interval exercises training on cardiovascular characteristics of pupils in Ibadan. Therefore, it is imperative to devote committed effort in finding out the efficacy of either continuous or interval trainings exercises together on cardiovascular characteristics of children, that will form the crops of healthy and sports giants in the nearest future. Hence the study examined effects of continuous exercise (CE) and interval exercise (IE) trainings on cardiovascular characteristics of primary public school pupils in Ibadan, Oyo State, measured in terms of heart rate, systolic blood pressure and diastolic blood pressure.

Methodology

The study was conducted in the exercise physiology laboratory and sports complex of the University of Ibadan, Ibadan, Nigeria for twelve weeks. The study was a randomized classic experimental research design with two experimental and one control groups (Isaac and Micheal,

Vol: 3:3
DOI: 10.3823/508

1981). A total of one hundred and eighty (180) volunteered pupils were drawn conveniently from four (two public and two private) primary schools in Ibadan based on type of school. The sample size ranges proportionately between thirteen (13) and ten (10) pupils from primary three (3); and twenty (20) and eighteen (18) from primary four in primary five (5), fifteen (15) pupils were from three schools and twelve (12) from one school. Primaries three to five classes were used due to the advice of parents' teachers' association (PTA) on age barrier. Each of the schools had representation ranges from 40 to 48 pupils. Systematic random sampling technique was used to allocate sixty (60) participants to each of the three groups, namely: the continuous exercise (CE), the interval exercise (IE) and the control groups.

The CE training group was a low intensities (35–54%HRmax) work load while the IE training group took part in short moderate intensities (55–69%HRmax) workload with increment at scheduled interval (Marwick et al., 2009). The intensities were sustained for 45 minutes in the CE group as well as 20 minutes at each interval in the IE group and repeated 3–5 times a week. Training at this intensity is related to working conditions well above the anaerobic threshold, inducing anaerobic muscle metabolism recognized (Holloszy and Coyle, 1984; Gosselink, Troosters and Decramer, 1997). The trainings took place three times a week in line with the position of the American College of Sports Medicine (2007) on quality and quantity of exercise training. In the CE group, the participants involved in five-station weekly activities of three (3) sets with 3, 2 and 1 repetitions respectively in the first week. Week second ,third, fourth, fifth, eighth, ninth, tenth and eleventh had four (4) sets of 4,3,2,and 1 repetition respectively whereas weeks six (6) and Seven (7) with four (4) sets had 4,3,3 and 3 repetitions. The last week had five (5) sets with 5,4,3,2 and 1 repetition in each of the stations. Excluding warm up and cool down, the participants were made to continuously rotating within the stations until activities are completed. They were randomly divided into five groups of twelve each. In the IE group, training protocol was based on incremental number of repetitions (3 sets of 3 to 12 repetitions each) in line with Faigenbaum and Westcott (2000) submission that 1 set of 11-15 repetitions that end at the point of fatigue is the best stimulus for adaptation for prepubertal resistance exercisers. Resistance was increased with each set. Participants were randomly divided into six lines of ten participants in each. Seven exercises were given one after the other and participants repeated after the instructors (researchers). The control group did not partake in any organised training during the period. However, the pupils were not restricted from their normal daily activities.

The cardiovascular variables of heart rate (HR), systolic blood pressure (SBP) and diastolic blood pressure (DBP) of the pupils in this study were measured and recorded pre-post trainings using Litman's stethoscope made in the United State of America (U.S.A.) and 2009 BOKANG Model of free style standing model sphygmomanometer calibrated from 0-300mmHg made in China by W.B.I.C.Wenzhou (CE0197) immediately after each training sessions. The heart rate of the participants was taken at the mitral area through auscultation in a sitting position. The researcher put on the headpiece of the stethoscope over the mitral area of the participants without too much pressure exerted and listened to the sound that was heard. The heart sounds of "lub-dub" that was heard was counted for ten (10) seconds. The counted numbers were multiplied by six (6) to make one (1) minute count and recorded. To get the systolic and diastolic blood pressure of the participants, the cuff of the sphygmomanometer was wrapped evenly and snugly around the arm of the participants at 2.5cm above the site of brachial pulsation. The pressure at which the first sound (korotkoff) was heard was recorded as the systolic blood pressure. The researchers continued with the deflating of the cuff noting the point when the last sound was heard which was recorded as diastolic blood pressure both in mmHg. The researchers finally deflated the cuff and removed it from the participants' arm. The obtained data were subjected to frequency counts, percentages, mean and standard deviation for analysis and discussions.

Results

The results show that pupils in primary three were 48(26.7%), those in primary four were 75 (41.7%) and those in primary five were 57 (31.6%). On the participants' age, 9 (5.0%) pupils were 7 years, 27 (15.0%) were 8 years, 36 (20.0%) were 9 years, 59 (32.8%) were 10 years, 20 (11.1%) were 11 years while 29 (16.1%) were 12 years with average age of 9 years 8 months. The result on gender indicates that 103 (57.2%) of the participants were male while 77 (42.8%) were female which means that most of the participants used in this study were males. The mean difference showed slight increase in height of 0.04m and 0.01m in the pre and post-test values of CE and IE; weight increased by 1.88kg in CE and 2.04kg in IE. The CE group had SBP pre-test mean of 97.33±8.99, IE group had 107.00±12.12 and control group had 101.07±12.52 however post-test means were 98.50±9.88, 95.17±14.20 and 103.17±9.65mmHg with mean differences of 1.17, 11.83 and 2.10mmHg. Pre-test means of 64.17±10.78, 65.33±5.67 and 65.12±8.79 as well as post-test means of 62.10±8.23, 60.67±7.87 and 62.83±8.85 with mean differences of 2.07, 4.66 and 2.29 mmHg were recorded for DBP in CE, IE and control groups respectively. Heart rate in CE group had pretest-posttest means of 82.27±9.32 and 77.25±11.56 with mean difference of 5.02bpm. In IE group HR pretest-posttest means are 81.07±4.95 and 81.37±11.87 with mean difference of 0.30bpm. The control group pretest-posttest Heart rate means are 79.98±10.39 and 86.97±12.37 with mean difference of 6.99bpm.

Table 1: Analysis of covariance to determine the effect of CE and IE on Systolic Blood Pressure of the Participants

Source of Variation	Sum of Squares	df	Mean Squares	F	Sig. of F	Remark
Covariates	162.658	1	162.658	1.237	.267	Sig.
Main Effects of Treatment Groups	1802.820	2	901.410	6.858	.001	
Explained	1965.478	3	655.159	4.984	.002	
Residual	23133.967	176	131.443			
Total	25099.444	179	140.220			

Table 1 indicated that there was significant difference in the SBP among the primary school pupils in Ibadan exposed to each of the experimental groups and control group [($F_{3,176}$) =6.858, p<0.05]. This indicates that there were significant differences in the effect of the trainings on SBP of the pupils. This is because the F-test at p<0.05 shows a significant difference

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http://ojmedicine.com | ISSN: 2174-680X
Vol: 3:3
DOI: 10.3823/508

exist among the three groups. In order to determine the magnitude and direction of the differences as well as the contribution of the trainings on SBP, MCA as presented below was applied.

Table 2: Multiple Classification Analysis showing the direction of the significant interaction effects, Grand mean = 98.94

Variable category	N	Unadjusted Deviation	Eta	Adjusted for Independents + Covariates Deviation	Beta
IE	60	-3.78	.28	-3.60	.27
CE	60	-.44		-.60	
Control	60	4.22		4.20	
Multiple R Square					.078
Multiple R					.280

The MCA in table 2 revealed a pattern similar to ANCOVA in table 1. From table 2, experimental group of IE has an adjusted mean score value of 95.17 (98.94-3.60) mmHg, experimental group of CE has the adjusted mean score value of 98.50 (98.94-0.60) mmHg and control group has the adjusted mean score value of 103.17 (98.94+4.20) mmHg. The result indicated that IE was the most effective; next to CE and control was the least effective. Detailed explanations were shown in the next scheffé post hoc table.

Vol: 3:3
DOI: 10.3823/508

Table 3: Scheffe Post hoc Analysis for Systolic Blood Pressure

Variable	Treatment Groups	Treatment Groups	Mean Difference	Sig.
Systolic Blood Pressure	IE	CE Control	-3.3333 -8.0000*	.282 .001
	CE	IE Control	3.3333 -4.6667	.282 .085
	Control	IE CE	8.0000* 4.6667	.001 .085

*=The mean significant is at the 0.05 level. The significant difference in SBP as indicated by scheffe in table 3 is IE and control ($P<0.05$).

Table 4: Analysis of covariance to determine the effect of CE and IE on Resting Diastolic Blood Pressure of the Participants

Source of Variation	Sum of Squares	df	Mean Squares	F	Sig. of F	Remark
Covariates	24.933	1	24.933	.459	.499	N.S.
Main Effects of Treatment Groups	143.377	2	71.688	1.319	.270	
Explained	168.310	3	56.103	1.032	.380	
Residual	9564.490	176	54.344			
Total	9732.800	179	54.373			

Table 4 showed that there was no significant difference improvement in the DBP among the primary school pupils in Ibadan exposed to each of the experimental groups and control group [($F_{3,176}$) =1.319, $p>0.05$]. This is because the F-test at $p<0.05$ shows that significant difference does not exist among the three groups. However, in order to determine the magnitude and direction of the contribution of the trainings on DBP, MCA as presented below was applied.

Table 5: Multiple Classification Analysis showing the direction of the significant interaction effects, Grand mean = 61.87

Variable category	N	Unadjusted Deviation	Eta	Adjusted for Independents + Covariates Deviation	Beta
IE	60	-1.20	.12	-1.18	.12
CE	60	.23		.20	
Control	60	.97		.98	

Multiple R Square					.017
Multiple R					.132

The MCA in table 5 revealed a pattern similar to ANCOVA in table 4. From table 5, experimental group of IE has an adjusted mean score value of 60.67 (61.87-1.18) mmHg, experimental group of CE has the adjusted mean score value of 62.10 (61.87+0.20) mmHg and control group has the adjusted mean score value of 62.83 (61.87+0.98) mmHg. The result indicated that IE was the most effective, after that was CE and control was the least effective.

Vol: 3:3
DOI: 10.3823/508

Table 6: Analysis of covariance to determine the effect of CE and IE on Heart Rate of the Participants

Source of Variation	Sum of Squares	df	Mean Squares	F	Sig. of F	Remark
Covariates	12.274	1	12.274	10.260	.000	Sig.
Main Effects of Treatment Groups	354.698	2	177.349	148.243	.000	
Explained	366.972	3	122.324	102.249	.000	
Residual	210.555	176	1.196			
Total	577.528	179	3.226			

In checking for significant difference, table 6 showed that there was significant difference improvement in the heart rate among the primary school pupils in Ibadan exposed to each of the experimental groups and control group [$(F_{3,176})$ =148.243, p<0.05]. This indicates that there were significant differences in the effect of the trainings on heart rate of the pupils. This is because the F-test at p<0.05 shows a significant difference exist among the three groups. In order to determine the magnitude and direction of the differences as well as the contribution of the trainings on heart rate, MCA as presented below was applied.

Table 7: Multiple Classification Analysis showing the direction of the significant interaction effects, Grand mean = 81.86

Variable category	N	Unadjusted Deviation	Eta	Adjusted for Independents + Covariates Deviation	Beta
IE	60	-.49	.30	-0.49	.31
CE	60	-4.61		-4.81	
Control	60	5.11		5.29	
Multiple R Square					.103
Multiple R					.321

The MCA in table 7 revealed a pattern similar to ANCOVA in table 6. From table 7, experimental group of IE has an adjusted mean score value of 81.37 (81.86-0.49) bpm, experimental group of CE has the adjusted mean score value of 77.25 (81.86-4.81) bpm and control group has the adjusted mean score value of 86.97 (81.86+5.29) bpm. The result indicated that IE was the most effective, after that was CE and control was the least effective. Detailed explanations were shown in the next scheffé post hoc table.

Table 8: Scheffe Post hoc Analysis for Heart Rate

Vol: 3:3
DOI: 10.3823/508

Variable	Treatment Groups	Treatment Groups	Mean Difference	Sig.
Heart Rate	IE	CE	-4.11667	.208
		Control	-5.60000	.056
	CE	IE	-4.11667	.208
		Control	-9.71667*	.000
	Control	IE	5.60000	.056
		CE	9.71667*	.000

*=The mean significant is at the 0.05 level. The significant difference in heart rate as indicated by scheffe in table 8 was between control and CE ($P<0.05$).

Discussions

The study showed that CE and IE trainings have positive effects on systolic and diastolic blood pressure as well as heart rate of pupils in primary school pupils in Ibadan, Nigeria. These findings support the earlier observations of Wisloff et al. (2007); Tjonna et al, (2008); and Hwang, Wu and Chou, (2011). Research shows that if children follow a 3-5 times a week routine of at least 20 minutes continuous activity for 12 weeks, then improvements in VO_2max of 7-26% are possible. On average, though, and the results of some of the better controlled experiments support this, a child can expect a 10% improvement in VO_2max after following an 'adult-like' IE training programme. The consensus from the research is that children can improve their aerobic fitness but not to the same degree as adults, when following a similar training programme. Effects of training on systolic blood pressure and heart rate are significantly evidence in the interval training group than the continuous group which corroborates the submission of Gibala and McGee (2008) that interval training stimulates physiological functional capability comparable with moderate-intensity continuous training.

Meta-analysis of the finding indicates that systolic blood pressure reduced in the training regimes, though better in the IE than CE, which implies improvements in the cardiovascular health of the participants. These support earlier notion of Lewington, Clarke, Qizilbash, Peto and Collins (2002) that blood pressure lowering would in the long term be associated with about 40% and 30% decreases in the risks of premature deaths due to stroke and ischemic heart disease. It has been maintained that anaerobic short-burst interval training is more beneficial for pre-pubertal children, as they can benefit greatly from this type of training via improvements in anaerobic glycolysis, which is limited at a young age (Helgerud, Hoydal, Wang, Karlsen, Berg, Bjerkaas, Simonsen, Helgesen, Hjorth, Bach and Hoff (2007). The most effective kind of endurance training for children will be high-intensity continuous or interval training, where heart rates reach Anaerobic Thresholds (AT) and above (Tjønna et al., 2008). The findings support the results of Lawal and Venkatseswarul (2010) that both intermittent / interval and continuous groups had a significant decline in blood pressure and heart rate of children and that the intermittent group had a greater decline in blood pressure and heart rate of both male and female children than their continuous training group counterparts. Abass and Moses (2013) reported that ideal levels of structured exercise regime should be administered to children in connection with

Vol: 3:3
DOI: 10.3823/508

the expected cardiovascular benefit from greater oxygen consumption based on the view approved by Stabouli, Papakatsika, Kotsis (2011).

Conclusion

The use of structured interval training exercise can serve as an effective alternate technique to the usual traditional continuous training in primary schools to induce superior positive changes in a range of physiological components of blood pressure and heart rate as well as performance and health-related markers in both apparently healthy and ailing children. Furthermore, teachers and parents alike must be encouraging children to decrease time spent in sedentary activities of playing video games, watching television to less than two hours per day and eating processed fatty foods. Development in advanced level of motor performance will also be enhanced through interval training exercise.

Vol: 3:3
DOI: 10.3823/508

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Vol: 3:3
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