ISSN 1996-3351

Asian Journal of Biological Sciences

Knowledgia
SCIENTIFIC
A Place to Publish Outstanding Research

http://knowledgiascientific.com

OPEN ACCESS Asian Journal of Biological Sciences

ISSN 1996-3351
DOI: 10.3923/ajbs.2019.342.348

Research Article

Effects of an 8 Week Continuous Exercise Training on the Electrocardiogram and Physiological Parameters of Institutional Security Personnel in Nigeria

O.O. Akinbiola, S.A. Adeniran and O. Ogunlade

Department of Kinesiology, Health Education and Recreation, Obafemi Awolowo University, Ile-Ife, Nigeria

Abstract

Background and Objective: This study determined the effects of continuous aerobic exercise training on the resting electrocardiogram and physiological parameters of security personnel in Obafemi Awolowo University Teaching Hospitals Complex (OAUTHC). The study adopted a pretest-posttest-control group experimental design. The population were male security personnel of OAUTHC, Ile-Ife and Obafemi Awolowo University (OAU), Ile-Ife. **Materials and Methods:** Twenty middle-aged volunteers from the OAUTHC Security Unit were purposively engaged as Continuous Training Group (n = 20). Twenty age-matched controls were purposively selected from the Obafemi Awolowo University Security Unit. A structured exercise training programme, Continuous Exercise Training Programme was used to train participants in the training group for 8 weeks. Resting electrocardiogram was recorded pre and post-intervention with a 12-lead electrocardiograph (SCHILLER-Cardiovit AT2-plus). Blood pressure was recorded pre and post exercise using aneroid sphygmomanometer. Stopwatch was used for timing performance in the 12 min run/walk test and an electronic BMI scale (Seca-220) was used for measuring height and weight. Body circumferences were measured with an inelastic tape and Borg's rating of perceived exertion scale was used to gauge exercise intensity. Data was recorded in a structured data sheet. Paired-sample t-test statistics was used to analyse data. **Results:** The results showed that continuous aerobic exercise had significant effect on three resting ECG parameters, RR-interval ($t = 4.759$, $p<0.05$), p-wave duration ($t = 6.757$, $p<0.05$) and QT-interval ($t = 4.474$, $p<0.05$) and three physiological parameters: heart rate ($t = 9.443$, $p<0.05$), systolic blood pressure ($t = 6.751$, $p<0.05$) and VO_2 max ($t = 6.881$, $p<0.05$). **Conclusion:** The study concluded that continuous aerobic exercises positively affect resting electrocardiogram and physiological parameters of security personnel.

Key words: Continuous exercise, electrocardiogram, physiological parameters, security personnel

Received: December 28, 2018 Accepted: February 01, 2019 Published: March 15, 2019

Citation: O.O. Akinbiola, S.A. Adeniran and O. Ogunlade, 2019. Effects of an 8 week continuous exercise training on the electrocardiogram and physiological parameters of institutional security personnel in Nigeria. Asian J. Biol. Sci., 12: 342-348.

Corresponding Author: O.O. Akinbiola, Department of Kinesiology, Health Education and Recreation, Obafemi Awolowo University, Ile-Ife, Nigeria

Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

The continuing epidemic of cardiovascular diseases (CVD) globally calls for renewed and intensive public health action to stem the tide. Cases of individuals collapsing at work or during play have become very common and fatalities or deaths arising from such incidence have been linked to cardiovascular diseases[1]. Several studies have indicated that the scourge of cardiovascular disease is no longer restricted to any particular population such as the aged any longer, but the prevalence is now rampant among different populations such as the athletes, non-athletes, military, the police, paramilitary, aged and even the youth.

Security personnel are typically expected to possess a certain level of fitness necessary for doing routine daily tasks. Standing, walking and pacing for long periods are part of their daily routines. It would seem self-evident that an occupation such as security guard would demand that such personnel stay fit as a part of the job requirements. Increasing security challenges and the sophistication of the modern day criminals also impose greater fitness demands on security personnel. Security guards may chase fleeing suspects, climb over fences and onto roof tops, subdue resisting arrestees and lift heavy objects such as recovered stolen property. These daily job engagements require above sedentary levels of strength and endurance.

Studies have shown that good physical conditioning plays an important role in health maintenance. Regular physical activity decreases the occurrence of hypertension, coronary artery disease, diabetes mellitus, stroke, osteoporosis and depression[2]. The correlations between physical activity, good work capacity and healthy lifestyle have long been established in the work of Aldana *et al*.[3]. Aerobic exercise sometimes called cardio exercise requires pumping of oxygenated blood by the heart to working muscles. It includes physical activities of low to high intensity that depends primarily on the aerobic energy system. It encompasses physical activities that are longer in duration but moderate in intensity, performed in the presence of oxygen. American Heart Association[4] and American College of Sports Medicine[1] recommends 30 min of moderately intense aerobic exercise for 5 days a week or 20 min of high intensity aerobic exercise 3 days a week to maintain good health and reduce risk of chronic disease. The benefits of good aerobic capacity are associated with low blood pressure, lowered heart rate at rest and lowered heart rate during sub-maximal exercise[5]. Aerobically fit individuals thus require less sympathetic activation to perform the same absolute physical workload than unfit individuals. Accurate measurement of fitness parameters in a population could play an important role in determining their health status and help prognosticate later risks to their health. Low level cardio-respiratory function is a strong and independent marker of cardiovascular disease and total mortality.

Electrocardiogram (ECG or EKG) is a graphic tracing of the electric current generated by the heart muscle during a heartbeat[6]. 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[7]. The normal electrocardiogram shows typical upward and downward deflections which correspond with the alternate contraction of the atria (two upper chambers) and of the ventricles (two lower chambers) of the heart[7]. According to ACSM[1], the electrocardiogram is of greatest use in diagnosing cardiac arrhythmias, acute and prior myocardial infarction (heart attacks), pericardial disease and cardiac enlargement.

MATERIALS AND METHODS

Participants: The study adopted a pre-test-posttest-control group experimental design. Twenty male security personnel met the inclusion criteria (middle-aged between ages 35-50 years and no history of cardiovascular diseases) out of 32 that volunteered for the study. Control (n = 20) with similar characteristics to the training group were purposively selected from the Obafemi Awolowo University Security Unit.

Data collection: Ethical clearance was obtained from the Obafemi Awolowo University Teaching Hospital's Research Ethics Committee for the study. Participants were briefed on the procedures, for the research through the subject information sheet and they signed informed consent form. Eight instruments were used for collecting data in the study. A structured exercise training programme, continuous exercise training programme was used to train participants in the experimental 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 training programmes. 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 min run/walk test and during other exercise regimes. A digital BMI stadiometer (Seca 220) was used to measure height and weight of participants. A structured data sheet: ECG and Physiological Parameters Proforma was used to record data. The Borg's rating of perceived exertion scale was used for gauging the intensity of exercise. 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_2 max) of participants in the training group was estimated at week one and at 8 eight of the training programme, using the Cooper 12 min Run/Walk test. Participant in the training group participated in a 45-60 min structured training programme, three times per week, for 8 weeks. Pulse rate and blood pressure of participants were measured before and after every exercise session.

Resting electrocardiogram: A 12-lead resting electrocardiogram machine (SCHILLER Cardiovit AT-2 plus.) in the Human Performance Laboratory of Department of Physical and Health Education 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 continuous exercise training group and the control had their resting ECG recorded as described in the protocol of the American College of Sports Medicine[1]. 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 4th intercostal space directly next to the right margin of the sternum, V_2 placed on the 4th 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 5th 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.

Test of maximal oxygen uptake (VO_2 max): The Cooper 12 min run/walk was used to estimate VO_2 max of participants in the continuous exercise training group. Participants run/walk continuously for 12 min. 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 3-5 min 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. The VO_2 max was estimated using Cooper[8] formula:

$$VO_2 \text{ max} = 0.0225 \times \text{meters covered} - 11.3$$

Eight weeks continuous aerobic training programme: The target heart rate zone was used to determine exercise intensity for the training programme. Participants' target Heart rate zone was predicted by subtracting the mean age of participants in the training group from 220 (HRmax = 220-age). The continuous aerobic training group did stretching and warm up exercises for 8 min and performed a medium paced jogging (5-8 km h^{-1}) lasting 30 min (60-65% HR) per session at 3 alternate days. There was a cool down session of 5-6 min after every exercise regimen. The duration of the jogging session was maintained between 40-45 min per session from the second week to the 3rd week after which the duration was increased by 5 min every week till the end of the 8 week of the programme. The Borg's scale of perceived exertion rating was administered to participants in the continuous exercise training group to gauge their rating of the intensity of the exercise sessions.

RESULTS AND DISCUSSION

The mean and standard deviation of age, height and weight of participants in the study were 41.1$\pm$5.68 years, 168.5$\pm$7.12 cm and 67.5$\pm$7.08 kg, respectively in Table 1. Table 2 presented summary of pre-test and post-test resting ECG parameters of participants in the continuous exercise training group and control.

Result of the student t-test presented in Table 3 indicated that there was significant difference between the pre-test and post-test of the RR-interval. The mean of participants' RR-interval at post-test as shown in Table 3 was significantly higher than what it was at the pre-test level ($t = -3.06$, $p<0.05$). The significant increase in the RR-interval at the post-test level showed that the 8 week continuous exercise training programme significantly affected the RR-interval. The finding of the current study with respect to continuous exercise training and the RR-interval is supported by Sone *et al.*[9], who reported that the RR-interval varies with the cycles of respiration. The authors suggested that the contribution of the parasympathetic nervous system to the heart rate regulation varies according to the level of HR and to the direction in the change in HR. The RR-interval is described as the intervals between two consecutive R peaks[10].

Table 1: Demographic characteristics of participants

Variables	CTG (n = 20) (x̄±SD)	CON (n = 20) (x̄±SD)	Total (n = 40) (x̄±SD)
Age (years)	40.9±7.12	41.0±4.64	41.0±5.68
Height (cm)	168.7±5.65	168.2±6.74	168.5±7.12
Weight (kg)	67.6±7.50	67.3±6.38	67.5±7.08

CTG: Continuous training group, CON: Control

Table 2: Summary of participants' pre-test and post-test resting ECG parameters

Variables	CTG (x̄±SD)	CON (x̄±SD)
RR-Intv. (msec)		
Pre	1071.9±217.50	1026.15±119.78
Post	1154.2±198.76	1005.10±111.69
P-Wave D. (msec)		
Pre	115.1±25.87	100.40±8.13
Post	120.7±30.44	95.10±12.17
PR-Intv. (msec)		
Pre	163.5±23.16	150.30±36.08
Post	166.6±23.06	150.30±38.54
ORS-Intv. (msec)		
Pre	106.9±44.49	122.50±59.12
Post	108.6±46.79	131.70±64.84
QT-Intv. (msec)		
Pre	397.1±44.63	385.40±51.23
Post	437.1±45.76	388.90±64.20
QTC (msec)		
Pre	404.7±36.01	424.90±51.02
Post	405.4±44.58	427.70±55.80
P-Axis (°)		
Pre	48.8±14.80	42.80±17.62
Post	46.5±17.39	41.00±21.68
QRS-Axis (°)		
Pre	48.9±25.91	33.20±47.76
Post	38.0±33.53	27.90±63.69
T-axis (°)		
Pre	33.7±16.96	24.00±47.04
Post	32.2±19.34	16.10±60.51

CTG: Continuous training group, CON: Control

The t-test statistic reported a significant difference between the pre-test and post test values of the P-wave duration (t = -2.16, p<0.05). The result showed that the duration of the P-wave increased significantly after the 8 week exercise intervention thus confirming that continuous exercise training significantly affects P-wave duration. This finding is consistent with the submission of Wilhelm *et al.*[11], who reported that lifetime training hours were associated with prolongation of signal-averaged P-wave duration and an increase in left atrial volume. The P-wave starts when the SA node fires and covers the transmission of the impulse through the three internodal pathways, the Bachmann bundle and the atrial myocytes themselves. Garcia[12] reported that the duration of the P-wave can vary between 0.08 and 0.11 sec in normal adults. The P-wave denoted atria depolarization, which is the conduction of an electrical impulse through the atria.

Table 3: T-test summary of pretest and post-test resting ECG parameters of participants in the continuous training group

Variables	CTG (x̄±SD)	df	t	p-value
RR-Intv (msec)				
Pre	1071.9±217.50	19	-3.06	0.006*
Post	1154.2±198.76	19		
P-Wave D. (msec)				
Pre	115.1±25.87	19	-2.16	0.044*
Post	120.7±30.44	19		
PR-Intv (msec)				
Pre	163.5±23.16	19	-1.33	0.199
Post	166.5±23.06	19		
ORS-Intv (msec)				
Pre	106.9±44.49	19	-0.88	0.393
Post	108.6±46.79	19		
QT-Intv (msec)				
Pre	397.1±44.63	19	-2.54	0.020*
Post	437.1±46.92	19		
QTC (msec)				
Pre	404.7±36.01	19	-0.18	0.861
Post	405.4±44.58	19		
P-axis (°)				
Pre	48.8±14.90	19	0.87	0.394
Post	46.5±17.39	19		
QRS-axis (°)				
Pre	46.9±25.91	19	1.35	0.195
Post	38.0±33.53	19		
T-axis (°)				
Pre	33.7±16.96	19	0.68	0.506
Post	32.2±19.39	19		

*Significance = p<0.05

The coordinated depolarization of the right and left atria marks the onset of atrial contraction. Podrid *et al.*[13] reported that the P-wave duration is 0.12 sec or less and the amplitude is usually 0.25 mV or less. The durations of participants' P-wave at the pre-test and post-test phases of the current study were within normal limits.

A significant difference was also found between the pre-test and post test values of the QT-interval (t = -2.54, p<0.05). Data in Table 3 showed that the QT-interval increased significantly after the 8 week continuous training programme (Pre-test = 397.1±44.63, Post Test = 437.1±45.76).

The QT-interval is measured from the beginning of the QRS-complex to the end of the T-wave and is best determined in lead II. According to Romano[14], the QT interval corresponds to electrical systole and it is the interval from the beginning of ventricular depolarization to the end of repolarization. Its duration is inversely proportional to the heart rate. Gertsch[15] opined that the QT-interval is time dependent and that the lower the rate, the longer the QT and vice versa. There was a general increase in the QT-interval at post-test with both exercise training groups but the increase was particularly significant with continuous exercise.

Table 4: Participants' heart rate, systolic blood pressure, diastolic blood pressure and VO_2 max in the continuous exercise training group

Variables	CTG (x̄±SD)	CON (x̄±SD)
Heart rate (bpm)		
Pre	62.30±9.65	64.85±7.60
Post	55.20±8.06	66.10±6.65
Systolic BP (bpm)		
Pre	115.75±11.84	123.00±5.71
Post	112.50±10.70	121.00±7.18
Diastolic BP (bpm)		
Pre	80.00±10.76	82.00±7.68
Post	79.00±6.61	81.00±7.18
VO_2 max (mL kg^{-1} min^{-1})		
Pre	38.10±5.72	36.52±3.08
Post	41.84±4.93	37.16±3.20

Table 5: T-test summary of pretest and post-test physiological variables of participants in the continuous training group

Variables	CTG (x̄±SD)	df	t-test	p-value
Heart rate (bpm)				
Pre	62.30±9.65	19	5.20	0.00*
Post	55.20±8.06	19		
Systolic BP (mmHg)				
Pre	115.75±11.84	19	3.63	0.02*
Post	112.50±10.70	19		
Diastolic BP (mmHg)				
Pre	80.00±10.76	19	0.61	0.55
Post	79.00±6.61	19		
VO_2 max (mL kg^{-1}min^{-1})				
Pre	38.10±5.72	19	-8.01	0.00*
Post	41.84±4.93	19		

*Significance = p<0.05

Nallamothu and Baman[16] submitted that a short or long QT interval may be due to an inherited arrhythmogenic condition and often may herald the risk of sudden death due to a lethal ventricular tachyarrhythmia. They further stressed that it can be benign and it may be due to the effect of drugs or an electrolyte disturbance. They also noted that the QT interval is Heart rate dependent and therefore, fluctuates with variations in HR cycles. As such, it is necessary to correct the QT for Heart rate. The corrected QT (QT_C) in the current study did not reflect any significant effect of exercise training.

The t-test statistics however did not show any significant difference in PR-interval (t = -1.33, p>0.05), QRS-duration (t = -0.88, p>0.05) and normalised QTc (t = -0.18, p>0.05). Concerning the Axes, t-test statistics revealed that there were no significant differences in P-Axis (t = 0.87, p>0.05), QRS-Axis (t = 1.35, p>0.05) and T-Axis (t = 0.68, p>0.05). These findings are in agreement with that of Mutikainen *et al.*[17] when they reported that the main electrocardiographic adaptations to long-term physical activity were connected to parameters related with lowering of the resting Heart rate. Drezner *et al.*[18] also reported that males, athletes and black/African individuals have higher QRS voltage, while obesity, older age and pulmonary disease may cause lower voltage.

Table 4 presented the summary of participants' physiological parameters at the pre-test and post-test stages.

The means of resting heart rate, systolic blood pressure, diastolic blood pressure and VO_2 max for the CTG group were 62.30±9.65/min, 115.75±11.84 mmHg, 80.00±10.76 mmHg and 38.10±5.72 mL kg^{-1} min^{-1}, respectively at pre-test and 55.20±8.06/min, 112.50±10.70 mmHg, 79.00±6.61 mmHg and 41.84±4.93 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 continuous exercise training group is presented in Table 5.

The t-test result in Table 5 revealed that there was a significant difference between the pre-test and post-test heart rates (t = 5.20, p<0.05). This showed that participants' heart rate was lowered significantly by the 8 week continuous exercise training programme. This finding agrees with the submission of Ali *et al.*[19], who reported that aerobic exercise training restores the Heart rate variability, increases the vagal tone and reduces the sympathetic tone in patients after myocardial infarction. The finding of the current study was also similar to that of Hottenrott *et al.*[20], who reported a significant lowering of the heart rate after a 12 week aerobic training programme, among a cohort of recreational endurance runners. The authors attributed the reduction in post intervention 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 of participants in the continuous exercise training group (t = -8.01, p<0.05) after the 8 week training programme. Participants' VO_2 max significantly increased from pre-test value of 38.10±5.72 to 41.84±4.93 mL kg^{-1} min^{-1} at post-test. Psilander[21] described the VO_2 max as the highest amount of oxygen that the body can utilize during exhaustive exercise. Losnegard and Hallen[22] reported a VO_2 max of 70-80 mL kg^{-1} min^{-1} among elite runners and cross-country skiers. Ekblom-Bak *et al.*[23] however, reported that the normal range of VO_2 max for sedentary individuals is 30-40 mL kg^{-1} min^{-1}. The finding of this study was similar to that of Smart and Steele[24], who reported a 13% increase in VO_2 max of congestive heart failure patients after 16 weeks of aerobic exercise training. The findings of the current study on continuous exercise training and VO_2 max was further corroborated by Hottenrott *et al.*[20], who reported significant improvement in peak oxygen uptake from 36.8±4.5 to 43.6±6.5 mL kg^{-1} min^{-1} after 12 weeks intervention among a group of recreational endurance runners.

The t-test statistics also found significant effect of continuous exercise training on systolic blood pressure of participants. Significant difference was found between pre-test and post-test systolic blood pressure ($t = 3.63$, $p<0.05$) but no significant difference was found between pre-test and post-test diastolic blood pressure ($t = 0.61$, $p>0.05$). Osbak *et al.*[25] had earlier reported that there was no significant difference in systolic blood pressure before and after exercise training period among an active group and the control group. The finding of the current study also differed from the finding of Henrique *et al.*[26], who reported a statistically significant reduction in systolic BP, diastolic BP and average BP following aerobic exercise among a cohort of chronic renal failure patients attending hemodialysis sessions. Only the systolic blood pressure of participants in the current study was affected by continuous exercise training. This could be due to the fact that participants in the study were apparently healthy with no history of renal or cardiovascular disease.

CONCLUSION

The study concluded that continuous aerobic exercise training increased the RR-interval, the P-wave and the QT-interval thereby causing a lowering of the heart rate. Continuous aerobic exercise also reduces systolic blood pressure.

REFERENCES

1. American College of Sports Medicine, 2014. ACSM's Guidelines for Exercise Testing and Prescription. 9th Edn., Lippincott Williams & Wilkins, Philadelphia, USA., ISBN-13: 9781609139551, pp: 19-137.
2. Senchina, D.S. and M.L. Kohut, 2007. Immunological outcomes of exercise in older adults. Clin. Interv. Aging, 2: 3-16.
3. Aldana, S.G., L.D. Sutton, B.H. Jacobson and M.G. Quirk, 1996. Relationships between leisure time physical activity and perceived stress. Perceptual Motor Skills, 82: 315-321.
4. American Heart Association, 2013. Guideline on the assessment of cardiovascular risk: A report of the American College of Cardiology/American Heart Association task force on practice guidelines. Circulation, 32: 313-320.
5. Ritvanen, T., V. Louhevaara, P. Helin, T. Halonen and O. Hanninen, 2007. Effect of aerobic fitness on the physiological stress responses at work. Int. J. Occup. Med. Environ. Health, 20: 1-8.
6. Sajjan, M., 2014. Learn ECG in a Day: A Systematic Approach. Jaypee Brothers Medical Publishers (P) Ltd., New Delhi, India, pp: 17-24.
7. Hampton, J.R., 2013. The ECG in Practice. 6th Edn., Elsevier Health Sciences, Nottingham, UK., ISBN: 9780702052446, pp: 23-48.
8. Cooper, K.H., 1968. A means of assessing maximal oxygen intake: Correlation between field and treadmill testing. J. Am. Med. Assoc., 203: 201-204.
9. Sone, R., F. Yamazaki, N. Fujii, Y. Fukuoka and H. Ikegami, 1996. Respiratory variability in R-R interval during sinusoidal exercise. Eur. J. Applied Physiol. Occup. Physiol., 75: 39-46.
10. Cammarota, C. and M. Curione, 2011. Modeling trend and time-varying variance of heart beat RR intervals during stress test. Fluct. Noise Lett., 10: 169-180.
11. Wilhelm, M., L. Roten, H. Tanner, I. Wilhelm, J.P. Schmid and H. Saner, 2011. Atrial remodeling, autonomic tone and lifetime training hours in nonelite athletes. Am. J. Cardiol., 108: 580-585.
12. Garcia, T.B., 2015. 12-Lead ECG: The Art of Interpretation. 2nd Edn., Jones and Bartlett Learning, Burlington, ISBN-13: 978-0763773519, pp: 12-25.
13. Podrid, P., R. Malhotra, R. Kakkar and P.A. Noseworthy, 2013. Podrid's Real-World ECGs: Volume 3, Conduction Abnormalities: A Master's Approach to the Art and Practice of Clinical ECG Interpretation. Cardiotext Publishing, Minnesota, ISBN: 9781935395966, Pages: 496.
14. Romano, M., 2015. Text Atlas of Practical Electrocardiography: A Basic Guide to ECG Interpretation. Springer-Verlag, Italy, ISBN: 9788847057418, pp: 14-24.
15. Gertsch, M., 2008. The ECG Manual: An Evidence-based Approach. Springer-Verlag, London, ISBN: 9781848001718, Pages: 339.
16. Nallamothu, B.K. and T.S. Baman, 2013. Inpatient Cardiovascular Medicine. Wiley & Sons Inc., Hoboken, New Jersey, ISBN: 9781118484814, Pages: 384.
17. Mutikainen, S., M. Perhonen, M. Alen, T. Leskinen and J. Karjalainen *et al.*, 2009. Effects of long-term physical activity on cardiac structure and function: A twin study. J. Sports Sci. Med., 8: 533-542.
18. Drezner, J.A., P. Fischbach, V. Froelicher, J. Marek and A. Pelliccia *et al.*, 2013. Normal electrocardiographic findings: Recognising physiological adaptations in athletes. Br. J. Sports Med., 47: 125-136.
19. Ali, A., M.R. Mehra, F.S. Malik, C.J. Lavie, R.N. Donna-Bass and R.V. Milani, 1999. Effects of aerobic exercise training on indices of ventricular repolarization in patients with chronic heart failure. Chest, 116: 83-87.
20. Hottenrott, K., S. Ludyga and S. Schulze, 2012. Effects of high intensity training and continuous endurance training on aerobic capacity and body composition in recreationally active runners. J. Sports Sci. Med., 11: 483-488.

21. Psilander, N., 2014. The effect of different exercise regimens on the mitochondrial biogenesis and performance. Ph.D. Thesis, Department of Physiology and Pharmacology, Karolinska Instituetet, Stockholm, Sweden.
22. Losnegard, T. and J. Hallen, 2014. Physiological differences between sprint-and distance-specialized cross-country skiers. Int. J. Sports Physiol. Perform., 9: 25-31.
23. Ekblom-Bak, E., M.L. Hellenius, O. Ekblom, L.M. Engstrom and B. Ekblom, 2009. Fitness and abdominal obesity are independently associated with cardiovascular risk. J. Internal Med., 266: 547-557.
24. Smart, N.A. and M. Steele, 2012. A comparison of 16 weeks of continuous vs intermittent exercise training in chronic heart failure patients. Congestive Heart Failure, 18: 205-211.
25. Osbak, P.S., M. Mourier, A. Kjaer, J.H. Henriksen, K.F. Kofoed and G.B. Jensen, 2011. A randomized study of the effects of exercise training on patients with atrial fibrillation. Am. Heart J., 162: 1080-1087.
26. Henrique, D.M.N., M.D.M. Reboredo, A. Chaoubah and R.B. de Paula, 2010. Aerobic exercise improves physical capacity in patients under chronic hemodialysis. Arq. Bras. Cardiol., 94: 823-828.