International Journal of Health and Medicine
Volume 2, Number 2 Year 2025
e-ISSN: 3047-793X, p-ISSN: 3047-7948, Page 24-33
DOI: https://doi.org/10.62951/ijhm.v2i2.321
Available online at: https://international.arikesi.or.id/index.php/IJHM

Predictive Role of P Wave Duration, Amplitudes and P Wave Morphology in Preeclamptic Pregnant Women in the Third Trimester of Pregnancy

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

[1]Department of Physiology, Ambrose Alli University, Ekpoma, Edo State, Nigeria
[2,4]Department of Physiology, Abia State University, Uturu, Abia State, Nigeria
[3] Department of Physiology, University of Benin, Benin City, Edo state, Nigeria
[5]Department of Physiology , David Umahi Federal University Health Services, Uburu. Ebonyi State, Nigeria
[6]Department of Public Health Institution, Imo State University, Owerri

Author correspondence: edebiriduncan@gmail.com

Abstract: *The ultimate goal of predicting preeclampsia that can enhance early detection and risk stratification in pregnant women, by leveraging the diagnostic potential of ECG patterns, we hope to improve maternal and fetal outcomes and contribute to the development of personalized care strategies for preeclamptic patients. Current diagnostic methods for preeclampsia rely primarily on routine blood pressure monitoring and proteinuria assessment, which have limited sensitivity and specificity. The aim of this study is to investigate the predictive role of P wave duration, amplitudes and morphology 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 statistically significant increases in P wave duration, amplitude and abnormal M pattern among preeclamptic compare to normotensive pregnant women, consistent with prior research, abnormal M pattern in P wave morphology is linked to atrial pathology in preeclampsia. 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.*

Key Words: *Preeclampsia, P wave Duration, P wave Amplitudes and P wave Morphology*

1. INTRODUCTION

Preeclampsia is a complex and multifactorial pregnancy disorder characterized by the onset of hypertension and organ dysfunction after 20 weeks of gestation(August and Sibai, 2017), affecting approximately 2-8% of pregnancies worldwide (Duley, 2009). Despite significant advances in obstetric care, preeclampsia remains a leading cause of maternal and fetal morbidity and mortality, accounting for over 50,000 maternal deaths globally each year(Ghulmiyyah and Sibai, 2012). The exact mechanisms underlying preeclampsia are still not fully understood, but it is widely recognized that early detection and prediction are critical to preventing adverse outcomes (Lee *et al*., 2023).Current diagnostic methods for preeclampsia rely primarily on routine blood pressure monitoring and proteinuria assessment, which have limited sensitivity and specificity(Dymara-Konopka *et al*., 2018). Moreover, these markers often appear late in the disease course,

Received: Januari 21, 2025; Revised: Februari 05, 2025;Accepted: Februari 19, 2025; Online Available: Februari 21, 2025

making early identification and timely interventions challenging. Consequently, there is a pressing need for novel predictive markers that can accurately identify women at risk of developing preeclampsia, enabling targeted surveillance, prophylactic measures, and personalized management strategies.

Recent studies have explored the potential of electrocardiographic (ECG) patterns as a non-invasive and readily available tool for predicting preeclampsia (Vonck *et al*., 2016). The P wave, which represents atrial depolarization, has garnered particular interest due to its association with cardiac remodeling and dysfunction in hypertensive disorders (Filos *et al*., 2019). Prolonged P wave duration, altered amplitudes, and changes in P wave morphology have been observed in preeclamptic women, suggesting that ECG analysis may provide valuable insights into the underlying pathophysiology (Angeli *et al*., 2015; DincgezCakmak *et al*., 2019).

This study aims to investigate the predictive role of P wave duration, amplitudes, and morphology in preeclamptic pregnant women during the third trimester, with the ultimate goal of identifying specific ECG markers that can enhance early detection and risk stratification. By leveraging the diagnostic potential of ECG patterns, we hope to improve maternal and fetal outcomes and contribute to the development of personalized care strategies for preeclamptic patients. Our findings may also shed light on the underlying cardiac mechanisms involved in preeclampsia, ultimately paving the way for novel therapeutic approaches and improved clinical management.

2. LITERATURE REVIEW

Preeclampsia remains a major cause of maternal and fetal morbidity, and early prediction is critical for improving outcomes. Traditional diagnostic methods rely on blood pressure and proteinuria; however, recent work has focused on identifying ECG-derived markers as cost-effective, noninvasive predictors of this multifactorial disorder. For instance, Uçar *et al.,* (2024) demonstrated that the Frontal QRS-T angle—defined as the absolute difference between the QRS and T-wave axes—is significantly higher in women who later develop preeclampsia. Their prospective pilot study showed that both first- and third-trimester measurements of the QRS-T angle were elevated compared with controls, with the third-trimester angle providing a sensitivity of 70% and specificity of 68% at a cutoff of 28° (Uçar *et al.,* 2024). These findings suggest that early changes in ventricular depolarization–repolarization heterogeneity may reflect underlying cardiac stress and endothelial dysfunction characteristic of preeclampsia.

In parallel, several studies have examined the impact of preeclampsia on fetal cardiac function using noninvasive fetal ECG monitoring. Lakhno (2014) reported that preeclamptic pregnancies are associated with altered fetal heart rate variability (HRV), including reduced total power and diminished vagal-mediated parameters (e.g., RMSSD and pNN50) alongside an increased T/QRS ratio. These changes are thought to result from an imbalance in the fetal autonomic nervous system, with a relative predominance of sympathetic over parasympathetic tone. Such autonomic dysregulation not only correlates with lower Apgar scores at birth but may also signal early myocardial compromise in the fetus (Lakhno, 2014).

Moreover, the utility of ECG parameters extends beyond mere detection. Studies have noted that ECG markers traditionally used in adult cardiology—such as QT dispersion and the Frontal QRS-T angle—also possess prognostic value in the obstetric setting. The widening of the QRS-T angle, in particular, is associated with increased heterogeneity of myocardial repolarization, a known risk factor for arrhythmias and adverse cardiovascular events in nonpregnant populations (Zhang *et al.,* 2017). This overlap underscores the concept that preeclampsia, which itself predisposes women to long-term cardiovascular disease, may be accompanied by subtle but measurable alterations in cardiac electrical activity long before clinical symptoms become overt.

Taken together, these studies highlight the potential role of ECG as a dual-purpose tool in preeclampsia: maternal ECG markers such as the Frontal QRS-T angle can serve as early indicators of the disease process, while fetal ECG analysis provides additional insight into fetal distress and autonomic dysfunction. Future research with larger cohorts and standardized protocols is needed to validate these markers further and to establish definitive cutoffs for clinical application.

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. It 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.

Fig. 1 HEARTSCREEN 112 C-1 ECG- Machine INNOMED 2011.

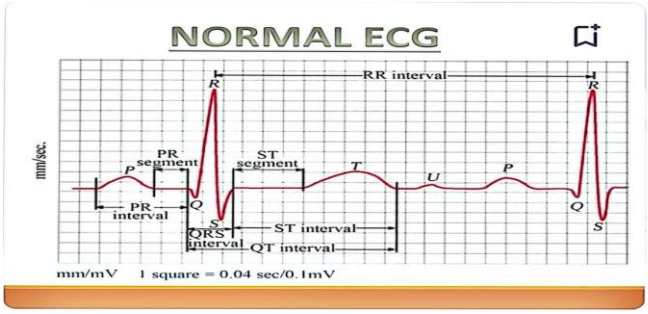

Fig: 2 Normal ECG Graph diagram

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.

4. RESULTS

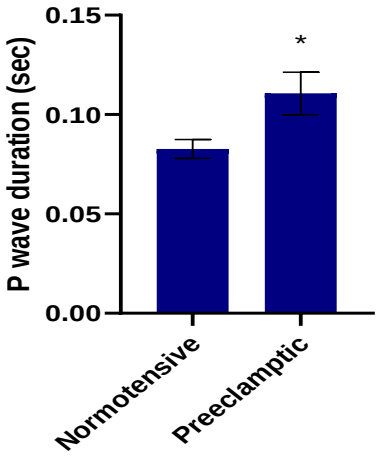

Fig. 3 P wave duration in the third trimester of pregnancy of normotensive n= 20 and preeclamptic n= 20 in pregnant women at third trimester.

Result in fig. 3 show a statistically significant increase in P wave duration in preeclamptic pregnant women compared to normotensive pregnant women at the third trimester of pregnancy ($p<0.05$)

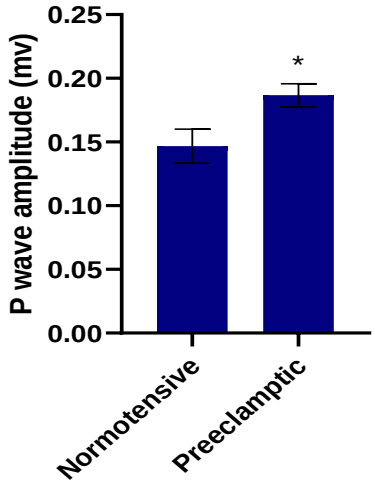

Fig.4 P- wave amplitude in the third trimester of pregnancy of normotensive n= 20 and preeclamptic n= 20 pregnant women at third trimester.

Result in fig.4: show a statistically significant increase in P wave amplitude in preeclamptic pregnant women compared to normotensive pregnant women at the third trimester of pregnancy ($p<0.05$)

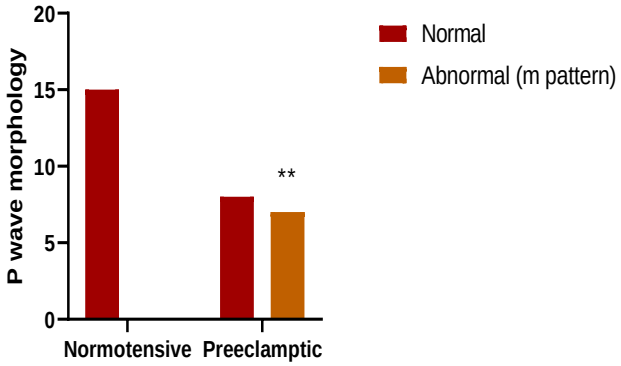

Fig.5 P wave morphology in the third trimester of pregnancy of normotensive n= 40 and preeclamptic n= 20 pregnant women in the third trimester of pregnancy.

Result in fig 5: show a statistically significant increase in the number of preeclamptic pregnant women who showed abnormal m pattern in P wave morphology compared to normotensive pregnant women all in their third trimester of pregnancy ($p<0.05$)

5. DISCUSSION

Electrocardiography (ECG) has garnered attention as a potential tool for predicting and monitoring preeclampsia due to its ability to detect subtle changes in cardiac electrical activity (Tiwari, 2023). This comprehensive examination aims to delve into the predictive role of various ECG patterns in identifying and managing preeclampsia.P wave duration reflects atrial depolarization time, while amplitude signifies the magnitude of atrial depolarization (Centurión*et al.,* 2018). Alterations in these parameters may indicate underlying atrial electrical remodeling and dysfunction, commonly observed in preeclampsia (Centurión*et al.,* 2018).Figure 4.1 highlights a statistically significant increase in P wave duration among preeclamptic pregnant women compared to normotensive counterparts during the third trimester of pregnancy ($p<0.05$). Similarly, figure 4.2 demonstrates a significant increase in P wave amplitude in preeclamptic pregnant women ($p<0.05$). Previous studies have corroborated these findings, emphasizing the association between prolonged P wave duration, increased P wave amplitude, and preeclampsia. DincgezCakmak*et al.,* (2019) compare P-wave dispersion values in hypertensive disorders of pregnancy, controls and also in preeclampsia and discovered thatin subgroup analysis, P-wave dispersionwere different between preeclamptic, chronic hypertensive, and gestational hypertensive patients. Also, they were significantly higher in chronic hypertension as compared to gestational hypertension and they were higher in

preeclampsia than in gestational hypertension.These present research is in agreement with the analysis by Raffaelli*et al.,* (2014) in which P-wave duration was significantly longer in the pre-eclamptic women than in the control group of normal pregnancy.Additionally, Brown (2018) underscored the multifactorial nature of cardiovascular changes in preeclampsia, with ECG parameters offering valuable insights into cardiac function and prognosis.

The M pattern refers to a distinct waveform observed in the P wave morphology, potentially indicative of atrial pathology or conduction abnormalities (Di Cintio, 2018). Figure 4.3 presents a statistically significant increase in the number of preeclamptic pregnant women exhibiting abnormal M pattern in P wave morphology compared to normotensive counterparts during the third trimester of pregnancy ($p<0.05$).The presence of abnormal M pattern in P wave morphology has been identified as a potential marker of atrial electrical remodeling and dysfunction in preeclampsia (Aksu*et al.,* 2022),Angeli*et al.,* (2011) investigated abnormal P-wave morphology during third trimester of pregnancy as potential predictor of hypertensive disorders during pregnancy. P-wave morphology was analyzed in all of the standard leads. The criteria used for the diagnosis of P-wave abnormality in lead V1 were: (1) bipeak interval in deeply notched P-wave with (2) terminal forces equal to or more negative than −0.04 mm·s, as obtained from the product of the depth of the terminal negative deflection and its duration (Angeli*et al.,* 2015). The following other criteria were used for the diagnosis of LA abnormality in any other lead than V1: (1) bipeak interval in deeply notched P-waves wider than 0.04 s; or (2) P-wave/PR-segment ratio greater than 1.6; or (3) P-wave higher than 3 mm; or (4) total P-wave duration greater than 0.11s (Angeli*et al.,* 2015). The primary outcome of the study was the development of gestational hypertension, pre-eclampsia and eclampsia.Abnormality of P-wave morphology in lead V1 tested as predictor of hypertensive disorders during pregnancy (Angeli*et al.,* 2011) is commonly used as an ECG sign of left atrial enlargement and it may be easily diagnosed by traditional visual interpretation of ECG tracings, without any need of digitalization or other computer facilities (Angeli*et al.,* 2015). Left atrial enlargement is very common in hypertensive subjects and may be an early sign of heart involvement in arterial systemic hypertension (Angeli*et al.,* 2015).The findings presented in figures 4.1 through 4.3 provide valuable insights into the predictive role of ECG patterns in preeclampsia. Prolonged P wave duration, increased P wave amplitude, and abnormal M pattern in P wave morphology are indicative of atrial electrical remodeling and dysfunction, commonly observed in

preeclamptic pregnant women. These ECG parameters offer valuable insights into cardiac function and prognosis, potentially aiding in early detection, risk stratification, and management of preeclampsia.

6. CONCLUSION

In conclusion, results from this present study show statistically significant increases in P wave duration and amplitude among preeclamptic pregnant women, consistent with prior research. Abnormal M pattern in P wave morphology is linked to atrial pathology in preeclampsia. 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.

7. LIMITATIONS

One key limitation of this study, is the relatively small sample size—only 40 participants (20 normotensive and 20 preeclamptic pregnant women) were recruited from a single hospital in Edo State, Nigeria. This limited sample may reduce the statistical power of the study and restrict the generalizability of the findings to broader populations.

REFERENCES

Aksu, E., Cuglan, B., Tok, A., Celik, E., Doganer, A., Sokmen, A., & Sokmen, G. (2022). Cardiac electrical and structural alterations in preeclampsia. *The Journal of Maternal-Fetal & Neonatal Medicine, 35*(1), 1–10.

Angeli, E., Verdecchia, P., Narducci, P., & Angeli, F. (2011). Additive value of standard ECG for the risk prediction of hypertensive disorders during pregnancy. *Hypertension Research, 34*(6), 707–713.

Angeli, F., Angeli, E., & Verdecchia, P. (2015). Novel electrocardiographic patterns for the prediction of hypertensive disorders of pregnancy—from pathophysiology to practical implications. *International Journal of Molecular Sciences, 16*(8), 18454–18473.

August, P., & Sibai, B. M. (2017). Preeclampsia: Clinical features and diagnosis. In Post T. W. (Ed.), *UpToDate*. Waltham, MA: UpToDate.

Brown, C. E. (2018). *Assessment of cardiovascular risk in women with a history of pre-eclampsia* (Doctoral dissertation, University of Glasgow).

Centurión, O. A., García, L. B., Marecos, A., Torales, J., Scavenius, K., Miño, L., & Sequeira, O. (2018). P-wave morphology, amplitude, duration and dispersion in atrial arrhythmias. *Journal of Cardiology and Therapeutics, 6*, 1–6.

Chaemsaithong, P., Sahota, D. S., & Poon, L. C. (2022). First trimester preeclampsia screening and prediction. *American Journal of Obstetrics and Gynecology, 226*(2), S1071–S1097.

Di Cintio, F. (2018). *Recognition of atrial pathologies in the elderly through the study of P wave morphology* (Doctoral dissertation, Politecnico di Torino).

Dincgez Cakmak, B., Dundar, B., Ketenci Gencer, F., Turker, U., & Kanat, S. (2019). P-wave and QT dispersion in hypertensive disorders of pregnancy. *The Journal of Maternal-Fetal & Neonatal Medicine, 32*(24), 4051–4059.

Duley, L. (2009, June). The global impact of pre-eclampsia and eclampsia. In *Seminars in Perinatology, 33*(3), 130–137. WB Saunders.

Dymara-Konopka, W., Laskowska, M., & Oleszczuk, J. (2018). Preeclampsia—Current management and future approach. *Current Pharmaceutical Biotechnology, 19*(10), 786–796.

Filos, D., Tachmatzidis, D., Maglaveras, N., Vassilikos, V., & Chouvarda, I. (2019). Understanding the beat-to-beat variations of P-waves morphologies in AF patients during sinus rhythm: A scoping review of the atrial simulation studies. *Frontiers in Physiology, 10*, 742.

Ghulmiyyah, L., & Sibai, B. (2012, February). Maternal mortality from preeclampsia/eclampsia. In *Seminars in Perinatology, 36*(1), 56–59. WB Saunders.

Lakhno, I. (2014). The impact of preeclampsia on fetal ECG morphology and heart rate variability. *Archives of Perinatal Medicine, 20*(1), 7–10.

Lee, N. M., Chaemsaithong, P., & Poon, L. C. (2023). Prediction of preeclampsia in asymptomatic women. *Best Practice & Research Clinical Obstetrics & Gynaecology.* https://doi.org/10.1016/j.bpobgyn.2023.102436

Raffaelli, R., Antonia Prioli, M., Parissone, F., Prati, D., Carli, M., Bergamini, C., ... & Franchi, M. (2014). Pre-eclampsia: Evidence of altered ventricular repolarization by standard ECG parameters and QT dispersion. *Hypertension Research, 37*(11), 984–988.

Tiwari, A. (2023). Labour monitoring in pregnant women using phonocardiography, electrocardiography and electromyography technique. *arXiv preprint arXiv:2306.17198.*

Uçar, E., Toprak, K., & Karataş, M. (2024). A novel electrocardiographic marker to predict the development of preeclampsia: Frontal QRS-T angle—A prospective pilot study. *Medicina, 60*(11), 1856.

Vonck, S., Staelens, A. S., Bollen, I., Broekx, L., & Gyselaers, W. (2016). Why non-invasive maternal hemodynamics assessment is clinically relevant in early pregnancy: A literature review. *BMC Pregnancy and Childbirth, 16*, 1–9.

Zhang, Z.-M., Rautaharju, P. M., Prineas, R. J., Tereshchenko, L., & Soliman, E. Z. (2017). Electrocardiographic QRS-T angle and the risk of incident silent myocardial infarction in the Atherosclerosis Risk in Communities study. *Journal of Electrocardiology, 50*, 661–666.