



ASSESSMENT OF CLINICAL DETERMINANTS ASSOCIATED WITH MATERNAL HEALTH RISK

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Abstract

Maternal health risk assessment is essential for early identification of women who may require closer monitoring and timely clinical intervention during pregnancy. This study assessed clinical determinants associated with maternal health risk using routinely measurable clinical and physiological indicators. An observational analytical design was adopted using a maternal health dataset containing age, systolic blood pressure, diastolic blood pressure, blood glucose, body temperature, heart rate, and maternal health risk level. Data were screened for completeness, duplicate observations, and clinically implausible values. After data preparation, the final analytical sample comprised 451 records. Descriptive statistics, risk-category distribution, correlation analysis, and one-way analysis of variance were used to examine differences across low, mid, and high-risk maternal health categories. The results showed that low-risk cases represented 51.66% of the sample, while mid-risk and high-risk cases represented 23.50% and 24.83%, respectively. High-risk cases had higher mean age, systolic blood pressure, diastolic blood pressure, blood glucose, body temperature, and heart rate compared with low-risk cases. Blood glucose showed the strongest difference across risk categories, followed by systolic and diastolic blood pressure. All selected indicators differed significantly across maternal health risk groups. The findings suggest that routinely available clinical indicators can support maternal risk assessment and may assist early identification of women requiring closer antenatal monitoring.

Keywords: maternal health risk; clinical determinants; blood glucose; blood pressure; antenatal care; pregnancy risk assessment

1. Introduction

Maternal health is a significant focus of medical and public health research as pregnancy complications still pose a significant burden to maternal health in terms of morbidity, mortality and long-term health effects. While worldwide efforts to ensure access to antenatal care and skilled maternal services have improved, preventable risks in pregnancy remain a significant concern, especially if clinical red flags are not detected in a timely fashion. This means that maternal risk assessment is critical for the prevention of death, serious illness and better pregnancy outcomes. Filippi et al. (2016) noted the impact of maternal health spans multiple levels of mortality and morbidity, suggesting the need for timely identification of clinical risks during pregnancy. Modern maternal health practice has shifted its emphasis to risk assessment in antenatal care. The World Health Organization has prioritised antenatal care as a screening, diagnostic, treatment, prevention and health promotion platform to promote a positive pregnancy experience and optimal maternal and perinatal outcomes (World Health Organization, 2023). In this regard, clinical indicators including blood pressure, blood glucose, maternal temperature and pulse, as well as maternal age, are still crucial due to their accessibility, measurability and interpretability in both institutional and community-based health care. These can be used to detect risk patterns and prevent serious complications.

Moving beyond mortality-based evaluation has also been noted to be important in maternal health research. Severe maternal morbidity is a highly problematic field of interest since a significant number of women are able to survive pregnancy-related complications but have significant health-related outcomes in the short and long term. Geller et al. (2018) reasoned that severe morbidity, rather than death-related outcomes, should be used to assess maternal health. Likewise, a systematic review and meta-analysis of Nik Hazlina et al. (2022) also indicated that the occurrence of severe maternal morbidities depends on a variety of clinical and obstetric factors, which is why it is necessary to identify risks early and conduct a systematic evaluation of maternal health determinants.

The quality of antenatal care is not just determined by the quality of contact with the service but also whether necessary clinical evaluations are conducted and interpreted appropriately. Lattof et al. (2020) suggested a conceptual framework to measure WHO antenatal care recommendations, highlighting the need to translate care recommendations into measurable indicators. Khatri et al. (2022) also emphasized that the quality of antenatal care is determined by input, process, and output elements, such as access to and utilization of suitable clinical assessments. This is especially applicable to maternal risk assessment since regular measurements may be used to facilitate prompt referral, intensive follow-up, and preventive care.

Blood pressure is one of the most significant maternal risk indicators among clinical determinants. Hypertensive pregnancy disorders are also known to be the significant causes of negative maternal and birth outcomes, and their prevention, diagnosis, and treatment are the key elements of maternal healthcare recommendations (Sinkey et al., 2020). Evidence-based on population also shows that disorders of hypertension of pregnancy are still a major burden globally, which supports the necessity of systematic examination of blood pressure in pregnancy (Wang et al., 2021). Besides the blood pressure, blood glucose is also clinically relevant since altered glucose levels can reflect upon the higher risk of metabolism and could lead to adverse maternal and fetal outcomes. Combined with cardiovascular indicators, cardiovascular and metabolic indicators will give a more comprehensive picture of the maternal risk condition.

The quality and availability of maternal health indicators are also useful in research and health-system monitoring. Kabue et al. (2023) revealed that priority maternal and newborn health indicators were different in availability across health registers, limiting their ability to consistently assess and monitor risks. Some more recent multi-country data also indicates that risk identification among pregnant women is an issue despite accessing antenatal care, which suggests that there is a disconnect between exposure to care and successful clinical risk detection (Arsenault et al., 2024). These results highlight the necessity of research that would analyse the relationship between routinely available clinical indicators and categories of maternal health risks. The current research, therefore, titled *Assessment of Clinical Determinants Associated with Maternal Health Risk*, will provide the evaluation of the connection between the chosen clinical and physiological markers and the levels of maternal health risk. In particular, the research will analyze the maternal age, systolic blood pressure, diastolic blood pressure, blood glucose, body temperature, and heart rate based on the risk categories of low, mid, and high. The study also helps in evidence-based maternal risk assessment by concentrating on routinely quantifiable clinical indicators and the ultimate aim of enhancing preventive maternal healthcare.

2. Methodology

2.1 Study Design and Data Source

This research used an observational form of analytical design to evaluate clinical determinants that were related to maternal health risk. A publicly accessible maternal health risk dataset was used to perform the analysis (Ahmed, 2022). The data set has both clinical and physiological measures of pregnant women and categorizes

maternal health risk in low-risk, mid-risk, and high-risk groups. The explanatory variables were maternal age, systolic blood pressure, diastolic blood pressure, blood glucose, body temperature and heart rate.

2.2 Data Preparation

The dataset had initially 1,014 records and seven variables. Screening of data was conducted to investigate the presence of missing values, repeated observations, consistency of variables and clinically implausible values. None of the missing values were found. Nonetheless, 562 duplicate records were identified and eliminated to eliminate repetitive records that could affect the analysis. Following removal of duplicates, 452 records were left over. A single clinically implausible heart rate was found and it was not plotted to the final dataset. The data was finally cleaned and consisted of 451 records upon which it was further analyzed.

2.3 Study Variables

The dependent variable was the maternal health risk level which was classified into low, mid risk and high risk. Clinical and physiological parameters that were independent were age, systolic blood pressure, diastolic blood pressure, blood glucose level, body temperature, and heart rate. These variables were deemed to be appropriate since they are generally measured indicators when looking at maternal health and monitoring risks.

2.4 Statistical Analysis

The clinical profile of the study population was summarized using descriptive statistics. All numerical variables had their measures of central tendency and dispersion, such as the mean, median, standard deviation, minimum and maximum values. To characterize the distribution of low-, mid-, and high-risk cases in terms of frequency and percentage, the frequency and percentage distribution of maternal health risk categories were calculated.

A group-wise analysis was conducted to compare clinical and physiological indicators in terms of maternal health risk categories. The three risk groups were compared in their mean values of age, systolic blood pressure, diastolic blood pressure, blood glucose level, body temperature, and heart rate to determine clinically meaningful patterns. Correlation analysis was done to identify the direction and the strength of the relationship between numerical clinical variables.

One-way analysis of variance was used to establish the level of significant differences in the selected clinical indicators among the three categories of maternal health risks. Age, systolic blood pressure, diastolic blood pressure, level of blood glucose, body temperature and heart rate were tested separately. A p-value of less than 0.05 was used as the statistical significance level. The review aimed at determining the relationship of clinical determinants with maternal health risk levels as opposed to proving causality.

3. Results

Following the preparation of data, the analytical sample of records was 451. The analysis has compared the distribution of maternal health risk categories and compared the selected clinical and physiological indicators in low-risk and mid-risk and high-risk groups.

3.1 Distribution of Maternal Health Risk Categories

As indicated in Table 1, low-risk cases constituted the biggest percentage of the sample. The overall proportion of the sample that was classified as a low risk case was 51.66%; among the 451 records examined, 233 fell into this category. There were 112 high-risk cases which comprise 24.83%, and 106 mid-risk cases which comprise 23.50%.

Table 1. Distribution of maternal health risk categories

Risk category	Frequency	Percentage
Low risk	233	51.66%
Mid risk	106	23.50%
High risk	112	24.83%
Total	451	100.00%

Figure 1 also indicates that low-risk cases were the most common, but almost half of the sample was of a middle-risk or high-risk category, which shows a significant number of women with a high maternal health risk.

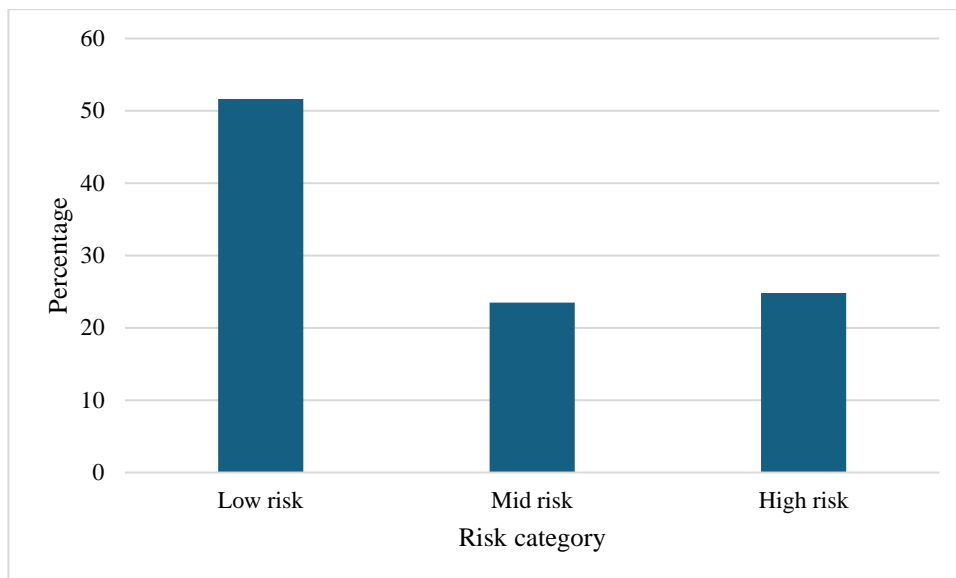


Figure 1. Distribution of maternal health risk categories

The distribution offers sufficient representation of all three categories of risks and helps to further compare clinical indicators between the risk groups.

3.2 Descriptive Profile of Clinical and Physiological Indicators

The descriptive statistics provided in Table 2 indicate clinical variation that is significant among the chosen indicators. The average age was 29.22 years with a variation of 10 to 70. The average systolic blood pressure was 110.53mmHg and the average diastolic blood pressure was 75.42 mmHg. The average blood glucose level was 8.35, mean body temperature and pulse rate were 98.69°F and 74.10 beats/minute, respectively.

Table 2. Descriptive statistics of clinical and physiological indicators

Variable	Mean	Median	Standard deviation	Minimum	Maximum
Age	29.22	25.00	13.77	10.00	70.00
Systolic BP	110.53	120.00	17.89	70.00	160.00
Diastolic BP	75.42	80.00	13.77	49.00	100.00
Blood Glucose	8.35	7.50	2.83	6.00	19.00
Body Temperature	98.69	98.00	1.41	98.00	103.00
Heart Rate	74.10	76.00	7.53	60.00	90.00

3.3 Comparison of Clinical Indicators Across Maternal Health Risk Categories

The group-wise comparison as shown in Table 3 indicates a steady rise in most of the clinical and physiological indicators between the low-risk group to the high-risk group. The age, systolic blood pressure, diastolic blood pressure, blood glucose, body temperature, and heart rate had the highest mean values on high-risk cases. The greatest change was seen in blood glucose, whereby the levels rose to 11.17 in the high-risk group, as compared to the 7.20 in the low-risk group.

Table 3. Clinical and physiological indicators across maternal health risk categories

Variable	Low risk Mean ± SD	Mid risk Mean ± SD	High risk Mean ± SD
Age	27.37 ± 13.89	28.54 ± 12.72	33.73 ± 13.57
Systolic BP	105.37 ± 15.51	112.41 ± 15.06	119.49 ± 20.97
Diastolic BP	72.72 ± 13.11	74.89 ± 12.17	81.54 ± 14.70
Blood Glucose	7.20 ± 0.57	7.89 ± 2.38	11.17 ± 3.94
Body Temperature	98.36 ± 1.11	98.86 ± 1.47	99.23 ± 1.71
Heart Rate	73.04 ± 7.02	73.90 ± 7.00	76.48 ± 8.50

The high-risk group had less favourable clinical profile compared to the low-risk and middle-risk groups as shown in Figure 2. The most pronounced separation among categories was demonstrated by blood glucose, then systolic and diastolic blood pressure. High risk cases also had a higher mean age which indicates that older maternal age might be linked to higher maternal health risk in the dataset analysed. The changes in body temperature and heart rate were less, but they were more prominent in the high-risk group.

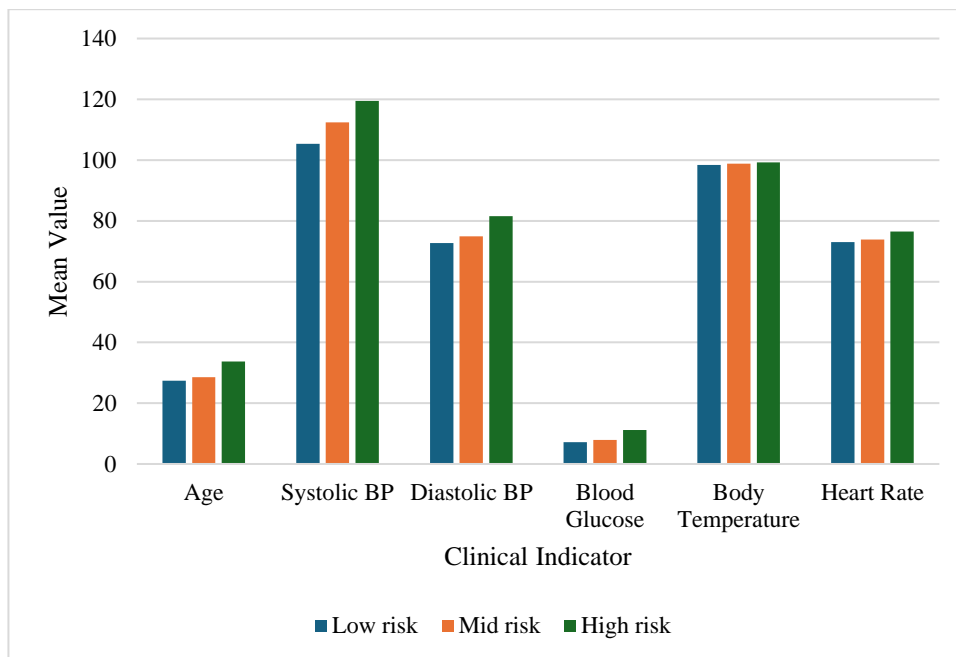


Figure 2. Mean clinical indicators across maternal health risk categories

Note. Variables are presented in their original measurement scales.

Figure 2 indicates that most of the clinical indicators were higher in the high-risk group than in the low-risk group. Nevertheless, since variables are reported in the original measurement scales, the visual magnitude of differences are to be interpreted with the results of group-wise descriptive statistics and ANOVA.

3.4 Correlation Among Clinical and Physiological Indicators

The results of the correlation in Table 4 indicate that the best positive relationship was between systolic and diastolic blood pressure. The age was found to have moderate positive relationships with systolic blood pressure, age and blood glucose, age and diastolic blood pressure, systolic blood pressure and blood glucose, diastolic blood pressure and blood glucose.

Table 4. Correlation among selected clinical and physiological indicators

Variable pair	Correlation coefficient
Systolic BP and Diastolic BP	0.790
Age and Systolic BP	0.378
Age and Blood Glucose	0.377
Age and Diastolic BP	0.348
Systolic BP and Blood Glucose	0.348
Diastolic BP and Blood Glucose	0.300
BS and Heart Rate	0.144

3.5 Statistical Differences Across Maternal Health Risk Groups

The results of one-way analysis of variance provided in Table 5 indicate that differences in all of the chosen clinical and physiological indicators between low-risk, mid-risk, and high-risk groups are statistically significant. The difference in age, systolic blood pressure, diastolic blood pressure, blood glucose, body temperature, and heart rate were significantly different at the $p < 0.05$ level, according to maternal health risk categories.

Table 5. One-way ANOVA results for clinical indicators across maternal health risk categories

Variable	F-value	p-value	Result
Age	8.525	<0.001	Significant
Systolic BP	27.148	<0.001	Significant
Diastolic BP	16.690	<0.001	Significant
Blood Glucose	114.152	<0.001	Significant
Body Temperature	16.201	<0.001	Significant
Heart Rate	8.193	<0.001	Significant

Blood glucose generated the largest F-value as it has the largest difference across categories of maternal health risk as shown in Figure 3. The F-value of systolic blood pressure was the second highest and the third was diastolic blood pressure and body temperature. In comparison with age and heart rate, which demonstrated relative lower F-values, however, both variables were significantly different between risk groups. These results suggest that clinical differences among maternal health risk categories existed according to the indicators chosen.

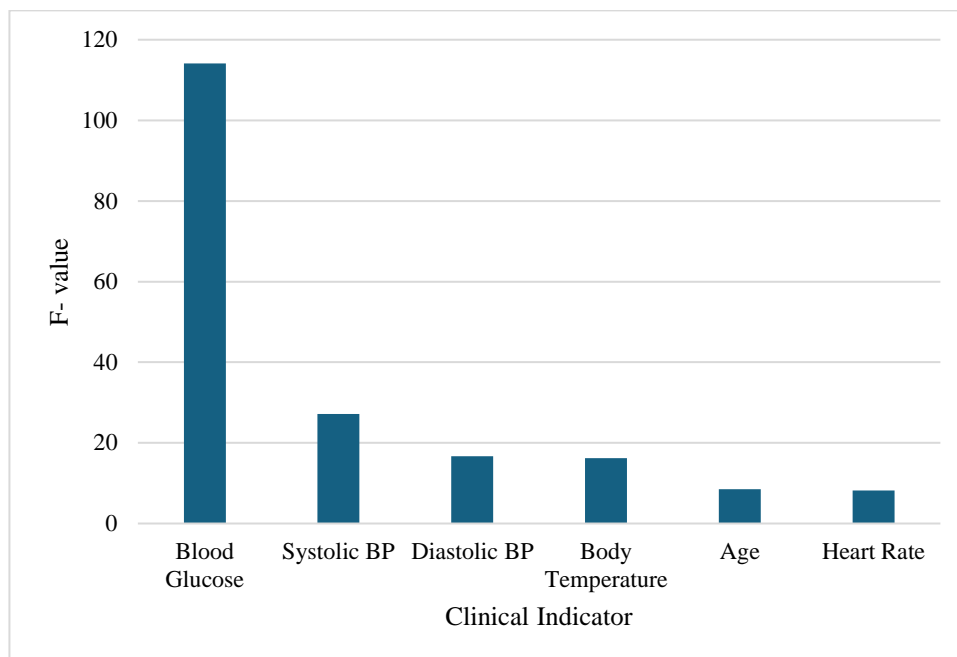


Figure 3. Relative magnitude of ANOVA F-values

4. Discussion

The current study evaluated clinical determinants of maternal health risk based on the chosen clinical and physiological indicators. The results indicated that there was a significant difference in maternal health risk categories by age, systolic blood pressure, diastolic blood pressure, blood glucose, body temperature, and heart rate. The high-risk cases tended to have a less favourable clinical profile, with an average higher in all indicators under analysis than in the groups of low-risk and mid-risk. These results contribute to the clinical significance of regular maternal surveillance and indicate that even the typical physiological tests could be used to offer helpful data on the maternal risk condition.

Among the findings that were most significant was the fact that blood glucose showed high differentiation within categories of maternal health risks. Blood glucose had the greatest statistical difference when compared to the other indicators studied with the high-risk group having significantly higher mean values as compared to both the low-risk and mid-risk groups. The clinical implications of this finding are that an abnormal glucose regulation during pregnancy is strongly associated with gestational diabetes mellitus and poor maternal outcomes. Past data has demonstrated that the maternal age, lifestyle-associated conditions, and indicators of metabolism are all linked to the risk of gestational diabetes, which confirms the relevance of the glucose level monitoring during pregnancy (Amiri et al., 2021). Gestational diabetes, on the other hand, has been extensively known to be a health issue that may lead to an adverse outcome on maternal health, fetal development, and cardiometabolic outcomes in the long term, which further prompts the need to recognize and provide a continuous clinical follow-up (Nakshine & Jogdand, 2023).

Signs of blood pressure also provided a clear difference among maternal health risk groups. The systolic and diastolic blood pressure levels were raised between low-risk and high-risk groups, which means that high blood pressure is a significant clinical characteristic that raises maternal health risk. This is in line with known evidence of maternal health since hypertensive disorders in pregnancy are leading causes of maternal and perinatal morbidity. According to the American Heart Association scientific statement, the clinical significance of proper diagnosis, treatment levels, and hypertension management in the course of pregnancy is emphasized, as high blood pressure may lead to severe complications, and it is necessary to monitor it (Garovic et al., 2022). The existing results thus support the importance of routine blood pressure measurement as an element of maternal risk assessment.

The correlation analysis also revealed that there was a strong positive association between systolic and diastolic blood pressure. This clinical relationship is predictable since both values are related factors of cardiovascular

status. More to the point, there were moderate positive relationships between age, blood pressure, and blood glucose. These correlations indicate that maternal risk might not be attributed to one clinical marker but as a result of a combination of metabolic and cardiovascular signs. Maresh et al. (2022) found that maternal blood pressure in pregnancy is linked to glucose metabolism and blood pressure, which confirms that there is a potential interconnection between cardiometabolic factors in pregnancy. Hence, the results of the present study can be correlated with the general knowledge that both glycaemic and blood pressure-based indicators should be evaluated combined in the context of maternal risk assessment.

The maternal age was also higher with the high-risk group as compared to the low and mid-risk groups. Though the age had a lower F-value than blood glucose and blood pressure, it was still significantly different among risk categories. This indicates that maternal age can be used to stratify the risk in cases where it is taken together with clinical measurements. It is possible that age can be not enough to define maternal risk but when it is added to the clinical interpretation, it can be reinforced by blood glucose and blood pressure indicators. This is especially applicable, as maternal demographic and clinical risk factors have been applied in early prediction methods of pregnancy-related metabolic issues, such as gestational diabetes (Wu et al., 2024). The trend of increased age in high-risk cases in this study justifies the consideration of maternal age in the normal risk assessment.

There were statistically significant but lower differences in body temperature and heart rate between the categories of maternal health risks. The mean body temperature and heart rate of the high-risk group were slightly higher than those of the other groups. These variations could be due to physiological stress, risk associated with infection, cardiovascular acclimatization, or other maternal health alterations; nevertheless, since the dataset lacks diagnostic data, these factors are to be viewed with caution. The results of Loerup et al. (2019) demonstrated that blood pressure and heart rate vary during normal pregnancy and pointed out that physiological measurements should be explained in the context of the anticipated pregnancy-related changes. As such, although heart rate and body temperature may play a role in differentiating the risk, more contextual data, including gestational age, infection status, medication use, and underlying health conditions, are needed to determine the clinical significance of these parameters.

There are also larger implications of the findings to the broader public health and preventive care. Glucose intolerance and hypertension complications in maternal health have also been major health issues in the world. Jiang et al. (2022) highlighted that hypertensive disorders and diabetes mellitus in pregnancy are significant worldwide issues with repercussions on the health of the mother and child. The current research aligns this issue by revealing that blood glucose and blood pressure were the most eminent signs that differentiate high-risk cases of mothers. These results indicate that available clinical metrics can aid in early detection of women, who might need increased attention, counselling, or referral to further examination.

The findings of the study can also be applied to the healthcare systems in which the resource constraints can influence the access to advanced diagnostic services. In primary care and community health settings, basic clinical indicators like blood pressure, blood glucose, body temperature, heart rate, and age can be regularly measured. The fact that they are related to maternal risk groups suggests that a systematic use of such indicators may be associated with the earlier identification of risk. Both clinical and non-clinical evidence have demonstrated that hypertensive disorders during pregnancy are related to negative maternal and perinatal outcomes, which further justify the necessity of early diagnosis and surveillance (Thi Huyen Anh et al., 2024). Thus, enhancing regular prenatal screening will probably decrease complications that can be avoided and enhance pregnancy-related care channels.

Overall, this study shows that the categories of maternal health risks are linked to the quantifiable changes in clinical and physiological signs. Blood glucose was the most powerful differentiating variable followed by systolic and diastolic blood pressure and age, body temperature, and heart rate were also significantly varied across the risk groups. These results advocate the significance of combined maternal risk measurement, through the use of clinical indicators that are routinely available. Nevertheless, these findings must be viewed as associations and not causal since the dataset lacks various other important maternal health factors like gestational age, parity, body mass index, haemoglobin level, antenatal care history, socioeconomic status, or past obstetric complications. Further research involving more detailed maternal health data might give a better understanding of the joint clinical, demographic, and healthcare-related factors of maternal health risk.

5. Conclusion

This study evaluated clinical determinants of maternal health risk based on clinical and physiological measures that could be routinely measured. The results revealed that the age, systolic blood pressure, diastolic blood pressure, blood glucose, body temperature, and heart rate had significant differences in their maternal health risk categories. The high-risk cases also exhibited unfavourable clinical picture, as the mean of all indicators studied was greater than in the low-risk and mid-risk categories. Blood glucose was found to be the most

significant differentiating variable in the categories of maternal health risks implying that it plays a significant role in identifying maternal health risk in women. There were also evident differences in systolic and diastolic blood pressure between the risk groups and this supports the clinical significance of regularly monitoring blood pressure in pregnancy. Though comparatively smaller differences were observed in age, body temperature, heart rate, but they significantly varied among the risk categories, which suggests they are important aspects of maternal health evaluation. The findings demonstrate the usefulness of incorporating easily available and simple clinical indicators into risk assessment of maternal health. As these indicators can be routinely measured in both the antenatal and primary healthcare environments, they could help healthcare providers identify the women that may need more attention, counselling, or referral. The results also emphasize the significance of preventive maternal treatment, especially by regularly monitoring blood pressure and glucose status. On the whole, this paper indicates that the chosen clinical and physiological outcomes have a significant and statistically significant relationship with the maternal health risk levels. Nevertheless, the results can be viewed as associative and not causal since the analysis was conducted using only available clinical variables. Future studies need to incorporate additional maternal health data including gestational age, parity, body mass index, haemoglobin level, antenatal care history, and obstetric complications to give a more detailed report of maternal health risk determinants.

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