International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2022): 7.942

Computational Assessment of Hypertensive Disorders in Pregnancy: Identifying Risk Factors and Early Indicators

R. Gomathi[1], Dr. K. Menaka[2]

[1]Research Scholar, Department of Computer Science, Urumu Dhanalakshmi College, (Affiliated to Bharathidasan University), Tiruchirappalli, Tamil Nadu, India

[2]Assistant Professor, PG & Research Department of Computer Science, Urumu Dhanalakshmi College, (Affiliated to Bharathidasan University), Tiruchirappalli, Tamil Nadu, India.
Email: *udccsmenaka[at]gmail.com*

Abstract: ***Hypertensive disorders during pregnancy, such as gestational hypertension and preeclampsia, pose significant risks to both maternal and fetal health. Early detection of these conditions is crucial to mitigate potential complications and ensure better outcomes. In this study, we present a computational analysis aimed at detecting hypertensive disorders in pregnant women. By leveraging statistical techniques, we explore the relationship between various clinical parameters and the risk of developing gestational hypertension and preeclampsia. Our findings provide valuable insights into the potential early indicators of these disorders, paving the way for more accurate and timely diagnosis, which could lead to improved maternal care and fetal well - being. This computational approach holds promise as an efficient and expedient tool for physicians to identify high - risk cases and implement proactive interventions during pregnancy.***

Keywords: Gestational Hypertension, Preeclampsia, Statistical Analyses

1. Introduction

Hypertensive disorder is considered to be one of the most common medical complications during pregnancy will lead to maternal and prenatal malady and mortality throughout the world [1]. Chronic, Gestational and Preeclampsia are considered to be the three common categories of hypertension among which the later form is regarded as the most severe form of hypertension for pregnant women. During pregnancy, the impulsive increase in the Blood Pressure (BP) levels leads to preeclampsia. The severity of preeclampsia can be tacit from the gestational week of the pregnant women. The development of preeclampsia before the 34th week of gestation is referred to as 'Early preeclampsia' and during or after it, is referred to as 'Late Preeclampsia'. The body conditions of pregnant women would be changed due to the raise in her BP level. High stress, overwork, unhealthy eating habits, less physical movements etc are the considerable causes for this [2].

The standard component for preeclampsia is in general the Gestational Hypertension (GH). The reason that many authors suggest methods for identifying the cause for hypertensive disorder / preeclampsia is that this is becoming a vital problem nowadays. The relationship of preeclampsia with that of SBP and DBP have been analysed in wide number of works. There are some unfocused maternal characteristics that could also help to identify preeclampsia at an earlier stage and this work focuses on identifying / screening those factors.

The vast variety of statistical methods assists researchers to undertake studies that include varieties of tasks regarding the collection of data, analyzing the collected data, making elucidation based on the statistical analyses and exploring the outcome of the findings. Using appropriate statistical method only will help to infer accurate results [3]. Anyone who wants to undergo any kind of treatment may consider performing statistical tests for their medical problem before going to treatments [4]. The use of some statistical methods and finding their impact in health care systems is vital as suggested in [5].

The condition of a patient could be easily understood in viewing these inputs and this could also help the physicians for further diagnosis. The statistical methods can also help to find the combinations of multiple factors only with the help of very few tests. Thus, this work will assist the physicians/doctors for detecting the causes for preeclampsia in pregnant women.

2. Literature Review

Wilson DL et al. [6] focused on observing whether hypertensive disorders and preeclampsia during pregnancy could be forced by Sleep Disordered Breathing (SDB). SDB has been illustrated by many features related to hypertensive disorders of pregnancy. They confirmed that the occurrence of SDB for a pregnant woman did not deteriorate her hypertension or preeclampsia. Moreira et. al. [7] proposed a study in which the pregnancy risks based on the symptoms of the patient were observed by the progress, performance estimation and comparison of numerous machine learning algorithms. Their contribution and purpose was to focus on finding a smart classifier for providing reliable results to identify issues related to pregnancy. They concluded that their study will help to reduce maternal and fetal deaths. Badriyah et al. [8] monitored that the grounds of maternal and infant mortality is high due to the severity of preeclampsia disease. Some data mining techniques were compared by them for predicting the risk level of the disease. The accuracy of the outcomes in all the techniques were also been observed in their study. Facco et al. [9] proposed a study to determine whether SDB during the child - bearing stage is a menace for the progress of retention and diabetes.

In their study, Pien et al. [10] conducted analyses using multivariable logistic regression to estimate the factors contributing to specific aspects of 3rd - trimester Sleep - Disordered Breathing (SDB) in pregnant women. In addition to this, they performed secondary analyses to explore the association between SDB and hypertensive disorders of pregnancy.

Carvalho et al. [11] conducted a comparative study focusing on maternal challenges and neonatal effects in women with severe preeclampsia. The researchers gathered data concerning both internal and external changes experienced by pregnant women, as well as the results of laboratory tests conducted during this stage. They also examined the complications arising during this period. By performing various statistical analyses, they sought to understand the underlying factors contributing to the development of preeclampsia.

In their research, Luo et al. [12] investigated the dynamic changes in pulsation signals in pregnant women. To achieve this, they employed machine learning (ML) techniques to classify and predict these changes in both the case group (women with specific conditions) and the control group (healthy women). Prior to conducting the study, they meticulously eliminated any noise present in the dataset. The study's findings revealed consistent results between conventional statistical methods and ML approaches, thereby validating the stability of their conclusions.

In their work, Feroz et al. [13] conducted a study focusing on Digital Health Interventions (DHI) implemented to support pregnant women at high risk for preeclampsia in low and middle - income countries. They examined the available evidence on the effectiveness of these interventions. The study concluded that while the evidence indicated some promise for the use of DHI in addressing the issue of preeclampsia, further potential studies are required before making definitive recommendations for their widespread use in managing preeclampsia.

3. Materials and Methods

The current study aims to explore the relationship between Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP) with Gestational Hypertension (GH) and Preeclampsia (PE). Carvalho et al. [11] investigated fetal characteristics in infants born to mothers who experienced severe preeclampsia before 26 weeks of pregnancy. The study utilized an open - source dataset previously used by Wilson ID et al. [6]. The research considered two crucial features, namely SBP and DBP, along with standard parameters such as Age, Blood Sugar, Heart Rate, Body Temperature, and Body Mass Index, which are essential for gestational women. Based on the levels of SBP and DBP, the dataset records were grouped into four categories based on risk levels. Category - 1 included instances with SBP<100 and a risk level labeled as "Low, " and SBP>130 with a risk level labeled as "High. " In Category - 2, instances with SBP<100 and a risk level labeled as "High, " and SBP>130 with a risk level labeled as "Low" were included. Category - 3 comprised instances with DBP<60 and a risk level labeled as "Low, " and DBP>80 with a risk level labeled as "High. " Lastly, Category - 4 contained instances with DBP<60 and a risk level labeled as "High, " and DBP>80 with a risk level labeled as "Low. "Among the four categories, Category - 2 was considered to be particularly unusual, while Category - 4 was considered moderate based on their risk levels. Categories 1 and 3 were seen as strong indicators of GH & PE based on the blood pressure measures. For further details on these four categories, please refer to Table - I.

Table I: The categorizations of SDP & DBP levels with Risk Factor

Category	SBP &d DBP Levels and Risk Factor
Category - 1	SBP < 100 & Risk Level: Low; SDP >130 & Risk Level: High
Category - 2	SBP < 100 & Risk Level: High; SDP >130 & Risk Level: Low
Category - 3	DBP < 60 & Risk Level: Low; DBP >80 & Risk Level: High
Category - 4	DBP < 60 & Risk Level: High; DBP >80 & Risk Level: Low

The study employed three statistical tests to verify the statistical significance of the relationship between SBP & DBP with GH & PE:

To assess the statistical significance of the study, the above tests were performed to test the intended null hypothesis that there is a strong mutual association between SBP &DBP with GH & PE. The average values of Age, SBP, DBP, Blood Sugar (BS) level, Mean body temperature, and Mean heart rate were calculated for each of the four categories based on the selected dataset. These results were then presented in Table - II for further analysis and interpretation.

Table II: Computed averages of basic features of patients dispersing over the four categories

Features	Category1	Category2	Category3	Category 4
Mean Age	32.4541	22.045	29.46	21.9
Mean SBP	113.5297	88.318	108.125	102.63
Mean DBP	77.408	62.818	73.39	74.25
Mean BS	10.39	9.35	10.23	8.23
Mean Body Temperature	98.13	101.36	98.03	99.833
Mean Heart Rate	75.83	75.13	75.42	72.59

4. Results and Discussion

Upon closer examination of Table II, several important observations can be made regarding the characteristics of gestational women in different categories:

The mean age of gestational women is found to be less than 25 years for the unusual categories (Category - 2 and Category - 4), while it is nearly 30 years for the usual categories (Category - 1 and Category - 3). This suggests that younger women are more likely to fall into the unusual categories, while older women tend to be in the usual categories. The mean SBP values show significant variations among all the categories, indicating that SBP alone is not sufficient to determine the presence of gestational hypertension, which could potentially lead to preeclampsia. Other factors may also be contributing to this condition.

Body Temperature, Blood Sugar, and Heart Rate: There are no considerable differences in the mean values of body temperature, blood sugar, and heart rate between the usual and unusual categories. This suggests that these parameters might not be strongly correlated with the risk levels of gestational hypertension and preeclampsia.

Category - 2 is considered to be very rare and stands out from the others due to noteworthy variation in mean DBP (Diastolic Blood Pressure). In contrast, the mean DBP remains almost the same for all the other categories. This indicates that DBP might play a more significant role in distinguishing Category - 2 from the rest.

The close examination of these parameters and their interdependence for gestational hypertension and preeclampsia could be crucial in identifying the condition at an earlier stage and potentially avoiding its severity. Understanding the complex relationship between age, SBP, DBP, and other vital parameters can aid in better detection and management of these pregnancy - related conditions, leading to improved maternal and fetal outcomes.

Table III: ANOVA experiment results

Category	*p - value*
I, II	0.719
I, III	0.924
I, IV	0.839
II, III	0.79
II, IV	0.88
III, IV	0.91
I, II, III	0.93
I, II, IV	0.94
I, III, IV	0.97
II, III, IV	0.96
I, II, III, IV	0.98

The Analysis of Variance (ANOVA) test is a statistical method used to compare the means of two or more groups to determine if there are significant differences or similarities among them. It helps to investigate whether there is a statistically significant relationship between the variables being studied.

In the context of the present study, ANOVA was likely employed to compare the means of Age, SBP, DBP, Blood Sugar (BS) level, Mean body temperature, and Mean heart rate among the four categories (Category - 1, Category - 2, Category - 3, and Category - 4) based on the risk levels. The computed p - values from the ANOVA tests were then presented in Table - III.

The p - value represents the probability of obtaining the observed results (or more extreme results) if the null hypothesis is true. A significance level (alpha) is chosen to determine the threshold for statistical significance. Typically, a significance level of 0.05 (5%) is commonly used, meaning that if the computed p - value is less than 0.05, there is less than a 5% chance of obtaining these results under the assumption of no significant difference, and the null hypothesis is rejected. On the other hand, if the p - value is greater than or equal to 0.05, there is insufficient evidence to reject the null hypothesis, and we consider the results not statistically significant.

By examining the p - values in Table - III, one can determine whether there are significant differences in the means of the groups for each variable (Age, SBP, DBP, Blood Sugar, Mean body temperature, and Mean heart rate) based on the risk categories. This information is crucial for drawing meaningful conclusions and interpreting the relationship between these parameters and gestational hypertension (GH) and preeclampsia (PE).

Category – I and III are usual cases which strongly indicate that there is an association between blood pressure values (SBP & DBP) and the higher risk of hypertensive disorder during pregnancy. Category – II & IV are unusual cases which are against the null hypothesis and which indicate that there may be some other parameters other than the blood pressure levels which may lead to high risk of pregnancy. On observing the values of ‘p’ in various cases in Table - III it could be noted that the value being greater than 90%, definitely comprised of Category I or Category III or both. This shows the powerful association between the blood pressure levels and high risk for preeclampsia. In some other cases, wherever Category II is present along with yet another Category, the p - value slightly reduces (nearer to 80%). These variations lead to explore further experiments.

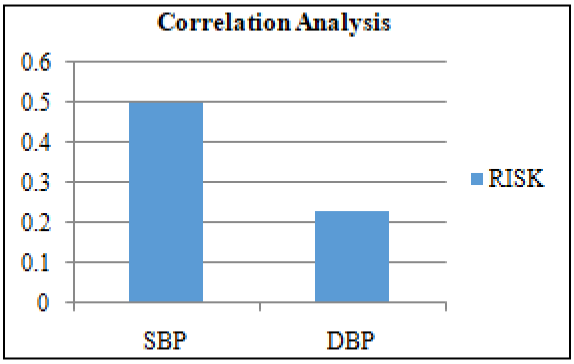

Figure 1: Pearson Correlation between SBP, DBP and Risk Level for the entire dataset

In the present study, the dependence of Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP) on the risk level during pregnancy was explored using Correlation Analysis. This analysis was conducted for the entire dataset of all 1014 patients. The results were presented in Fig.1.

From Fig.1, it was observed that there is a moderate correlation between SBP and the risk level during pregnancy. However, the correlation between DBP and the risk level is very low, indicating that DBP may not be strongly associated with the risk level in this context.

Regression Analysis was also performed to determine the relationships among the variables and estimate trends. The value of R (correlation coefficient) in the regression analysis indicates the strength and direction of the relationship between the variables. A higher R value suggests a stronger relationship between the variables used in the analysis. In this study, Regression Analysis was used to predict the correlation between the predicted values of "Risk" over the values of SBP and DBP.

Additionally, the R - Squared value, also known as the coefficient of determination, is a measure of goodness of fit in regression analysis. It represents the percentage of data points that fall on the regression line. A higher R - Squared value indicates a better fit of the data to the regression line.
The results of the linear regression analysis conducted between SBP & Risk, DBP & Risk for the entire dataset and the four risk categories were depicted in Figures 2 (a) to (c). These figures likely illustrate how well the data points align with the regression line for each variable, providing insights into the strength and direction of the relationships between SBP, DBP, and the risk levels of gestational hypertension and preeclampsia.

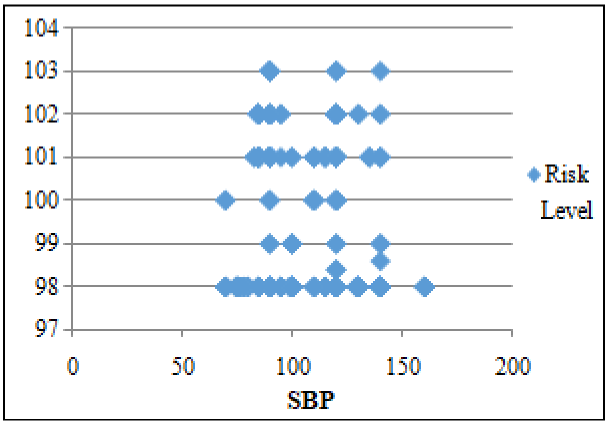

Figure 2 (a): Test on Linear Regression for the entire dataset for SBP Vs Risk

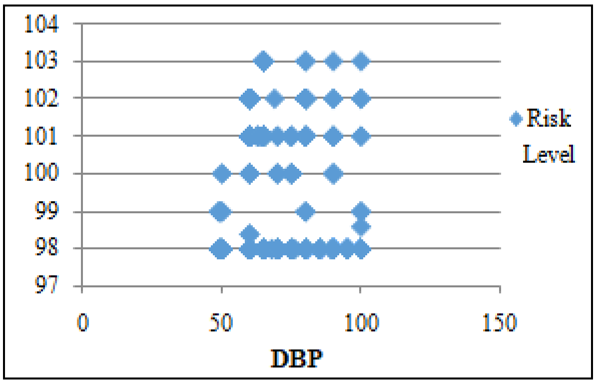

Figure 2 (b): Test on Linear Regression for the entire dataset for DBP Vs Risk

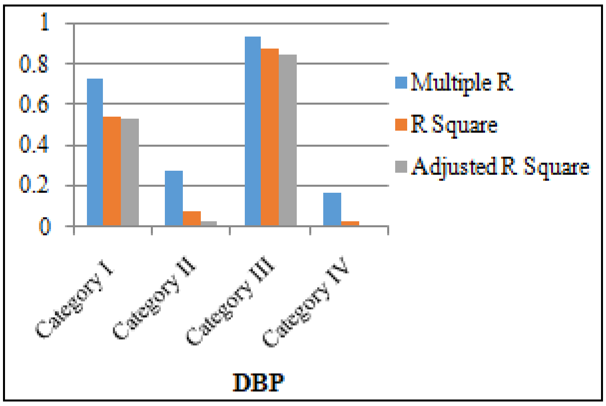

Figure 2 (c): Test on Linear Regression for the 4 Categories of data

Fig.2 (c) justifies that for Categories I & III, the R value, R Square value and Adjusted R square value shows higher significance of more than 0.5 to 0.9 which is relatively lower (<0.3) for the other two categories viz. Category II & IV. This shows the interdependence of SBP, DBP and the risk for hypertension / preeclampsia during pregnancy. While Category I is fitted to compare SBP and risk level and Category III for DBP & risk level, among these two categories, the linear regression outputs show higher significance for DBP Vs risk level than the first category.

On viewing the outputs of various statistical experiments, the fact that is being explored is that the study should be proceeded further by considering other important physiological confines like age, blood sugar, body temperature and heart rate and some other factors for exploring the problem of identifying the presence of hypertension / preeclampsia at an early stage for pregnant women.

5. Conclusion

This study aimed to investigate the relationship between blood pressure levels and the risk for pregnant women during their pregnancy. The objective was to enable early diagnosis of potential problems in pregnant women, thereby helping to prevent risks associated with hypertension and preeclampsia. While many pregnant women with high blood pressure deliver healthy babies without major complications, some cases can pose risks to both the mother and the fetus. The research focused on pregnant women whose blood pressure levels increased periodically during their pregnancy, leading to potential complications during pregnancy and delivery, particularly when compared to women with normal blood pressure levels. This condition is known as gestational hypertension and may result in low birth weight and premature delivery. In more severe cases, it may progress to preeclampsia, which poses significant threats to both the mother and the fetus. The study employed statistical analyses to identify the development of hypertensive disorders and preeclampsia in pregnant women at an early stage by closely monitoring clinical observations. The aim was to facilitate the early detection and prevention of such problems to ensure better maternal and fetal outcomes.

For future work, the researchers suggested the use of machine learning approaches to more accurately detect and predict the development of hypertensive disorders and preeclampsia. Utilizing machine learning algorithms could potentially serve as a valuable prediction tool for physicians, allowing them to identify high - risk cases more efficiently and take timely preventive measures. This advancement could greatly benefit the healthcare system and improve the overall care for pregnant women at risk of developing these conditions.

References

[1] J. F. Carreño and P. Qiu, "Feature selection algorithms for predicting preeclampsia: A comparative approach, " 2020 IEEE International Conference on Bioinformatics and Biomedicine (BIBM), 2020, pp.2626 - 2631, doi: 0.1109/BIBM49941.2020.9313108.

[2] R. Beri, M. K. Dubey, A. Gehlot and R. Singh, "Health Assessment Model to Identify and Control Risk Associated with Preeclampsia using IoT, " 2020 8th International Conference on Reliability, Infocom Technologies and Optimization (Trends and Future Directions) (ICRITO), 2020, pp.421 - 425, doi: 10.1109/ICRITO48877.2020.9197786.

[3] Winters R, Winters A, Amerdee RG, “Statistics: A brief Overview”, Ochsner J.2010; 10: 213 - 216.

[4] Cleophas, TJ, Zwinderman, SH., “Regression analysis in medical research”, Springer International; 2018.

[5] Vinnarasi P, Menaka K, “Vitamin D Deficiency and its impact on Thyroid Disorder – A ComputationalAnalysis”, NeuroQuantology, July2022, Volume 20, Issue 8, Page 5835 - 5843, doi: 10.14704/nq.2022.20.8. NQ44609.

[6] Wilson DL, Howard ME, Fung AM, O’Donoghue FJ, Barnes M, Lappas M, et al. (2020), “Sleep - disordered breathing does not impact maternal outcomes in women with hypertensive disorders of pregnancy”, PLoS ONE 15 (4): e0232287. https: //doi. org/10.1371/journal.

[7] Mário W. L. Moreira, Joel J. P. C. Rodrigues, Francisco H. C. Carvalho. Naveen Chilamkurti·Jalal Al - Muhtadi. “Biomedical data analytics in mobile - health environments for high - risk pregnancy outcome prediction”, Victor Denisov8 - Journal of Ambient Intelligence and Humanized Computing https: //doi. org/10.1007/s12652 - 019 - 01230 - 4. - 2019.

[8] TessyBadriyah, MuhlisTahrir, IwanSyarif, “Predicting the Risk of Preeclampsia with History of Hypertension Using Logistic Regression and Naive Bayes”, International Conference on Applied Science and Technology (iCAST), 26 - 27 Oct.2018, 978 - 1 - 5386 - 7548 - 9/18/$31.00 ©2018 IEEE.

[9] Francesca L. Facco, MD, MSCI, Corette B. Parker, DrPH, Uma M. Reddy, MD, MPH, Robert M. Silver, MD, Matthew A. Koch, MD, PhD, Judette M. Louis, MD, MPH, Robert C. Basner, MD, Judith H. Chung, MD, PhD, Chia - Ling Nhan - Chang, MD, Grace W. Pien, MD, MSCE, Susan Redline, MD, MPH, William A. Grobman, MD, MBA, Deborah A. Wing, MD, MBA, Hyagriv N. Simhan, MD, David M. Haas, MD, MS, Brian M. Mercer, MD, Samuel Parry, MD, Daniel Mobley, RPSGT, Shannon Hunter, MS, George R. Saade, MD, Frank P. Schubert, MD, MS, and Phyllis C. Zee, MD, PhD, “Association Between Sleep - Disordered Breathing and Hypertensive Disorders of Pregnancy and Gestational Diabetes Mellitus”, HHS Public Access, Obstet Gynecol.2017 January; 129 (1): 31–41. doi: 10.1097/AOG.0000000000001805.

[10] Grace W Pien, Allan I Pack, Nicholas Jackson, Greg Maislin, George A Macones, Richard J Schwab, “Risk factors for sleep - disordered breathing in pregnancy”, Thorax 2014; .69: 371–377. doi: 10.1136/thoraxjnl - 2012 - 202718.

[11] Carvalho MA, Bejjani L, Francisco RPV, Patino EG, Vivanti A, Batista FS, et al. (2021) “Outcomes following medical termination versus prolonged pregnancy in women with severe preeclampsia before 26 weeks”, PLOS ONE16 (2): e0246392. https: //doi. org/10.1371/journal. pone.0246392.

[12] Zhi - yu Luo, Ji Cui, Xiao - juanHu, Li - ping Tu, Hai - dan Liu, Wen Jiao, Ling - zhi Zeng, Cong - cong Jing, Li - jie Qiao, 1 Xu - xiang Ma, YuWang, JueWang, Ching - Hsuan Pai, Zhen Qi, Zhi - feng Zhang, and Jia - tuo Xu, “A Study of Machine - Learning Classifiers for Hypertension Based on Radial Pulse Wave”, Hindawi BioMed Research International Volume 2018, Article ID 2964816, 12 pages https: //doi. org/10.1155/2018/2964816.

[13] Shahil Feroz A, Afzal N, Seto E., “Exploring digital health interventions for pregnant women at high risk for pre - eclampsia and eclampsia in low - income and - middle - income countries: a scoping review”, BMJ Open 2022; 12: e056130. doi: 10.1136/ bmjopen - 2021 - 056130.