Resting ECG Characteristics among Professional Female Footballers in Nigeria

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Abstract

This study aimed at evaluating the prevalence of abnormal electrocardiographic (ECG) patterns in female footballers to assess the need for screening program for conditions that leads to sudden cardiac death (SCD) among athletes.

Background: Pre-participation 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: 56 female footballer's ages 19 to 40 years underwent ECG screening. Electrocardiograms were analyzed for group 1 (training-related) and group 2 (potentially pathological) patterns following the 2010 European Society of Cardiology guideline for interpreting ECG in athletes.

Results: Mean age of the players was 26.3 ± 5.0, mean body mass index was 23.12 kg/m^2 ± 2.49, mean resting heart rate was 73.55 beats per minute ± 13.26, mean systolic blood pressure was 127.77 mmHg ± 119.47, and mean diastolic blood pressure was 71.62 mmHg ± 8.94. 42.9% of the participants had normal ECG. Group 1 patterns occurred in 30.4% of the female footballers while Group 2 patterns occurred in 37.5%. Anterior ischemia comprised the majority (19.6%) of the changes, sinus bradycardia (16.1%) and T-wave inversions constituted 12.5%.

Conclusions: The study demonstrated that apart from sinus bradycardia, non-exercise related ECG changes such as ischemia and T wave abnormalities were major ECG changes among female footballers in Nigeria. ECG is vital to identify cardiac abnormalities in order to minimize the risk of sudden cardiac death during exercise.

Keywords: Electrocardiogram, footballers, sudden cardiac death, athlete

INTRODUCTION

Athletes frequently have electrocardiographic (ECG) changes, which are known as "athletes heart" and typically reflect a physiologically benign remodeling of the heart in response to consistent, intense activity.(1) The athletic heart syndrome (AHS) or "athletes heart" refers to a constellation of clinical, electrocardiographic, and echocardiographic variations of normal that are present in well-trained athletes who play sports that need long-term training in aerobic exercise.(2) Atrioventricular (AV) conduction delay, systolic flow murmurs, sinus bradycardia, early repolarization, and heart chamber enlargement are among findings seen in AHS. (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)

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. (9) 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. (9–11) Over the past ten years, there has been a significant increase in research on soccer. Although the amount of research on footballers that has been published has increased exponentially, the number of studies that focus on women is falling behind that on men. This study aimed to evaluate the resting ECG characteristics of professional female footballers of the Nigerian Football League using the 2010 recommendations for 12-lead ECG interpretation by the 2010 European Society of Cardiology (ESC)(12) 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 female football players.

The participants were professional footballers from two football clubs, both are 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 the stadium by GoodHeart Medical Consultants research center.

Resting ECG:
A standard 12-lead ECG was obtained using a EDAN PC-based ECG (SE-301). All ECGs were reported independently by two experienced investigators, with third opinions sought from two international cardiologists. Athletes' ECG characteristics were classified into 'common' and 'uncommon' traits (Table 1) according to the recent 2010 ESC report.

A standard 12-lead ECG examination was performed during quiet respiration in a supine position and analysed according to the most recent ESC classification.(12)

The recent ESC classification distinguished 'Common and Training-related ECG changes' (Sinus bradycardia, First-degree AV block, IRBBB, Early repolarisation, Isolated QRS voltage criteria for left ventricular hypertrophy) and 'Uncommon and Training-unrelated ECG changes' (T-wave inversion, ST-segment depression, Pathological Qwaves, Left atrial enlargement, Left-axis deviation/left anterior hemiblock, Right-axis deviation/left posterior hemiblock, Right ventricular hypertrophy, Ventricular pre-excitation, Complete left- or right bundle branch block, Long- or Short-QT interval, Brugada-like early repolarisation). The two classifications (ESC 2010) differ mainly in terms of the ECG finding of isolated voltage criteria for left ventricular hypertrophy (classified as 'common' in the ESC classification) and the inclusion of ion channelopathies in the ESC guidelines.

Statistical analysis was done using the Microsoft excel 2015 and STATA version 15.0. Quantitative variables were summarized using means ± standard deviation while qualitative data were summarized as frequencies and percentages. Informed consent was taken from all participants in the study.

Table 1: European Society of Cardiology Classification of Changes of the Athlete's Electrocardiogram

Group 1: Common and Training-related ECG Changes	Group 2: Uncommon and Training-unrelated ECG Changes
Sinus bradycardia	T-wave inversion
First-degree AV block	ST-segment depression
Incomplete RBBB	Pathological Q-waves
ER	LA enlargement
Isolated QRS voltage criteria LVH	RA enlargement
	LAD
	RAD
	RVH
	Ventricular pre-excitation
	LBBB
	Long-QTc interval (>440 ms, men; >460 ms, women)
	Short-QTc interval (>380 ms)
	Brugada-like ER

Data from Corrado et al.(12).

AV = atrioventricular; ECG = 12-lead electrocardiogram; ER = early repolarization; LA = left atrial; LAD = left-axis deviation; LBBB = left bundle-branch block; LVH = left ventricular hypertrophy; RA = right atrial; RAD = right-axis deviation; RBBB = right bundle-branch block; RVH = right ventricular hypertrophy.
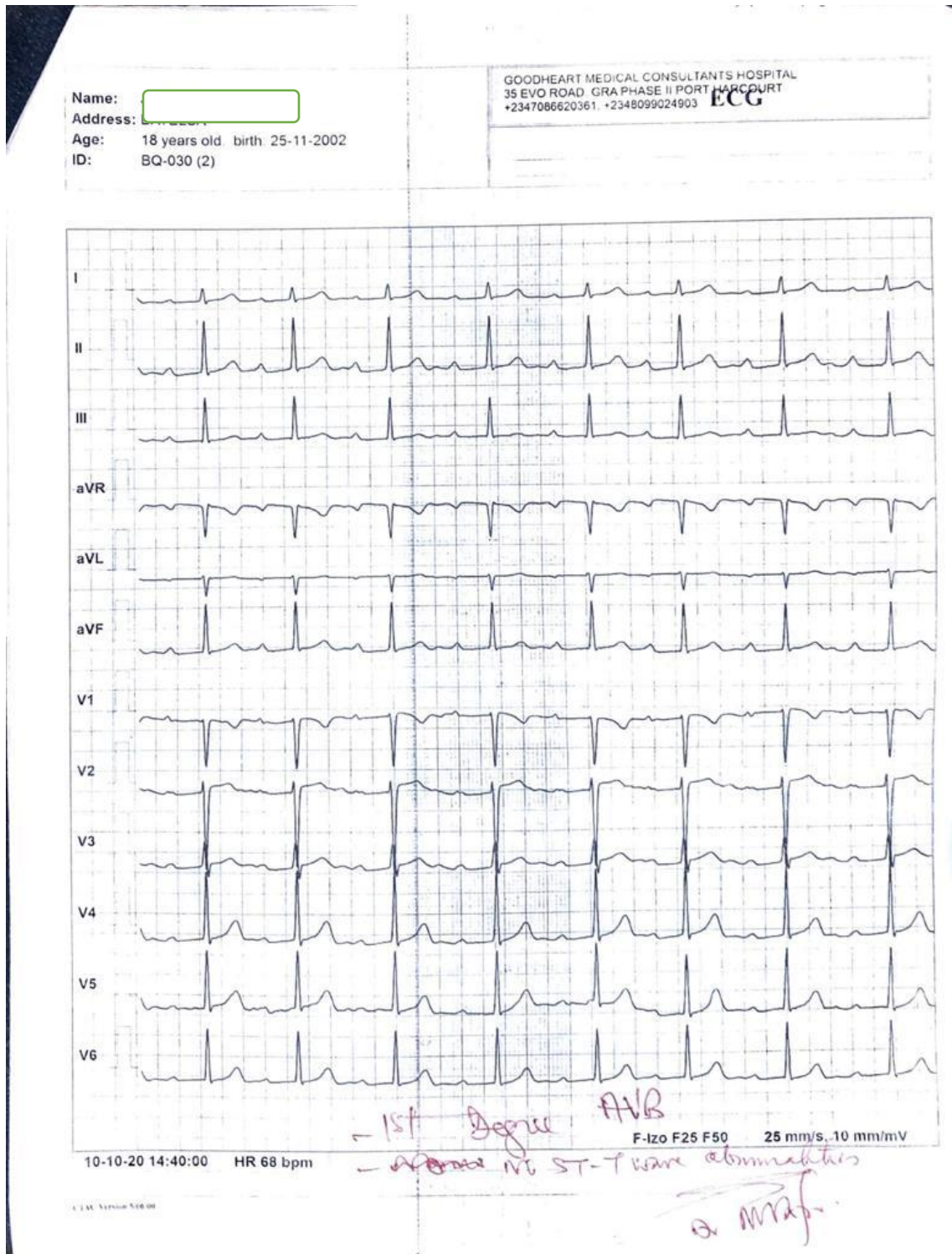
Fig

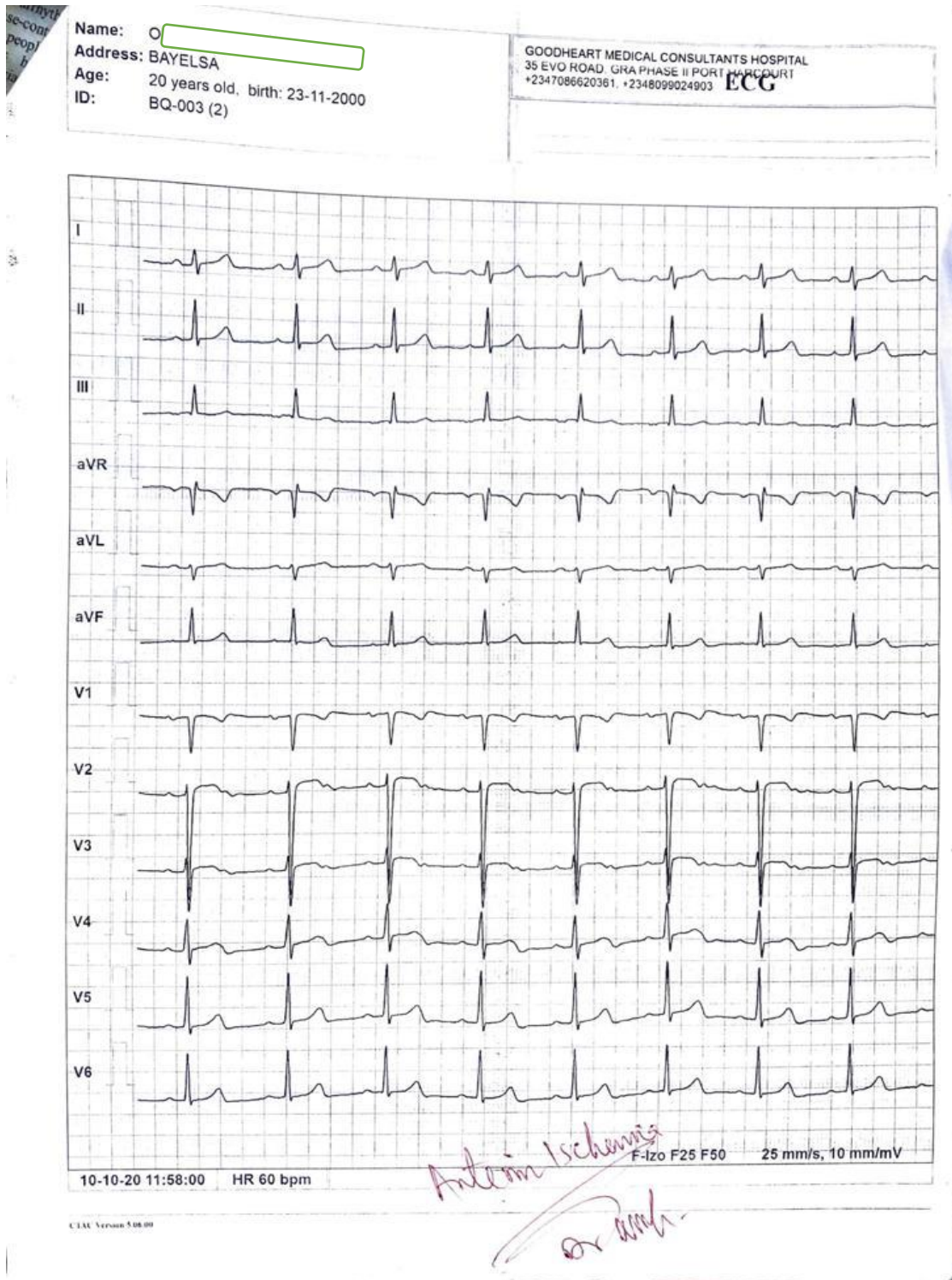1: ECG showing 1st degree AVB, a common training-related ECG changes

Fig 2: ECG showing Anterior ischemia, an uncommon and training-unrelated ECG Change

RESULTS

A total of 56 female footballers were included in this study with ages ranging from 17 to 40 years.

Table 2 shows the anthropometric characteristics of footballers. Mean age of the footballers was 26.3 ± 5.0, mean height was 1.6 m ± 0.1, mean weight was 62.24 kg ± 8.65, mean body mass index was 23.12 kg/m2 ± 2.49, mean waist circumference was 78.79 cm ± 6.92, mean hip circumference was 94.66 cm ± 6.21, mean systolic blood pressure was 127.77 mmHg ± 119.47, mean diastolic blood pressure was 71.62 mmHg ± 8.94 and mean resting heart rate was 73.55 beats per minute ± 13.26.

Table 3 shows the types of ECG findings. The most common ECG changes were anterior ischemia (n=11, 19.6%), sinus bradycardia (n = 9, 16.1%), abnormal t wave inversion (n = 7, 12.5%), early repolarization (n = 4, 7.1%), AV block 1º (n=4, 7.1%), septal ischemia (n = 4, 7.1%). The least common are left atrial enlargement (LAE), arrhythmia and tall T wave which all have a frequency of 1.8% (n = 1) each.

A total of 24 footballers (42.9%) had no ECG changes, while the rest (57.1%) had one or more ECG changes. Common ECG changes were seen in 17 footballers (30.4%) while Uncommon ECG changes were seen in 21 footballers (37.5%), some of the footballers had a combination of the common and uncommon ECG changes.

Table 2: Anthropometric characteristics of the footballers

	Mean	SD
Age (years)	26.3	5.01
Height (m)	1.6	0.1
Weight (kg)	62.24	8.65
BMI (kgm^{-2})	23.12	2.49
Waist Circumference (cm)	78.79	6.92
Hip Circumference (cm)	94.66	6.21
Systolic BP (mmHg)	127.77	119.47
Diastolic BP (mmHg)	71.62	8.94
Heart Rate (b/m)	73.55	13.26

N= 56 participants

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

Table 3: ECG changes of female footballers

ECG CHANGES	Number	Percentage
Group 1 ECG Changes		
Sinus Bradycardia	9	16.1
Early repolarization	4	7.1
AV block 1º	4	7.1
Group 2 ECG Changes		
LAE	1	1.8
Arrhythmia	1	1.8
Septal Ischemia	4	7.1
Anterior ischemia	11	19.6
Inferior ischemia	2	3.6
T-wave inversion	7	12.5
Tall T-wave	1	1.8
ST elevation	2	3.6

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 female football players' ECGs. As to the ECG classification by the ESC, 37.5% of football players in this study had uncommon ECG patterns. These uncommon ECG changes raises the suspicion of structural heart disease or cardiomyopathy of which subsequent echocardiographic evaluation will help confirm changes consistent with cardiomyopathy. These pre-participation screenings of footballers are important in identifying athlete that may be potential victims of SCD.

Thirty percent (30.4%) of these female footballers had common or training-related ECG changes among the common (group 1) ECG changes seen in these female footballers, sinus bradycardia was the most prevalent (16.1% of total participants), early repolarization and first-degree AV block had a prevalence of 7.1% each. Of the training-unrelated ECG changes, anterior ischemia (19.6%) was most common, T-wave inversion (12.5%), septal ischemia (7.5%) and ST elevation (3.6%) inferior ischemia (3.6%). In general, anterior ischemia was the most common ECG changes among these footballers accounting for 19.6% of the total changes, then sinus bradycardia (16.1%) and T wave inversion (12.5). Our study's sinus bradycardia percentage was lower than the 65% in fellow female in the UK(13) and that of male athletes in United Kingdom (57.6%), Dutch football players (56%), Indian athletes with endurance training (42%) and Malaysian footballers (69.9%).(14–17)

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.(18) But according to current research, this adaptation might be the consequence of pacemaker ion channel remodeling and intrinsic heart rate reset.(19,20) Nigerian professional

female footballers demonstrated a normal mean resting heart rate (73 beats per minute) compared to European athletes (59 beats per minute) and Malaysian athletes (53 beats per minute).(14,17)

Early repolarization (7.1%) in our study was far lower than that seen in female athletes show similar changes to male athletes but to a lesser extent. In particular, early repolarization and voltage criteria are significantly less common among female athletes.(21,22) 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(17,18)

There is very low occurrence of sinus arrhythmias (1.8%) found during our pre participation screening is similar to that found among Malaysian footballers (0%)(17) but very low compared to Dutch footballers (20%), trained endurance Indian athletes (12%)(15,16). The low occurrence of respiratory sinus arrhythmias in this study could be explained as athletes were required to perform ECG procedure during quiet respiration, as a result, the variation in heart rhythm between inspiration and expiration was invisible to us.

In this study, the percentage of abnormal T wave inversions (12.5%) was lower than that of Indian endurance athletes (16%)(16) but higher than that seen in Malaysian footballers(17). All the footballers with abnormal T wave inversion were advised and referred for further cardiovascular evaluation.

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. This anomaly can be a sign of a developing, mildly problematic cardiac condition. Apart from that, 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. None of the football players screened for this study had a life threatening heart condition. The number of abnormal ECGs in this study is lower than reported in other studies, however subjects with T wave inversion should have further cardiovascular evaluation following the ESC guideline. This emphasizes the importance of pre-participation screening for athletes.

REFERENCES

1. Wilson MG, Chatard JC, Carre F, Hamilton B, Whyte GP, Sharma S, et al. Prevalence of electrocardiographic abnormalities in West-Asian and African male athletes. Br J Sports Med. 2012 Apr;46(5):341–7.

2. Rost R. THE ATHLETE'S HEART. Cardiol Clin. 1997 Aug;15(3):493–512.

3. Corrado D, Basso C, Thiene G. Essay: Sudden death in young athletes. The Lancet. 2005 Dec 1;366:S47–8.

4. Mehra R. Global public health problem of sudden cardiac death. J Electrocardiol. 2007 Nov;40(6):S118–22.

5. Adetiba E, Iweanya VC, Popoola SI, Adetiba JN, Menon C. Automated detection of heart defects in athletes based on electrocardiography and artificial neural network. Meng W, editor. Cogent Eng. 2017 Jan 1;4(1):1411220.

6. Bent RE, Wheeler MT, Hadley D, Froelicher V, Ashley E, Perez MV. Computerized Q wave dimensions in athletes and hypertrophic cardiomyopathy patients. J Electrocardiol. 2015 May 1;48(3):362–7.

7. Corrado D, Zorzi A. Sudden death in athletes. Int J Cardiol. 2017 Jun;237:67–70.

8. Grazioli G, Usín D, Trucco E, Sanz M, Montserrat S, Vidal B, et al. Differentiating hypertrophic cardiomyopathy from athlete's heart: An electrocardiographic and echocardiographic approach. J Electrocardiol. 2016 Jul;49(4):539–44.

9. Akpa M, Dodiyi-Manuel S. Regular Screening among Sportsmen in Nigeria: Rationale and Basis. Niger J Med. 2013 Dec;22(4):292.

10. Adeseye AA, Lookman KO. Structural and functional adaptations to exercise: Echocardiographic findings among professional footballers on routine screening among Nigerians - A view of athletes′ heart. Niger J Cardiol. 2015 Dec;12(2):111.

11. Zdravkovic M, Milovanovic B, Hinic S, Soldatovic I, Durmic T, Koracevic G, et al. Correlation between ECG changes and early left ventricular remodeling in preadolescent footballers. Physiol Int. 2017 Mar 1;104(1):42–51.

12. Corrado D, Pelliccia A, Heidbuchel H, Sharma S, Link M, Basso C, et al. Recommendations for interpretation of 12-lead electrocardiogram in the athlete. Eur Heart J. 2010 Jan 1;31(2):243–59.

13.   Morrison B, Mohammad A, Oxborough D, Somauroo J, Lindsay S, Drane AL, et al. The 12-lead electrocardiogram of the elite female footballer as defined by different interpretation criteria across the competitive season. Eur J Sport Sci. 2022 Oct 3;22(10):1475–83.

14.   Chandra N, Bastiaenen R, Papadakis M, Panoulas VF, Ghani S, Duschl J, et al. Prevalence of Electrocardiographic Anomalies in Young Individuals. J Am Coll Cardiol. 2014 May 20;63(19):2028–34.

15.   Bohm P, Ditzel R, Ditzel H, Urhausen A, Meyer T. Resting ECG findings in elite football players. J Sports Sci. 2013 Sep 1;31(13):1475–80.

16.   Bessem B, De Bruijn MC, Nieuwland W. Gender differences in the electrocardiogram screening of athletes. J Sci Med Sport. 2017 Feb;20(2):213–7.

17.   Aziz MAB, Abu Hanifah R. Characteristics of resting ECG among sabah professional male footballers. Malays J Mov Health Exerc. 2021 Jun;10(1):55.

18.   Drezner JA, Sharma S, Baggish A, Papadakis M, Wilson thew G, Prutkin JM, et al. International criteria for electrocardiographic interpretation in athletes (deel 2). | Sport & Geneeskunde | EBSCOhost [Internet]. 2017 [cited 2024 Jan 22]. p. 44. Available from: https://openurl.ebsco.com/contentitem/gcd:133944545?sid=ebsco:plink:crawler&id=ebsco:gcd:133944545

19.   D'Souza A, Bucchi A, Johnsen AB, Logantha SJRJ, Monfredi O, Yanni J, et al. Exercise training reduces resting heart rate via downregulation of the funny channel HCN4. Nat Commun. 2014 May 13;5(1):3775.

20.   Bahrainy S, Levy WC, Busey JM, Caldwell JH, Stratton JR. Exercise training bradycardia is largely explained by reduced intrinsic heart rate. Int J Cardiol. 2016 Nov 1;222:213–6.

21.   Brosnan M, Gerche AL, Kalman J, Lo W, Fallon K, MacIsaac A, et al. Comparison of Frequency of Significant Electrocardiographic Abnormalities in Endurance Versus Nonendurance Athletes. Am J Cardiol. 2014 May 1;113(9):1567–73.

22.   Rawlins J, Carre F, Kervio G, Papadakis M, Chandra N, Edwards C, et al. Ethnic Differences in Physiological Cardiac Adaptation to Intense Physical Exercise in Highly Trained Female Athletes. Circulation. 2010 Mar 9;121(9):1078–85.