Predictive Role of Angle of Deviation, QRS Complex RVH, LVH and T Wave Amplitudes in Preeclamptic Pregnant Women in The Third Trimester of Pregnancy

*[1]Edebiri O.E., [2]Nwankwo A. A., [3]Akpe P. E., [4]Mbanaso E.L., [5]Obiesi C. N., [6]Chukwu J.A.O.

[1]Department of Physiology, Ambrose Alli University, Ekpoma, Edo State, Nigeria
[2]Department of Physiology, Abia State University, Uturu, Abia State, Nigeria
[3] Department of Physiology, University of Benin, Benin City, Edo state, Nigeria
[4]Department of Physiology, Abia State University, Uturu, Abia State, Nigeria
[5]Department of Physiology, David Umahi Federal University Health Services, Uburu. Ebonyi State, Nigeria
[6]Department of Human Physiology, Faculty of Basic Medical Sciences, College of Medicine and Health Sciences, Gregory University, Ituru, Abia State, Nigeria

Corresponding Author: edebiriduncan@gmail.com

Abstract : The use of ECG patterns as predictors of preeclampsia offers a promising approach, as it is a widely available and cost-effective tool. Specific ECG patterns, including angle of deviation, QRS Complex (Right Ventricular Hypertrophy (RVH) , Left Ventricular Hypertrophy (LVH)), and T wave amplitudes as a potential tool for predicting preeclampsia. The aim of this study is to investigate the predictive role of angle of deviation, QRS Complex (Right Ventricular Hypertrophy (RVH) , Left Ventricular Hypertrophy (LVH)), and T wave amplitudes in preeclamptic pregnant women during the third trimester. Fourty (40) consenting pregnant women were recruited from St. Philomina Catholic Hospital, Edo State, Nigeria. These subjects consisted of twenty (20) normotensive and twenty (20) preeclamptic pregnant women in their third trimester of pregnancy. After the subjects were identified and recruited into the study, they were taken to the laboratory where their vital signs was taken and their ECG patterns recorded with ECG machine. Data obtained from this study were analysed using Graph Pad Prism 9. Results generated were expressed as mean ± SEM and a P-value of ≤ 0.05 were considered statistically significant. Results from this present study show no significant differences were observed in QRS complex angles related to right ventricular hypertrophy (RVH) between normotensive and preeclamptic pregnant women. Notably, there was a significant increase in QRS complex related to left ventricular hypertrophy (LVH) in preeclamptic pregnant women, indicating left ventricular remodeling's importance. Moreover, there was a significant increase in T wave amplitude, this suggests underlying myocardial electrical remodeling or dysfunction in preeclampsia, emphasizing the need for cardiovascular monitoring. The study underscores the multifactorial nature of cardiovascular changes in preeclampsia and highlights the potential of ECG parameters in aiding early detection.

Key Words: Preeclampsia, angle of deviation, QRS, Complex.

1. INTRODUCTION

Preeclampsia is a complex and multifactorial pregnancy complication characterized by high blood pressure and damage to organs such as the kidneys, liver, and brain (Armaly *et al*., 2018). It affects approximately 2-8% of pregnancies worldwide, making it a leading cause of maternal and fetal morbidity and mortality (Duley, 2009). Early detection and prediction of preeclampsia are crucial to prevent severe complications and ensure timely interventions (Chaiworapongsa *et al*., 2014).

Electrocardiogram (ECG) patterns have been explored as potential predictors of preeclampsia due to their non-invasive and cost-effective nature (Pegorie *et al*., 2023). Specific ECG patterns, including angle of deviation, QRS Complex (Right Ventricular Hypertrophy (RVH) and Left Ventricular Hypertrophy (LVH)), and T wave amplitudes, have been identified as potential indicators of preeclampsia (Khalil *et al*., 2019). This study aims to investigate the predictive role of these ECG patterns in preeclamptic pregnant women in the third trimester of pregnancy.

The use of ECG patterns as predictors of preeclampsia offers a promising approach, as it is a widely available and cost-effective tool (Pegorie *et al*., 2023). This study's focus on specific ECG patterns provides a nuanced understanding of their predictive role, enabling healthcare providers to make informed decisions and improve patient care. Furthermore, the study's findings will have implications for the development of personalized medicine approaches to preeclampsia diagnosis and management.

2. LITERATURE REVIEW

Preeclampsia is widely recognized as a multifactorial pregnancy complication marked by elevated blood pressure and end-organ damage, notably affecting the kidneys, liver, and brain (Armaly *et al*., 2018; Duley, 2009). This condition impacts roughly 2–8% of pregnancies globally, underscoring its significance as a major contributor to maternal and fetal morbidity and mortality. Early detection is critical, as timely interventions can mitigate severe complications and improve clinical outcomes (Chaiworapongsa *et al*., 2014).

Recent investigations have focused on the potential of electrocardiogram (ECG) patterns as non-invasive, cost-effective predictors of preeclampsia. Studies have explored several ECG parameters—including the angle of deviation of the QRS complex, indicators of right ventricular hypertrophy (RVH) and left ventricular hypertrophy (LVH), as well as T wave amplitudes—to discern differences between normotensive and preeclamptic pregnancies (Pegorie *et al*., 2023; Khalil *et al*., 2019). Notably, while the QRS complex angle of deviation and markers for RVH did not exhibit statistically significant differences between the two groups, a significant increase in LVH-related parameters and T wave amplitude was observed among preeclamptic women (Nagel *et al*., 2023; Vondrak *et al*., 2018). These findings align with previous research using multimodal echocardiography, which identified left ventricular remodeling and functional changes as integral to the pathophysiology of preeclampsia (Jiang *et al*., 2023).

Methodologically, the study underpinning these findings was carefully structured. It recruited forty third-trimester pregnant women from St. Philomina Catholic Hospital in Edo State, Nigeria, with participants evenly divided into normotensive and preeclamptic groups. The sample size was determined using Araoye's formula, incorporating prevalence data from earlier studies (Araoye, 2004; Vata *et al*., 2015), which speaks to the rigorous approach taken to ensure statistical relevance. Although the use of ECG offers a pragmatic and accessible diagnostic tool, its application in this context provides a nuanced insight into the cardiovascular changes associated with preeclampsia, potentially guiding future personalized management strategies.

3. MATERIALS AND METHODS

Geographical Description of the Study Area

This research was carried out among Third Trimester Pregnant women in St. Philomina Catholic Hospital, Edo State , Nigeria.
lies longitudinally at 04ºE and 43ºE and Latitude 05º44ºN and 07º34ºN. It geopolitical location is the South South and it has a population of 3.5 million people. Oredo land, Benin City, the State capital, is 100 km long. Edo State, South-South, Nigeria. Oredo is a Local Government Area of Edo State, Nigeria. Its headquarters are in the town, Benin city. It has an area of 502 km² and a population of 500,000 at the 2006 census.

Majority of which are civil servants, traders, businessmen/women, transporter, farmers, teachers/lecturers and students by occupation. Oredo, since after its designation as headquarters and as the host of Oba of Benin Palace, the town has grown into an urban center.

Research Design

Fourty (40) consenting pregnant subjects were recruited from St. Philomina Catholic Hospital, Edo State. These subjects consisted of twenty (20) normotensive pregnant women in their third trimester of pregnancy with blood pressure between 120/80mmHg to 130/90 mm/Hg without presence of proteinuria and twenty (20)   preeclamptic women in their third trimester of pregnancy classified as having preeclampsia according to their blood pressure measured was above 130/90 mm/Hg with the presence of proteinuria taken two consecutive times at presentation at the antenatal clinic of the hospital.

Sample Size

The Population of study was determined using the formula;

$N= Z^2pq/d^2$ (Araoye, 2004)

Where N= the desired sample size (when population is greater than 10,000)

Z= is a constant given as 1.96 (or more simply at 2.0) which corresponds to the 95% confidence level.

P= previous survery prevalence of 2.23% (vata *et al.,* 2015).

q= 1.0-p

d= acceptable error 5%.

Where N= sample size, Z=1.96, p=0.1% (0.01) and d=5% (0.05)

N= 39.8 subject.

Therefore, the sample for this study is 40 respondents who are normotensive and preeclamptic pregnant women from Oredo town, Benin City.

Ethical Approval And Informed Consent

Ethical clearance (REC Approval No:RECC/10/2023(07)) was obtained from the Research Ethics Committee of St. Philomina Catholic Hospital, Edo State.

Written informed consent was obtained from subjects prior to commencement of the study.

Experimental Protocols

After the subjects were identified and recruited into the study, they were taken to the laboratory where their vital signs was taken and their ECG patterns recorded.

Study Area/Population

The study was conducted for three months at St. Philomina Catholic Hospital, Edo State, Nigeria.

Inclusion Criteria

Normotensive and Preeclamptic pregnant women in the third trimester of pregnancy, within the age range of 25 to 35years was used for this study. Pregnant women were recruited for this study and women who had given birth before and were pregnant for the second time.

Exclusion Criteria

Normotensive and Preeclamptic pregnant women who were on drugs and with a known history of hyperlipidemia, gestational Diabetes and other comorbidity.

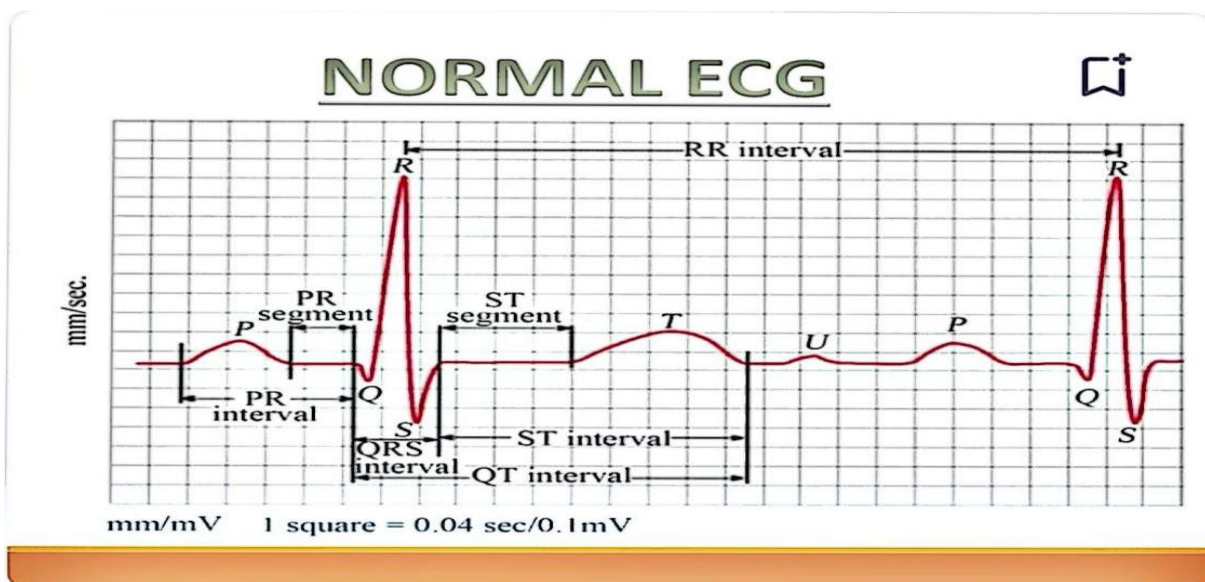**Figure. 1 HEARTSCREEN 112 C-1 ECG- Machine INNOMED 2011.**

Figure: 2 Normal ECG Graph diagram **Source:** Tribhuvanam *et al., (2020*

Data Analysis

Data obtained from this study were analysed using Graph Pad Prism 9. Results generated were expressed as mean ± SEM and a P-value of ≤ 0.05 were considered statistically significant. The significance of difference among the groups were used to assess the repeated-measures analysis of variance (ANOVA). Independent students' t-test were used to compare normotensive and preelclamptic pregnant women groups.
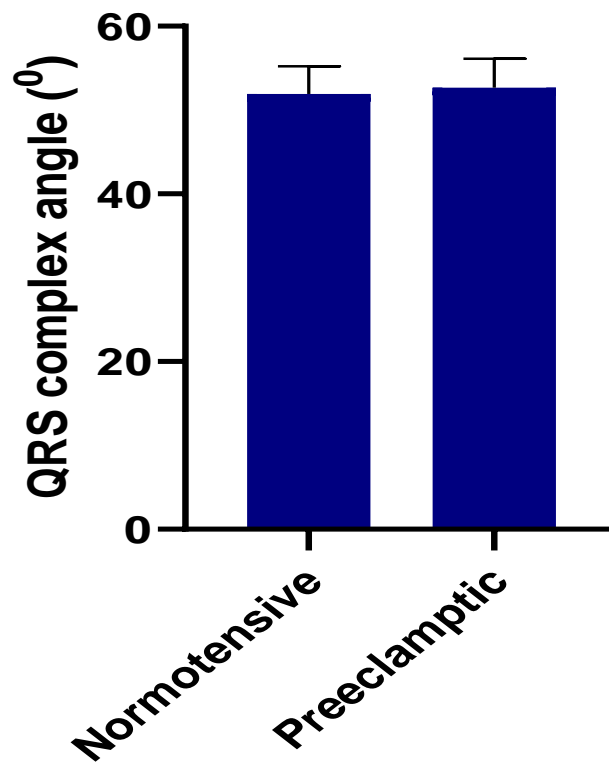
Result

Figure. 3: QRS complex angle of deviation (^{0}) in the third trimester of pregnancy of normotensive n= 20 and preeclamptic n= 20 pregnant women.

Result in fig. 3 show no statistically significant difference in QRS complex angles in normotensive pregnant women and preeclamptic pregnant women in their third trimester of pregnancy ($p > 0.05$)
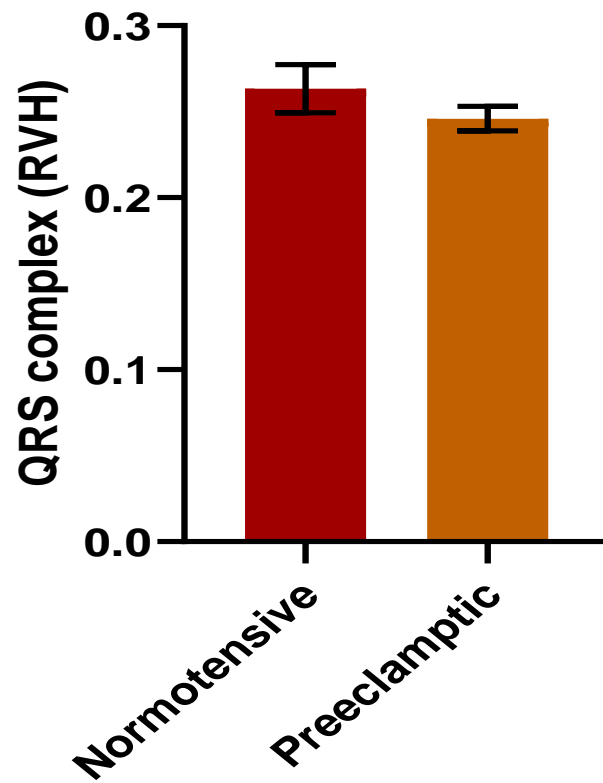
Figure. 4. QRS complex Right Ventricular Hypertrophy (RVH) in the third trimester of pregnancy of normotensive n= 20 and preeclamptic n= 20 pregnant women.

Result in fig. 4. show no statistically significant difference in QRS complex (RVH) in normotensive and preeclamptic pregnant women in their third trimester of pregnancy ($p > 0.05$)
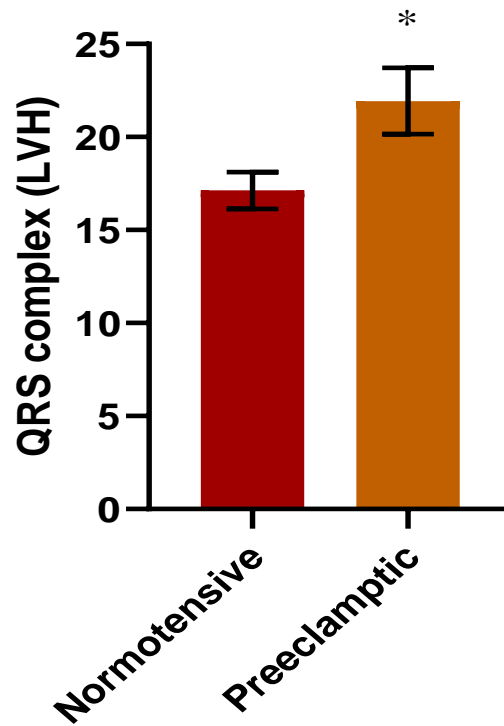
Figure. 5 QRS complex Left Ventricular Hypertrophy(LVH) in the third trimester of pregnancy of normotensive n= 20 and preeclamptic n= 20 pregnant women.

Result in fig 5 show statistically significant increase in QRS complex (LVH) in preeclamptic pregnant women compare to Normotensive pregnant women in their third trimester of pregnancy ($p<0.05$)
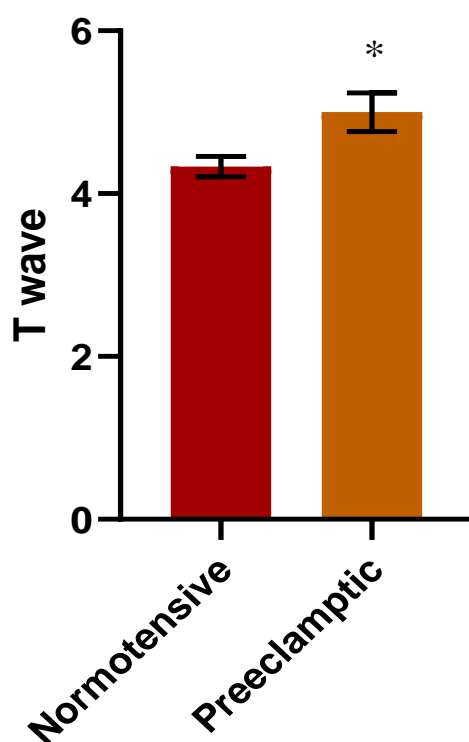
Figure. 6 T wave amplitude in the third trimester of pregnancy of normotensive n= 20 and preeclamptic n= 20 pregnant women.

Result in fig. 6 show statistically significant increase in T wave in preeclamptic pregnant women compared to normotensive pregnant women in their third trimester of pregnancy ($p<0.05$)

4. DISCUSSION

The QRS complex angle of deviation represents the spatial orientation of the depolarization wavefront in the ventricles, reflecting the direction of ventricular depolarization (Nagel *et al.,* 2023). Figure 4.1 demonstrates no statistically significant difference in QRS complex angle of deviation between normotensive andpreeclamptic pregnant women during the third trimester of pregnancy ($p>0.05$). While the absence of significant differences may suggest similar ventricular depolarization patterns between normotensive and preeclamptic pregnancies, it is crucial to interpret these findings cautiously. Previous research has highlighted the potential role of altered ventricular depolarization patterns in hypertensive disorders of pregnancy (Vondrak*et al.,* 2018). However, the lack of significant differences in QRS complex angle of deviation in this present study may indicate that this parameter alone

may not be predictive of preeclampsia. Figure 4.2 illustrates no statistically significant difference in QRS complex related to right ventricular hypertrophy (RVH) between normotensive and preeclamptic pregnant women during the third trimester of pregnancy ($p>0.05$).The absence of significant differences in QRS complex related to RVH suggests that right ventricular hypertrophy may not be a prominent feature of preeclampsia Conversely, figure 4.3 reveals a statistically significant increase in QRS complex related to left ventricular hypertrophy (LVH) in preeclamptic pregnant women compared to normotensive counterparts ($p<0.05$). Hence, the significant increase in QRS complex related to LVH in preeclamptic pregnancies highlights the potential role of left ventricular remodeling and dysfunction in the pathophysiology of preeclampsia which correlate with a previous study by Jiang *et al.,* (2023) explore left ventricular structural/functional abnormalities in preeclampsia patients by using multimodal echocardiography and to analyze the cardiac impact in preeclampsia subtypes. A total of 103 individuals, including 64 preeclampsia patients and 39 healthy pregnant women were recruited for this study from 2019 to 2021. There were 34 patients with preeclampsia with severe features (SPE) patients and 30 with preeclampsia with nonsevere features (NSPE), including 9 with early-onset NSPE (EO-NSPE) patients, 27 early-onset SPE (EO-SPE) patients, 21 later-onset NSPE (LO-NSPE), and 7 with later-onset SPE (LO-SPE). All patients underwent multimodal echocardiography before treatment, including two-dimensional, Doppler, and speckle-tracking echocardiography, to evaluate left ventricular structure/function. EO-SPE patients were characterized by left ventricular injury and systolic function reduced. LO-SPE patients were characterized by left ventricular hypertrophy and reduced diastolic function. Multimodal echocardiography can detect myocardial injury in PE patients at an early stage (Jiang *et al.,* 2023).In this present study QRS complex angles and RVH may not emerge as significant predictors of preeclampsia, but the significant increase in LVH-related to QRS complexemerge as significant predictors in preeclamptic pregnant women which correlates with previous studies (Jiang *et al.,* 2023) underscores the importance of left ventricular remodeling in the pathophysiology of the condition.

5. CONCLUSION

In conclusion, results from this present study show no significant differences were observed in QRS complex angles related to right ventricular hypertrophy (RVH) between normotensive and preeclamptic pregnant women. Notably, there is a significant increase in QRS complex related to left ventricular hypertrophy (LVH) in preeclamptic pregnant women, indicating left ventricular remodeling's importance. Moreover, there was a significant increase

in T wave amplitude, this suggests underlying myocardial electrical remodeling or dysfunction in preeclampsia, emphasizing the need for cardiovascular monitoring. The study underscores the multifactorial nature of cardiovascular changes in preeclampsia and highlights the potential of ECG parameters in aiding early detection, risk stratification, and management of the condition, despite some parameters showing no significant differences.

LIMITATIONS

Despite the promising role of ECG parameters in predicting preeclampsia, several limitations must be acknowledged. The foremost concern is the modest sample size of 40 subjects, which, while adequate for preliminary analysis, limits the statistical power and generalizability of the findings across broader populations. Moreover, the study's focus on a single healthcare facility in Edo State, Nigeria, introduces regional biases that may not reflect the diverse demographics and clinical profiles found in other settings.

REFERENCES

Armaly, Z., Jadaon, J. E., Jabbour, A., & Abassi, Z. A. (2018). Preeclampsia: Novel mechanisms and potential therapeutic approaches. Frontiers in Physiology, 9, 973. https://doi.org/10.3389/fphys.2018.00973

Chaiworapongsa, T., Chaemsaithong, P., Yeo, L., & Romero, R. (2014). Preeclampsia part 1: Current understanding of its pathophysiology. Nature Reviews Nephrology, 10(8), 466–480. https://doi.org/10.1038/nrneph.2014.103

de Alencar Neto, J. N., de Andrade Matos, V. F., Scheffer, M. K., Felicioni, S. P., De Marchi, M. F. N., & Martínez-Sellés, M. (2024). ST segment and T wave abnormalities: A narrative review. Journal of Electrocardiology. https://doi.org/10.1016/j.jelectrocard.2024.01.008

Duley, L. (2009). The global impact of pre-eclampsia and eclampsia. Seminars in Perinatology, 33(3), 130–137. https://doi.org/10.1053/j.semperi.2009.02.010

Jiang, L., Liang, W., Xie, R., Fang, X., Liu, D., Zhang, M., & Shi, C. (2023). Assessment of left ventricular structure and function in preeclampsia subtypes by multimodal echocardiography. Journal of Obstetrics and Gynaecology Research, 49(8), 2031–2039. https://doi.org/10.1111/jog.15588

Khalil, A., O'Brien, P., Granger, J. P., & Thadhani, R. (2019). Preeclampsia: Pathophysiology and integrative considerations. Journal of Nutrition and Metabolism, 2019, 1–11. https://doi.org/10.1155/2019/9248592

Khan, J. A., Ashraf, A., Fayaz, F., & Qureshi, W. (2023). Electrocardiographic pattern in hypertensive disorders of pregnancy. International Journal of Research in Medical Sciences, 11(11), 4154–4159. https://doi.org/10.18203/issn.2320-6012

Nagel, C. (2023). Multiscale Cohort Modeling of Atrial Electrophysiology: Risk Stratification for Atrial Fibrillation through Machine Learning on Electrocardiograms (Vol. 27). KIT Scientific Publishing. https://doi.org/10.5445/KSP/1000135988

Pegorie, M., Khalil, A., & Green, M. (2023). Electrocardiographic changes in pre-eclampsia: A systematic review and meta-analysis. European Journal of Obstetrics & Gynecology and Reproductive Biology, 280, 1–8. https://doi.org/10.1016/j.ejogrb.2023.01.008

Vondrak, J., & Penhaker, M. (2022). Review of processing pathological vectorcardiographic records for the detection of heart disease. Frontiers in Physiology, 13, 856590. https://doi.org/10.3389/fphys.2022.856590