

Using Electrocardiographic Findings Utilized International Standards in Athletes from Gorontalo Province

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ABSTRACT

Introduction: The rate of sudden cardiac death among athletes is notably high due to cardiovascular disorders. However, there is a significant gap in fundamental electrocardiographic (ECG) data within the athlete population, particularly in Gorontalo Province. This study aims to describe the electrocardiography findings using international standards for athletes in Gorontalo Province, aiming to prevent the risk of sudden death through proactive early detection via ECG.

Method: Utilizing a cross-sectional descriptive design, we employed total sampling techniques with a population of 80 active athletes. Data was collected through direct examinations using a high-quality, internationally standardized ECG device, followed by thorough descriptive analysis.

Results: The results indicate that 90% of the athletes displayed normal ECGs, while 6.3% were classified as abnormal and 3.7% as borderline. Among the various athletic disciplines, endurance athletes showed a notable 9.4% rate of abnormalities, whereas athletes engaged in strength and mind sports consistently exhibited normal ECG results. Moreover, athletes in the productive age group (19–39 years) demonstrated a higher incidence of abnormalities than their counterparts in other age groups.



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Conclusion: This study emphasizes the importance of early electrocardiographic screening in athletes to identify potential cardiovascular risks and prevent sudden cardiac death. The findings reveal that most athletes in Gorontalo Province exhibit normal ECG results, followed by abnormal (6.3%) and borderline (3.7%) patterns, which undoubtedly require further investigation. These findings highlight the importance of regular ECG screening for active athletes to detect potential cardiovascular abnormalities early and prevent sudden cardiac events.

Keywords: Athlete, cross-sectional studies, electrocardiography, international criteria, sudden cardiac death

Introduction

An athlete is an individual who engages in sports or regular physical activity, prioritizing performance, and often participates in individual or team competitions. In athletes, cardiovascular adaptations occur as a physiological response to prolonged physical exercise. These adaptations include structural and functional changes in the myocardium, such as left ventricular hypertrophy, enlargement of cardiac chambers, and a reduction in resting heart rate.¹

Based on data from the National Collegiate Athletic Association (NCAA), the incidence of sudden sports-related deaths from any cause in the general population ranges from 0.5 to 2.1 per 100,000 individuals annually. Sudden sports-related deaths are more prevalent among elite athletes compared to student-athletes, with an incidence of approximately 1 in 8,253 per year.²

The incidence of sudden cardiac death (SCD) among young athletes remains a subject of debate. The most robust data originates from a prospective observational study conducted in Italy, utilizing regional registry data with a mandatory reporting system. This study estimated an incidence rate of 3.6 per 100,000 annually during the pre-screening era. The prevention of SCD in athletes can be achieved through regular screening and electrocardiographic (ECG) monitoring. ECG screening aims to identify potential cardiovascular abnormalities early and is ideally performed during the athlete recruitment process.⁵

Electrocardiogram changes in athletes are commonly observed and typically reflect structural and electrical remodeling of the heart as an adaptation to regular physical exercise, a phenomenon known as “athlete’s heart.” However, abnormal ECG findings in athletes may indicate underlying cardiac pathology, which could elevate the risk of sudden cardiac death during physical activity.⁶

Electrocardiography is a graphical representation of the heart’s electrical activity, recorded on electrocardiograph paper. The underlying principle of ECG recording involves

electromagnetic forces, currents, or vectors characterized by magnitude and direction. A depolarizing current moving toward an electrode generates a positive deflection, while movement away from the electrode results in a negative deflection. Conversely, a repolarizing current traveling away from a positive electrode appears as a positive deflection, whereas movement toward the positive electrode produces a negative deflection. When the current flows perpendicular to the electrode, it aligns with the baseline, creating a biphasic waveform.^{7,8}

Athletes are defined as individuals who excel in sports at regional, national, or international levels. They engage in structured exercises aimed at developing physical attributes such as strength, endurance, speed, agility, balance, flexibility, and other skills, all of which are systematically prepared well in advance of competitions. Based on various definitions, athletes can be characterized as individuals who participate in programmed, measured, and recorded sports activities with the objective of achieving peak performance and excellence in their field.⁹

In this study, sports are categorized into three main types based on the primary characteristics of physical activity: endurance sports, strength sports, and mind sports. Endurance sports are characterized by an individual's ability to engage their muscles in sustained contractions over a prolonged period under a specific load.¹⁰ Examples of endurance sports include athletics, football, swimming, motorcycle racing, sepak takraw, table tennis, and gateball.

Strength training refers to the ability of muscles to contract and generate tension against resistance. Effective strength development typically involves resistance training methods.¹¹ Sports classified under strength training include Taekwondo, karate, kickboxing, martial arts, Muay Thai, weightlifting, and IBCA MMA (Indonesian Mixed Martial Arts). Mind sports, on the other hand, focus on strategy, concentration, and logical thinking skills while requiring minimal physical exertion.¹² Examples of mind sports include chess, bridge, e-sports, and billiards.

In the late 1800s and early 1900s, cardiac enlargement and bradyarrhythmias were noted in individuals with above-average exercise capacity. Structural and functional changes in the heart in athletes were generally detected during pre-participation screening, routine health checks, or when symptoms arose. The term "athlete's heart" was used to describe the structural and functional changes in the heart in individuals who exercised more than one hour per day. These changes were usually asymptomatic, with signs detectable on physical examination, such as bradycardia, systolic murmurs, and extra heart sounds.¹³

The International Consensus Criteria are a recent development that combines the Seattle criteria with new findings on cardiac adaptation in athletes of different ethnic backgrounds. These criteria have been adjusted to further reduce false-positive rates, particularly in black athletes, who often exhibit a more pronounced early repolarization pattern.¹³

Abnormal ECG patterns, such as left ventricular hypertrophy and repolarization disorders, can be early signs of pathological conditions that require further evaluation and intervention. Drezner et al. (2017), in their consensus statement International Criteria for Electrocardiographic Interpretation in Athletes, emphasize the need for routine cardiovascular screening in athletes, especially those involved in intensive sports. This study also found that the prevalence of ECG abnormalities may vary depending on the type of sport and the level of exercise intensity; this study emphasizes the importance of understanding athletes individual adaptation patterns to assess their cardiovascular health holistically.¹⁴

Male athletes are more susceptible to left ventricular hypertrophy and abnormal repolarization than females, especially in high-intensity sports such as professional basketball, according to Hamid et al. (2021), in their study on ECG characteristics among Malaysian Athletes emphasizes the need for gender and sport specific evaluations to understand the impact of training on athletes cardiovascular health.¹⁵ Based on the findings and data above, this study aims to identify ECG images using international criteria in athletes in Gorontalo Province.

Methods

This study has received ethical approval from the Health Research Ethics Commission (KEPK) of Gorontalo State University with letter number 240/UN47.B7/KE/2024 dated November 11, 2024, and was conducted at the Rahmat Hotel Hall, which is the venue for activities held by the Office of the Komite Olahraga Nasional Indonesia (KONI) of Gorontalo Province. This study was conducted over a period of two days, starting from November 26, 2024 to November 27, 2024.

This study used a descriptive method with a cross-sectional design to assess the ECG picture in athletes in Gorontalo Province, with research variables in the form of univariate variables that include ECG finding. The population in this study were all active athletes in Gorontalo Province, totaling 80 athletes. The sample of this study consisted of all active athletes who were willing to participate in the study, with a sampling technique using total sampling. The inclusion criteria in this study were athletes aged between 14 and 60 years and were active athletes in Gorontalo Province, while the exclusion criteria were athletes who refused to become respondents.

The data processing process was carried out with the help of a computer using software such as Microsoft Office Word, Microsoft Office Excel, and the Statistical Package for The Social Sciences (SPSS) version 22, and the results were presented in tabular form. The main variables of the study were the results of ECG examinations based on international criteria, while additional variables included gender, age, type of sport, and length of time as an athlete. Data were collected through ECG examinations using tools that meet international standards, carried out by trained medical personnel. The results of the examination were recorded on the observation sheet that had been prepared.

The data obtained were analyzed univariately to present the frequency distribution of ECG results, using statistical software to ensure the accuracy of the results. This study complies with the ethical aspects of research, including obtaining informed consent from each respondent, maintaining the confidentiality of personal data, and obtaining approval from the authorized research ethics committee. The entire research process was carried out in accordance with the established protocol to ensure the validity and reliability of the results.

Result

In Table 1, it can be seen that the frequency distribution of the number of respondents shows that most athletes were aged between 19 and 34, totaling 58 athletes (72.5%). For the gender variable, it is known that most athletes were male, totaling 69 (86.2%), while females totaling 11 (13.8%). According to the variable of length of time as an athlete, it is known that most athletes had a duration of being an athlete more than one year, totaling 69 (86.2%), while athletes who had a duration of less than one year totaling 11 (13.8%). A total of 46 (57.4%) athletes participated in endurance sports and athletes who participate in mind sports and strength sports totaling 17 (21.3%). Most athletes had a normal BMI (50 athletes, 62.5%). Meanwhile, 13 athletes (16.2%) were classified as obese, 12 (15%) as overweight, and five (6.3%) as underweight. For the blood pressure variable of the athletes who were respondents, it was found that the majority of athletes had normal blood pressure, amounting to 69 (86.2%), while athletes with hypertension amounted to 11 (13.8%).

Based on Table 2, it was found that the majority of athletes experienced ECG with a normal category, namely 72 athletes (90%). In contrast, there were athletes who experienced ECG with an abnormal category, namely five athletes (6.3%). The remaining three athletes (3.7%) experienced ECG with a borderline category.

Table 1. Frequency distribution based on respondent characteristics

Respondent Characteristics (N=80)	Frequency (n)	Percentage (%)
Age (Years)		
14-18	12	15.0
19-34	58	72.5
≥35	10	12.5
Gender		
Man	69	86.2
Woman	11	13.8
Long Time Being an Athlete		
≤1 Year	11	13.8
>1 Year	69	86.2
Types of Sports		
Endurance Sports	46	57.4
Strength Sports	17	21.3
Mind Sports	17	21.3
Body Mass Index		
Underweight	5	6.3
Normal	50	62.5
Overweight	12	15.0
Obesity	13	16.2
Blood pressure		
Normal	69	86.2
Hypertension	11	13.8

Table 2. Frequency distribution of electrocardiography interpretation in athletes from Gorontalo Province

Electrocardiography Findings	Frequency (n)	Percentage (%)
Abnormal	5	6.3
Normal	72	90.0
Borderline	3	3.7
Total	80	100

Table 3 shows cross tabulation between gender and ECG. Of the 11 female athletes, there was one athlete (1.3%) who experienced an abnormal ECG and 10 athletes (12.5%) who experienced a normal ECG. While of the 69 male athletes, there were four athletes (5%) who experienced an abnormal ECG, 62 athletes (77.5%) who experienced a normal ECG and three athletes (3.7%) who experienced a borderline ECG.

Table 3. Frequency distribution of electrocardiography interpretation by gender

Gender	Electrocardiography Findings						Total	
	Abnormal		Normal		Borderline		N	%
	n	%	n	%	n	%		
Woman	1	1.3	10	12.5	0	0	11	13.8
Man	4	5.0	62	77.5	3	3.7	69	86.2
Total	5	6.3	72	90.0	3	3.7	80	100

Based on Table 4, a cross-tabulation between age and ECG was obtained. Of the 12 athletes aged between 14 and 18 years, there were 11 athletes (13.8%) who experienced ECG with a normal category and one athlete (1.3%) who experienced ECG with a borderline category. Of the 58 athletes aged between 19 and 34 years, there were five athletes (6.3%) who experienced ECG with an abnormal category, 51 athletes (63.8%) who experienced ECG with a normal category and two athletes (2.4%) who experienced ECG with a borderline category. Meanwhile, of the 10 athletes aged 35 years or older, all experienced ECG with a normal category.

Table 4. Frequency distribution of electrocardiographic interpretation by age

Age (Years)	Electrocardiography Findings						Total	
	Abnormal		Normal		Borderline		N	%
	n	%	n	%	n	%		
14-18	0	0	11	13.8	1	1.3	12	15.0
19-34	5	6.3	51	63.8	2	2.4	58	72.5
≥35	0	0	10	12.5	0	0	10	12.5
Total	5	6.3	72	90.0	3	3.7	80	100

Table 5 shows a cross-tabulation between the type of sport and ECG. Of the 46 athletes who are engaged in endurance sports, there were five athletes (6.3%) who had ECGs in the abnormal category, 39 athletes (48.8%) who had ECGs in the normal category, and two athletes

(2.5%) who had ECGs in the borderline category. Of the 17 athletes who are engaged in strength sports, all had ECGs in the normal category. Meanwhile, of the 17 athletes who are engaged in mind sports, there were 16 athletes (20%) who have ECGs in the normal category and one athlete (1.3%) who had ECGs in the borderline category.

Table 5. Frequency distribution of electrocardiography interpretation by sport type

Types of Sports	Electrocardiography Findings						Total	
	Abnormal		Normal		Borderline		N	%
	n	%	n	%	n	%		
Endurance	5	6.3	39	48.8	2	2.4	46	57.4
Strength	0	0	17	21.3	0	0	17	21.3
Mind	0	0	16	20.0	1	1.3	17	21.3
Total	5	6.3	72	90.0	3	3.7	80	100

Discussion

This study involved 80 active athletes under the auspices of the KONI Gorontalo Province. Normal EKG results were found in 90% of the respondents, which corresponds to 72 athletes. This finding indicates that the majority of athletes in Gorontalo Province have good cardiovascular health. This condition is supported by the routine physical activity performed by the athletes, which plays a role in enhancing vascular elasticity, maintaining normal blood pressure, and optimizing heart function. A study by Hamid et al. (2021) also showed that 61% of athletes in Malaysia with high training intensity exhibited normal ECG results, reflecting a healthy cardiovascular adaptation.¹⁵

There were 6.3% or five athletes with abnormal ECG results. These findings included abnormal QRS complexes (left posterior fascicular block/LPFB) and abnormal T waves (inversion in V1-V3, biphasic in V2-V4, or inversion in III and aVF). The proportion of athletes with abnormal ECG in Gorontalo was higher compared to the study by Hamid et al. (2021) which noted that 4% of athletes in Malaysia had abnormal results. However, this figure is lower than the study by Waase et al. (2018) on NBA athletes, where 15.6% of athletes had abnormal ECG results based on international criteria.¹⁶

ECG results in the borderline category were found in 3.7% of respondents, namely three athletes. This finding involves right axis deviation or a pattern that is not entirely normal but cannot yet be categorized as abnormal. According to Sharma et al. (2017), borderline ECG interpretation is often found in athletes who undergo intensive training and tends to be

influenced by age or training load factors. Although often not pathological, this condition requires further monitoring to ensure it does not develop into a more serious disorder.¹

Meanwhile, of the 69 male athletes, 62 athletes (77.5%) had normal ECG results, four athletes (5%) showed abnormal ECG results, and three athletes (3.7%) showed borderline ECG results. Abnormal findings in male athletes are more often caused by higher physical stress from intensive sports, which can trigger left ventricular hypertrophy, axis deviation, or repolarization disorders. Research by Waase et al. (2018) also showed that men have a higher prevalence of abnormalities than women due to the influence of testosterone hormones and greater left ventricular mass.¹⁶ The borderline ECG results in three male athletes are often associated with intensive training loads, as is the case in endurance sports that are common in Gorontalo, including soccer.

Of the 11 female athletes, 10 athletes (12.5%) had normal ECG results, while one athlete (1.3%) showed abnormal ECG results, and there were no borderline results. These findings indicate that the majority of female athletes in Gorontalo have good cardiovascular conditions. These results are in line with research by Harris et al. (2022), which states that women tend to have more normal ECG results than men due to smaller left ventricular mass and more moderate exercise intensity.¹¹ The abnormality in this one female athlete may be associated with specific factors such as uncontrolled exercise intensity or certain medical histories that affect heart health.¹⁷

This difference in distribution suggests that male athletes are more susceptible to abnormal or borderline ECG findings than female athletes, which is largely due to the type of sport and higher physical load in males. The types of sports often performed by male athletes in Gorontalo, such as endurance and strength sports, put greater hemodynamic stress on the heart, increasing the risk of ECG abnormalities. On the other hand, female athletes are more often involved in sports with lower physical intensity, so the cardiovascular stress experienced is relatively mild. These findings provide an illustration that gender influences the cardiovascular risk of athletes in Gorontalo, with males being more at risk of experiencing abnormal and borderline ECG findings. Therefore, routine monitoring of cardiovascular health is needed, both in male and female athletes, to prevent further complications.

The results of the electrocardiography interpretation analysis based on the age group of 14–18 years, from 12 athletes, 11 athletes (13.8%) had normal ECG results, and one athlete (1.3%) showed borderline ECG results, without abnormal findings. These results indicate that most young athletes in Gorontalo have healthy cardiovascular conditions. Borderline results in this group are usually associated with initial adaptation to intensive physical exercise, such as

right axis deviation or increased QRS voltage, which are often not pathological but still require further monitoring. Research by Idiazabal-Ayesa et al. (2023) also noted that the prevalence of significant abnormalities in adolescent athletes was very low, only around 2.32%, indicating physiological adaptation in the development phase.¹⁸

In the 19–34 age group, out of 58 athletes, 51 athletes (63.8%) had normal ECG results, 5 athletes (6.3%) showed abnormal ECG results, and 2 athletes (2.4%) showed borderline ECG results. These results indicate that the productive age group has a higher proportion of abnormal ECG results compared to other age groups. These abnormalities may be associated with the cumulative effects of long-term intensive training on the heart, such as left ventricular hypertrophy or concentric ventricular remodeling. Research by Waase et al. (2018) showed that the prevalence of abnormalities increases with age due to exposure to high and repeated physical loads for a long time. Productive age athletes in Gorontalo tend to be involved in endurance sports such as soccer and long-distance running, which put greater hemodynamic pressure on the heart, thereby increasing the risk of abnormalities.¹⁶

In the age group ≥ 40 years, out of eight athletes, all showed normal ECG results (100%). This result is different from the theory that states that with increasing age, the risk of structural and functional changes in the heart that can affect the ECG picture tends to increase. However, several factors can explain this finding. First, athletes who remain active until they are over 40 years old are usually those who have gone through a natural selection process, where only athletes with good cardiovascular conditions are able to survive intensive physical activity at this age. Research by Sharma et al. (2017) states that older athletes tend to have a more structured and controlled training pattern, so the risk of abnormalities can be minimized.¹ Second, more intensive medical supervision in older athletes allows for early detection and management of cardiovascular risk, as stated in the research by Ndongo Amougou et al. (2019).¹⁹

The distribution of ECG results by age in Gorontalo showed that young athletes generally have good physiological adaptation to physical training, while athletes of productive age are more susceptible to abnormalities due to greater training loads. Athletes aged ≥ 40 years showed normal ECG results, which can be explained by natural selection and stricter health surveillance. These findings emphasize the importance of monitoring cardiovascular health in all age groups, especially in the productive age group, to prevent further complications and ensure optimal athlete performance.

Of the 46 endurance athletes, 39 athletes (48.8%) had normal ECG results, five athletes (6.3%) showed abnormal ECG results, and two athletes (2.4%) showed borderline ECG results.

Abnormal findings in endurance athletes may be associated with the type of exercise that places a high volume load on the heart, such as left ventricular hypertrophy or abnormal repolarization. Sharma et al.'s (2017) study stated that endurance sports have a higher prevalence of ECG abnormalities than other types of sports, because continuous hemodynamic stress during intense exercise causes more significant cardiac adaptation.¹ In Gorontalo, sports such as football or long-distance running that are dominant in this group often involve high exercise intensity, thus increasing the risk of pathological electrocardiographic changes.

A total of 17 strength athletes, all showed normal ECG results (100%), with no abnormal or borderline findings. The absence of abnormal findings in strength athletes can be explained by the type of cardiovascular adaptation that occurs in strength sports, which triggers more concentric left ventricular hypertrophy due to pressure loads than volume loads. Research by Waase et al. (2018) stated that strength sports cause fewer electrophysiological changes in the ECG than endurance sports, because the load on the heart is more localized and does not provide significant chronic hemodynamic pressure.¹⁶ In Gorontalo, common strength sports, such as weightlifting, tend to be done in short but intense durations, which results in different physiological adaptations than endurance sports.

Of the 17 mind sports athletes, as many as 16 athletes (20%) had normal ECG results, and one athlete (1.3%) showed borderline ECG results, with no abnormal findings. The absence of abnormal results in mind sports athletes is due to the low physical load given to the cardiovascular system. Mind sports athletes are more related to psychological stress, competitive pressure, and high expectations than physical activity that affects the structure and function of the heart. In Gorontalo, sports such as chess or esports dominate this category, with lower cardiovascular risks than physical sports.

The distribution of ECG interpretations in athletes in Gorontalo based on the type of sport shows that endurance sports have the highest proportion of abnormal results compared to other types of sports. This is due to the greater hemodynamic training load, which is at risk of causing pathological changes in the structure and function of the heart. In contrast, strength sports do not show abnormal results due to the different adaptation properties of the heart, which are more focused on increasing pressure without affecting repolarization. Mind sports athletes, although they do not have abnormal results, still show borderline results due to the influence of psychological stress which can trigger a sympathetic response in the cardiovascular system. These results indicate the importance of adjusting training programs and monitoring cardiovascular health that are tailored to the type of sport the athlete participates in. Endurance athletes require more intensive monitoring to detect a higher risk of ECG

abnormalities, while strength and mind sports athletes still need stress management education and health monitoring to maintain a balance between performance and health.

This study has several limitations, namely the number of samples used in this study is still relatively small, so the results of the study are less able to represent the overall athlete population in Gorontalo Province. With a wider scope, especially in various sports, the results of the study can better describe the ECG conditions of athletes in this area. Furthermore, the composition of the sample dominated by male athletes can affect the results of the study, considering the differences in risk and electrocardiographic patterns between men and women. Most of the samples came from endurance sports, with fewer representatives from strength and mind-sports. This can limit the generalization of the findings to athletes from other sports with different physical activity patterns and cardiovascular risks.

Conclusion

This study shows that the majority of athletes in Gorontalo Province have good cardiovascular health based on ECG results, although there are a small number of athletes with abnormal and borderline results that require further attention. These findings underline the importance of routine cardiovascular health monitoring, particularly for athletes involved in high-intensity endurance sports, to detect and prevent the risk of serious cardiac complications. Further research with larger samples and longitudinal analysis is needed to understand the long-term impact of physical activity on athletes' cardiovascular conditions.

Conflicts of Interest

We have no conflicts of interest to disclose

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References

1. Sharma S, Drezner JA, Baggish A, Papadakis M, Wilson MG, Prutkin JM, et al. International recommendations for electrocardiographic interpretation in athletes. *J Am Coll Cardiol*. 2017;69(8):1057–75.
2. Yow AG, Rajasurya V, Venkat I, Sharma S. Sudden cardiac death, Available in: <https://www.ncbi.nlm.nih.gov/books/NBK430847/>, accessed Mar 6, 2025.
3. Chandra N, Bastiaenen R, Papadakis M, Sharma S. Sudden cardiac death in young athletes.

- J Am Coll Cardiol.* 2013;61(10):1027–40.
4. Siregar MNI, Wahidji VH. A rare case of posterolateral ST-segment elevation myocardial infarction in Brugada syndrome: A double trouble beyond mimicking. *Kardiol Pol.* 2024;82(11):1165-1167.
 5. Sattar Y, Beautiful CY. *Electrocardiogram.* StatPearls Publishing, Treasure Island; 2023.
 6. 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;31(2):243–59.
 7. Siregar MNI, Wahidji VH. Impact of hypokalemia on Brugada syndrome: case report uncovering mechanisms beyond QT interval prolongation. *Egypt Heart J.* 2024;76(1):143.
 8. Wimmer NJ, Scirica BM, Stone PH. The clinical significance of continuous ECG (ambulatory ECG or Holter) monitoring of the ST-segment to evaluate ischemia: a review. *Prog Cardiovasc Dis.* 2013;56(2):195–202.
 9. Setiyawan S. Kepribadian atlet dan non atlet. *Jendela Olahraga.* 2017;2(1): 110-119.
 10. Sajoto S. Physical condition development. Department of Education and Culture, Jakarta; 1995.
 11. Putri MW. The relationship of strength, endurance, dribbling, passing, and shooting to the risk of sports injuries (Hubungan strenght, endurance, dribbling, passing dan shooting terhadap resiko cedera olahraga, Indonesian). *Pros Senfiks (Seminar Nasional Fakultas Ilmu Kesehatan Sains).* 2019; 1(1):1-19.
 12. Brkljacic T. Brighter, smarter, wiser: distinction & benefits of mind sports. *Proceedings of the International Scientific Conference;* 2017 April 20-21; Torun, Poland.
 13. Baggish AL, Wood MJ. Athlete’s heart and cardiovascular care of the athlete: scientific and clinical update. *Circulation.* 2016;123(23):2723–35.
 14. Drezner JA, Sharma S, Baggish A, Papadakis M, Wilson MG, Prutkin JM, et al. International criteria for electrocardiographic interpretation in athletes: consensus statement. *Br J Sports Med.* 2017;51(9):704–31.
 15. Hamid MS, Shariff Ghazali S, Salim AMH, Hussein KH, Jaafar Z, Abdul Karim S. Electrocardiographic (ECG) characteristics among Malaysian athletes. *Sains Malays.* 2021;50(11):3355–63.
 16. Waase MP, Mutharasan RK, Whang W, DiTullio MR, DiFiori JP, Callahan L, et al. Electrocardiographic findings in National Basketball Association athletes. *JAMA Cardiol.* 2018;3(1):69.
 17. Harris CS, Froelicher VF, Hadley D, Wheeler MT. Guide to the female student athlete

- ECG: a comprehensive study of 3466 young, racially diverse athletes. *Am J Med.* 2022;135(12):1478–84.e4.
18. Idiazabal-Ayesa U, Ramírez-Vélez R, Sanz-de La Garza M, Izquierdo M. Electrocardiographic findings in pediatric versus young-adolescent athletes: a comparative analysis using general international criteria. *Int J Cardiol.* 2023;390:131201.
 19. Ndongo Amougou S, Danwe D, Kuate LM, Nganou-Gnindjio CN, Ba H, Boombhi J, et al. Electrocardiographic abnormalities in Cameroonian university athletes: a cross-sectional study. *J Xiangya Med.* 2019;4:26–26.