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Clinical and Electrocardiographic Profile of Candidates for the Physical Education and Sports Teaching Aptitude Examination in Senegal

Ngoné Diaba Gaye[1,2*], Joseph Salvador Mingou[1,3], Ahmed Hamid Subra[1,2], Malick Ndiaye[1,4], Marguerite Tening Diouf[1,4], Lamine Ly[4], Seydina Oumar Gueye[4], Mamadou Adama Thiam[4], Alassane Mbaye[1,5], Abdoul Kane[1,4], Aliou Alassane Ngaïdé[1,4]

[1]Faculty of Medicine, Cheikh Anta Diop University, Dakar, Senegal
[2]Department of Cardiac Rehabilitation, Ibra Mamadou Wane Medical Center, Dakar, Senegal
[3]Cardiology Department, Aristide Le Dantec Hospital, Dakar, Senegal
[4]Cardiology Department, Dalal Jamm Hospital, Dakar, Senegal
[5]Cardiology Department, Idrissa Pouye General Hospital, Dakar, Senegal
Email: *diabagaye@gmail.com

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Abstract

Introduction: Regular physical activity is beneficial for cardiovascular health, but intense exercise may be associated with clinical and electrocardiographic adaptations that can sometimes be difficult to distinguish from pathological abnormalities. Among candidates for the aptitude certificate for physical education and sports teaching, who are exposed to endurance and sprint events, cardiovascular assessment is an important preventive issue. The objectives of this study were to evaluate the clinical and electrocardiographic profiles of candidates for this examination, describe the abnormalities observed, and identify situations requiring monitoring or further investigation. Methods: This prospective cross-sectional study, with descriptive primary and exploratory comparative analyses, was conducted from 19 to 21 December 2022 at the National Centre for Popular and Sports Education in Thiès. Cardiologist-led screening was available only at the Thiès centre during the final three days of the national examination. All 89 consecutively approached candidates consented and were included. Resting 12-lead ECGs were interpreted using prespecified international criteria. The primary objective was to estimate the prevalence of clinical and ECG findings; sex comparisons were secondary and exploratory, with effect estimates and 95% confidence intervals. Results: The sample included 70 men (78.7%) and 19 women (21.3%), with a mean age of 30.58 ± 7.14 years. All participants reported physical activity, although training volume and com-

petitive level were not recorded. Single-visit blood-pressure values fell within the grade 1 and grade 2 office ranges in 16.9% (95% CI 10.5 - 26.0) and 2.2% (95% CI 0.6 - 7.8), respectively. All ECGs showed sinus rhythm. Bradycardia occurred in 29.2% (95% CI 20.8 - 39.4), T-wave inversion in 23.6% (95% CI 16.0 - 33.4), prolonged Bazett-corrected QT interval (QTc) in 11.2% (95% CI 6.2 - 19.5), first-degree atrioventricular block in 7.9% (95% CI 3.9 - 15.4), left atrial enlargement in 6.7% (95% CI 3.1 - 13.9), and incomplete right bundle branch block in 5.6% (95% CI 2.4 - 12.5). Conclusion: Several ECG findings are classified as training-related when observed in appropriately trained athletes; however, their attribution to exercise could not be established because training exposure was not quantified. Repolarisation abnormalities and prolonged QTc require specialist interpretation. These findings support a structured, context-appropriate cardiovascular screening and referral pathway for this candidate population.

Keywords

Electrocardiogram, Pre-Participation Screening, Physical Activity, Sports Eligibility, Senegal

1. Introduction

Regular physical activity reduces cardiovascular mortality, improves functional capacity and represents a major strategy for the prevention of non-communicable diseases. However, in individuals exposed to intense or competitive exercise, it may be associated with cardiovascular adaptations that can modify both the clinical examination and the resting electrocardiogram. The main challenge is to distinguish physiological manifestations of athlete's heart from abnormalities that may reveal an undiagnosed cardiomyopathy, channelopathy or conduction disorder associated with a risk of serious exercise-related events [1]-[5].

Pre-participation medical evaluation therefore plays a central role in cardiovascular prevention among athletes. Resting electrocardiography, when combined with history-taking and physical examination, improves the detection of silent cardiovascular disease compared with screening based on questionnaires alone. However, ECG interpretation requires specific criteria in order to reduce false-positive findings [6]-[10]. International recommendations now distinguish between training-related normal findings, borderline findings and abnormal findings requiring further investigation [11]-[14]. In resource-limited settings, the challenge is twofold: to ensure the safety of sports events and to develop realistic referral pathways that are proportionate to risk, available before competition, and acceptable to candidates, supervisors and training institutions within the current Senegalese context.

In Senegal, candidates for the Certificate of Aptitude for Physical Education and Sports Teaching represent a specific population: young adults, physically active, exposed to endurance and sprint events, and expected to supervise sports practice

over the long term. However, local data on their clinical and electrocardiographic profile remain limited, while most published series originate from Europe or North America [15]-[18]. The primary objective was to estimate the prevalence of clinical and resting ECG findings among candidates for this examination. The secondary, exploratory objective was to compare selected clinical and ECG findings between male and female participants and to identify findings requiring monitoring or cardiological assessment before clearance for sports participation.

2. Methods

This prospective cross-sectional study, with descriptive primary and exploratory comparative analyses, was conducted from 19 to 21 December 2022 at the National Centre for Popular and Sports Education (CNEPS) in Thiès, Senegal. Approximately 2,500 candidates participated in the national examination across two centres. Cardiologist-led clinical and electrocardiographic assessment was available only at the Thiès centre during the final three days of the examination. All candidates presenting at Thiès during this recruitment window were consecutively invited. Candidates aged 18 years or older who agreed to undergo clinical and ECG assessment were eligible; refusal to participate and pregnancy were exclusion criteria. All 89 candidates approached provided written informed consent and met the eligibility criteria; there were no refusals and no exclusions. Candidates attending the other centre or presenting outside the cardiologist-availability window were not approached. The resulting sample was therefore a consecutive time-window convenience sample rather than a random sample of the national examination population.

Data were collected using a pre-established survey form comprising three sections: medical history, clinical examination and electrocardiographic assessment. The interview collected information on age, sex, geographical origin, occupation, personal and family history, sports practice, alcohol consumption and smoking status. The clinical examination included assessment of general condition, weight, height, body mass index, heart rate, respiratory rate, peripheral oxygen saturation, temperature and cardiovascular auscultation. Training frequency, session duration, cumulative training history, weekly exercise exposure and competitive level were not collected.

Blood pressure was measured using an OMRON M6 electronic blood pressure monitor after ten minutes of rest, in the seated position, on both arms. Two consecutive measurements were performed by the same technician, and the highest values were retained. Weight was measured using an OMRON scale in lightly dressed, barefoot participants; height was measured with a portable stadiometer. Body mass index was calculated in kg/m^2 and classified according to World Health Organization thresholds. Because blood pressure was assessed at a single visit, these categories were interpreted as office blood-pressure ranges and not as definitive hypertension diagnoses.

All participants underwent a resting 12-lead ECG in the supine position using a portable six-channel SCHILLER electrocardiograph. The parameters analysed

included rhythm, heart rate, frontal QRS axis, P-wave morphology and duration, PR interval, QRS duration, QT interval, repolarisation, ST segment, T waves and voltage criteria for ventricular hypertrophy. QTc was calculated using the Bazett and Hodges formulas; classification was based on Bazett-corrected QTc, with prolongation defined as ≥470 ms in men and ≥480 ms in women. Left atrial enlargement was defined by a P-wave duration >120 ms in leads I or II together with a negative terminal P-wave component in V1 ≥1 mm in depth and ≥40 ms in duration. Left-axis deviation was defined as a frontal QRS axis <−30˚. An ECG voltage criterion for left ventricular hypertrophy was defined by a Lewis index >17 mm. T-wave inversion was defined as a negative T wave ≥1 mm in depth in at least two contiguous leads, excluding aVR, lead III and V1. ST-segment depression was defined as depression ≥0.5 mm in at least two contiguous leads. ECG interpretation followed the International Criteria for ECG Interpretation in Athletes [11] [12].

Data were analysed using SPSS version 21. Qualitative variables were described as frequencies and percentages, and quantitative variables as means and standard deviations. The primary analysis estimated the prevalence of clinical and ECG findings with Wilson 95% confidence intervals. Secondary sex comparisons were exploratory and were expressed as mean differences or absolute prevalence differences with 95% confidence intervals; Newcombe intervals were used for differences between proportions.

The study protocol was reviewed and approved by the Research Ethics Committee of Cheikh Anta Diop University (UCAD), Dakar; the committee did not issue a formal approval reference number for this study. All participants provided written informed consent before enrolment. Direct personal identifiers were removed from the research dataset, and analyses were conducted using deidentified data accessible only to the research team.

3. Results

Approximately 2,500 candidates participated in the national examination across two centres. Because cardiologist-led screening was available only during the final three days at the Thiès centre, 89 consecutively assessed candidates were enrolled; there were no refusals or exclusions (**Figure 1**). The sample comprised 70 men (78.7%) and 19 women (21.3%), with a male-to-female ratio of 3.68. The mean age was 30.58 ± 7.14 years (range 19 - 50 years). The 20 - 29-year and 30 - 39-year age groups represented 41.6% and 40.4% of the sample, respectively (**Figure 2**). Men were, on average, 5.50 years older than women (31.76 ± 6.95 versus 26.26 ± 6.25 years; mean difference 5.50 years, 95% CI 2.12 - 8.88).

All candidates reported practising physical activity, although training frequency, duration, weekly exposure and competitive level were not recorded. Football was the most commonly reported sport (62.9%), followed by athletics (43.8%). Football participation was more frequent among men than women (75.7% versus 15.8%; absolute prevalence difference 59.9 percentage points, 95% CI 35.4 - 73.3) (**Figure 3**). No candidate reported current smoking; 4.5% reported previous smoking and

4.5% occasional alcohol consumption.

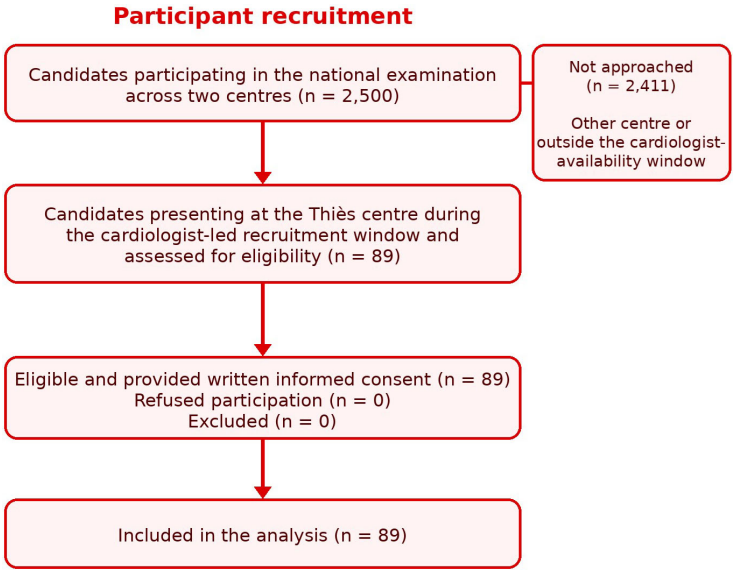

Figure 1. Participant recruitment flow.

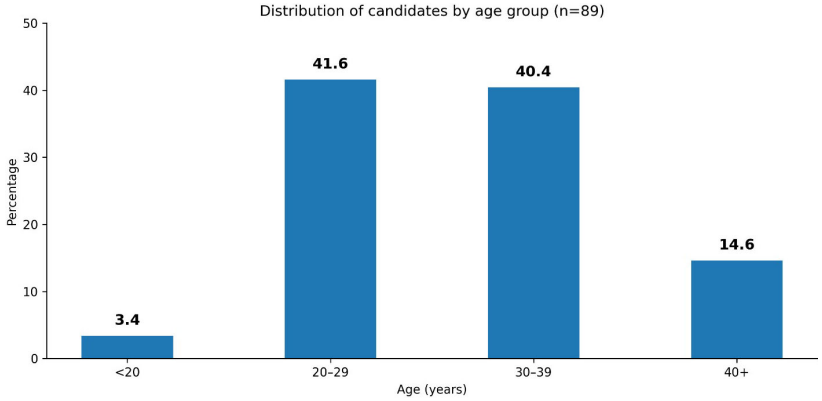

Figure 2. Distribution of candidates by age group (n = 89).

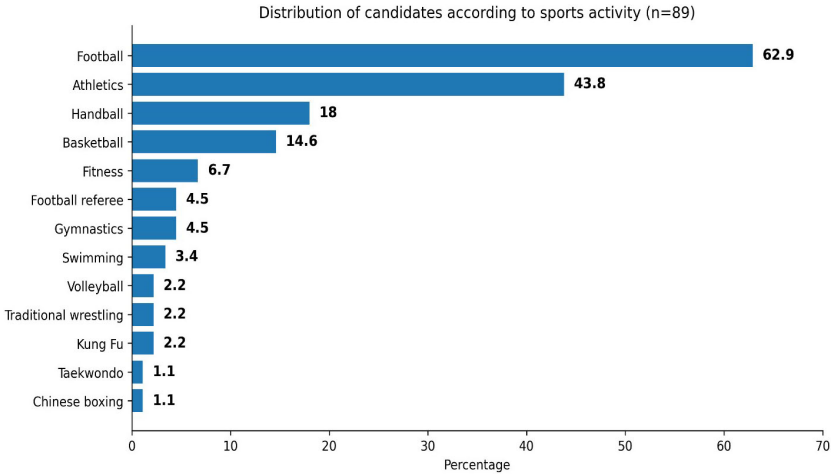

Figure 3. Distribution of candidates according to reported sports activity (n = 89).

Mean weight was 67.11 ± 11.11 kg, mean height was 1.75 ± 0.08 m and mean body mass index was 21.97 ± 3.23 kg/m^2. Mean systolic blood pressure was 130.92 ± 13.08 mmHg and mean diastolic blood pressure was 79.24 ± 9.10 mmHg. At this single examination-day assessment, blood-pressure values were within the optimal range in 20.2% of candidates, the normal range in 60.7%, the grade 1 office range in 16.9% (95% CI 10.5 - 26.0), and the grade 2 office range in 2.2% (95% CI 0.6 - 7.8); no value was within the grade 3 range. The mean clinical heart rate was 70.99 ± 15.32 bpm.

All ECGs showed regular sinus rhythm. The mean ECG heart rate was 71.10 ± 16.47 bpm; bradycardia <60 bpm was observed in 26 candidates (29.2%, 95% CI 20.8 - 39.4), while a heart rate >100 bpm was observed in five (5.6%, 95% CI 2.4 - 12.5) (Figure 4). The frontal QRS axis was normal in 83 candidates (93.3%); six had left-axis deviation <−30˚ (6.7%, 95% CI 3.1 - 13.9) (Table 1). Left atrial enlargement was noted in six candidates (6.7%, 95% CI 3.1 - 13.9). The mean PR interval was 168.82 ± 32.46 ms; first-degree atrioventricular block (PR interval >200 ms) was observed in seven candidates (7.9%, 95% CI 3.9 - 15.4) (Table 2). The mean QRS duration was 87.40 ± 11.12 ms. Incomplete right bundle branch block occurred in five candidates (5.6%, 95% CI 2.4 - 12.5). Prolonged Bazett-corrected QTc occurred in ten candidates (11.2%, 95% CI 6.2 - 19.5) (Figure 5), early repolarisation in three (3.4%, 95% CI 1.2 - 9.4), ST-segment depression in two (2.2%, 95% CI 0.6 - 7.8), T-wave inversion in 21 (23.6%, 95% CI 16.0 - 33.4) (Figure 6), and an ECG voltage criterion for left ventricular hypertrophy by the Lewis index in four (4.5%, 95% CI 1.8 - 11.0). Exploratory sex-specific estimates and absolute prevalence differences are presented in Table 3; all confidence intervals for ECG sex differences included the null value.

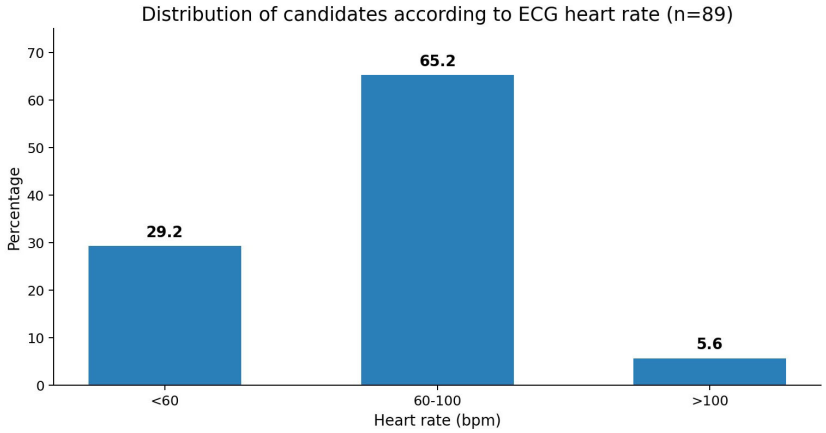

Figure 4. Distribution of candidates according to ECG heart rate (n = 89).

Table 1. Distribution of frontal QRS axis according to sex (n = 89).

QRS axis	Male n (%)	Female n (%)	Overall n (%) [95% CI]	Female-male difference pp (95% CI)
Normal	64 (91.4%)	19 (100.0%)	83 (93.3%) [86.1 to 96.9]	8.6 (−8.9 to 17.5)
Left-axis deviation (<−30°)	6 (8.6%)	0 (0.0%)	6 (6.7%) [3.1 to 13.9]	−8.6 (−17.5 to 8.9)

Table 2. Distribution of PR interval according to sex (n = 89).

PR interval	Male n (%)	Female n (%)	Overall n (%) [95% CI]	Female-male difference pp (95% CI)
120 - 200 ms	66 (94.3%)	16 (84.2%)	82 (92.1%) [84.6 to 96.1]	−10.1 (−32.1 to 3.0)
>200 ms	4 (5.7%)	3 (15.8%)	7 (7.9%) [3.9 to 15.4]	10.1 (−3.0 to 32.1)

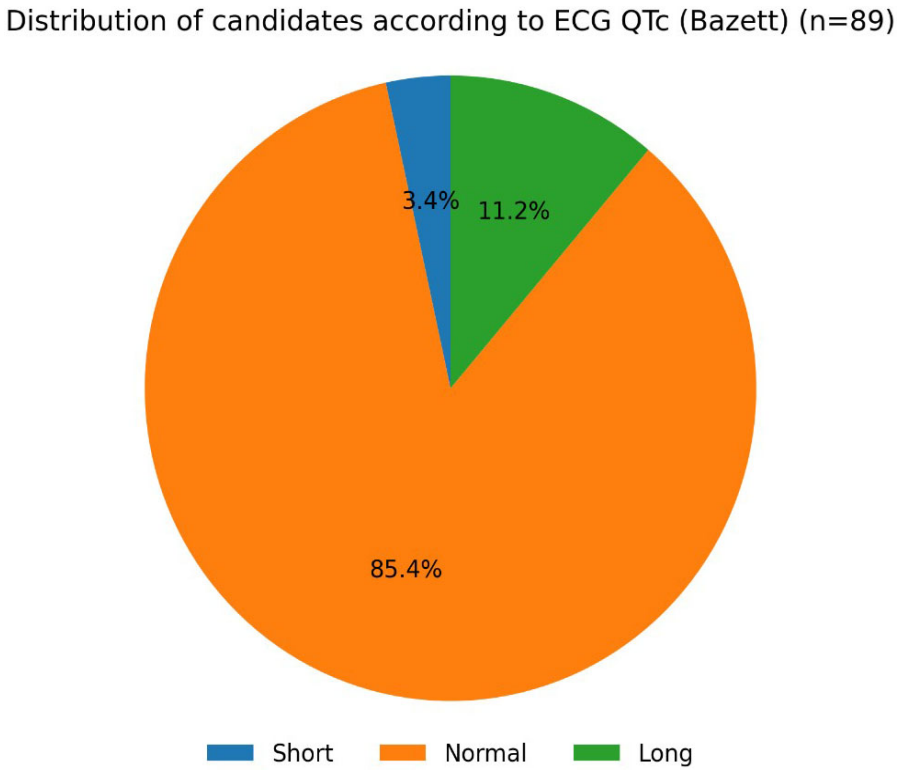

Figure 5. Distribution of candidates according to Bazett-corrected QTc classification (n = 89).

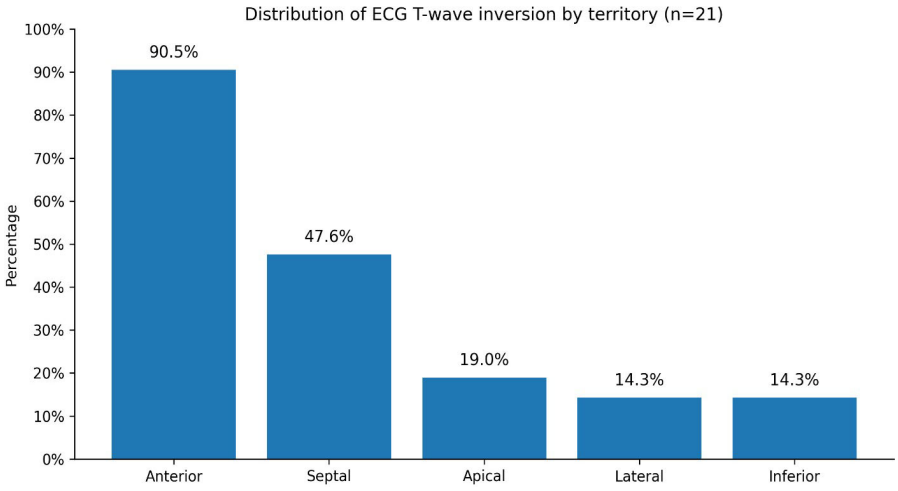

Figure 6. Distribution of ECG T-wave inversion by territory among candidates with T-wave inversion (n = 21); territories were not mutually exclusive.

Table 3. Exploratory sex comparisons of selected ECG findings (n = 89).

ECG finding	Male n (%)	Female n (%)	Overall n (%) [95% CI]	Female-male difference pp (95% CI)
Left atrial enlargement	3 (4.3%)	3 (15.8%)	6 (6.7%) [3.1 to 13.9]	11.5 (−1.3 to 33.5)
Left-axis deviation	6 (8.6%)	0 (0.0%)	6 (6.7%) [3.1 to 13.9]	−8.6 (−17.5 to 8.9)
First-degree AV block	4 (5.7%)	3 (15.8%)	7 (7.9%) [3.9 to 15.4]	10.1 (−3.0 to 32.1)
ST-segment depression	1 (1.4%)	1 (5.3%)	2 (2.2%) [0.6 to 7.8]	3.8 (−3.8 to 23.2)
Precordial T-wave inversion	2 (2.9%)	0 (0.0%)	2 (2.2%) [0.6 to 7.8]	−2.9 (−9.8 to 14.1)
Inferior T-wave inversion	3 (4.3%)	0 (0.0%)	3 (3.4%) [1.2 to 9.4]	−4.3 (−11.9 to 12.8)
Anteroseptal T-wave inversion	8 (11.4%)	2 (10.5%)	10 (11.2%) [6.2 to 19.5]	−0.9 (−13.1 to 20.7)
LVH voltage criterion	4 (5.7%)	0 (0.0%)	4 (4.5%) [1.8 to 11.0]	−5.7 (−13.8 to 11.5)
Early repolarisation	2 (2.9%)	1 (5.3%)	3 (3.4%) [1.2 to 9.4]	2.4 (−5.8 to 21.9)
Prolonged QTc	10 (14.3%)	0 (0.0%)	10 (11.2%) [6.2 to 19.5]	−14.3 (−24.3 to 3.7)

Values are n (%) unless otherwise indicated. CI, confidence interval; pp, percentage points; AV, atrioventricular; LVH, left ventricular hypertrophy; QTc, corrected QT interval. Absolute prevalence differences are female minus male and were calculated using Newcombe 95% confidence intervals. These comparisons were exploratory.

4. Discussion

This study describes the clinical and electrocardiographic profile of Senegalese candidates for the aptitude examination for physical education and sports teaching. The principal finding was the coexistence of an overall young, physically active profile with office blood-pressure elevations and several ECG findings, including sinus bradycardia, first-degree atrioventricular block, incomplete right bundle branch block, prolonged QTc and repolarisation abnormalities. Although some of these findings are classified as training-related in athlete-specific ECG criteria, the absence of quantified training exposure prevents their attribution to chronic exercise adaptation in this cohort. The results nevertheless support a structured cardiovascular assessment and referral pathway before intense physical exercise [1] [6] [11].

The male predominance is consistent with several African and international series involving athletic populations, but it also highlights the need to improve fe-

male participation in physical education training pathways. The mean age, around 30 years, places this cohort beyond the age range of many studies involving school or university athletes. This is relevant because cardiovascular risk factors and acquired abnormalities become more frequent with increasing age [19]-[21]. Blood-pressure values within the grade 1 or grade 2 office ranges require confirmation using standardised repeat office measurements or out-of-office monitoring; the present single-visit assessment cannot establish a diagnosis of hypertension [22] [23].

The ECG findings should be interpreted with caution. In appropriately trained athletes, isolated sinus bradycardia, first-degree atrioventricular block and incomplete right bundle branch block are commonly classified as training-related findings [11]-[14]. Conversely, T-wave inversion in at least two contiguous leads, ST-segment depression and prolonged QTc are findings requiring specialist assessment, particularly when persistent, extensive or associated with symptoms, family history or abnormal clinical findings [11] [24]-[27]. In this study, the frequency of T-wave inversion and the presence of prolonged QTc support standardised review by a cardiologist trained in athlete ECG interpretation. However, because training exposure was not measured, physiological adaptation and underlying pathology cannot be distinguished from the present data alone.

This study has several limitations. Cardiologist-led recruitment was confined to the final three days at the Thiès centre; consequently, the 89 participants constituted a consecutive time-window convenience sample rather than a representative sample of all 2,500 national candidates. This availability-based selection limits generalisability and may have introduced selection bias. The small sample also limited precision and precluded robust multivariable analysis. Training frequency, duration, weekly exercise exposure, cumulative training history and competitive level were not collected, preventing formal classification of participants by training status and limiting interpretation of possible exercise-related ECG adaptation. Blood pressure was assessed during a single examination-day visit, and systematic echocardiography, exercise testing, Holter monitoring and ambulatory blood-pressure confirmation were unavailable. The pathological significance of observed abnormalities therefore could not be established. Nevertheless, the study provides locally relevant data on a practical sports public-health issue in a resource-constrained setting. The findings support development of a context-appropriate pre-participation pathway incorporating a standardised questionnaire, clinical examination, resting ECG interpreted using international criteria, and a clearly defined cardiology referral process [7] [10] [11] [28].

5. Conclusions

Candidates evaluated at the Thiès centre during the final three days of the national physical education and sports teaching aptitude examination were predominantly male, physically active young adults. Single-visit clinical assessment identified blood-pressure elevations requiring standardised confirmation. Resting ECG

identified sinus bradycardia, first-degree atrioventricular block, incomplete right bundle branch block and early repolarisation, which may be recognised as training-related findings in appropriately trained athletes. However, because training exposure was not quantified, these findings cannot be attributed to athletic adaptation in this cohort. T-wave inversion, prolonged QTc and ST-segment depression require careful specialist interpretation.

These findings support a structured, context-appropriate cardiovascular pathway for candidates undergoing fitness assessment. Such a pathway should combine a standardised history and clinical examination with ECG interpretation using international criteria and a defined cardiology referral process for abnormal findings. It should protect candidates while avoiding inappropriate exclusion based on isolated findings or unconfirmed office blood-pressure elevations. Multicentre studies with systematic training-exposure assessment, cardiac imaging and longitudinal follow-up are needed before nationally representative estimates or definitive screening-effectiveness conclusions can be drawn.

Author Contributions

Conceptualization: AAN. Formal analysis: AHS. Writing—original draft: NDG, AAN and JSM. Writing—review and editing: all authors. All authors critically revised the manuscript, approved the final version and agreed to be accountable for the work.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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