



**St. Paul's Hospital
Millennium Medical College**
የቅዱስ ጳውሎስ ሆስፒታል ሚሊኒየም ሕክምና ኮሌጅ

**Magnitude of Preeclampsia and its association with Low neonatal
Apgar score and other associated factors among preterm babies
at SPHMMC, Addis Ababa, Ethiopia.**

By: Nahom Asfaw (Intern)

A Research Thesis submitted to the School of Public Health St Paul's Hospital
Millennium Medical College in partial fulfillment of the requirements for the
degree of Doctor of Medicine

March, 2026

Addis Ababa, Ethiopia

St. Paul's Hospital Millennium Medical College

School of Public Health

Magnitude of Preeclampsia and its association with Low neonatal Apgar score and other associated factors among preterm babies at SPHMMC, Addis Ababa, Ethiopia.

Investigator: - Nahom Asfaw (Intern)

Advisor(s): - Hanna Feleke

Dr.Aida Tilahun

March, 2026

Addis Ababa, Ethiopia

Acknowledgment

I would like to express my sincere gratitude to my advisors, Hanna Feleke and Dr. Aida Tilahun, for their invaluable guidance, support, and constructive feedback throughout the development of this research proposal. Their expertise and encouragement were instrumental in shaping this study.

I also extend my appreciation to St. Paul's Hospital Millennium Medical College, School of Public Health, for providing the academic environment and resources necessary for this research. The insights gained from the institution's commitment to public health research have been invaluable.

Table Of Content

Acknowledgment	I
Table Of Content.....	II
List of Abbreviations and Acronyms	IV
List of Tables	V
Abstract.....	1
1. Introduction.....	2
1.1. Background.....	2
1.2. Statement of the Problem.....	4
1.3. Significance of the Study	6
2. Literature Review.....	7
2.1. Prevalence of Preeclampsia Among Preterm Deliveries	7
2.2. Preeclampsia as a Risk Factor for Preterm Birth	7
2.3. Association Between Preeclampsia and Neonatal Apgar Score	7
2.4. Determinants and Predictors of Adverse Perinatal Outcomes	8
3. Research Objectives.....	9
3.1. General Objective	9
3.2. Specific Objectives	9
4. Methodology	10
4.1. Study Design.....	10
4.2. Study Setting and Period.....	10
4.3. Source Population	10
4.4. Study Population.....	10
4.5. Inclusion and Exclusion Criteria.....	10
4.6. Variables	10
4.7.Operational Variables	11
4.8. Sampling and Sample size calculation.....	11
4.9. Data Collection	12
4.10. Data Analysis.....	12
4.11. Data Quality Control.....	13
5. Ethical Considerations	14
6. Dissemination of Results	15

7. Results.....	16
7.1. Socio-demographic characteristics of mothers	16
7.2. Obstetric characteristics of mothers.....	16
7.3. Magnitude of Preeclampsia and neonatal outcomes	17
7.4. Factors Associated with Low Apgar Score.....	18
7.4.1. Multivariate Logistic Regression Analysis	20
8. Discussion	23
Strengths and Limitations	24
Recommendations.....	25
9. References.....	25
10. Annex.....	28
Data Collection Form.....	29
Dummy Table	31
DECLARATION FORM.....	Error! Bookmark not defined.

List of Abbreviations and Acronyms

ANC	Antenatal Care
APH	Antepartum Hemorrhage
CS	Cesarean Section
GA	Gestational Age
LBW	Low Birth Weight
MRN	Medical Record Number
NICU	Neonatal Intensive Care Unit
OR	Odds Ratio
PE	Preeclampsia
PROM	Premature Rupture of Membranes
SPSS	Statistical Package for the Social Sciences
SVD	Spontaneous Vaginal Delivery
UTI	Urinary Tract Infection
WHO	World Health Organization

List of Tables

Table 1.....16

Table 2.....17

Table 3.....17

Table 4.....19

Table 5.....20

Table 6.....21

Table 7.....32

List of Figures

Figure 1.....18

Abstract

Background: Preeclampsia is a leading cause of maternal and neonatal morbidity and mortality, particularly in low-resource settings. Its impact on neonatal outcomes, including Apgar scores, is of significant clinical concern, especially among preterm deliveries.

Objective: This study aims to determine the prevalence of preeclampsia and assess its association with neonatal Apgar scores among preterm deliveries at St. Paul's Hospital Millennium Medical College (SPHMMC), Addis Ababa, Ethiopia.

Methods: A retrospective cross-sectional study was conducted using medical records of 173 preterm deliveries from January 2023 to January 2025. Bivariate analysis using Chi-square tests and multivariable logistic regression were employed to identify independent predictors of low Apgar scores (<7). All statistical analyses were performed using SPSS version 27.

Results: The prevalence of preeclampsia among preterm deliveries was 38.7%. In the multivariable analysis, preeclampsia was found to be a potent independent predictor of low neonatal Apgar score. Neonates born to mothers with preeclampsia had nearly 6 times higher odds of a low 1st-minute Apgar score (AOR = 5.78, 95% CI: 2.50–13.37, $p < 0.001$) and 2.5 times higher odds of a low 5th-minute Apgar score (AOR = 2.58, $p = 0.042$) compared to those born to normotensive mothers. Other significant predictors of low neonatal APGAR score include birth weight <1500g ($p < 0.001$) and early gestational age ($p = 0.018$).

Conclusion: Preeclampsia significantly compromises immediate neonatal adaptation in preterm births. The high risk of low Apgar scores underscores the need for specialized neonatal resuscitation teams.

Keywords: Preterm Birth, Preeclampsia, neonatal Apgar score, Ethiopia, Addis Ababa, SPHMMC.

1. Introduction

1.1. Background

Preterm birth is defined as the birth of a baby before 37 completed weeks of gestation(1). It is a major global health challenge and the leading cause of neonatal mortality and morbidity worldwide(2,3). The causes of preterm birth are multifactorial and can include infections, cervical insufficiency, uterine abnormalities, multiple pregnancies, and various maternal medical conditions and obstetric complications such as preeclampsia(1). In Ethiopia, the pooled national prevalence of preterm birth is around 10.48%(4).

Preeclampsia (PE) is a serious hypertensive disorder of pregnancy that occurs after 20 weeks of gestation, characterized by elevated blood pressure and proteinuria, and potentially other organ dysfunctions(1). It remains one of the leading causes of maternal and perinatal morbidity and mortality globally, with substantial prevalence in Ethiopia and sub-Saharan Africa. A systematic review in Ethiopia reported a pooled prevalence of preeclampsia to be around 11.5%(5). Various factors such as maternal age above 35 years, history of hypertension, multiple pregnancies, and lifestyle factors are identified determinants of preeclampsia in the Ethiopian context(6).

The importance of preeclampsia extends beyond maternal health, as it significantly affects neonatal outcomes(7). Neonates born to mothers with preeclampsia often face complications arising from compromised placental perfusion leading to fetal hypoxia, intrauterine growth restriction, and premature delivery(8). One critical early indicator of neonatal well-being is the Apgar score, which evaluates heart rate, respiratory effort, muscle tone, reflex irritability, and skin color immediately after birth. Low Apgar scores at 1 and 5 minutes post-delivery are associated with higher neonatal morbidity and mortality risks(8).

Studies in sub-Saharan Africa highlight that neonates from pregnancies complicated by preeclampsia and eclampsia experience significantly lower Apgar scores and worse perinatal outcomes compared to neonates of normotensive pregnancies(9). This is consistent with findings from Ethiopian hospitals such as those in Addis Ababa, where neonates born to preeclamptic mothers showed increased admission rates to neonatal intensive care units and lower Apgar scores(10). Capacity building for neonatal resuscitation and improved antenatal management have been recommended to mitigate these adverse outcomes(5).

Globally, the incidence of preeclampsia ranges from 2% to 8% of pregnancies, with an estimated 46,000 maternal deaths and over 500,000 perinatal deaths annually attributed to hypertensive disorders of pregnancy(11). Sub-Saharan Africa bears a disproportionate share of this burden, with maternal mortality rates up to 14 times higher than global averages related to

hypertensive complications(9). Ethiopia, in particular, experiences high maternal mortality rates, with preeclampsia contributing significantly to adverse perinatal outcomes including low Apgar scores and increased neonatal mortality(12). According to national and regional data, approximately 1 in 8 pregnant women in Ethiopia suffer from preeclampsia, with resultant neonatal complications representing a critical public health concern(5). This highlights the urgency of focused research and targeted interventions at referral centers such as SPHMMC to reduce this burden and improve neonatal survival and long-term developmental outcomes.

In summary, preeclampsia is a significant public health challenge in Ethiopia, affecting more than one in ten pregnancies and contributing to adverse neonatal conditions, including low Apgar scores(5). This research can provide valuable insights into local prevalence and neonatal outcomes, with implications for enhancing maternal and child health strategies regionally.

1.2. Statement of the Problem

Preeclampsia is a leading cause of maternal and neonatal morbidity and mortality in sub-Saharan Africa, including Ethiopia(10). The prevalence of preeclampsia in Ethiopia has been reported to range from 4% to over 11% in various hospital-based studies, with a substantial proportion of women presenting late in pregnancy and often with severe features(5,6).

Preterm birth, often precipitated by obstetric complications like preeclampsia, is a major contributor to neonatal complications and death in Ethiopia. Studies have shown that preeclampsia increases the risk of preterm delivery by more than twofold(13). This relationship is critical in the Ethiopian context, where the majority of tertiary hospitals already face high neonatal case loads and limited capacity in neonatal intensive care units. Neonates born preterm to mothers with preeclampsia are at particularly heightened risk for poor outcomes such as low Apgar scores, low birth weight, respiratory distress, sepsis, and early neonatal mortality(14,15). A recent study in Addis Ababa found that 14.7% of neonates born to mothers with severe preeclampsia had a low fifth-minute Apgar score, and nearly half of these neonates experienced at least one adverse perinatal outcome(6). These findings indicate the strong association between maternal hypertensive disorders and compromised neonatal vitality at birth. Similarly, research from other Ethiopian tertiary hospitals has demonstrated that the prevalence of low Apgar scores among neonates born to mothers with preeclampsia ranges from 12% to 18.8%, with early-onset preeclampsia linked to even higher rates of poor neonatal outcomes, including perinatal mortality and admission to NICU(16,17). Such evidence highlights the urgent need for closer surveillance of high-risk pregnancies and timely interventions to reduce neonatal complications.

The association between preeclampsia and low Apgar scores is multifactorial. Preeclampsia leads to uteroplacental insufficiency and abnormal placental perfusion, resulting in fetal hypoxia, intrauterine growth restriction, and an increased likelihood of emergency preterm delivery(18). These pathophysiological processes directly contribute to compromised neonatal condition at birth, reflected in lower Apgar scores. In resource-limited settings like Ethiopia, where advanced neonatal resuscitation skills and intensive care equipment are not consistently available, these risks are compounded, resulting in worse outcomes for vulnerable neonates(19).

Despite the introduction of evidence-based interventions such as magnesium sulfate for seizure prophylaxis, antihypertensive treatment protocols, and improvements in antenatal screening, the perinatal condition of neonates born to mothers with preeclampsia remains a pressing concern in Ethiopia(20). Enhanced antenatal screening, timely referral pathways, and better-

equipped delivery wards are repeatedly emphasized as critical measures to reduce neonatal complications and improve Apgar scores in this population(19,20).All these factors increase the burden on the healthcare system, leading to overcrowded neonatal units, increased demand for specialized care, and long-term consequences for families and communities(10).

In conclusion, preeclampsia remains a significant public health challenge in Ethiopia, particularly among preterm deliveries at tertiary hospitals like SPHMMC. Its strong association with low neonatal Apgar scores and adverse perinatal outcomes shows the urgent need for context-specific research and targeted interventions. Addressing this issue through improved antenatal screening, better preparedness for neonatal resuscitation, and tailored clinical guidelines could substantially improve neonatal survival and long-term outcomes in Ethiopia(10,13,16).

1.3. Significance of the Study

Preeclampsia is a major contributor to adverse neonatal outcomes, particularly in low-resource settings like Ethiopia. While several studies have evaluated the relationship between preeclampsia and perinatal outcomes, most have assessed this association among all deliveries. However, preterm neonates represent a uniquely vulnerable population with inherently higher risks of neonatal depression, low Apgar scores, and increased need for resuscitation. Evaluating the effect of preeclampsia specifically within preterm deliveries is therefore important to better understand the magnitude of risk in this high-risk subgroup. Additionally, although low Apgar score is a key indicator of immediate neonatal well-being and need for resuscitation, limited local evidence exists examining the association between maternal preeclampsia and Apgar score among preterm neonates in Ethiopian tertiary hospitals. Generating institution-specific data from SPHMMC is important for guiding clinical preparedness, particularly for neonatal resuscitation and management of high-risk preterm births.

The findings of this study will help healthcare providers identify preterm neonates at higher risk of low Apgar scores when maternal preeclampsia is present. This may support improved delivery room preparedness, early neonatal intervention, and allocation of skilled personnel during high-risk deliveries. Furthermore, the study may assist hospital administrators and policymakers in strengthening clinical protocols for management of hypertensive disorders in pregnancy and improving neonatal care services.

Finally, this study will contribute to the limited body of local evidence regarding preeclampsia and neonatal outcomes among preterm deliveries and may serve as a baseline for future prospective or multicenter studies. By focusing specifically on preterm births, this research provides targeted evidence that may improve immediate neonatal outcomes in high-risk pregnancies.

2. Literature Review

This section provides a comprehensive review of existing literature concerning preeclampsia and its association with neonatal Apgar score. Special emphasis is placed on incorporating findings from local Ethiopian research to provide a context-specific understanding of these relationships and identify existing knowledge gaps.

2.1. Prevalence of Preeclampsia Among Preterm Deliveries

Preeclampsia remains a significant obstetric complication in sub-Saharan Africa, with a notable impact on maternal and neonatal health. In Ethiopia, the prevalence of preeclampsia among pregnant women has shown an increasing trend over the past decade. A retrospective study in Addis Ababa government hospitals reported that the proportion of women with preeclampsia rose from 2.2% in 2009 to 5.6% in 2013, reflecting a 154% increase over five years(10). Similarly, a study at Ayder Referral Hospital in northern Ethiopia found that out of 8,502 deliveries, 362 (4.3%) were complicated by preeclampsia, with the majority presenting with severe features(17).

In a recent cross-sectional study at two public hospitals in Addis Ababa, the prevalence of preeclampsia with severe features was substantial, and more than half of the affected women experienced at least one adverse perinatal outcome(6). These findings are consistent with data from other African countries, where preeclampsia accounts for 10–15% of maternal deaths and is a leading cause of preterm birth and perinatal morbidity(13,21).

2.2. Preeclampsia as a Risk Factor for Preterm Birth

Preeclampsia is a well-established risk factor for preterm delivery. In a case-control study at St. Paul's Hospital Millennium Medical College (SPHMMC) in Addis Ababa, twin pregnancies complicated by preeclampsia were 2.6 times more likely to result in preterm birth compared to normotensive controls(13). Another study in the Amhara region found that women with preeclampsia had five times higher odds of delivering preterm compared to those without the condition(22). These results are echoed in other African settings, where preeclampsia is consistently identified as a major contributor to medically indicated preterm births(21). The increased risk of preterm delivery among women with preeclampsia is attributed to the need for early intervention to prevent severe maternal and fetal complications, as well as the direct effects of the disease on placental function and fetal growth(6,22).

2.3. Association Between Preeclampsia and Neonatal Apgar Score

The relationship between preeclampsia and neonatal Apgar scores has been explored in few local and African studies. A cross-sectional study in Debre Tabor Specialized Hospital found that preeclampsia was significantly associated with a low Apgar score at five minutes(18).

Similarly, research at Ayder Referral Hospital reported that 18.8% of neonates born to mothers with preeclampsia had a low Apgar score, and earlier gestational age at diagnosis was a strong predictor of poor perinatal outcome(17).

In Mettu Karl Referral Hospital, 18.5% of neonates born to mothers with hypertensive disorders of pregnancy had a low Apgar score, and preterm delivery was significantly associated with this outcome(14). A recent prospective study in Eastern Ethiopia also identified low fifth-minute Apgar score as a determinant of perinatal mortality and neonatal complications among women with severe preeclampsia and eclampsia(20). These findings are supported by studies from other African countries, such as Indonesia, where preeclampsia was associated with a twofold increase in the risk of low Apgar scores at both the first and fifth minutes(21).

2.4. Determinants and Predictors of Adverse Perinatal Outcomes

Multiple factors influence the risk of adverse perinatal outcomes among women with preeclampsia. In Addis Ababa, lack of formal education, inadequate antenatal care, referral status, and family history of hypertension were all associated with higher rates of unfavorable perinatal outcomes among women with severe preeclampsia(6). In Mettu Karl Referral Hospital, lack of antenatal care and preterm delivery were significant predictors of low Apgar scores and perinatal mortality(14). Socioeconomic development, improved referral systems, and enhanced antenatal care are recommended to mitigate these risks(6,14). The introduction of magnesium sulfate and other evidence-based interventions has improved outcomes, but perinatal morbidity and mortality remain high, especially among preterm infants(6,20).

Despite some improvements in neonatal care, the burden of preeclampsia and its complications remains substantial in Ethiopia. A five-year review in Addis Ababa showed a decrease in neonatal complications from 76% in 2009 to 66% in 2013, but the rates of preterm birth, low birth weight, and low Apgar scores remain high(10). These trends highlight the need for early detection, prompt management, and specialized care for high-risk pregnancies, particularly in tertiary hospitals like SPHMMC. Strengthening antenatal care, raising community awareness, and improving health system capacity are essential steps toward reducing the impact of preeclampsia on neonatal outcomes(6,10).

3. Research Objectives

3.1. General Objective

To assess magnitude of preeclampsia and its association with neonatal Apgar score among preterm deliveries in SPHMMC, Addis Ababa, Ethiopia.

3.2. Specific Objectives

1. To identify the prevalence of preeclampsia among preterm deliveries in SPHMMC.
2. To assess the association between preeclampsia and neonatal Apgar score among preterm deliveries in SPHMMC.
3. To identify other factors associated with low neonatal Apgar score among preterm deliveries in SPHMMC.

4. Methodology

4.1. Study Design

This study employed a retrospective cross-sectional study design.

4.2. Study Setting and Period

The study was conducted in SPHMMC, a major referral hospital in Ethiopia. This setting was chosen due to its high patient volume, comprehensive obstetric and neonatal care services, and availability of detailed medical records, which are essential for a retrospective study. The study period covered from Jan 2023 to Jan 2025, allowing for the inclusion of a sufficient number of cases and controls to achieve adequate statistical power.

4.3. Source Population

The source population comprised all pregnant women who delivered prematurely at SPHMMC during the specified study period.

4.4. Study Population

The study population comprised all pregnant women who delivered prematurely at SPHMMC who meet the inclusion criteria.

4.5. Inclusion and Exclusion Criteria

Inclusion Criteria

- All records of pregnant women who delivered at St. Paul's Hospital Millennium Medical College (SPHMMC) between January 2023 and January 2025.
- All births classified as preterm (before 37 completed weeks of gestation).
- Availability of complete medical records including data on preeclampsia and Apgar scores.

Exclusion Criteria

Participants will be excluded based on the following criteria:

- Births occurring outside the study period (January 2023 to January 2025).
- Term births (births at or after 37 completed weeks of gestation).
- Incomplete or missing medical records that prevent the extraction of essential data points.
- Multiple gestations (e.g., twins, triplets)
- Major congenital anomalies (these may confound Apgar outcomes)

4.6. Variables

Dependent Variable

- Neonatal Apgar Score: Apgar score at 1 and 5 minutes, with low Apgar defined as <7 at 5 minutes(18).

Independent Variables

•Preeclampsia (PE), gestational age, birth weight, mode of delivery, maternal age, parity, residence

4.7.Operational Definition

Preterm Birth: Live birth occurring before 37 completed weeks of gestation(1),

Preeclampsia (PE): Presence or absence of new-onset hypertension with proteinuria or end-organ dysfunction after 20 weeks of gestation(1).

Neonatal Apgar Score: Apgar score at 1 and 5 minutes, with low Apgar defined as <7 at 5 minutes(18).

4.8. Sampling and Sample size calculation

Sampling : This research used simple random sampling to select eligible cases

For the first objective

$$n = \frac{Z^2 \cdot p \cdot (1-p)}{d^2} = \frac{(1.96)^2 (0.115) (1-0.115)}{(0.05)^2} = 157 \text{ with } 10\% \text{ contingency} = 173$$

Where:

- n = the required sample size
- Z = the Z-score corresponding to the desired confidence level. For a 95% confidence level, Z = 1.96.
- p = the estimated proportion of preeclampsia in the population(5)
- d = the acceptable margin of error. A 5% (0.05) margin of error was used.

For the second objective

Association b/n PE and neonatal Apgar score OR = 3.37(18)

$$p1 = \frac{(OR \times p2)}{1 - p2 + (OR \times p2)} = \frac{3.37 \times 0.10}{0.9 + 0.337} = 0.272$$

$$n = \frac{(Z\alpha/2 + Z\beta)^2 \times (p1(1-p1) + p2(1-p2))}{(p1 - p2)^2} = \frac{(1.96 + 0.84)^2 \times (0.272 \times 0.728 + 0.10 \times 0.90)}{(0.272 - 0.10)^2} = 84$$

Total sample size 168

Where:

p2 = Proportion of low Apgar score in non-preeclamptic preterm births 0.10 (assumed from local data)

Z = the Z-score corresponding to the desired confidence level. For a 95% confidence level, $Z = 1.96$.

Power: 80% ($Z\beta = 0.84$)

Ratio of exposed to unexposed: 1:1

Since a study with multiple objectives should adopt the larger sample size the final sample size for this study therefore was 173.

4.9. Data Collection

Data for this study was meticulously collected through a retrospective review of medical records of women who delivered within the specified time frame at SPHMMC. To ensure the highest degree of consistency, accuracy, and standardization in data capture, a comprehensive extraction form, designed as a structured questionnaire, using google forms was utilized. This approach was critical for enhancing the reliability of the collected information.

The data extraction form was adapted from previous similar studies with some modifications. It was structured to systematically capture relevant information from the medical records, including but not limited to:

- Maternal Demographic Information: Age, parity, residence (urban/rural)
- Antenatal Care (ANC) Details: any complications noted during ANC.
- Obstetric Complications: Detailed information regarding the diagnosis, severity, and management of Preeclampsia.
- Delivery Details: Mode of delivery (vaginal, C-section), gestational age at delivery, and any intrapartum complications.
- Neonatal Outcomes: Birth weight (measured in grams), gestational age at birth, Apgar scores
- Other Relevant Clinical Data: Any other medical conditions or interventions that could influence the study outcomes.

4.10. Data Analysis

Upon completion of data collection, all meticulously gathered information underwent a rigorous process of entry, cleaning, and analysis to ensure the integrity and validity of the study findings. The Statistical Package for Social Science (SPSS) version 27 statistical software was used as the primary tool for all analytical procedures. Raw data extracted from medical records was systematically entered into a pre-designed database within SPSS. To minimize transcription errors and enhance data quality, measures like double data entry checks were implemented.

Before any statistical analysis commenced, the data set underwent a comprehensive cleaning process to address missing values, outliers, and inconsistencies.

Descriptive statistics was employed to summarize the socio-demographic characteristics of the study population, the prevalence of preeclampsia among preterm deliveries.

Inferential statistical methods were used to assess the associations and correlations between preeclampsia and neonatal Apgar scores among preterm neonates, directly addressing the study's specific objectives.

This comprehensive data analysis plan enabled a thorough investigation of the research questions, providing strong evidence on the correlation between preeclampsia and neonatal Apgar cores among preterm neonates in Ethiopia.

4.11. Data Quality Control

Data quality was assured through careful design of structured form used during the data collection adapted from similar research done in the past, it was utilized to ensure consistency, accuracy, and completeness of the collected information.

5. Ethical Considerations

Ethical clearance was obtained from the Institutional Review Board of St.Paul's Hospital Millennium Medical college. Robust measures were implemented to ensure the security of all collected data, both during and after the data collection phase. Once data was extracted and entered into electronic google form format, it was stored on a password-protected computer and a secure server. Access to the data was restricted to the principal investigator. Data was used solely for academic and research purposes. Findings may be disseminated through academic publications, conference presentations, or policy briefs, without disclosing any individual identities.

This study complies with the ethical principles outlined national and institutional guidelines on research involving human subjects.

6. Dissemination of Results

The findings of this study will be disseminated through multiple channels to ensure that they reach stakeholders who can act on the results:

Academic Dissemination: The final research report will be submitted to St. Paul's Hospital Millennium Medical College as part of the fulfillment for academic requirements. Manuscripts will be prepared for submission to peer-reviewed journals.

Institutional Feedback: A summary report will be shared with the participating hospital and relevant healthcare authorities and a feedback session can be organized on the findings of the research.

7. Results

7.1. Characteristics of mothers

A total of 173 preterm deliveries were included in this study. The majority of mothers fell within the age group of 25–29 years, accounting for 45.1% of the study population, followed by those aged 20–24 years and 30–34 years, each contributing 19.7%. Mothers older than 34 years represented 14.5%, while those younger than 20 years constituted only 1.2%. The mean maternal age was 27.65 ± 4.66 years, indicating that most preterm deliveries occurred among women in their late twenties.

Table 1: Characteristics of mothers who had preterm delivery at SPHMMC from Jan 2023 - Jan 2025

Variable	Category	Frequency	Percent (%)
Age	<20	2	1.2%
	20-24	34	19.7%
	25-29	78	45.1%
	30-34	34	19.7%
	>34	25	14.5%
Residency	Urban	109	63.0%
	Rural	64	37.0%

In terms of residency, a higher proportion of mothers (63.0%) were from urban areas, whereas 37.0% were from rural settings. This distribution suggests that preterm delivery cases were more frequently reported among urban residents in this study setting.

7.2. Obstetric characteristics of mothers

Out of the 173 mothers (32.9%) were primiparous. Most of the mothers delivered vaginally accounting (54.9%).

Regarding their clinical profile, 94.0% of the mothers were diagnosed with severe preeclampsia, while 6.0% had preeclampsia without severe features. In 53.7% of the mothers preeclampsia was diagnosed early on while 46.3% had a late diagnosis.

Table 2: Obstetric characteristics of mothers who had preterm delivery at SPHMMC from Jan 2023 to Jan 2025

Parity	Primiparous	57	32.9%
	Multiparous	118	67.1%
Delivery	Vaginal	103	54.9%
	Cesarean	74	45.1%

7.3. Magnitude of Preeclampsia and neonatal outcomes

The prevalence of preeclampsia among preterm deliveries was 38.7%. Among preterm neonates 75 had a low 1st minute APGAR score. Out of the 75 preterm neonates 32 had a low APGAR score at the 5 minute mark. Most of the deliveries happened during the late preterm period accounting for 69.9%.

Table 3: Magnitude of Preeclampsia and key neonatal outcomes among preterm deliveries at SPHMMC from Jan 2023 - Jan 2025

Variable		Frequency	Percent (%)
Preeclampsia	Yes	67	38.7%
	No	106	61.3%
Birth Weight	<1000	3	1.7%
	1000-1499	26	15.0%
	1500-2499	59	34.1%
	2500-4000	85	49.1%
Gestational Age	28-31+6 weeks	17	9.8%
	32-33+6 weeks	35	20.2%

	34-36+6 weeks	121	69.9%
1st min APGAR	<7 (Low)	75	43.4%
	>=7 (More	98	56.6%
5th min APGAR	<7 (Low)	32	18.5%
	>=7 (More	141	81.5%

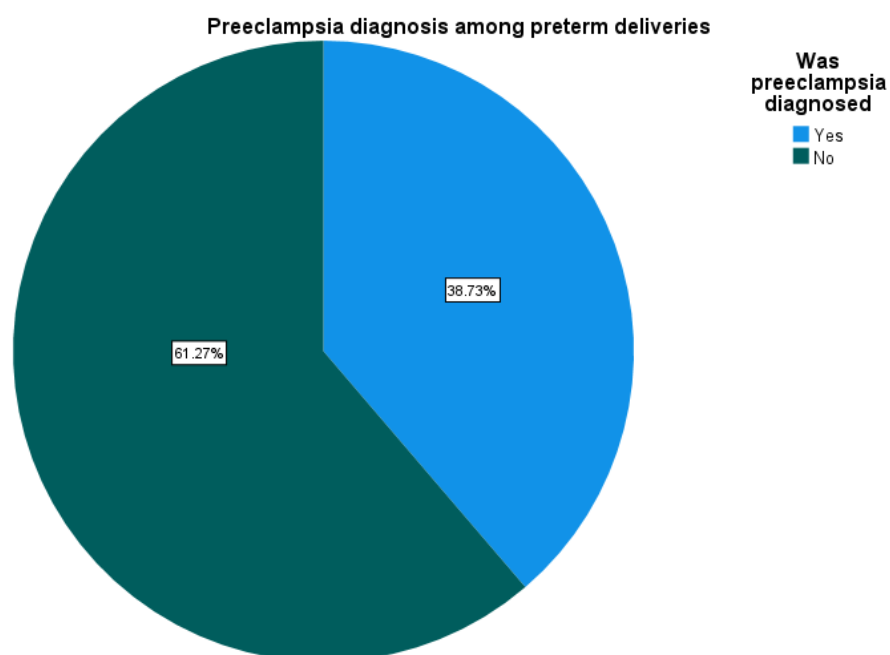


Fig 1. Prevalence of preeclampsia among mothers who had preterm delivery at SPHMMC from Jan 2023 - Jan 2025

7.4. Factors Associated with Low Apgar Score

To identify factors associated with low Apgar scores, both bivariable and multivariable logistic regression analyses were performed. Initially, bivariable logistic regression analysis was conducted to assess the association between each independent variable and low neonatal Apgar score at the 1st and 5th minutes. Variables with p-value less than 0.25 in the bivariable analysis were entered into multivariable logistic regression to control for potential confounders. Statistical significance was declared at p-value < 0.05.

Table 4: Bivariate analysis of factors associated with 1st and 5th-minute Apgar scores among preterm neonates at SPHMMC from Jan 2023 - Jan 2025

Variable	Categories	Low 1st min APGAR	P-value	Low 5th min APGAR	P-value
Preeclampsia	Yes	46	<0.001	19	0.008
	No	29		13	
Age	<20	1	0.157	0	0.439
	20-24	18		10	
	25-29	27		12	
	30-34	14		6	
	>34	15		4	
Residence	Urban	46	0.690	20	0.948
	Rural	29		12	
Parity	Primiparous	24	0.816	10	0.821
	Multiparous	51		22	
Mode of delivery	Cesarean	45	<0.001	20	<0.023
	Vaginal	30		12	
Gestational Age	Early Preterm	12	<0.001	5	<0.016
	Moderate Preterm	22		9	
	Late Preterm	41		18	
Birth Weight	<1000	3	<0.001	3	<0.001
	1000-1499	25		12	
	1500-2499	29		9	
	2500-4000	18		8	

7.4.1. Multivariate Logistic Regression Analysis

In the bivariable analysis, variables such as maternal age, type of preeclampsia, gestational age, and mode of delivery were tested. Variables with a p-value < 0.25 were moved to the multivariable model.

In the multivariable logistic regression analysis, preeclampsia, early gestational age, and low birth weight remained significant independent predictors of low 1st minute Apgar score. Neonates born to mothers with preeclampsia had nearly 6 times higher odds of 1st minute low Apgar (AOR = 5.78, 95% CI: 2.50–13.37, $p < 0.001$) compared to those born to normotensive mothers. Similarly, being born early preterm (AOR = 6.54, $p = 0.043$) and weighing less than 1500g (AOR = 6.58, $p < 0.001$) significantly increased the odds of the outcome. Interestingly, while the crude analysis showed a significant association with mode of delivery, this association was not maintained after adjusting for confounders ($p = 0.109$)

Table 5: Multivariable logistic regression analysis of predictors for low 1st-minute Apgar score among preterm neonates at SPHMMC from Jan 2023 - Jan 2025

Variable	Category	Percentage	Frequency of 1 st min low APGAR	AOR 95% CI)	COR	p-value
Preeclampsia	Yes	61.33%	46	5.784 (2.502-13.370)	5.894 (3.033-11.452)	<0.001
	No	38.66%	29	1.00	1.00	
Gestational age	Early preterm	16%	12	6.548 (1.8-15.2)	8.20 (2.1-16.5)	0.043
	Moderate Preterm	29.33%	22	2.610 (1.1-6.5)	3.80 (1.2-7.2)	0.142
	Late Preterm	54.66%	41	1	1	
Birth Weight	<1500	37.33%	28	6.58 (4.2-25.1)	7.38 (5.1-28.3)	<0.001

	1500-2499	38.66%	29	3.47 (1.5-5.8)	3.41 (1.5-5.8)	0.004
	2500-4000	24%	18	1	1	
Mode of Delivery	C/S	60%	45	2.079 (0.849-5.088)	3.181 (1.712-5.909)	0.109
	Vaginal	40%	30	1	1	

Factors significantly associated with a low 5th-minute Apgar score included maternal preeclampsia, early gestational age, and very low birth weight. After adjusting for confounders, neonates born to mothers with preeclampsia were 2.58 times more likely to have a low score (AOR = 2.58, $p = 0.042$). Early preterm birth increased the odds of a low score six-fold (AOR = 6.12, $p = 0.018$). The strongest predictor in this model was birth weight <1500g, which carried 5.6 times the odds of a low 5th-minute Apgar score (AOR = 5.60, $p < 0.001$). Mode of delivery did not reach statistical significance in the adjusted model ($p = 0.109$)

Table 6: Multivariable logistic regression analysis of predictors for low 5th-minute Apgar score among preterm neonates at SPHMMC from Jan 2023 - Jan 2025

Variable	Category	Percentage	Frequency Low 5 th min APGAR	AOR 95% CI)	COR	p-value
Preeclampsia	Yes	59.38%	19	2.579 (1.035-6.425)	2.863 (1.306-6.277)	0.042
	No	40.62%	13	1.00	1.00	
Gestational age	Early preterm	15.63%	5	6.12 (1.507-15.2)	6.58 (2.1-16.5)	0.018
	Moderate Preterm	28.12%	9	4.035 (1.1-18.312)	5.80 (1.2-19.2)	0.071

	Late Preterm	56.25%	18	1	1	
Birth Weight	<1500	46.88%	15	5.6 (4.3-18.1)	6.55 (3.1-13.8)	<0.001
	1500-2499	28.12%	9	1.72 (0.58-5.1)	1.58 (0.57-4.4)	0.004
	2500-4000	25%	8	1	1	
Mode of Delivery	C/S	62.5%	20	2.127 (0.779-5.811)	2.361 (1.073-5.194)	0.109
	Vaginal	37.5%	12	1	1	

8. Discussion

The aim of this study was to determine the association between maternal preeclampsia and low neonatal Apgar scores among preterm deliveries at Saint Paul's Hospital Millennium Medical College (SPHMMC), Addis Ababa, Ethiopia. In this study, preeclampsia was significantly associated with an increased likelihood of low Apgar scores at 1 and 5 minutes among preterm neonates. Preterm infants born to mothers with preeclampsia had markedly higher risk of immediate neonatal depression compared with infants born to normotensive mothers, even after adjusting for key confounders such as gestational age and birth weight. The findings are consistent with other Ethiopian studies reporting perinatal complications associated with hypertensive disorders in pregnancy. In a multicenter cross-sectional study conducted at two public hospitals in Addis Ababa, low fifth-minute Apgar scores were noted in 14.7% of newborns born to mothers with preeclampsia with severe features, along with high rates of low birth weight and prematurity, which are closely linked with low Apgar scores and neonatal compromise (6). Similarly, a population-based study from Mettu Karl Referral Hospital documented low Apgar scores in 18.5% of pregnancies complicated by pregnancy-related hypertension, reinforcing the relationship between hypertensive disorders and impaired immediate neonatal adaptation (14). These findings align with our results, indicating that preeclampsia contributes to higher rates of neonatal depression at birth in Ethiopian women. Additional evidence from Ethiopia supports the broader relationship between preterm birth and low Apgar scores: in a recent case-control study in the North Shoa Zone, preterm birth itself was an independent determinant of low fifth-minute Apgar scores, with preterm deliveries nearly four times more likely to have a low score compared to term deliveries (22). While this study did not focus specifically on preeclampsia, it highlights prematurity as a key pathway through which hypertensive disorders may exert perinatal risk. Moreover, studies in the Tigray region reported that approximately 12.3–47.8% of neonates born to mothers with preeclampsia-eclampsia had Apgar scores <7 at 5 minutes, illustrating the prevalence of low Apgar in this population and the potential effect of early-onset, severe hypertensive disease on neonatal outcomes (16).

The pathophysiological link between preeclampsia and low Apgar scores is biologically plausible: preeclampsia is characterized by abnormal placentation and maternal endothelial dysfunction, which limits trans-placental oxygen and nutrient transfer and increases the risk of intrauterine growth restriction and chronic fetal hypoxia. These in turn predispose neonates to perinatal depression, reflected in lower Apgar scores. Additionally, preeclampsia frequently

necessitates preterm delivery to preserve maternal safety, further exposing the neonate to complications of immaturity.

Although mode of delivery showed a significant association with low Apgar score in the bivariable analysis, this association disappeared after adjustment in the multivariable model. This suggests that the initial relationship was likely confounded by other clinical factors such as gestational age, birth weight and maternal preeclampsia. In this study cesarean delivery was more frequently performed in high risk pregnancies, including early preterm births and pregnancies complicated by preeclampsia. These conditions are independently associated with low Apgar scores likely account for the apparent association observed between cesarean delivery and low Apgar in the bivariable analysis (8,14,20). This finding is consistent with previous studies in which mode of delivery showed an association with low Apgar score in unadjusted analysis but did not remain significant after controlling for confounding variables (24). This suggests that cesarean delivery often reflects underlying fetal compromise rather than being direct determinant of neonatal depression.

The observed association has important clinical and public health implications in Ethiopia and similar low-resource settings. First, low Apgar scores are associated with increased need for neonatal resuscitation, intensive care admission, morbidity, and possibly long-term neurodevelopmental sequelae. Clinicians should therefore anticipate higher risk of perinatal compromise among preterm infants of preeclamptic mothers and ensure that deliveries occur in facilities equipped with skilled neonatal resuscitation and supportive care. Additionally, this evidence underscores the need for enhanced antenatal surveillance of women with hypertensive disorders, including early detection and strict blood pressure control, to delay preterm delivery where safe and feasible.

From a policy perspective, strengthening antenatal care (ANC) coverage and quality — particularly early screening for preeclampsia and monitoring of fetal well-being — may mitigate some of the deleterious effects on neonatal outcomes. Given that low Apgar scores in preterm infants often reflect underlying hypoxia, interventions such as timely corticosteroid administration to enhance fetal lung maturity and magnesium sulfate for neuroprotection should be optimized where available.

Strengths and Limitations

This study has several strengths. First, it focuses on preterm deliveries at a tertiary referral hospital providing insight into a high-risk obstetric subgroup and also it is a clinically relevant group. The use of multivariable logistic regression helped control potential confounders and adequate sample size was used improving statistical power.

However, the study also has limitations. Its retrospective design may have introduced selection bias and limited control over confounding variables and inability to establish causality between the different factors. The reliance on hospital records may be affected by incomplete documentation or inconsistent Apgar scoring practices. Furthermore, this being a single-center study limits generalizability to other Ethiopian regions with different health system capacities and population characteristics.

Recommendations

Based on these findings, we recommend the following:

1. Clinical Practice:

- The neonatology team at SPHMMC should be present during delivery of preterm neonates born to mothers with preeclampsia due to the increased risk of low Apgar scores and respiratory compromise.

2. Health Systems:

- Since early onset diagnosis of preeclampsia was 53% at our hospital, SPHMMC and other tertiary hospitals should enhance first trimester screening and standardize early referral for high risk women to improve timely detection and management.
- SPHMMC hospital administration should improve availability of neonatal resuscitation equipment in delivery rooms.
- Addis Ababa City Health Bureau should support training on management of hypertensive disorders in pregnancy.

3. Research:

- Prospective, multi-center studies to validate these associations across diverse Ethiopian populations.
- I recommend a prospective cohort study that follows these low-Apgar neonates to assess the actual neurodevelopmental impact in the Ethiopian context.

9. References

1. Cunningham F, Leveno K. Williams Obstetrics. 26th edition. McGraw Hill; 2022.

2. CDC. Maternal Infant Health. 2025 [cited 2025 Sept 6]. Preterm Birth. Available from: <https://www.cdc.gov/maternal-infant-health/preterm-birth/index.html>
3. Ohuma EO, Moller AB, Bradley E, Chakwera S, Hussain-Alkhateeb L, Lewin A, et al. National, regional, and global estimates of preterm birth in 2020, with trends from 2010: a systematic analysis. *Lancet Lond Engl*. 2023 Oct 7;402(10409):1261–71.
4. Muchie KF, Lakew AM, Teshome DF, Yenit MK, Sisay MM, Mekonnen FA, et al. Epidemiology of preterm birth in Ethiopia: systematic review and meta-analysis. *BMC Pregnancy Childbirth*. 2020 Sept 29;20(1):574.
5. Kassa BG, Asnkew S, Ayele AD, Nigussie AA, Demilew BC, Mihirete GN. Preeclampsia and its determinants in Ethiopia: A systematic review and meta-analysis. *PloS One*. 2023;18(11):e0287038.
6. Tadese M, Damesa WA, Solomon GS, Fitie GW, Mitiku YM, Tessema SD, et al. Prevalence and determinants of adverse perinatal outcomes of preeclampsia with severe features at two selected public hospitals in Addis Ababa, Ethiopia. *Front Pediatr* [Internet]. 2024 Feb 8 [cited 2025 Sept 6];12. Available from: <https://www.frontiersin.org/journals/pediatrics/articles/10.3389/fped.2024.1345055/full>
7. Tesfahun E, Tadesse S, Hailu A, Minda A, Ekubay M, Tariku B, et al. Prevalence of Preeclampsia and Associated Factors among Antenatal Care Attending Mothers at Tirunesh Beijing General Hospital, Addis Ababa, Ethiopia. *Adv Public Health*. 2023;2023(1):1132497.
8. Getachew B, Etefa T, Asefa A, Terefe B, Dereje D. Determinants of Low Fifth Minute Apgar Score among Newborn Delivered in Jimma University Medical Center, Southwest Ethiopia. *Int J Pediatr*. 2020 Mar 4;2020:9896127.
9. Lawrence ER, Beyuo TK, Kobernik EK, Moyer CA, Oppong SA. A comparative analysis of neonatal outcomes in pregnancies complicated by preeclampsia and eclampsia in Ghana. *AJOG Glob Rep*. 2022 May 19;2(3):100061.
10. Wagnew M, Dessalegn M, Worku A, Nyagero J. Trends of preeclampsia/eclampsia and maternal and neonatal outcomes among women delivering in addis ababa selected

government hospitals, Ethiopia: a retrospective cross-sectional study. *Pan Afr Med J.* 2016;25(Suppl 2):12.

11. Pre-eclampsia [Internet]. [cited 2025 Sept 6]. Available from: <https://www.who.int/news-room/fact-sheets/detail/pre-eclampsia>

12. Frontiers | Obstetrical and perinatal outcomes of women with preeclampsia at Woldia Comprehensive Specialized Hospital, Northeast Ethiopia [Internet]. [cited 2025 Sept 6]. Available from: <https://www.frontiersin.org/journals/medicine/articles/10.3389/fmed.2024.1326333/full>

13. Sium AF, Lucero-Prisno DEI, Gudu W. Perinatal outcomes of twin pregnancies complicated with preeclampsia at a tertiary hospital in Ethiopia: A case-control study. *Public Health Chall.* 2022 Dec;1(4):e37.

14. Seyom E, Abera M, Tesfaye M, Fentahun N. Maternal and fetal outcome of pregnancy related hypertension in Mettu Karl Referral Hospital, Ethiopia. *J Ovarian Res.* 2015 Mar 15;8:10.

15. Aynalem YA, Mekonen H, Getaneh K, Yirga T, Chanie ES, Bayih WA, et al. Determinants of neonatal mortality among preterm births in Black Lion Specialized Hospital, Addis Ababa, Ethiopia: a case-cohort study. *BMJ Open.* 2022 Feb 10;12(2):e043509.

16. Teka H, Yemane A, Abraha HE, Berhe E, Tadesse H, Gebru F, et al. Clinical presentation, maternal-fetal, and neonatal outcomes of early-onset versus late onset preeclampsia-eclampsia syndrome in a teaching hospital in a low-resource setting: A retrospective cohort study. *PloS One.* 2023;18(2):e0281952.

17. Legesse AY, Berhe Y, Mohammednur SA, Teka H, Goba G. Prevalence and Determinants of Maternal and Perinatal Outcome of Preeclampsia at a Tertiary Hospital in Ethiopia. *Ethiop J Reprod Health.* 2019 Nov 5;11(4):8–8.

18. Zewude SB, Ajebe TM, Gessesse SS, Wassie TH. Proportion and predictive factors of low apgar score at five minute among singleton term neonates delivered in Debre Tabor specialized hospital, northwest Ethiopia: A cross-sectional study. *Int J Afr Nurs Sci.* 2021 Jan 1;15:100322.

19. tantu T, tantu T, Hailu Y, Gashaw D, Melkamu B. Prevalence and factors associated with low 5th minute APGAR score among mothers who birth through emergency cesarean section: prospective cross-sectional study in Ethiopia. *BMC Pregnancy Childbirth*. 2025 Mar 25;25(1):342.
20. Godana A, Tesi S, Nigussie S, Dechasa M. Perinatal outcomes and their determinants among women with eclampsia and severe preeclampsia in selected tertiary hospitals, Eastern Ethiopia. *Pregnancy Hypertens*. 2023 Dec;34:152–8.
21. Pragitara CF, Etika R, Herawati L, Aditiawarman A. Risks of preterm birth and low Apgar score among preeclamptic women. *JKKI J Kedokt Dan Kesehat Indones*. 2020 Apr 30;6–17.
22. Adugna DG. Prevalence and associated risk factors of preterm birth among neonates in referral hospitals of Amhara Region, Ethiopia. *PLOS ONE*. 2022 Oct 27;17(10):e0276793.
23. Girma G. Perinatal outcomes of pregnancies complicated by hypertensive disorders of pregnancy in late preterm in three teaching hospitals in Addis Ababa, Ethiopia [thesis]. Addis Ababa University; 2021.
24. Abebe A, et al. Determinants of low fifth minute Apgar score among newborns delivered at public hospitals in Hawassa City, South Ethiopia. *BMC Pregnancy Childbirth* 2021.

10. Annex

Study Title: Prevalence of Preeclampsia and its association with neonatal Apgar score among preterm deliveries in SPHMMC, Addis Ababa, Ethiopia.

Study Site: SPHMMC, Addis Ababa, Ethiopia

Study Period: Jan 2023 to Jan 2025

Purpose: To assess prevalence of preeclampsia and its association with neonatal Apgar score among preterm deliveries in SPHMMC, Addis Ababa, Ethiopia.

Data Collection Form

Variable	Option	Skip
Section I Demographics and socioeconomic information		
1.1. Maternal Age (years):		
1.2. Residence:	1. Urban 2. Rural	
Part II Obstetric Factors		
2.1. Parity (number of previous live births):		
2.2. Gravidity (number of pregnancies):		
2.3. ANC follow up during this pregnancy?	1. Yes 2. No	
2.4. Any Complications Noted During ANC:	1. Yes 2. No	
2.5. Was Preeclampsia diagnosed?	1. Yes 2. No	
2.6. When was it diagnosed?	1. Early (before 34 weeks) 2. Late (after 34 weeks)	
2.7. If Yes, severity:	1. Mild 2. Severe	
2.8. BP at diagnosis:		
2.9. Proteinuria:	1. Yes 2. No	
2.10. Other severity features?		
2.11. Any other obstetric complication during pregnancy?	1. Yes 2. No	
2.12. If yes what was it?	1. APH 2. PROM	
2.13. Is there any Medical illness during pregnancy?	1. Yes 2. No	

2.14. If yes what was the illness?	1. UTI 2. Anemia 3. RVI 4. Diabetes 5. Malaria 6. Thyroid disease 7. Heart disease	
Section III Delivery and Neonatal Information		
3.1. Mode of Delivery:	1. Vaginal 2. Cesarean	
3.2. Gestational Age at Delivery (weeks):		
3.3. Birth Weight (grams):		
3.4. Apgar Score at 1 minute:		
3.5. Apgar Score at 5 minutes:		
Section IV General Information		
4.1. Patient Medical Record Number (MRN):		
4.2. Date of Data Collection:		
4.3. Data Collector's Name:		
4.4. Data Collector's Signature:		

Note: Data extraction form is adapted from similar research done in the past(6,18,23).

Dummy Table

Table 7: Association between preeclampsia and neonatal Apgar score among Preterm Births at SPHMMC from Jan 2023 - Jan 2025

Study ID	Maternal Age	Parity	GA at Delivery (wks)	PE (Y/N)	Severity	BP at Dx

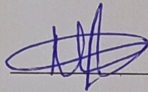
Proteinuria	Mode of Delivery	Birth Weight (g)	Apgar 1 min	Apgar 5 min	Notes

Note: This table is designed to present the association between preeclampsia and neonatal Apgar score among preterm births.

Declaration

I, the undersigned student, declare that this research project is my original work in partial fulfillment of the requirement for the **Degree of Doctor in Medicine, MD**. I also declare that it has never been presented in this or any other higher institution and that all resources and materials used in the research work have been duly acknowledged.

Name of the student: Nahom Asfaw

Signature: 

Date: 25/03/2026

Approval of Advisors

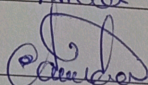
This research work has been submitted for examination with my approval.

Name of School of Public health advisor 1: Hanna Feleke

Signature: 

Date: 25/3/26

Name of Clinical advisor 2: Aider

Signature: 

Date: 24-03-26