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EFFECTS OF AN 8-WEEK INTERMITTENT AEROBIC EXERCISE ON THE ELECTROCARDIOGRAM AND PHYSIOLOGICAL PARAMETERS OF INSTITUTIONAL SECURITY PERSONNEL IN NIGERIA

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Abstract:
This study determined the effects of an 8-week intermittent aerobic exercise training on the resting electrocardiogram and physiological parameters of institutional security personnel in Obafemi Awolowo University Teaching Hospitals Complex (OAUTHC). The study adopted a pretest-posttest-control group experimental design. The population for the study were male security personnel of OAUTHC, Ile-Ife. Forty middle-aged volunteers who met the inclusion criteria were randomly assigned to either of Intermittent Training Group, ITG (n = 20) or control (n = 20). A structured exercise training programme, Intermittent Exercise Training Programme was used to train the ITG for 8 weeks. Resting ECG was recorded pre and post-intervention with a 12-lead Electrocardiograph, weight and height were measured with an electronic BMI scale. Blood pressure was recorded before and after exercise sessions. Participants in ITG performed the 12-minutes run/walk test before and after the 8 weeks intervention. Borg's rating of perceived exertion scale was used to gauge exercise intensity and a structured data sheet was used for recording data. Paired- sample t- Test statistics was used to analyse data. The results showed that intermittent aerobic exercise training neither produced significant effect on the resting ECG parameters in terms of intervals; RR- interval ($t = -0.79$; $p > 0.05$), P- wave duration ($t = -0.64$; $p > 0.05$), PR- interval ($t = -0.08$; $p > 0.05$), QRS- Complex ($t = -0.99$; $p > 0.05$) and QTC ($t = -1.20$; $p > 0.05$) nor axes P-Axis ($t = -0.06$; $p > 0.05$), QRS- Axis ($t = 0.78$; $p > 0.05$) and T- Axis ($t = 0.60$; $p > 0.05$). It however affected participants' heart rate ($t = 4.41$; $p < 0.05$) and VO2 max ($t = -11.25$; $p < 0.05$). The study concluded that intermittent aerobic exercise training produced no

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significant effect on the resting ECG parameters but significantly reduced heart rate and increased VO2 max.

Keywords: intermittent exercise, electrocardiogram, physiological parameters, security personnel

1. Introduction

The increase in the number of sudden deaths and stroke occurring at the workplace or after a brief visit to the hospital confirms that cardiovascular diseases (CVDs) are on the increase. Majority of the global mortality and disease burden from CVD is borne by low and middle-income countries. Ogedengbe, Kolawole, Alfa, Onaadepo, and Adelaiye (2012) corroborated this assertion when they said that cardiovascular diseases are becoming more frequent occurrence in the developing countries. The World Health Organization (WHO, 2012) reported that nearly one billion people have high blood pressure (hypertension) globally and two third of these are in developing countries. Several studies have suggested that cardiovascular disease is no longer restricted to any particular population, but has been found to be very rampant among diverse populations such as the athletes, non-athletes, military, the police, paramilitary, aged and even the youth. Early diagnosis is key in the treatment and management of cardiovascular diseases, the World Heart Federation (2015) therefore advised that individuals should go for periodic electrocardiographic evaluation and blood pressure check. One of the useful diagnostic and prognostic tools for early detection of cardiovascular diseases as well as the ability of the heart to cope under stressful conditions is electrocardiogram.

Electrocardiogram (ECG or EKG) is a graphic tracing of the electric current generated by the heart muscle during a heartbeat (Sajjan, 2014). The Electrocardiogram is recorded by applying electrodes at 10 different locations of the body, one on each of the four limbs and six at different locations on the anterior surface of the chest to record the electrical activity of the heart (Hampton, 2013). The normal electrocardiogram shows typical upward and downward deflections which correspond with the alternate contraction of the atria (the two upper chambers) and of the ventricles (the two lower chambers) of the heart (Hampton, 2013). According to the American College of Sports Medicine (ACSM, 2014) the electrocardiogram is of greatest use in diagnosing cardiac arrhythmias, acute and prior myocardial infarctions (heart attacks), pericardial disease, and cardiac enlargement.

Security officers are engaged in physical challenges on a regular basis. They are therefore expected to possess a certain level of fitness necessary for doing routine daily tasks. Standing, walking and pacing for long periods are part of the daily routines of security guards. Coping with emerging security challenges such as, cultism, kidnapping and terrorism requires above sedentary levels of strength and endurance. The sophistication of the modern day criminals have also imposed greater fitness demands

on security personnel. Studies have shown that good physical conditioning play an important role in health maintenance. Regular physical activity decreases the occurrence of hypertension, coronary artery disease, diabetes mellitus, stroke, osteoporosis and depression (Senchina and Kohut, 2007). The correlations between physical activity, good work capacity and healthy lifestyle have long been established in the work of Aldana, Sutton, Jacobson and Quirk (1996).

Aerobic exercise sometimes called cardio exercise includes physical activities of low to high intensity that depends primarily on the aerobic energy system. It consist of physical activities that are longer in duration but moderate in intensity which are performed in the presence of oxygen. The American Heart Association (2013) and the American College of Sports Medicine (2014) recommends 30 minutes of moderately intense aerobic exercise for five days a week or 20 minutes of high intensity aerobic exercise three days a week to maintain good health and reduce risk of chronic disease. Low level cardio-respiratory function is a strong and independent marker of cardiovascular disease and total mortality. The benefits of good aerobic capacity are associated with low blood pressure, lowered resting heart rate and lowered heart rate during sub-maximal exercise (Ritvanen, Louhevaara, Helin, Halonen and Hanninen, 2007). Aerobically fit individuals may require less sympathetic activation to perform the same absolute physical workload than unfit individuals. Accurate measurement of fitness parameters in a population may help in determining health status and help prognosticate later risks to health.

2. Methods

2.1 Participants

The study adopted a pre-test-posttest- control group experimental design. The study population was the male security personnel of Obafemi Awolowo University Teaching Hospitals Complex (OAUTHC). Forty middle-aged (35-50 yrs.) male security personnel who met the inclusion criteria (no history of cardiovascular diseases) were randomly assigned to Intermittent Training Group, ITG (n = 20) and Control (n = 20).

2.2 Data Collection

The study was cleared by the Obafemi Awolowo University Teaching Hospital's Research Ethics Committee. Participants were duly acquainted of the procedures for the research through the subject information sheet and they signed an informed consent form. An exercise training programme tagged "Intermittent Aerobic Exercise Training Programme" was used to train participants in the intervention group for 8 weeks. A 12-lead resting Electrocardiogram machine (SCHILLER Cardiovit AT-2 plus.) was used to record resting ECG of participants before and after the 8-week exercise intervention. Blood pressure of participants was measured with an aneroid sphygmomanometer (ADC 450D). A Stopwatch (Philip Fitness PC808) was used to record participant's performance in the Cooper's 12 minute run/walk test and during other exercise

regimes. A digital BMI stadiometer (Seca 220) was used to measure height and weight of participants. The Borg's Rating of Perceived Exertion scale was used for gauging the intensity of exercise and a structured data sheet: ECG and Physiological Parameters Profoma was used to record data. Resting ECG, blood pressure and Heart rate of participants were recorded at the beginning of the training programme as baseline (pre-test) values. The cardio- respiratory endurance (VO_2max) of participants in the intermittent exercise group was estimated at week one and at week eight of the training programme, using the Cooper 12 min Run/Walk test. Participant in the intervention group participated in a 45 - 60 minutes structured training programme, three times per week, for eight weeks. Pulse rate and Blood pressure of participants were measured before and after every exercise session.

2.3 Recording of resting electrocardiogram

A 6-channel, 12-lead resting Electrocardiograph (SCHILLER Cardiovit AT-2 plus.) in the Human Performance Laboratory of Department of Physical and Health Education, Obafemi Awolowo University was used to record ECG. The resting ECG parameters of interest to the current study were the RR- interval, P-wave duration, PR-interval, QRS-interval, QT-interval, corrected QT (QTc), P-Axis, QRS-Axis and the T-Axis. Participants in the intermittent exercise training group and the control had their resting ECG recorded as described in the protocol of the American College of Sports Medicine (ACSM, 2014). Bio-data; age, sex, height and weight were recorded before the test. Blood pressure was measured while sitting with an aneroid sphygmomanometer. Four limb electrodes and six chest (precordial) electrodes were fixed on participant's body as indicated in the ACSM's guideline. The four limb electrodes were attached to the four limbs in the following order; RA affixed to the anterior surface of the right arm, LA on the anterior surface of the left arm, LL on the anterior aspect of the left leg and RL was placed on the anterior aspect of the right leg. The six chest electrodes were affixed to the chest as follows; V_1 on the 4^{th} intercostal space directly next to the right margin of the sternum, V_2 placed on the 4^{th} intercostal space directly next to the left margin of the sternum, V_3 was placed directly between V_2 and V_4, V_4 was placed on the 5^{th} intercostal space on the left midclavicular line, V_5 placed horizontal to V_4, anterior on the left anterior axillary line and V_6 placed horizontal to V_4 and V_5 on the left midaxillary line.

2.4 Test of Maximal Oxygen Uptake (VO_2 max)

The Cooper 12- Minute run/ walk was used to estimate VO_2max of participants in the intermittent exercise training group. Participants run/walk continuously for 12-minutes. They were encouraged to pace rather than walk or run at full speed and to maintain the pacing till the end of the test period. At the completion of the test, they walked slowly for 3 to 5 minutes to prevent venous pooling. The total distance covered in 12 min was recorded for individual participant. The Borg's rating of perceived exertion was administered to participants in the intervention groups to gauge individual participant's rating of the intensity of the test. The total distance covered was recorded

to the nearest meter. VO_2 max was estimated using Cooper (1968) formula; (VO_2 max = 0.0225 x meters covered – 11.3).

2.5 The 8- weeks Intermittent Aerobic Training Programme

The target Heart rate zone was used to determine exercise intensity for the intermittent group. Participants stretched and warmed up for 8-10 minutes before performing a range of long intermittent exercises at 85- 90% HR for 3 days in a week interspersed with a light to moderate pace walking. An exercise set comprised jogging (4 mins.), stair climbing (4 mins.), rope-skipping (4 mins.) and sprinting between 5 cones positioned 5 meters apart (4 mins). Activities were performed with rest intervals of 40-50 seconds for the first three weeks and the interval was reduced by 5 seconds every week from week four through week eight. The work to rest ratio was also increased from the fourth week by introducing activities such as light jogging and walking during the rest phase till the end of the programme. The Borg's scale of perceived exertion rating was administered to participants in the intervention groups at the end of the 1st, 4th and 7th weeks to gauge individual participant's perceived rating of the intensity of the exercise sessions.

3. Results and Discussion

Table 1: Demographic Characteristics of Participants

Variables	ITG (n = 20) ($\bar{x}$ ± SD)	CON (n = 20) ($\bar{x}$ ± SD)	Total (n = 40) ($\bar{x}$ ± SD)
Age (yrs.)	41.3 ± 5.28	41.0 ± 4.64	41.1 ± 5.68
Height (cm)	170.1 ± 8.96	168.2 ± 6.74	169.0 ± 7.12
Weight (kg)	67.7 ± 7.36	67.3 ± 6.38	67.5 ± 7.08

ITG = Intermittent Training Group; CON = Control

The mean and standard deviation of age, height and weight of participants in the study were 41.1 ± 5.68yrs, 169.0 ± 7.12cm and 67.5 ± 7.08kg respectively. Table 2 presents summary of pre-test and post-test resting ECG parameters of participants in the intermittent exercise training group and control.

Table 2: Summary of Participants' Pre-test and Post-test Resting ECG Parameters

Variables		ITG ($\bar{x}$ ± SD)	CON ($\bar{x}$ ± SD)
RR- Intv. (ms)	**Pre-Test**	1035.1 ± 125.41	1026.15 ± 119.78
	Post Test	1046.7 ± 150.32	1005.1 ± 111.69
P- Wave D. (ms)	**Pre-Test**	107.2 ± 19.15	100.4 ± 8.13
	Post Test	108.1 ± 19.50	95.1 ± 12.17
PR- Intv. (ms)	**Pre-Test**	158.7 ± 39.03	150.3 ± 36.08
	Post Test	159.1 ± 43.51	150.3 ± 38.54
ORS- Intv. (ms)	**Pre-Test**	117.6 ± 56.24	122.5 ± 59.12
	Post Test	126.1 ± 62.30	131.7 ± 64.84
QT- Intv. (ms)	**Pre-Test**	407.5 ± 50.49	385.4 ± 51.23
	Post Test	413.5 ± 58.18	388.9 ± 64.20
QTC (ms)	**Pre-Test**	420.7 ± 46.64	424.9 ± 51.02
	Post Test	425.5 ± 48.02	427.7 ± 55.80
P-Axis (°)	**Pre-Test**	42.7 ± 17.70	42.8 ± 17.62
	Post Test	42.8 ± 18.60	41.0 ± 21.68
QRS-Axis (°)	**Pre-Test**	29.5 ± 46.71	33.2 ± 47.76
	Post Test	23.2 ± 60.03	27.9 ± 63.69
T-Axis (°)	**Pre-Test**	28.3 ± 47.67	24.0 ± 47.04
	Post Test	23.5 ± 62.29	16.1 ± 60.51

ITG = Intermittent Training Group; CON = Control

Table 3: t-Test Summary of Pretest and Post-Test resting ECG parameters of Participants in the Intermittent Training Group

Variables		ITG ($\bar{x}$ ± SD)	df	t	p
RR- Intv. (ms)	**Pre**	1035.1 ± 125.41	19	-0.79	0.437
	Post	1046.7 ± 150.32	19		
P- Wave D. (ms)	**Pre**	107.2 ± 19.15	19	-0.64	0.533
	Post	108.1 ± 19.50	19		
PR- Intv. (ms)	**Pre**	158.7 ± 39.03	19	-0.08	0.936
	Post	159.1 ± 43.51	19		
ORS- Intv. (ms)	**Pre**	117.6 ± 56.24	19	-0.99	0.331
	Post	126.1 ± 62.30	19		
QT- Intv. (ms)	**Pre**	407.5 ± 50.49	19	-1.20	0.245
	Post	413.5 ± 58.18	19		
QTC (ms)	**Pre**	420.7 ± 46.64	19	-1.29	0.214
	Post	425.5 ± 48.02	19		
P-Axis (°)	**Pre**	42.7 ± 17.70	19	-0.06	0.953
	Post	42.8 ± 18.60	19		
QRS-Axis (°)	**Pre**	29.5 ± 46.71	19	0.78	0.443
	Post	23.2 ± 60.03	19		
T-Axis (°)	**Pre**	28.3 ± 47.67	19	0.60	0.552
	Post	23.5 ± 62.29	19		

* Sig = $p < 0.05$

The Paired sample t- Test showed that there was no significant difference in all the resting ECG parameters among participants of the intermittent exercise training group. Significant difference was not found in the ECG intervals at Pre- test and Post Test levels, RR- interval ($t = -0.79$; $p > 0.05$), P- wave duration ($t = -0.64$; $p > 0.05$), PR- interval ($t = -0.08$; $p > 0.05$), QRS- Complex ($t = -0.99$; $p > 0.05$) and QTC ($t = -1.20$; $p > 0.05$). No significant difference was also found in axes of the resting ECG of the participants in the ITG. The P- Axis ($t = -0.06$; $p > 0.05$), QRS- Axis ($t = 0.78$; $p > 0.05$) and T- Axis ($t = 0.60$; $p > 0.05$) all showed that there were no significant differences between pre- test and post-test values. This finding suggested that intermittent exercise may have no significant effect on resting ECG parameters in terms of rate, interval and axes.

The finding of the current study did not agree with the finding of Hemida, Rahmy, Mohamed and Kaddah (2016) who reported that intermittent aerobic exercise training had positive effect on glucose level, Heart rate, blood pressure, RR- interval and QT- interval in a cohort of Type 1 Diabetic patients with autonomic neuropathy. The participants in the current study were apparently healthy with no history of diabetes. When the ECG strips were physically examined for ST segment morphology, participants' ST segment appeared to be normally configured and did not show significant difference at pre-test and post-test. Table 4 presents the summary of participants' physiological parameters at pre-test and post-test.

Table 4: Participants' Heart rate, Systolic Blood Pressure, Diastolic Blood Pressure and VO_2 max in the intermittent exercise training group and Control

Variables		**ITG** ($\bar{x}$ ± SD)	**CON** ($\bar{x}$ ± SD)
Heart rate (bpm):	**Pre**	64.15 ± 9.18	64.85 ± 7.60
	Post	58.50 ± 9.45	66.10 ± 6.65
Systolic BP (mmHg) :	**Pre**	119.50 ± 8.26	123.00 ± 5.71
	Post	119.00 ± 3.08	121.00 ± 7.18
Diastolic BP (mmHg):	**Pre**	78.50 ± 6.71	82.00 ± 7.68
	Post	78.25 ± 6.34	81.00 ± 7.18
VO_2 max ($ml.kg^{-1}min^{-1}$):	**Pre**	39.29 ± 6.68	36.52 ± 3.08
	Post	43.05 ± 7.11	37.16 ± 3.20

The means of resting Heart rate, systolic blood pressure, diastolic blood pressure and VO_2 max for the ITG group were 64.15 ± 9.18 /min, 119.50 ± 8.26 mmHg, 78.50 ± 6.71 mmHg and 39.29 ± 6.68 ml. kg^{-1} min^{-1} respectively at pre- test and 58.50 ± 9.45 /min, 119.00 ± 3.08 mmHg, 78.25 ± 6.34 mmHg and 43.05 ± 7.11 ml. kg^{-1} min^{-1} respectively at the post-test. Result of t-Test statistics comparing pretest and post test data on physiological parameters in the intermittent exercise training group is presented in Table 5.

Table 5: t-Test Summary of Pretest and Post-Test Physiological Variables of Participants in the Intermittent Training Group

Variables		ITG ($\bar{x}$ ± SD)	df	t	p
Heart rate: (bpm)	**Pre**	64.15 ± 9.18	19	4.41	0.00*
	Post	58.50 ± 9.45	19		
Systolic BP: (mmHg)	**Pre**	119.50 ± 8.26	19	0.33	0.75
	Post	119.00 ± 3.08	19		
Diastolic BP: (mmHg)	**Pre**	78.50 ± 6.71	19	0.33	0.75
	Post	78.25 ± 6.34	19		
VO_2 max: ($ml.kg^{-1}min^{-1}$)	**Pre**	39.29 ± 6.68	19	-11.25	0.00*
	Post	43.05 ± 7.11	19		

* Sig = $p < 0.05$

The result of the t- Test statistics showed that there was significant effect of intermittent exercise training on the Heart rate of participants ($t = 4.41$; $p < 0.05$). This finding is similar to that of Hottenrott, Ludyga and Schulze (2012) who found that resting Heart rate reduced significantly in both intermittent aerobic exercise group and continuous aerobic exercise groups post exercise intervention. The authors attributed the improvement in Heart rate to increased vagal tone, improved efficiency of peripheral muscles and higher stroke volume.

Significant difference was also found in the VO_2 max ($t = -11.25$; $p < 0.05$) of participants in the intermittent exercise training group after the 8- week training programme. The t- Test statistics however found no significant effect of intermittent exercise training on blood pressure of participants. No significant difference was found between pre- test and post-test Systolic blood pressure ($t = 0.33$; $p > 0.05$) and Diastolic blood pressure ($t = 0.33$; $p > 0.05$). The current finding concerning intermittent exercise training and blood pressure differed from the one reported by Gunjal, Shinde, Kazi and Khatri (2013) who reported that a 12-week aerobic intermittent exercise reduced systolic blood pressure and diastolic blood pressure by 12mmhg and 8mmhg respectively among a cohort of hypertensive. The disparity in the result of the current study and that of Gunjal et al. (2013) could be due to the fact that participants in the current study were apparently healthy with no history of hypertension. Also, the current study was for duration of 8-weeks compared to the 12-weeks of Gunjal and colleagues.

This study found that intermittent exercise training significantly affected the maximum oxygen uptake of participants. This finding supports the submission of Smart and Steele (2012) who reported a significant increase (21%) in VO_2 max of patients with congestive heart failure after a 16-week intermittent exercise training programme. Sloth, Sloth, Overgaard and Dalgas (2013) reported that intermittent training may improve different muscle metabolic changes in substrate utilization corresponding to adaptations typically associated with high volume endurance training relying heavily on aerobic energy turnover. The authors submitted that specific oxidative adaptations in type II fibers could be partly responsible for the intermittent training-induced increases in VO_2 max.

Foster, Meyer, Georgeakopoulos, Ellestad, Fitzgerald, Tilman, Weinstein, Young and Roskamm (1999) compared the cardiovascular responses of a group of adults in two separate aerobic exercise trials involving continuous exercise and intermittent exercise. They reported that no significant difference was found for any of the variables. Scribbans, Vecsey, Hankinson, Foster and Gurd (2016) in a meta-analysis of twenty eight studies involving healthy volunteers reported that training at any intensity above 60% of VO_2 max is likely to improve maximal oxygen uptake in healthy adults.

The study concluded that intermittent aerobic exercise training produced no significant effect on the resting ECG parameters but significantly reduced heart rate and increased VO_2 max.

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