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ORIGINAL RESEARCH

Patterns of resting electrocardiogram of male college track and field athletes

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Abstract. This study sought to determine the resting Electrocardiogram of male college Track and Field athletes, with a view to identifying electrocardiographic changes attributable to cardiac adaptations and possible differences in ECG morphologies by the athletic event. A descriptive survey design was used in the study. The population was male track and field athletes of Obafemi Awolowo University (OAU), Ile-Ife, Nigeria. Eighteen athletes; track (n=10) and field (n=8), were purposively selected from the OAU Athletics team that participated in the 14th West-African Universities' Games, held at the University of Port-Harcourt, Rivers State Nigeria in 2018. Resting ECG was recorded with a 12-lead Electrocardiograph (SCHILLER-Cardiovit AT-2 plus), blood pressure was recorded with a digital blood pressure monitor (OMRON-M6 Comfort), weight, height, and BMI were recorded with an electronic BMI scale (SECA-220). Descriptive statistic of mean and standard deviation was computed and a paired-sample t-test was used to compare the resting ECG of athletes in the two divisions. Track and field athletes had mean RR-interval, P-wave, PR-interval, QRS-interval, QT-interval, and QTc of 993.22 ± 111.51ms, 97.12 ± 10.87ms, 157.00 ± 34.34ms, 120.67 ± 58.22ms, 376.94 ± 55.34ms and 416.78 ± 46.98mm respectively. With regards to voltage, athletes had mean voltages of 0.11 ± 0.09mm, -0.98 ± 0.77mm, and 1.54 ± 0.73mm for P-wave in lead II, S in V_I, and R in V_5 respectively. When athletes' ECGs in the two divisions were compared, a significant difference was only found in the RR-interval ($t = -3.08$; $p < 0.05$). The study concluded that there were no distinctive morphological differences in the resting ECG of Nigerian collegiate track and field athletes.

Keywords. Athletes, blood pressure, heart rate, resting ECG, track and field.

Introduction

Phillipides' death following his completion of the historic 42,196 km run, which coursed through the valley of Marathon to the city of Athens, with the intention of breaking the news of the Greek army's victory over their adversary the Persians, had been rightly touted the first recorded sudden death of an athlete by several scholars and researchers (Bessem, 2017). Basu & Malhotra (2018) had earlier found that sudden cardiac death (SCD) topped the causes of deaths in athletes and that a large proportion of sudden cardiac death morbidities are connected with intrinsic cardiovascular disease. In a recent study on how to identify high-risk athletes using electrocardiography, Gray et al. (2020) posited that sudden cardiac death (SCD) is the leading non-traumatic cause of mortality in athletes during sport. Though its occurrence among athletes may be considered relatively low when compared with the general population, the sudden death of an athlete represents a tragic and devastating event (Sokunbi et al., 2021), which on many occasions attracts wide publicity due to the fact that sporting engagements are widely patronized. Such sad events have been on the increase in the world of sports since the turn of the 19th century when the advent of the internet, computers, and social media made it possible for sports and athletic engagements to be viewed by millions of audiences at different locations on the globe.

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Athletes are considered to be operating at the ceiling of human physiological and functional capabilities and are thus construed as representing the healthiest individuals within any given society. The sight of young athletes dropping dead on the field of play provoked the search for prevention through screening (Bessem, 2017), which led notable international sports federations like the FIFA and the International Olympic Committee to lead the advocacy for compulsory pre-participation screening for all competitive athletes. Several authors (Parry-Williams & Sharma, 2017; Gray et al., 2020) had suggested that individuals who engage in regular, moderate to intensive exercise at least 4-8 hours a week can develop a series of physiological adaptations ranging from modifications in cardiac structure and function to autonomic tone, a phenomenon the authors referred to as 'the athlete's heart'. The phenomenon clinically regarded as "Athlete's Heart Syndrome" has been described in the works of several authors (Crouse et al., 2009; Di Paolo et al., 2012; Drezner et al., 2013; Parry-Williams & Sharma, 2017; Basu & Malhotra, 2018; Gassina et al., 2019; Gray et al., 2020) as a constellation of cardiac adaptations that occur in cardiac structure and function due to prolonged engagement in intensive exercise training.

This adaptive modification of the athlete's heart in terms of structure and function has been an important subject of academic discourse and inquiry among scientists for many decades because there are no clear-cut distinctions between these benign, training-induced structural and functional remodeling of the athlete's heart and what constitutes indices of cardiac myopathies in the clinical setting. It thus becomes a great challenge, to distinguish physiologic and training-related ECG changes and indications that may reflect underlying cardiac disorders (Waase et al., 2017). Moreover, many scholars have reported that ECG taken from athletes presented a wide range of abnormalities and alterations similar to those typifying organic heart diseases (Waase, 2017).

More recent empirical studies have identified those ECG adaptations (electrical and structural remodeling of the athlete's heart) resulting from regular exposure to intensive exercise training. Basu & Malhotra (2018) highlighted these features in the European Society of Cardiology (ESC) Consensus of 2005, Revised ESC Recommendations of 2010, Seattle criteria of 2013, and Refined Criteria of 2014. The highlights of these various recommendations were summarized in the publication of the international recommendations for ECG interpretation in athletes, which classified electrocardiographic findings in athletes under three classes: Normal ECG findings, borderline ECG findings, and abnormal ECG findings. Electrocardiographic findings, such as enlarged cardiac chamber size and increased vagal tone in athletes are considered normal physiological adaptations to regular exercise and do not require further evaluation in asymptomatic athletes with no significant family history of cardiac myopathy. The recommendations also listed increased QRS voltage, incomplete right bundle branch block, early repolarization, sinus bradycardia, sinus arrhythmia, ectopic atrial rhythm, junctional escape, first-degree atrioventricular block, and Mobitz type 1 second-degree atrioventricular block as normal variants in athletes ECG. Thus, accurate differentiation of ECG patterns reflecting cardiac adaptation to exercise training from those that indicate cardiac pathology is crucial (Parry-Williams & Sharma, 2017).

Athletics cover a wide spectrum of competitive sporting activities performed on the field and the track, with each of the constituent sports presenting unique physiological and performance demands. Athletes are considered to be the healthiest and fittest individuals within any given society and are construed as operating at the ceiling of human physiological and functional capabilities. This very fact makes the sudden and horrific collapse or the death of an athlete on the field of play a tragic and worrisome phenomenon. There is empirical evidence that the athlete's heart presents a number of electrical and structural remodeling, similar to those typical of organic heart diseases, and these patterns could be detected using the electrocardiogram. Few studies have investigated these characteristics among track and field athletes and fewer still have delineated such among athletes in college settings. This study, therefore, sought to determine the electrocardiographic characteristics of male college track and field athletes at Obafemi Awolowo University, Ile-Ife, Nigeria.

Methods

Participants

The sample for the study comprised 18 male track and field athletes; track (n=10), and field (n=8), drawn from the Obafemi Awolowo University Athletics team that participated in the 14th West African Universities Games (WAUG), held at the University of Port-Harcourt, Rivers State, Nigeria in 2018. Athletes were screened for cardiovascular diseases by the cardiovascular unit of the

University's Health Centre before they were invited to the WAUG camp. Only the athletes in the track and field division who were cleared and had been in the training camp for a minimum of 8 weeks before the WAUG competition were engaged in the study.

Data Collection

The study was cleared by the Obafemi Awolowo University's Teaching Hospital's Research Ethics Committee (ERC/2018/03/45). Participants were duly informed of the testing procedures and were sensitized to their importance to their health. Written consent was obtained from every participant through a consent form. Participants' height and weight were measured, and BMI was estimated with an electronic BMI scale (SECA 220). Resting blood pressure was recorded using a digital sphygmomanometer (OMRON M6 Comfort), while participants sat on a straight-backed chair in a relaxed position.

The 12-Lead ECG

A 12-lead resting Electrocardiograph (SCHILLER Cardiovit AT-2 plus) was used to record the resting ECG of athletes in conformity with the protocol of the American College of Sports Medicine, ACSM (2014). Participants lay supine and rested for 5 minutes, during which they attained quiet respiration. The four limb electrodes were positioned with RA on 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 on the anterior aspect of the right leg, and six precordial electrodes; V_1 on the 4^{th} intercostal space right sternal border, V_2 placed on the 4^{th} intercostal space left sternal border, V_3 positioned directly between V_2 and V_4, V_4 was fixed on the 5^{th} intercostal space on the left midclavicular line, V_5 placed horizontally to V_4, anteriorly on the left axillary line and V_6 placed horizontally to V_4 and V_5 on the left midaxillary line. Axes, durations, intervals, and amplitudes of the ECG waves were analyzed using the Electrocardiograph's software, and recorded ECGs were reviewed by a cardiologist. Heart rate below 60bpm was taken for sinus bradycardia, PR interval greater than 200 milliseconds was considered prolonged, while lesser than 120 milliseconds was considered short. The wide QRS complex was interpreted as greater than 120 milliseconds and deviations in its axis were given as more negative than 0° or more positive than 110°. The Bazett formula was used to correct the QT interval and LVH was screened for using the Sokolow-Lyon criterion. Data were recorded in a structured proforma sheet.

Data Analysis

Data were analyzed with the IBM-20 version of the Statistical Package for Social Sciences (SPSS) software. Descriptive statistics of mean and standard deviation were used to describe data and the paired sample t-test statistics were used to compare the resting ECG of athletes in track and field divisions.

Results

As shown in Table 1, the mean age of collegiate track and field athletes in the current study was 20.78 ± 2.26yrs while their mean weight, height, and BMI were 73.31 ± 8.60kg, 173.28 ± 6.98cm, and 24.50 ± 3.19kg/m^2 respectively. The means of weight, height, and BMI of track and field athletes in the current study were similar to that of Barbieri et al. (2017), who reported means of 73.0 ± 7.5kg, 177.9 ± 7.1cm, and 23.0 ± 1.8kg/m^2 respectively for weight, height, and BMI of sprint athletes of Caucasian and African origin. The athletes in the current study were within normal ranges of Heart rate (60.97 ± 3.72bpm), systolic blood pressure (116.67 ± 5.94mmHg), and diastolic blood pressure (79.50 ± 5.46mmHg) respectively. Varga-Pinter et al. (2011) had reported similar blood pressure values for Dry-land athletes (124 ± 12.7mmHg/ 78.2 ± 9.4mmHg) and Aquatic athletes (127.3 ± 13.3mmHg/ 81.6 ± 9.5mmHg) in a previous study. They affirmed that blood pressure values were lower in athletes of dynamic sports such as track and field, ball games, and endurance sports than in static-muscular activity athletes or power athletes. Nigerian collegiate track and field athletes were not significantly different in age, BMI, systolic and diastolic blood pressures, but they differed significantly in heart rate $t = -2.52$; $p < 0.05$, weight, $t = -2.87$; $p < 0.05$ and height, $t = -2.16$; $p < 0.05$ respectively. A sizable number of athletes in the field division had heart rate values lower than 60bpm which was suggestive of bradycardia. This trend was not noticed with their counterparts in the field division, whose heart rates were normal. Table 2 summarizes the resting ECG patterns of athletes in the study.

Table 1
Demographic characteristics of track and field athletes (Mean ± SD).

Variables	Field (n = 8)	Track (n = 10)	Total (n = 18)	t	df	p
Age (yrs)	21.38 ± 2.50	20.30 ± 2.06	20.78 ± 2.26	-1.00	16	0.33
Weight (kg)	78.75 ± 9.57	68.95 ± 4.58	73.31 ± 8.60	-2.87	16	0.01*
Height (cm)	176.88 ± 7.14	170.4 ± 5.62	173.28 ± 6.98	-2.16	16	0.04*
BMI (kg/m^2)	25.34 ± 4.11	23.83 ± 2.22	24.50 ± 3.19	-0.99	16	0.33
Heart Rate (BPM)	57.63 ± 4.60	64.30 ± 2.83	60.97 ± 3.72	-2.52	16	0.04*
Systolic BP (mmHg)	118.8 ± 3.54	115.0 ± 7.07	116.67 ± 5.94	-1.36	16	0.19
Diastolic BP (mmHg)	80.1 ± 4.79	79.0 ± 6.15	79.50 ± 5.46	-0.42	16	0.68

** p < 0.05*

Table 2
Summary of resting ECG patterns of track and field athletes (Mean ± SD).

Variables	Field	Track	Total	t	df	p
RR intv (ms)	1067.13 ± 77.16	934.10 ± 100.60	993.22 ± 111.51	-3.08	16	0.01*
P Wave (ms)	98.75 ± 11.13	95.90 ± 11.08	97.17 ± 10.87	-0.54	16	0.60
PR intv (ms)	155.00 ± 41.69	158.60 ± 29.49	157.00 ± 34.34	0.22	16	0.83
QRS Comp (ms)	126.25 ± 68.21	113.00 ± 51.35	119.63 ± 59.78	2.61	16	0.87
QT intv (ms)	404.13 ± 63.41	355.20 ± 38.42	376.94 ± 55.34	-2.03	16	0.06
QTc (ms)	438.25 ± 44.99	399.60 ± 43.09	416.78 ± 46.98	-1.86	16	0.08
P in Lead II	0.11 ± 0.11	0.12 ± 0.07	0.11 ± 0.09	0.21	16	0.84
S in V_I	-1.15 ± 0.84	-0.84 ± 0.73	-0.98 ± 0.77	0.86	16	0.40
R in V_5	1.63 ± 0.77	1.48 ± 0.73	1.54 ± 0.73	-0.42	16	0.68
Sokol	3.27 ± 1.44	3.22 ± 1.39	3.24 ± 1.37	-0.08	16	0.94
P-Axis (deg.)	44.13 ± 20.69	43.30 ± 21.28	43.67 ± 20.40	-0.08	16	0.94
QRS-Axis (deg.)	28.25 ± 66.65	39.20 ± 40.94	34.33 ± 52.42	0.43	16	0.67
T-Axis (deg.)	-9.88 ± 84.06	33.90 ± 18.70	14.44 ± 59.97	1.61	16	0.13

** p < 0.05; ms = millisecondes; deg. = degrees*

Data in Table 2 showed that track and field athletes had the mean RR interval of 993.22 ± 111.51ms, while the means of their P- wave, PR interval, QRS interval, QT interval, and QTc were 97.12 ± 10.87ms, 157.00 ± 34.34ms, 119.63 ± 59.78ms, 376.94 ± 55.34ms and 416.78 ± 46.98mm respectively. The patterns observed with these ECG parameters are normal when considered in light of existing criteria and international recommendations for ECG interpretation in athletes.

In terms of ECG voltage, track and field athletes in this study had normal ECG voltages with mean amplitudes of 0.11 ± 0.09mm, -0.98 ± 0.77mm, and 1.54 ± 0.73mm for P wave in lead II, S in V_I and R in V_5 respectively. The mean of athletes' Sokolow-Lyon index was 3.24 ± 1.37mm, with regards to the ECG axis; collegiate track and field athletes in the current study had means of 43.67 ± 20.40°, 34.33 ± 52.42°, and 14.44 ± 59.97° respectively for P axis, QRS axis, and T axis. These patterns were also within the scope of normal variants expected of athletes' ECGs. Sharma et al. (2018) affirmed that axis deviation and voltage criteria for atrial enlargement account for > 40% of abnormal ECG patterns in athletes, but do not correlate with cardiac pathology. When the resting ECGs of athletes in the track division were compared with their counterparts in the field division, a significant difference was found only in the RR interval, t = -3.08; P < 0.05 but not in other ECG parameters.

Discussion

This study sought to determine the resting electrocardiogram of collegiate track and field athletes in Nigeria, with a view to identifying electrocardiographic changes attributable to cardiac adaptations and possible differences in ECG morphologies by the athletic event. The resting ECG morphologies of track and field athletes in the current study were within normal limits, they were neither borderline nor abnormal ECG findings. Sharma et al. (2018) reported that regular and long-term involvement in vigorous exercise for at least 4 hours a week is associated with unique electrical manifestations. The authors argued that such manifestations merely reflect enlarged cardiac chamber size and increased vagal tone. Sharma et al. listed increased QRS voltage, incomplete right bundle branch block, early repolarization, sinus bradycardia, sinus arrhythmia, ectopic atrial rhythm, and junctional escape as some of the normal variants seen in athletes' ECG, that do not require further evaluation in asymptomatic athletes, particularly in the absence of a significant family history of cardiac disease. The patterns found with the voltages and axes of athletes' ECG in this study were also within the scope of normal variants expected of athletes' ECG. According to Sharma et al. (2018) axis deviation and voltage patterns similar to those used as criteria for atrial enlargement contributes to > 40% of abnormal ECG patterns in athletes but do not correlate with cardiac pathology. Track and field athletes in the current study did not significantly differ in their resting ECG morphologies. The lack of distinctive morphological differences in the ECG of athletes in the two divisions of athletics (track and field) was similar to the findings of Pentikainem et al. (2021) who found that young athletes had similar ECG and blood pressure characteristics independent of their sports. Pentikainem et al. (2021) had reported no significant difference in the ECG characteristics of endurance and non-endurance athletes, with the exception of the PR interval, which they found to be longer in endurance athletes than their non-endurance counterparts.

Limitations

This study engaged only 18 track and field athletes drawn from the same tertiary institution, thus limiting the generalizability of the study beyond the track and field sports from which the participants were drawn. A larger sample size covering all the sports in athletics may produce more robust findings on the ECG of collegiate athletes.

Conclusions

The study concluded that the resting ECG patterns of track and field athletes in the current study were within normal limits, they were neither borderline nor abnormal ECG findings. There were no distinctive morphological differences in the resting ECG of Nigerian collegiate track and field athletes.

Authors' Contribution

Study Design: OOA, OO; Data Collection: OOA, OO; Statistical Analysis: OOA; Manuscript Preparation: OOA, OO; Funds Collection: OO.

Ethical approval

The study was approved by the Obafemi Awolowo University's Teaching Hospital's Research Ethics Committee (ERC/2018/03/45, 2018), it was carried out in accordance with the Declaration of Helsinki.

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Conflict of Interest

Authors declared no conflict of interest

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