Gender-Related ECG Differences Among Professional Footballers in Southern Nigeria

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Abstract

This study aimed at evaluating the prevalence of abnormal electrocardiographic (ECG) patterns in male and female footballers and comparing the similarities and differences between the genders.

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 are always screened for cardiac disorders.*

Methods*: 85 (29 males and 56 females) 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 International Criteria for Interpretation of Electrocardiogram in Athletes 2017.*

Results: *Mean age of the players was 25.9 ± 4.5, mean body mass index was 23.5 kg/m^2 ± 2.3, mean resting heart rate was 68.3 beats per minute ± 14.2, mean systolic blood pressure was 127.3 mmHg ± 96.9, and mean diastolic blood pressure was 73.5 mmHg ± 9.5. The females had higher mean age (26.3 ± 5.01 years), mean systolic blood pressure (127.77 ± 119.47 mmHg) and heart rate (73.55 ± 13.26 bpm) than the males. Group 1 patterns occurred in 50.6% of the footballers (89.7% males and 30.4% females) while Group 2 patterns occurred in 43.53% (55.2% for males and 37.5% for females). Sinus bradycardia was the major ECG changes (30.59%) and seen more in male footballers (60.71% of males). T-wave inversion (34.48% vs 12.5%, p = 0.014), anterior ischemia (12.94%), ST elevation (48.28% vs 3.57%, p = 0.000) were more significantly more common among the male footballers than females.*

Conclusions: *The study demonstrated that apart from sinus bradycardia and early repolarization, non-exercise related ECG changes such as ischemia, ST elevation and T wave abnormalities were major ECG changes among male and 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, professional, footballers, sudden cardiac death, athlete, Nigeria*

INTRODUCTION:

Electrocardiographic (ECG) abnormalities commonly observed in athletes are referred to as "athletes heart" and are generally caused by a physiologically benign remodeling of the heart brought on by prolonged, high-intensity exercise.(1) 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).(2,3) An athlete's sudden cardiac death (SCD) always leaves the family, the team, and the community in shock. The most common medical cause of sudden death in athletes is sudden cardiac death (SCD), with estimates varying greatly depending on the demographic.(3) According to a recent study, the incidence of SCD in athletes ranged from one in 40,000 to one in 80,000 annually.(2–4)

Males are more at risk of SCD than females.(5) Only adult males engaged in endurance sports can experience extreme athlete's heart symptoms; in rare occasions, these can coincide with symptoms seen in people with hypertrophic cardiomyopathy (HCM). Conversely, there are no ECG or echocardiographic abnormalities that could be interpreted as indicative of HCM in white female athletes.(6)

Worldwide, cases of sudden death are always celebrated. Although there is no strategy in place to avoid sudden deaths among Nigerian football players, Akpa claimed that there is cause for concern due to the rise in reports of these deaths. (7) Pre-participation screening helps to the identify asymptomatic athletes who have potentially lethal cardiovascular abnormalities(5,8) According to the consensus panel guidelines of the American Heart Association and the European Society of Cardiology, cardiovascular monitoring is ethically, legally, and medically justified for young competitive athletes.(5,9) To the best our knowledge, there are very few studies done strictly for baseline characteristics of ECG among professional footballers in Nigeria assessing both male and female. Therefore, the aim of this study was to analyze resting ECG changes amongst professional footballers according to the recent ECG classifications and to determine the frequency of suspicious findings using the International Criteria for Interpretation of Electrocardiogram in Athletes.(10) The objectives are to determine the sex of footballers with more abnormal ECGs and the type of ECG abnormality commonly seen in each sex.

METHOD:

Study design

This study represents a descriptive, retrospective study in a sample of highly trained football players. The participants were professional footballers from three Division 1 Football Clubs of the Nigerian Football Federation. All athletes competed at the national level and exercised about 6h/week. The screening took place in Port Harcourt Rivers State Nigeria at the stadium by GoodHeart Medical Consultants research unit ahead of a national competition.

12- Lead 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. . ECG was interpreted 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

A descriptive data analysis was performed using STATA version 15 and were expressed using mean and standard deviation (SD). Differences of proportions between groups were tested using chi-square test with a significance defined as $p < 0.05$ throughout.

RESULTS:

A total of 29 professional male were recruited for the study. Table 1 summarizes the clinical characteristics of the study participants. The mean age of the males (25.1 ± 3.4 years) was lesser than that of the females (26.3 ± 5.01 years) while the combined mean age was 25.9 ± 4.5 years. The mean height of the male and female footballers were 1.8 ± 0.1 and 1.6 ± 0.1, respectively, while the mean weight for male and females were 78.6 ± 7.2 kg and 62.24 ± 8.65, respectively and the total 67.8 ± 11.3 kg. BMI of male and female footballers was comparable, the females had lower waist circumference (78.79 ± 6.92 cm) than the males (83.1 ± 3.8). The mean systolic blood pressure (BP) of males (126.2 ± 11.9) was lower than that of females (127.77 ± 119.47 mmHg) while the mean diastolic for males (77.1 ± 9.5 mmHg) was higher than that of females (71.62 ±

8.94 mmHg). The mean heart rate for male (58.2 ± 9.8 beat/min) was lower than that of female (73.55 ± 13.26 beat/min).

Table 1: Comparison of the mean of baseline clinical characteristics of the footballers

	Male	**Female**	**Total**
Age (years)	25.1 ± 3.4	26.3 ± 5.01	25.9 ± 4.5
Height (m)	1.8 ± 0.1	1.6 ± 0.1	1.7 ± 0.1
Weight (kg)	78.6 ± 7.2	62.24 ± 8.65	67.8 ± 11.3
BMI (kgm^{-2})	24.3 ± 1.8	23.12 ± 2.49	23.5 ± 2.3
Waist Circumference (cm)	83.1 ± 3.8	78.79 ± 6.92	80.3 ± 6.4
Hip Circumference (cm)	99 ± 3.7	94.66 ± 6.21	96.1 ± 5.8
Systolic BP (mmHg)	126.2 ± 11.9	127.77 ± 119.47	127.3 ± 96.9
Diastolic BP (mmHg)	77.1 ± 9.5	71.62 ± 8.94	73.5 ± 9.5
Heart Rate (b/m)	58.2 ± 9.8	73.55 ± 13.26	68.3 ± 14.2

ECG patterns in male versus female footballers. Group 1 ECG patterns were present in majority of males than females (89.7% vs. 30.4%) while the combined occurrence was 50.6% (n= 43). All group 1 ECG patterns were less prevalent in females compared with male footballers. Sinus bradycardia was common in both groups, whereas early repolarization (17.86% for male) and isolated voltage criteria for left ventricular hypertrophy was predominantly a feature in male footballers (55.56%) (Table 2). The proportion of individuals with a completely normal ECG was 39.3% (n = 22) of females but only 6.9% (n= 2) of male (Fig. 1). Group 2 ECG changes were more common in male than in females. In females group 2 changes was 37.5% (n = 21) and in males 55.2% (n=16). T-wave inversion was more common in male footballers than female footballers (34% vs. 12.50%; p = 0.014) ST elevation was significantly more common in males than females (48.28% vs. 3.57%; p = 0.000). Tall T wave, Right atrial enlargement (RAE) and left anterior hemi block were rare among the footballers.

Table 2: Comparison of the ECG changes between the male and female footballers

ECG CHANGES	**MALE N = 29**	**FEMALE N = 56**	**TOTAL N = 85**	**P-VALUE**
Group 1				
Sinus Bradycardia	17 (60.71)	9 (16.07)	26 (30.59)	*0.000
ER	5 (17.86)	4 (7.14)	9 (10.59)	0.304
LVH	15 (55.56)	0	15 (17.65)	*0.000
AV block 1º	4 (14.29)	4 (7.14)	8 (9.41)	0.543
Arrhythmia	3 (10.71)	1 (1.79)	4 (4.71)	0.186

Group 2				
LAE	1 (3.57)	1 (1.79)	2 (2.35)	0.868
Septal Ischemia	2 (7.14)	4 (7.14)	6 (7.06)	0.962
Anterior ischemia	0	11 (19.64)	11 (12.94)	*0.038
Inferior ischemia	1 (3.57)	2 (3.57)	3 (3.53)	0.982
T-wave inversion	10 (34.48)	7 (12.50)	17 (20.00)	*0.014
Tall T-wave	0	1 (1.79)	1 (1.18)	0.770
ST elevation	14 (48.28)	2 (3.57)	16 (18.82)	*0.000
RAE	1 (3.57)	0	1 (1.18)	0.357
Left anterior hemi block	1 (3.57)	0	1 (1.18)	0.357

*significant p-value

DISCUSSION

Previous research indicates that ECG screening in sportsmen may reduce the incidence of sudden cardiac death (SCD); (11) however, data for Nigerian football players is scarce.

The International Criteria for ECG Interpretation in Athletes 2017 consensus guidelines is one of the most recent recommendations for ECG interpretation in athletes. It replaced the Seattle Criteria, which was developed in 2013 and improved specificity for ECG-detectable pathological conditions associated with SCD while retaining sensitivity.(10)

This study found that sinus bradycardia is the most common ECG changes (30.59%) among footballers with an occurrence of 60.7% in males and 16.07% in females. The result for males is similar to 69.9% found among Malaysian footballers (8) and higher than 55% in European footballers(12). Sinus bradycardia among the female footballers in this study is lower than 65% found among their female counterparts in the U.K (13). In general sinus bradycardia is higher in athletes than non-athletes as can be seen in a study among European athletes and non-athletes where its occurrence was 26.1% in non-athletes and 57.6% in athletes. (14) Sinus bradycardia, defined by a resting heart rate <60 beats min−1, is the most frequent rhythm disturbance in response to exercise training. Possible mechanisms for the lower heart rate include: 1) increased parasympathetic tone; 2) decreased responsiveness to beta-adrenergic stimulation; 3) decreased intrinsic heart rate. (15,16) Nigerian footballers showed a higher mean resting heart rate (68 beats per minute) compared to European athletes (59 beats per minute) (12).

The occurrence of sinus arrhythmia in this study was 4.7%, the male footballers had a non-significant higher (10.71%) occurrence than the female (1.79%) with p-value 0.186. This result in lower than that found in trained endurance Indian athletes (12%), and Malaysian university athletes (42.5%). (17,18) The low occurrence of sinus arrhythmias in this study could be explained as athletes were required to perform ECG procedure in quiet respiration. Thus, we were unable to see the difference in heart rhythm during inspiration and expiration. Presence of sinus arrhythmias indicates a healthy, fit cardiorespiratory fitness, and young in age.(8) Early repolarization (ER) was insignificantly higher in males than females (17.86% vs. 7.14%; p = 0.304). Similar studies in Romania and the UK also found ER to be higher in males than females. (19,20) LVH was

higher in males than female (55.56% vs. 0%) with a significant difference (p = 0.000) between the two groups.

The most common abnormal ECG changes seen in this study was abnormal T wave inversion (20%), ST elevation (18.82%), and anterior ischemia (12.94%). In this study, the percentage of abnormal T wave inversions (20%) was higher than that of Indian endurance athletes (16%), Sabah footballers (4%) and European football players (2.3%).(8,21,22) Finding abnormal T wave inversion is crucial for the early diagnosis of cardiomyopathy which may not show symptoms for years and may eventually be linked to negative consequences. As such, it should be considered a possible red flag on the ECG of young, seemingly healthy athletes and deserves more research.(20,21) This result, meanwhile, might be typical for athletes who are African Americans or younger than sixteen.(20)

The occurrence of left atrial enlargement (LAE) is very low (2.35%) in this study (3.57% for males vs. 1.79% for females). Studies in the Malaysian university athletes and Sabah football players in Malaysia did not find LAE among the athletes,(8,18) though it is primarily observed in American football players (48.1%), primarily African Americans.(12) According to a comprehensive review, left atrial enlargement is frequently observed in elite endurance athletes.(23) Similarly, RAE and left anterior hemi block were rarely prevalent in both genders (3.57% for males vs. 0% for females), respectively.

CONCLUSION:

This study demonstrated that a significant percentage of footballers had abnormal ECG recordings and men were more likely than women to have abnormal ECG patterns. The majority of these are benign and have to do with the body's physiological response to high amounts of physical activity. Footballers showing ECG changes that are uncommon such as T wave inversion and ST elevation are recommended to do further cardiovascular evaluations as this can reveal underlying, concealed structural heart disease or life-threatening arrhythmogenic cardiomyopathies, which may be responsible for exercise-related sudden cardiac death (SCD).

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