Resting ECG Characteristics Among Professional Male Footballers in Nigeria: Assessing the Prevalence of Abnormalities Using Current Guideline

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Abstract

This study aimed at evaluating the prevalence of abnormal electrocardiographic (ECG) patterns in male footballers who are preparing for competition assessing the need for screening program for conditions that leads to sudden cardiac death (SCD) among athletes.

Background: *Pre-competition screening with ECG reduces the incidence of SCD in athletes. However, SCDs has very low occurrence in athletes. In Nigeria, people with symptoms or family history of hereditary heart problems or early cardiac death are the only ones who can be screened for cardiac disorders.*

Methods*: 29 male footballer's ages 20 to 30 years underwent ECG screening. Electrocardiograms were analyzed for group 1 (training-related) and group 2 (training unrelated) patterns following the International Criteria for Interpretation of Electrocardiogram in Athletes.*

Results: *Mean age of the players was 25.1 ± 3.4, mean body mass index was 24.3 kg/m^2 ± 1.4, mean resting heart rate was 58.2 beats per minute ± 9.8, mean systolic blood pressure was 126.2 mmHg ± 11.9, and mean diastolic blood pressure was 77.1 mmHg ± 9.5. 42.9% of the participants had normal ECG. Group 1 patterns occurred in 79.3% of the male footballers while Group 2 patterns occurred in 58.6%. Sinus bradycardia (60.71%) and Left ventricular hypertrophy (LVH) (55.56%) comprised the majority of the changes. ST elevation and T-wave inversion were the major training unrelated or uncommon ECG changes with occurrence of 48.28% and 34.48%, respectively.*

Conclusions: *The study demonstrated that apart from sinus bradycardia, non-exercise related ECG changes such as ST elevation and T wave inversion were major ECG changes among male footballers. ECG is important in identifying cardiac abnormalities in order to minimize the risk of sudden cardiac death during exercise.*

Keywords: *Electrocardiogram, professional, male footballers, sudden cardiac death, athlete*

INTRODUCTION

Reversible physiological changes in the heart might result from professional and competitive sports training. These abnormalities can take the form of different electrocardiographic (ECG) variations that resemble the changes observed in people suffering from structural heart diseases. These changes occurring in athletes is known as "athletes heart." (1,2)

Certain characteristics found in the ECG of athletes, however, can be indicative of an underlying hereditary or congenital cardiovascular condition that could worsen sudden cardiac death (SCD). Cardiovascular problems that may already exist can be found with pre-participation screening using a 12-lead ECG.(1,3) The incidence of SCD has been reported to be approximately 1–2 per 100,000 persons-year worldwide and the number in athletes has increased in recent decades.(4) An estimated 300,000 cases of SCD are reported in Africa annually with athletes being 2.5 times more likely to experience this occurrence than non-athletes.(5) As per the American Heart Association and various other research, the most common cause of SCD in athletes is Hypertrophic Cardiomyopathy (HCM), an inherited heart condition featured by a pathological thickening of the heart wall. (6–8)

Regular screening significantly decreased the prevalence of SCD in competitive athletes in Italy by 89%, which helped shape the European Society of Cardiology's (ESC) screening recommendations.(3,9) A 12-lead electrocardiogram (ECG) at rest has been added to centers that have expertise with athlete ECG screening, and this has shown to improve sensitivity in identifying cardiovascular irregularities.(10)

Based on the frequency of ECG findings, their relationship to exercise training, and their association with pathological conditions associated with SCD that require further clinical investigation to confirm (or exclude) underlying cardiovascular disease, the 2010 ESC criteria were the first to divide ECG findings into two groups: common and training-related (group 1) versus uncommon and training-unrelated (group 2). (11) There was debate surrounding the objectivity of electrocardiogram (ECG) interpretation, citing subjective interpretation, high false positive rates, and questionable cost-benefit outcomes as contributing factors.(12) These challenges have resulted in notable disparities between North American and European screening guidelines, with the latter commonly recommending a resting 12-lead ECG for all young athletes. However, the adoption of standardized ECG evaluation criteria such as the 'Seattle Criteria' and the more recent 'International Criteria' has played a significant role in enhancing the accuracy of ECG interpretation.(11,13)

In order to effectively employ ECG in the cardiovascular care of athletes, aberrant findings must be confirmed or disorders linked to SCD must be ruled out using the proper follow-up studies. However, depending on the expertise and training of the clinician, the clinical reaction to aberrant ECG readings may differ. (11) In the past, there have been instances of sudden cardiac deaths among African and Nigerian football players both locally and in Europe; but, in Nigeria,

particularly among local football players in the local league, the frequency has grown recently. Although there is no policy for preventing SCD among Nigerian footballers, an increased report of SCD among these folks is of a great concern. (14) In order to predict the risk of SCD in professional football players, echocardiographic and electrocardiographic measures are crucial. These measures are essential in determining the structural and functional adaptations among athletes. (14–16) This study aimed to evaluate the resting ECG characteristics of professional male footballers of the Nigerian Football League using the International Criteria for Interpretation of Electrocardiogram in Athletes (11) and to determine the occurrence of abnormal cardiac findings.

MATERIAL AND METHOD

Study design

This study represents a descriptive, retrospective study in a sample of highly trained male football players.

The participants were professional footballers from two football clubs, both were Division 1 Football Clubs of the Nigerian Football Federation. All athletes competed at the national level and exercised 6h/week.

The screening took place in Port Harcourt Rivers State Nigeria at GoodHeart Medical Consultants Hospital's research center.

Resting ECG:

A standard 12-lead ECG was obtained using EDAN PC-based ECG (SE-301). All ECGs were reported independently by two experienced investigators. . ECG was interpreted using using the International Criteria for Interpretation of Electrocardiogram in Athletes 2017 which classified the changes into two groups.

Normal ECG results in athletes (Group 1)

These training-related ECG changes are physiological responses to consistent exercise; they are accepted as typical variations in athletes and, in the case of asymptomatic athletes without a noteworthy family history, do not necessitate additional testing.

Abnormal ECG results in athletes (Group 2)

These ECG results may indicate the existence of pathological cardiovascular disease and call for additional diagnostic testing. They are unrelated to consistent training or the anticipated physiological adaptation to exercise.

Statistical analysis

Data was entered in Excel version 20. Descriptive data analysis was performed using STATA version 15 and were expressed using mean and standard deviation (SD).

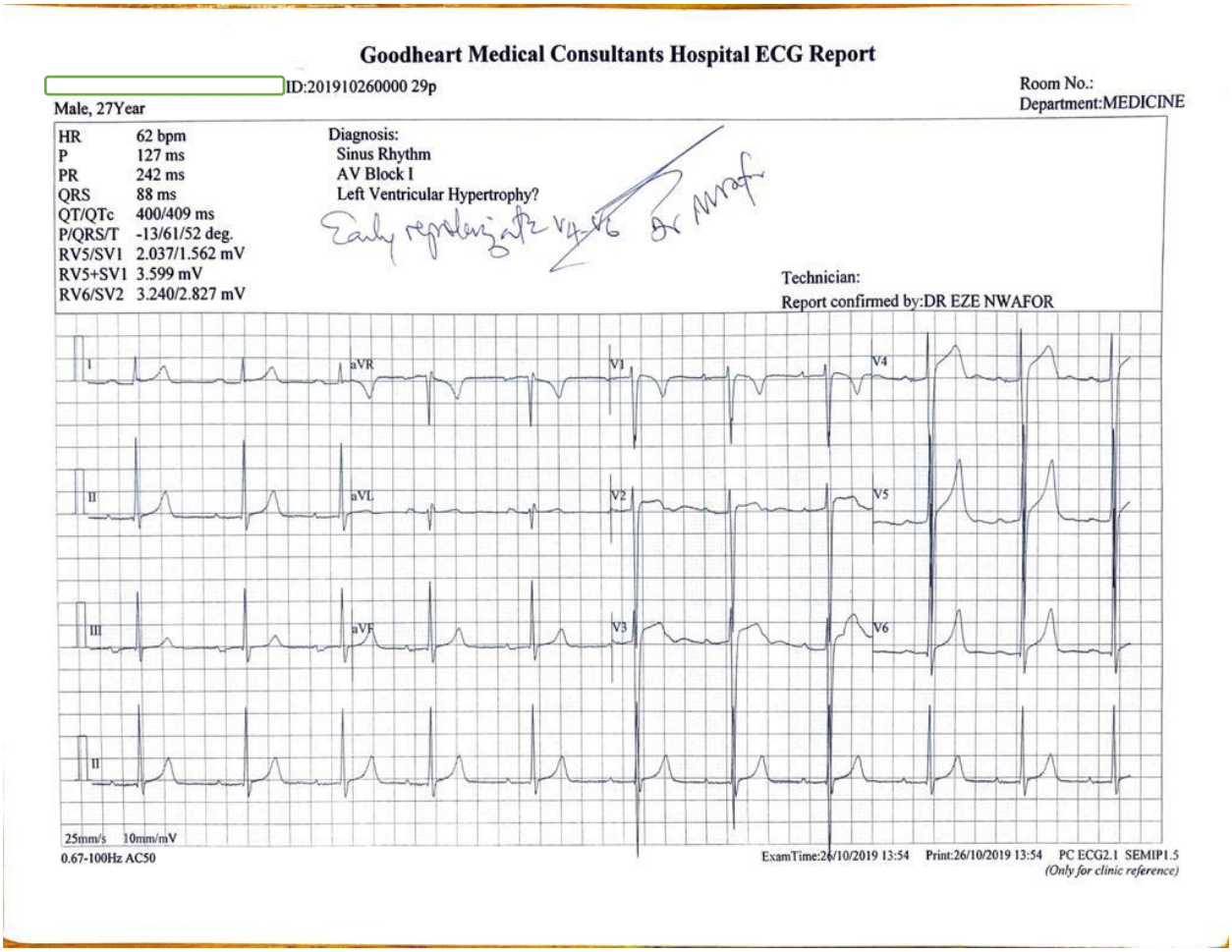

Fig 1: ECG showing 1st degree AVB, LVH and early repolarization, common training-related ECG changes

RESULTS

A total of 29 male footballers were included in this study. The participants' ages were between 22 and 31 years.

Table 1 shows the anthropometric characteristics of footballers. Mean age of the footballers was 25.1 ± 3.4, mean height was 1.8 m ± 0.1, mean weight was 78.6 kg ± 7.2, mean body mass index was 24.3 kg/m^2 ± 1.8, mean waist circumference was 83.1cm ± 3.8, mean hip circumference was 99cm ± 3.7, mean systolic blood pressure was 126.2 mmHg ± 11.9, mean diastolic blood pressure was 77.1 mmHg ± 9.1 and mean resting heart rate was 58.2 beats per minute ± 9.8.

Table 2 shows the types of ECG findings. The most common ECG changes were sinus bradycardia (60.71%, n = 17), Left ventricular hypertrophy (55.56%, n =15), ST elevation (48.28%, n = 14), abnormal T wave inversion (34.48%, n = 10), early repolarization (17.86%, n = 5), AV block 1º (14.29%, n = 4). The least common are left atrial enlargement (LAE), right atrial enlargement

(RAE), inferior ischemia and right anterior hemi block arrhythmia, all had a frequency of 3.57% (n = 1) respectively.

A total of 2 footballers (6.9%) had no ECG changes, while the rest (93.1%) had one or more ECG changes. Common ECG changes were seen in 23 footballers (79.3%) while Uncommon ECG changes were seen in 17 footballers (58.6%), some of the footballers had a combination of the common and uncommon ECG changes.

Table 1: Anthropometric characteristics of the footballers

	Mean	SD
Age (years)	25.1	3.4
Height (m)	1.8	0.1
Weight (kg)	78.6	7.2
BMI (kgm^{-2})	24.3	1.8
Waist Circumference (cm)	83.1	3.8
Hip Circumference (cm)	99	3.7
Systolic BP (mmHg)	126.2	11.9
Diastolic BP (mmHg)	77.1	9.5
Heart Rate (b/m)	58.2	9.8

N= 29 participants

BP = Blood pressure, BMI = body mass index, SD = Standard deviation, kg = kilogram, m = meters, mm = millisecond

Table 2: ECG changes of female footballers

ECG CHANGES	Number	Percentage
Group 1		
Sinus Bradycardia	17	60.71
LVH	15	55.56
ER	5	17.86
AV block 1º	4	14.29
Arrhythmia	3	10.71
Group 2		
ST elevation	14	48.28
T-wave inversion	10	34.48
Septal Ischemia	2	7.14
LAE	1	3.57
RAE	1	3.57
Inferior ischemia	1	3.57
Left anterior hemi block	1	3.57

AV = atrioventricular; ER = early repolarization; LAE = left atrial enlargement; RAE = right atrial enlargement; LVH = left ventricular hypertrophy; RA = right atrial; RVH = right ventricular hypertrophy.

DISCUSSION

The goal of this study was to use a recent guideline for ECG classifications in order to assess the prevalence of anomalies in professional male football players' ECGs. As to the ECG classification by the International Criteria for Interpretation of Electrocardiogram in Athletes, 58.6% of football players in this study had uncommon ECG patterns. These ECG changes questions cardiomyopathy of which further echocardiographic evaluation will help confirm changes consistent with cardiomyopathy. Screening of footballers are important in identifying athlete that may be potential victims of SCD.

Seventy-nine percent (79.3%) of these male footballers had common or training-related ECG changes. Among the common (group 1) ECG changes seen in these footballers, sinus bradycardia was the most prevalent (60.71% of total participants), LVH was 55.56%, early repolarization and first-degree AV block had a prevalence of 17.86% and 14.29%, respectively. Of the training-unrelated ECG changes, ST elevation (48.28%) and T-wave inversion (34.48%) were most common while others had lower occurrence (Table 2). In general, sinus bradycardia was the most common ECG changes among these footballers accounting for 60.7% of the total changes, followed by LVH, ST elevation and T-wave inversion. The prevalence of sinus bradycardia in this study was lower than that of male athletes in United Kingdom (57.6%), Dutch football players (56%), Indian athletes with endurance training (42%) and Malaysian footballers (69.9%).(17–19)

A natural physiological adaptation, asymptomatic sinus bradycardia with a heart rate between 30 and 59 beats per minute is frequently linked to elevated vagal tone and potential structural atrial remodeling.(11) But according to current research, this adaptation might be the consequence of pacemaker ion channel remodeling and intrinsic heart rate reset.(20,21) In this study, professional male footballers demonstrated a similar mean resting heart rate (58 beats per minute) to European athletes (59 beats per minute) and Malaysian athletes (53 beats per minute).(17,19)

The prevalence of early repolarization (17.86%) in this study was lower than that seen in Malaysian male footballers (65.3%) and European football players (64%). (18,19) Early repolarizations are closely related to exercise training and fitness level, and has been established to be more prevalent in athletes, young individuals, males, and people of black ethnicity. (11,19) An increase in the J point and then the ST segment, which is typically concave upward, horizontal, or ascending and is usually followed by a big positive T wave, in a high-level athlete. Some publications have referred to this phenomenon as "early repolarization syndrome."(22) (Fig 1).

The occurrence of sinus arrhythmias (10.71%) found during this pre competition screening is slightly lower compared to Dutch footballers (20%) and similar to trained endurance Indian athletes (12%)(18,23). ST elevation occurred in 48.28% of footballers in this study. A study in Mali found over 50% of football players had ST segment elevation, with a frequency that was substantially higher in males than in women, (22). Another study found that male footballers have

ST elevations that their counterpart.(24) The percentage of abnormal T wave inversions (34.48%) was higher than that of Indian endurance athletes (16%)(23) but higher than that seen in Malaysian footballers(19). T wave inversion was frequently found in footballers with higher occurrence in males than in females.(22,23)

Research that evaluated the independent relationships between group 2 ECG patterns and athletic status, sex, ethnicity, age, and body surface area found that male sex, athletic status, and black ethnicity showed the strongest relationship. (17)

While no heart condition that required stopping training was found in the football players who were checked, it is highly advised that all athletes participating in competitive sports get screened thoroughly.

One limitation of our retrospective analysis is that we did not evaluate the long-term effects in athletes with significant abnormalities in their ECG as this screening was performed on the footballer prior to a national competition. It would be preferable to do a correlation research in conjunction with an echocardiography examination for every footballer because it can translate the actual ECG findings onto structural alterations in the heart. This could show how the anatomy and physiology have adapted through their electro-conductive manifestations.

CONCLUSION:

The majority of the ECG changes observed in these Nigerian football players were due to the expected physiological changes following regular exercise training. The number of abnormal ECGs in this study is a bit higher than reported in other studies, however subjects with T wave inversion should have further cardiovascular evaluation following the International Criteria for Interpretation of Electrocardiogram in Athletes. This emphasizes the importance of pre-competition screening for athletes.

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