ARSI UNIVERSITY

COLLEGE OF HEALTH SCIENCE

DEPARTMENT OF GYNECOLOGY AND OBSTETRICS

Immediate Adverse Neonatal Outcomes and Associated Factors among Deliveries with Non-Reassuring Fetal Heart Rate in public Health Facilities of Asela Town, Ethiopia

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ACRONYMS/ ABBREVIATIONS

ACOG- American College of Obstetrics and Gynaecology

AHC- Asela Health Center

ANC – Antenatal Care

AFSOL-Active First Stage of Labor

APH- Aburapsio Placenta

ARDS-Acute Respiratory Distress Syndrome

ARTH - Asela Referral and Teaching Hospital

CD-Caesarean Delivery

CPD-Cephalo Pelvis Disproportion

CTG- contraction tocograpgy

EDHS – Ethiopian Demographic Health Survey

EFM - Electrical Fetal Monitoring

EJRH - Ethiopian Journal of Reproductive Health

FHR - Fetal Heart Rate

HHC - Hilala Health Center

IUGR-Intra Uterine Growth Restriction

IUFED-Intra uterine Fetal Death

LFSOL-latent First Stage of Labor

LMIC- Low and Middle Income Countries

MDGs - Millennium Development Goals

MSAF - Meconium Stain Amniotic Fluid

NGOs - Non - Governmental Organization

NICU - Neonatal Intensive Care Unit

NMR - Neonatal Mortality Rate

NRFHS - Non-Reassuring Fetal Heart Status

PIH - Pregnancy Induced Hypertension

SDGs - Sustainable Development Goals

WHO - World Health Organization

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Abstract

Introduction: Non-reassuring fetal heart rate patterns during labor indicate potential fetal distress and may lead to adverse neonatal outcomes. However, local evidence on neonatal outcomes following Non-reassuring fetal heart rate status in Asela town public health facilities is limited.

Objectives: To assess immediate adverse neonatal outcomes and associated factors among deliveries complicated by Non-reassuring fetal heart rate status at Asela public Health facilities in 2025.

Methods: A facility-based cross-sectional study was conducted from October to December 2025 among 282 postpartum mothers at Asella referral and teaching hospital, Asela and Halial Health Centers. Participants were selected using systematic random sampling. Data were collected through interviews and chart reviews and analyzed using SPSS version 25. Factors associated with immediate adverse neonatal outcomes identified at a significance level of $p < 0.05$.

Results: In the current study, 282 mothers were participated with the response rate of 100%. The prevalence of immediate adverse neonatal outcome was 30.9%(87) (CI: 25.5%, 36.5%) Of these cases, 29.4%(83) occurred at Asella referral and teaching hospital, 1.1%(3) at Asella health center, and 0.4%(1) at Hilal. The common adverse outcomes were neonatal care unit admission 87 (30.9%), respiratory distress (13.8%), neonatal sepsis (12.4%), low APGAR scores at 5 minutes (5.3%), hypoxic encephalopathy (5.3%), and early neonatal death (3.2%). In multivariable analysis, maternal age ≥35 years (AOR: 15.86; 95% CI: 1.97, 52.2), bad obstetric history (AOR 9.87, 95% CI 1.61–34.2), Current pregnancy Complication (AOR 2.78, 95% CI 1.22–6.33), preterm neonates (<37 weeks) (AOR 15.27,95% CI 3.45–38.5), referral from another health facility (AOR 5.39, 95% CI 2.2–13.2),MSAF (AOR 4.37, 95% CI 1.86–10.24), prolonged ROM (AOR 1.22, 95% CI 1.03–4.24) diagnosis of Non-reassuring fetal heart rate status during the active first stage of labor (AOR 14.1, 95% CI 4.41–32.3), and during the second stage (AOR 14.7, 95% CI 3.35–29.51) were significant factors associated with immediate adverse neonatal outcomes.

Conclusion: Nearly one-third of neonates among deliveries complicated by Non-reassuring fetal heart rate status experienced immediate adverse outcomes in Asela. The common adverse outcomes were neonatal care unit admission, respiratory distress, neonatal sepsis, low APGAR scores, HIE, and early neonatal lose. Advanced maternal age, a bad obstetric history, presence of current pregnancy complications, prematurity, and referral from other health facilities, meconium-stained amniotic fluid, prolonged rupture of membrane, and diagnosis of fetal compromise during active first stage of labor or second stage of labor were significant determinants. Therefore, I recommend better antenatal care, faster referral systems, and improved fetal monitoring and resuscitation

Keywords: Magnitude, Outcome, Fetus, Neonates, Asela.

1. INTRODUCTION

1.1. Background

The term "fetal distress" has traditionally been used to describe situations in which the fetus experiences insufficient oxygen during pregnancy or labor, often identified through abnormal fetal heart rate (FHR) patterns. However, despite its widespread use, "fetal distress" lacks a clear definition, which complicates both its diagnosis and treatment (American College of Obstetricians and Gynecologists (ACOG)). It is often confused with "birth asphyxia," which refers to a lack of oxygen to the fetus before, during, or after delivery, typically due to factors such as low maternal oxygen levels or reduced blood flow, often caused by umbilical cord compression (1).

To address the confusion between these two terms, ACOG has recommended replacing "fetal distress" with the term "non-reassuring fetal status," which more accurately reflects the condition and its underlying causes (2).

There are various methods for monitoring fetal heart rate during labor, including intermittent auscultation (using a Pinnard stethoscope or Doppler) and continuous electronic fetal monitoring (EFM). A key advantage of FHR monitoring is its ability to detect fetal hypoxia (insufficient oxygen) by identifying abnormal heart rate status (3). However, the use of FHR monitoring can also lead to an increased risk of unnecessary caesarean sections, particularly if the results are misinterpreted (4).

Non-reassuring fetal status is not an adverse event in itself but rather an indication of an underlying condition that may lead to oxygen deprivation for the fetus, which could result in fetal hypoxia and metabolic acidosis. Fetal oxygenation is reliant on maternal oxygen levels and placental blood flow, so any disruptions in maternal health, uterine blood supply, placental transfer, or fetal gas exchange can contribute to non-reassuring fetal status (3).

Conditions commonly associated with this status include maternal cardiovascular diseases, anaemia, diabetes, hypertension, infections, placental abruption, abnormal fetal presentation, intrauterine growth restriction (IUGR), and umbilical cord compression (5).

Non-reassuring fetal heart rate status (NRFHRS) during labor are important indicators of potential fetal distress and often necessitate immediate medical interventions to avoid adverse neonatal outcomes such as low Apgar scores, the need for neonatal resuscitation, and admission to NICU (4).

Approximately 37.3% required ventilation, while around 30.5% necessitated NICU admission following the delivery of NRFHRS. Were as 4.8% of fetus still birth In terms of the overall neonatal outcome, over half of the 58 new borns (46.8%) had an adverse outcome, (11).

Several factors contribute to the likelihood of adverse neonatal outcomes following NRFHRS among which these four are considered here. First, maternal Factors: Conditions such as hypertensive disorders, diabetes, and infections during pregnancy can increase the likelihood of NRFHRS and subsequent neonatal complications (6). Second, intrapartum Factors: Issues like prolonged labor, meconium-stained amniotic fluid, and umbilical cord complications (e.g., cord prolapse or cord compression) are key intrapartum factors that heighten the risk of NRFHRS (7). Third, delivery Interventions: The timing and method of delivery, particularly emergency cesarean sections performed due to NRFHRS, have a significant impact on neonatal outcomes. Delays in decision-making during these situations can exacerbate the risks to the neonate (8). And fourth, healthcare Access and Quality: The availability of skilled healthcare providers, appropriate monitoring equipment, and timely interventions are essential in minimizing the adverse outcomes associated with NRFHRS (9).

A comprehensive understanding of these factors is essential for developing strategies to improve perinatal outcomes in cases involving NRFHRS. Early detection and swift management of non-reassuring fetal status, along with addressing the associated maternal and intrapartum factors, are critical for reducing the occurrence of immediate adverse neonatal outcomes.

1.2. Statement of the Problem

Globally, the prevalence of NRFHRS ranges from 8.9% to 30.7%, and it is responsible for approximately half of all stillbirths. An estimated 1.2 million stillbirths and 2.1 million early neonatal deaths occur annually, with 98% of these deaths occurring in low- and middle-income countries, particularly in Sub-Saharan Africa (10). NRFHRS is associated with an elevated risk of perinatal morbidity and mortality, as well as increased admissions to neonatal intensive care units (NICUs). Additionally, it remains a leading cause of operative deliveries, with 36% of such deliveries involving NRFHRS, and 47.1%-58% of these cases resulting in either vacuum or caesarean section deliveries (9)

NRFHRS patterns during labor are significant indicators of potential fetal compromise. They are associated with increased risks of adverse neonatal outcomes such as low Apgar scores, neonatal intensive care unit (NICU) admission, respiratory distress, and early neonatal death. (10) Neonatal outcomes serve as crucial indicators of maternal and newborn health, with adverse outcomes representing significant challenges to global healthcare systems.(7). This issue is particularly acute in low- and middle-income countries, where resource limitations can delay interventions, thereby increasing the risk of adverse neonatal outcomes.

The need for immediate interventions such as caesarean sections or instrumental vaginal deliveries is critical when abnormal fetal heart rate tracings are detected (7). Despite the importance of these interventions, determining the most effective strategy remains challenging. Limited information on managing abnormal FHR patterns, particularly in low-resource settings, further complicates the issue (11).

Factors influencing neonatal outcomes in NRFHRS cases include maternal health, labor management, mode of delivery, and healthcare system inefficiencies (11). However, the specific contribution of these factors in various settings, particularly in low-resource environments, remains unclear. Known risk factors for NRFHRS include antepartum haemorrhage, amniotic fluid disorders, intrauterine growth restriction, use of anaesthesia, and abnormal fetal presentation (7). NRFHRS can lead to serious health problems for the neonate, including hypoxia and in severe cases, stillbirth or perinatal death and in long term cerebral palsy, seizures, hearing and vision impairment (8).

Ethiopian studies have highlighted the impact of NRFHRS on neonatal health. Over 21% of labors in the country are complicated by NRFHRS, with 50.8% of affected infants having an Apgar score of 7 or higher, while 37.3% require ventilation, and 30.5% need NICU admission post-delivery. Approximately 4.8% of these neonates experience stillbirth. Despite these alarming statistics, the neonatal mortality rate (NMR) in Ethiopia remains high at 30 deaths per 1,000 live births, highlighting the urgent need for improved perinatal care (10).

The Ethiopian government's Health Sector Transformation Plan (HSTP-II) (2021–2024) includes specific goals aimed at improving new-born survival and development. Interventions such as clear delivery practices, exclusive breastfeeding, early identification of danger signs, and timely treatment of complications like sepsis and birth asphyxia have been shown to effectively reduce neonatal mortality (12). Despite these efforts, adverse neonatal outcomes, such as low Apgar scores, neonatal asphyxia, and NICU admissions, remain prevalent following deliveries with NRFHRS, necessitating further investigation into the contributing factors (9). Although the Ethiopian government has developed strategy and plan to improve the wellbeing of mothers and children (13), the level of adverse birth outcomes are major public health problems in areas such as Shire, Tigray, (22.6%) (14), Gondar (23%)(15), Awi (41.1%) (16), Gamogofa (37.6%)(17), Hawassa (18.3%) (18), and Hosanna, (24.5%) (19). Consequently, the mortality rate of neonates, infants, and under five-children has been 29, 48, and 67 per 1000 live births, respectively (10).

Although there is limited research focusing on adverse neonatal outcomes in the context of NRFHRS at Asela, studies from other parts of Ethiopia provide valuable insights. For instance, one study found that mothers receiving high-dose oxytocin experienced a significantly higher incidence of NRFHRS (23.1%) compared to those on low-dose regimens, which resulted in more adverse perinatal outcomes (23.1% vs. 7.4%) (9). These findings underscore the need for appropriate labor management and monitoring strategies to reduce NRFHRS and associated complications.

Asela Referral and Teaching Hospital and two public health centers serves a large population in the Arsi zone and neighboring zones of the Oromia region, providing critical obstetric services, yet there is limited local evidence on the burden of immediate adverse neonatal outcomes following NRFHRS. Understanding the magnitude of these outcomes and identifying associated factors is crucial for improving intrapartum care strategies, optimizing neonatal outcomes, and guiding clinical decision- making. Therefore, investigating the immediate adverse neonatal outcomes and their

associated factors among deliveries complicated by NRFHRS in public health facilities of Asela town is essential for developing targeted interventions to reduce neonatal morbidity and mortality.

1.3. Significance of the Study

The importance of this study cannot be overemphasized, as it fills a very important knowledge gap concerning the immediate adverse neonatal effects that exist for deliveries that experience non-reassuring fetal heart rate status complications. Despite the increased use of electronic fetal monitoring, interpretation and care still pose a challenge, especially when human resources and infrastructure are limited. The public health facility in Asela town covers a large population that has a high rate of complicated pregnancies, but evidence regarding the neonatal effects of NRFHRS has been lacking. The current study fills the knowledge gap by providing context-relevant information that plays a pivotal role in improving maternity and neonatal care.

This research also helps to fill the gap in the existing literature on fetal heart rate monitoring, where the best practices for the management of the condition are still controversial. Through the prevention of neonatal morbidity and mortality, the research helps to ensure the survival of the child. Besides, it serves as a base line data for further studies.

2. LITERATURE REVIEW

2.1. Magnitude of NRFHRS and Adverse Neonatal Outcomes

Although the prevalence of NRFHRS varies by location and healthcare setting, estimates from around the world indicate that between 10% and 25% of laboring women are affected. NRFHRS is a major issue in African countries, where rates vary based on regional medical circumstances. For instance, a study conducted in Ethiopia discovered that almost 21% of laboring women had NRFHRS, and more than one-third of these new-born needed NICU admission or ventilation (7). The frequency varies between 15% and 25% in nations such as South Africa and Nigeria (21).

NRFHRS was present in 41.5% of individuals in the South Omo Zone of Southern Ethiopia, including anomalies like as bradycardia (57.5%) and tachycardia (42.5%). Of these, 15.6% had instrumental delivery, 33.3% were treated with resuscitation, and 51.1% needed a caesarean section (22).

Immediate neonatal outcomes following deliveries complicated by NRFHRS are often severe, with significant morbidity and mortality. One of the most common adverse outcomes is low Apgar scores, particularly at the first and fifth minute's post-delivery (20). A study in South India found that among 191 women, 88.5% were classified as Category II, while 11.5% were categorized as Category III. This finding aligns with other studies, which have observed that more than 80% of cardiotocography (CTG) patterns during labor fall into Category II, and only 16% of fetuses maintain a Category I pattern until delivery. Among the 169 mothers with Category II FHR patterns, 4.2% of babies experienced adverse neonatal outcomes, whereas 40.9% of babies born to mothers with Category III FHR patterns had poor neonatal outcomes. The need for cord pH testing in babies born depressed at birth and with low Apgar scores was 6.7% for those with Category II tracing and 50% for those with Category III tracing. Furthermore, the rate of cesarean sections differed significantly between the two categories, with 33.7% of patients with Category II and 65.4% with Category III FHR patterns requiring a caesarean section (21).

An investigation conducted in Uganda stated that out of 106 patients who had unfavorable outcomes, 73 (67.2%) were admitted to the NICU, 63 (23.8%) had a low Apgar score, 30 (11.3%) had a fresh stillbirth, and 18 (6.8%) had early-onset newborn infections. With 6 occurrences (2.3%), early newborn fatalities were the least common. (35)

A study in Kenya found that 40% of neonates delivered after NRFHRS had low Apgar scores, indicating immediate neonatal distress (22). Additionally, several African studies report that between 30% and 50% of neonates born under these conditions require resuscitation (8). The need for NICU admission is another common outcome. A study in South Africa found that 25% of infants born following NRFHRS were admitted to intensive care due to complications like respiratory distress and hypoxia (9).

Byiringiro (2019) reported that the prevalence of cesarean sections performed due to non-reassuring fetal status was 17.5%. Persistent fetal bradycardia was identified as the most common fetal heart rate abnormality, accounting for 53% of cases. The target decision-to-delivery interval of 30 minutes was achieved in 38.6% of the cases. The majority of neonates (88.1%) had reassuring Apgar scores at 5 minutes. However, 17.2% required ventilation at birth, 12.9% were admitted to the NICU, and 1.1% resulted in stillbirths. Meconium was present in 11.3% of the cases. Fetal tachycardia and bradycardia were significantly linked to the need for neonatal ventilation ($p = 0.014$, $p = 0.04$). Additionally, fetal tachycardia and decelerations were associated with lower 5-minute Apgar scores ($p = 0.028$, $p = 0.004$) (23).

In many African countries, delays in recognizing and managing NRFHRS significantly contribute to adverse neonatal outcomes. Limited access to skilled birth attendants, inadequate fetal monitoring, and delays in initiating cesarean sections or instrumental deliveries often worsen fetal distress (12). A study in Nigeria revealed that only 40% of women with NRFHRS received timely intervention, which led to higher neonatal morbidity rates (24). Furthermore, the lack of adequate neonatal resuscitation equipment and trained personnel, particularly in rural and underserved areas, exacerbates the risk of poor neonatal outcomes (22).

A study conducted in South Gondar Zone found that more than one-third (37.3%) of neonates and approximately one-third (30.5%) required ventilation and NICU admission after delivery, respectively. Additionally, 4.8% of fetuses in this study were stillborn after developing NRFHRSS. Overall, nearly half (46.8%) of neonates who were born after NRFHRS had unfavorable neonatal outcomes. In this study, 37.3% of neonates required immediate ventilation following delivery due to NRFHRS (25). An institutional based case-control study in North West, Ethiopia on the determinant of adverse early neonatal outcomes following emergency cesarean section revealed that an indication of NRFHRS was 5.2 times more adverse newborn outcome compared to counter one (AOR=5.2, 95%CI: 1.1, 26) (26).

2.2. Factors Associated with NRFHRS

2.2.1. Socio-Demographic Factors

Research from various studies highlights the significant role of socio-demographic factors in predicting non-reassuring fetal heart rate (NRFHRS). Key predictors consistently identified include maternal parity, anemia, and referral status. A study in South Gondar indicated that primigravid women were 86% more likely to experience NRFHRS compared to multigravid women (25). Furthermore, primigravida women were nearly three times more likely to experience NRFHRS than those with prior pregnancies. This increased risk is linked to complications such as preeclampsia, prolonged labor, and other obstetric issues that negatively affect both maternal and fetal conditions, leading to abnormal fetal heart rate patterns. Additionally, the anxiety and stress experienced by primigravida women, being new to the labor process, can disrupt blood flow to the fetus, causing uterine hypoxia (27).

Among the factors linked to poor neonatal outcomes among emergency obstetric referrals during labor at Jinja Regional Referral Hospital, women over 35 years of age were 1.72 times more likely than those under 35 to experience poor neonatal outcomes (p-value<0.05) (20).

Anemia is another significant factor, with women suffering from anemia being 4.59 times more likely to experience NRFHRS compared to those without anemia. Moreover, women referred from other health facilities had a 95% higher likelihood of experiencing NRFHRS than those who came directly from home (27). A study by Misba S. (2023) further corroborated this, finding that mothers referred from other healthcare settings had a 4.2 times higher likelihood of experiencing NRFHRS (AOR = 4.2, 95% CI = 1.087, 5.906) (28). In South Omo Zone, the prevalence of NRFHRS was 63% lower among non-referred mothers compared to those who were referred (29). Similarly, a study in Finote Selam revealed that mothers referred from other health facilities were nearly three times more likely to develop NRFHRS than those directly admitted to the hospital. Factors such as delays in transportation, lack of intrauterine resuscitation before or during referral, and poor health-seeking behavior, especially among mothers referred from rural centers, could contribute to this increased risk (27).

2.2.2. Antepartum Factors of NRFHRS and Adverse Neonatal Outcome

According to the American Pregnancy Association (2024), various factors can contribute to fetal distress or non-reassuring fetal status (NRFHRS). These factors include anemia (the most common obstetric condition associated with NRFHRS), oligohydramnios (low amniotic fluid), pregnancy-induced hypertension (PIH), post-term pregnancies (lasting 42 weeks or longer), intrauterine growth restriction (IUGR), and meconium-stained amniotic fluid (MSAF) (2).

According to a Ugandan tertiary hospital study, mothers who were referred with antepartum hemorrhage had a 2.48-fold higher chance of having unfavorable neonatal outcomes (p-value<0.05) and mothers who were referred with non-reassuring fetal status had a 1.90-fold higher chance of having unfavorable neonatal outcomes (p-value<0.05) than mothers who were referred without APH or non-reassuring fetal status (20).

In Africa, 24% of neonatal deaths were due to birth asphyxia and it is also a leading cause of brain damage. Factors related to birth asphyxia can arise in the antepartum and intrapartum periods. Premature rupture of membrane (PROM), prolonged labor, meconium stain-amniotic fluid, and fetal distress were intrapartum factor (30).

A case control study conducted in Gamo Gofa revealed that rural residence, multigravida, being a male baby and lack of knowledge about danger signs during pregnancy and labor was a factor which had associations with adverse birth outcomes (17). Besides, a study done in 5 selected hospitals of Mekelle city stated that rural place of residence (AOR = 5.992 to 95% CI [1.011-35.809]), low monthly income (AOR = 4.364), middle monthly income (AOR = 4.364), and emergency caesarean section (AOR = 9.969) were the potential risk factors for adverse neonatal outcomes (31).

The research done on the prevalence of adverse birth outcome and associated factors among women who delivered in Hawassa town governmental health institutions indicated that Presence of Previous History of adverse pregnancy outcome, on ante-natal attendance, presence of cat in the house, presence of chronic disease/s, younger mother and Poor Knowledge of preconception care were significant predictor of adverse pregnancy outcome (18).

A case control study conducted in Debre Tabor town, Northwest Ethiopia, found that older maternal age, low education, and early sexual debut were linked to worse pregnancy

outcomes. Mothers aged 35 to 44 years had an adjusted odds ratio (AOR) of 2.54 (95% CI 1.27, 5.06); those aged 55 years and older had an AOR of 4.18 (95% CI 1.73, 9.13). Both groups were more likely to experience adverse pregnancy outcomes compared to mothers aged 24 years and under. Additionally, low education played a role in negative pregnancy outcomes. Mothers with no formal education were twice as likely to face these issues, with an AOR of 2.15 (95% CI 1.41, 2.81). Those with only primary education had an AOR of 1.6 (95% CI 1.06, 4.6) compared to mothers with higher education (32).

2.2.3. Intrapartum Factors of NRFHRS and Adverse Neonatal Outcome

Research has shown that the likelihood of NRFHRS is 3.3 times higher among mothers who undergo labor induction or augmentation compared to those experiencing spontaneous labor. Specifically, the odds are 4.2 times greater with induction (AOR = 4.2, 95% CI = 1.65, 8.099) and 3.33 times higher with augmentation (AOR = 3.33, 95% CI = 1.408, 6.22). Additionally, NRFHRS is 3.59 and 4.5 times more prevalent among mothers with Grade 2 and 3 meconium- stained amniotic fluid, respectively (28). A study in Gonder Zone found that women who had induced labor were 3.78 times more likely to experience NRFHRS compared to those with spontaneous labor (25). Similarly, mothers who underwent labor augmentation were three times more likely to develop NRFHRS than those who did not (27). The use of oxytocin in such cases increases the risk by intensifying uterine contractions, which reduces uterine blood flow and can result in hypoxemia and fetal heart rate disturbances.

An institutional based case-control study in North West, Ethiopia on the determinant of adverse early neonatal outcomes following emergency cesarean section revealed that Non-reassuring fetal heart rate was the most common indication for an emergency cesarean section, accounting for 37.4% of cases (26).

In South Gonder Zone, the risk of NRFHRS was found to be 14 times higher in women with MSAF than those with clear amniotic fluid (25). Similarly, in South Omo Zone, NRFHRS prevalence was 89% higher in mothers with MSAF compared to those with clear amniotic fluid (29). Foetuses with MSAF were also found to be six times more likely to develop NRFHRS than those with clear amniotic fluid in a study conducted at Finote Selam Hospital. The passage of meconium is often associated with fetal hypoxic stress, which increases colonic activity and peristalsis, leading to meconium release (27).

Other factors influencing NRFHRS include prolonged rupture of membranes, which increases the likelihood by 11.7 times compared to those without this condition, and low birth weight, which carries a 5.08 times higher risk of NRFHRS (25). A study in South Gonder found that NRFHRS was 57% less common among mothers aged 20–34 compared to those under 20. In South Omo Zone, mothers who did not attend antenatal care were 3.46 times more likely to experience NRFHRS than those who did, and mothers with obstetric complications had a 2.71 times greater chance of having fetal heart rate abnormalities compared to those without complications. The study also revealed that fetuses with a nuchal cord had a 1.70 times higher prevalence of NRFHRS than those without a nuchal cord (29).

Research conducted in Gonder university hospital revealed that women having history of either preterm delivery or small baby (AOR: 3.1, 95% CI 1.1- 8.4) were more likely to have preterm births. Similarly, history of delivering preterm or small baby (AOR: 8.4, 95% CI 2.4-29.4), preterm birth (AOR: 5.5, 95% CI 2.6- 11.6) and hypertension (AOR: 5.8, 95% CI 1.8-19.6) were associated factors with low birth weight. Ante partum hemorrhage (AOR: 8.43, 95% CI 1.28- 55.34), hypertension (AOR: 9.5, 95% CI 2.1-44.3), history of perinatal death (AOR: 13.9, 95% CI 3.3- 58.5) and lack of antenatal care follow up (AOR: 9.7, 95% CI 2.7 - 35.8) were significantly associated with still birth (15).

2.2.4. Conceptual frame work

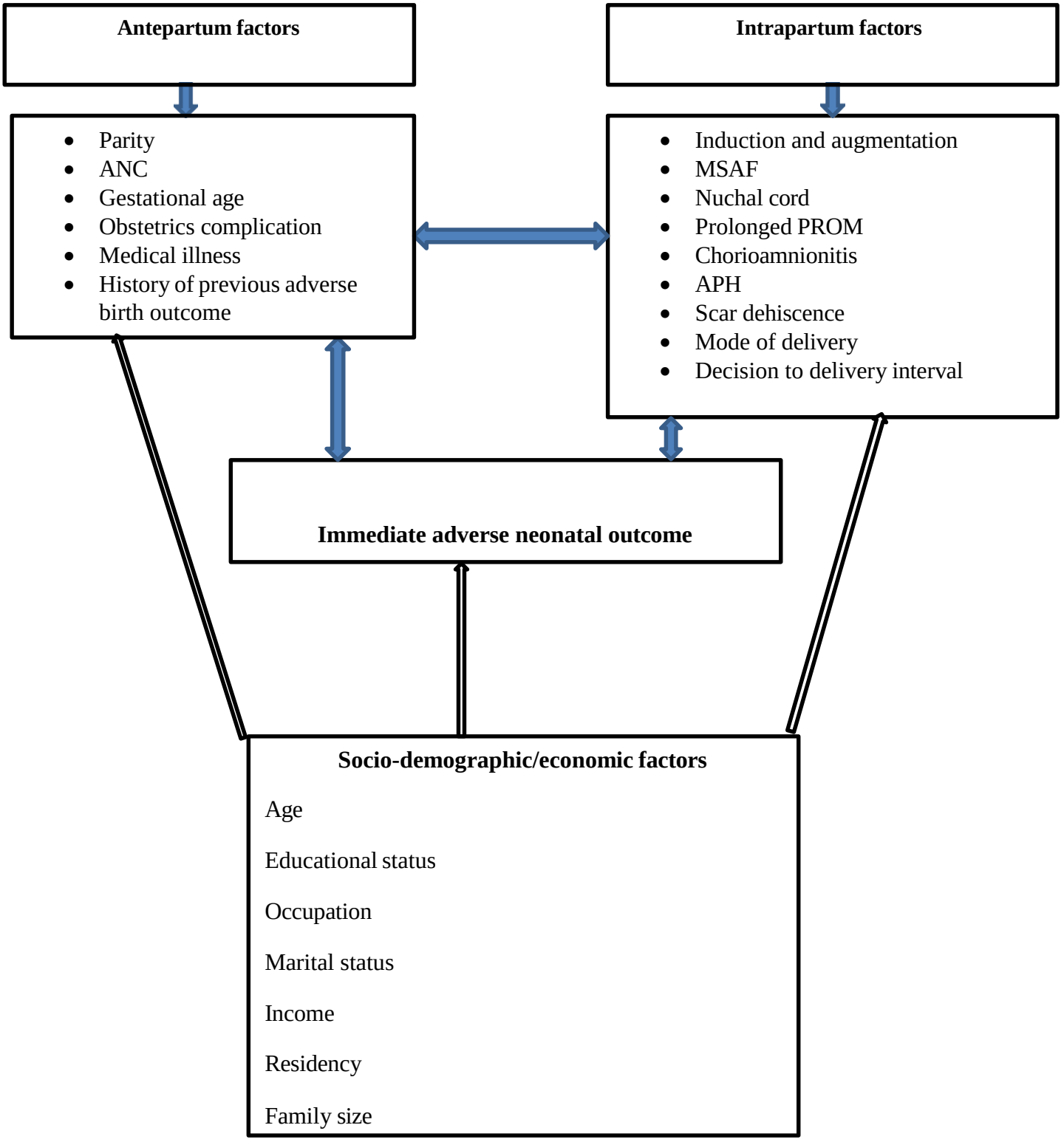

Figure 1: Conceptual framework on factors associated with immediate neonatal outcome among delivery of NRFHRS obtained by reviewing different literatures *(11,17–20,26,31)*

3. OBJECTIVES

3.1. General objectives

1. To assess the immediate adverse neonatal outcomes and associated factors among deliveries complicated by Non-Reassuring Fetal Heart Rate Status at public Health facilities in Asela town, Ethiopia from October to December , 2025.

3.2. Specific objectives

1. To determine the magnitude of immediate adverse neonatal outcomes among deliveries with Non-Reassuring Fetal Heart Rate Status at public Health facilities in Asela town, Ethiopia
2. To identify the factors associated with immediate adverse neonatal outcomes among deliveries with Non-Reassuring Fetal Heart Rate Status at public Health facilities in Asela town, Ethiopia

4. METHODS AND MATERIALS

4.1. Study area

This study was conducted at Asella Referral and Teaching Hospital (ARTH), Asella Health Center (AHC) and Halila Health Center (HHC), Asella, Ethiopia. These health facilities are located in Asella town, approximately 175 km southeast of Addis Ababa, the capital city of Ethiopia. Arsi University was established on October 15, 2014, as one of the third-generation public universities in Ethiopia. ARTH serves as the only referral hospital in the Arsi zone, with a catchment population of about 3.5 million people.

The hospital has a total capacity of approximately 310 beds distributed among four major inpatient departments: Internal Medicine, Surgery, Obstetrics and Gynecology, and Pediatrics. Within the Department of Obstetrics and Gynecology, the gynecology ward is equipped with about 24 beds, while the obstetrics ward, which includes prenatal, postoperative, and labor wards, has approximately 36 beds. Asella Referral and Teaching Hospital provides a broad range of healthcare services, including general outpatient services, emergency outpatient care, an adult intensive care unit, maternal and child health services, voluntary counseling and testing, antiretroviral therapy services, and both major and minor operating rooms.

The Department of Obstetrics and Gynecology offers comprehensive gynecologic and obstetric care, including 24-hour delivery and abortion services and specialized care for high-risk pregnancies. These services are delivered by a multidisciplinary team consisting of 14 consultant obstetricians and gynecologists, two urogynecology subspecialists, 29 resident physicians, three general practitioners, and 47 midwifery nurses. At Asella health center there are about 62 health professional out of them 7 midwife ,01 radiographer working on obstetric ultrasound and one emergency surgeon similarly man power at HHC about 51 health professional out of them 51 midwife 01 emergency surgeon at both health centers were emergency caesarean section service given in collaboration with Asella referral and teaching hospital

This skilled workforce supports continuous, high-quality maternal and reproductive health services for a large and diverse patient population. The hospital manages an average of 475 deliveries per month (ranging 460–579). Over the last three months, 370 emergency cesarean deliveries or operative vaginal deliveries were performed due to NRFHRS**.** Around 126

emergency CD at AHC and 55 CD at HHC were performed for the last three month and 96 and 35 CD for indication of NRFHRS, respectively (33).

4.2. Study design and period

A Facility-based cross-sectional study was conducted on women who deliver with NRFHRS at ARTH, AHC and HHC from October to December 2025.

4.3. Source Population

All mothers who give birth at ARTH, AHC, and HHC regardless of the mode of delivery.

4.4. Study Population

All mothers who delivered at ARTH, AHC, and HHC during the study period and diagnosed with Non-Reassuring Fetal Heart Rate (NRFHRS) during labor.

4.5. Inclusion criteria

- ✓ All laboring mothers diagnosed with NRFHRS during labor.

4.6. Exclusion criteria

Laboring mothers was excluded from the study if they meet any of the following conditions:

- Diagnosed with intrauterine fetal death (IUFD) at or before admission.
- Mothers with incomplete medical records.
- Diagnosed with gross congenital fetal anomalies, such as:
  - Anencephaly
  - Spina bifida
  - Hydrocephalus
- Cases where NRFHRS is not the indication for delivery intervention.

4.7. Sample size determination

Sample size was determined by using a single population proportion formula by taking 95% Confidence interval and margin of error is 0.05.Proportion of NRFHRS 21.16% at south Gondar zone public hospitals (27).

The sample size was determined using the following single population proportion formula

$$n = Z\alpha^2 \, p(1-p) / d^2$$

Where n=sample size,

Z=Z statistics for 95% level of confidence (1.96),

P=prevalence of the outcome (0.2116), and

d=margin of sampling error to be tolerated (0.05). $n = Z\acute{a}^2 p(1-p)/d^2 = (1.96)^2 \times .2116(1-0.2116)(.05)^2$ =256 mothers

By adding 10% non-response rate, the final sample size was -282

4.8. Sampling techniques/ procedure

Among government health facilities in Asella town, all health facilities were included in the study. Sample sizes were allocated to health centers using proportionate probability techniques. The study was conducted in each selected health facilities to find and register those women who were eligible according to inclusion criteria. Thus, the total of 282 participants was selected using systematic random sampling. Over the last three months, 370 emergency cesarean deliveries or operative vaginal deliveries were performed due to NRFHRSS at ARTH. Around 126 emergencies CD at AHC and 55 CD at HHC were done for the last three month and 96 and 35 CD were for indication of NRFHRS, respectively. So, the total numbers of CS deliveries with indication of NRFHRS in three health facilities over the past three month were 501 and the sampling interval was 1.78≈2. . The first subject was selected by systematic random sampling method among the first 2 women. Thereafter, every 2nd woman was enrolled based on the eligibility criteria.

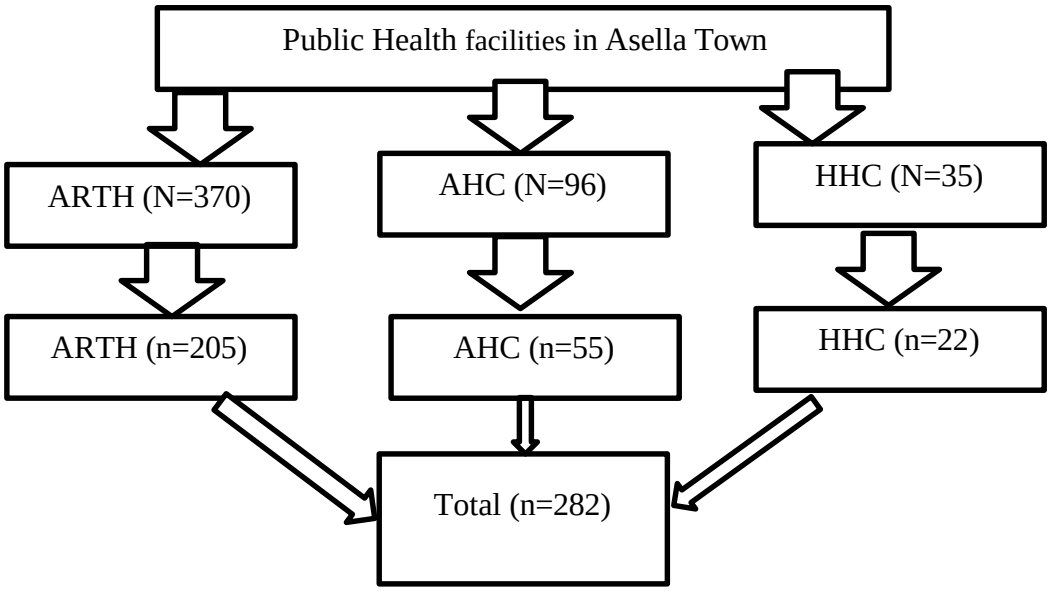

Figure 2: Proportionate fraction of sample size of each public health facilities of Asella Town, 2025 (n = 282)

4.9. Operational definitions

Non-reassuring fetal heart rate status (NRFHRS): Considered when one or more of the following (Tachycardia or bradycardia for more than 10 minutes), reduced FHR variability, decelerations and absence of accelerations) occur in the intrapartum period (29).

A baseline fetal heart rate status: normal between 110 to 160 bpm, Tachycardia >160 bpm bradycardia <110 bpm (25).

Immediate adverse neonatal out comes of NRFHRS: is defined as the neonate experienced at least one of the complications includes (APGAR<7 score at 1st minute and 5th minutes, still birth, need for ventilation (asphyxia) and needs for neonatal NICU admission, fetal death during intrapartum, RDS, neonatal jaundice, neonatal sepsis), within 24h after delivery, because most morbidity and mortality for both maternal and neonatal occurs with in this period of time.(25,34,35).

The participants were assessed for the presence of immediate adverse neonatal out comes with the option of yes or no. Yes response received a sore of "1", and No response received a score of "0".

4.10. Study Variables

4.10.1. Dependent variable

- ✓ Immediate adverse neonatal outcome

4.10.2. Independent variables

- ✓ Sociodemographic characteristics (maternal residence, age, and marital status)
- ✓ Antepartum findings (suspected or confirmed fetal growth restriction, amniotic fluid disorders, being primigravida, antepartum hemorrhage, and preeclampsia),
- ✓ Intrapartum findings (referral from outset, oxytocin induction/augmentation, abnormal vaginal bleeding in labor, MSAF and prolonged ROM).

4.11. Data Collection Tools, personnel and Procedure

A structured and pretested questionnaire, adapted from various relevant literature sources (21, 22, 24, 25, 27, 29), was used for data collection. The questionnaire is divided into three parts:

- **Part 1:** Sociodemographic characteristics of the mothers (e.g., residence, age, marital status).
- **Part 2:** Antepartum profile (e.g., ANC follow-up, number of pregnancies, type of pregnancy, ultrasound findings, maternal medical illnesses, obstetric history,

hematocrit levels, and blood group).

- **Part 3:** Intrapartum profile of mothers and fetuses (e.g., mode of admission, gestational age, fetal presentation, onset and duration of labor, fetal heart rate on admission, stage of labor at admission and at detection of NRFHRS, and intrapartum complications)

All medical interns, residents, midwives, and clinical nurses were informed to report to the principal investigator once a mother is admitted for delivery.

Data collection was performed by three trained BSc nurses assigned to the postnatal and postoperative wards from October to December 2025. Additionally, a face-to-face exit interview, maternal and neonatal chart review and standard checklist were conducted with mothers after delivery to complete the data collection process.

4.12. Data quality assurance

Orientation of 1 day was given to data collectors before the actual data collection. The questionnaire was pretested in Kersa primary hospital for around 14 mothers two weeks prior to data collection to see for the accuracy of responses, language clarity, and appropriateness of the tools. Interview questions was revised, edited, and those found to be unclear was modified after pre-test is conducted. The data collectors was closely monitored by the principal investigator daily during the process and collected data was sent to the investigator on daily basis with electronic during data collection. The questionnaire was prepared in English then translated into local language (Afan Oromo) then back to English for consistency.

4.13. Data processing and analysis

Data were entered into Kobo Collect and then exported to Statistical Package for the Social Sciences (SPSS) version 25 for analysis. Prior to analysis, data cleaning was performed to check for completeness and consistency. Descriptive statistics was used to summarize the data: frequencies and percentages for categorical variables, and means with standard deviations for continuous variables. Binary logistic regression analysis was conducted to examine associations between independent variables and immediate adverse neonatal outcomes. Both Crude Odds Ratios (COR) and Adjusted Odds Ratios (AOR) with 95% confidence intervals (CI) were calculated. Those variables with p-values of less than 0.2 in the bivariable analysis were entered into the multivariable analysis. In turn, those variables with a p-value of less than 0.05 in multivariable analysis were considered as significant predictors of immediate adverse neonatal outcomes.

4.14. Ethical considerations

Ethical clearance was obtained from Arsi University, College of Health Sciences, Institutional Review Board and letter of permission for data collection was obtained from department of gynecology and obstetrics. The purpose of the study was explained for all participants and oral consent was obtained from the study subjects to participate in the study. Moreover, participants who did not want to participate or withdraw at any stage of the study were allowed without restrictions. Confidentiality was maintained at all levels of the study by avoiding the name of participants and using codes to identify them.

5. RESULTS

5.1. Socio-demographic characteristics

In the current study, 282 mothers were participated with the response rate of 100%. The participants predominantly fell within the age range of 21–34 years (80.9%), followed by ≤ 20 (14.9%). Most women were married (90.4%). In terms of religion, more than half of the participants were Orthodox (52.8%), followed by Muslim (42.2%). The majority of participants belonged to the Oromo ethnic group (77.66%). More than half of the participants resided in urban areas (51.1%).

Educational attainment among mothers varied, with 35.6% having completed primary school and 31.2% having ability to read and write. Fathers' education levels were slightly higher, with 37.6% having completed primary school. In terms of occupation, most of mothers were house wives (80.1%). Fathers were mainly farmers (44.7%), government employees (22%), and merchants with making up 28.6%. Household income was predominantly found within the low-income group (80.9%) (Table 1).

Table 1: Sociodemographic characteristics of the respondents at public health facilities in Asela town, Ethiopia. 2025

Variables	**Category**	**Frequency**	**Percentage**
Mothers age (n=282)	≤ 20	42	14.9
	21-34	228	80.9
	≥ 35	12	4.3
Marital status (n=282)	Married	255	90.4
	Single	20	7.1
	Divorced	7	2.5
Religion (n=282)	Muslim	119	42.2
	Orthodox	149	52.8
	Protestant	14	5
Ethnicity (n=282)	Amhara	58	20.57
	Gurage	5	1.77
	Oromo	219	77.66
Place of residence (n=282)	Urban	144	51.1
	Rural	138	48.9
Mothers education (n=282)	Unable to read and write	19	6.7
	Able to read and write	88	31.2
	Primary school	101	35.6
	Secondary school	57	20.2
	College and above	17	6
Husbands education (n=255)	Able to read and write	43	16.9
	Primary school	96	37.6
	Secondary school	55	21.6
	College and above	61	23.9

Mothers occupation (n=282)	Housewives	226	80.1
	Merchant	21	7.4
	Farmer	7	2.5
	Government employee	17	6
	Daily laborer	11	3.9
Husbands occupation (n=255)	Merchant	73	28.6
	Farmer	114	44.7
	Government employee	56	22
	Daily laborer	5	2
	Driver	7	2.7
Monthly income (n=282)	Low-income	228	80.9
	Middle-income	54	19.1

5.2. Antepartum Characteristics of the Respondents

A total of 282 pregnant women who delivered at public health facilities in Asella town, Ethiopia, in 2025 were included in the study. Regarding parity, more than half of the participants were Primiparous 163 (57.8%), followed by multiparous women 90 (31.9%). Almost all respondents, 269 (95.4%), had attended antenatal care (ANC) during the current pregnancy. Among those who had ANC follow-up, 123 (45.7%) attended 1–3 contact, 131 (48.7%) attended 4–7 contact, and only 15 (5.6%) had eight or more ANC contact. A history of bad obstetric outcomes was reported by 20 (7.1%) participants, of whom 15 (5.3%) experienced early neonatal loss and 5 (1.8%) had a history of stillbirth.

Regarding obstetric history, 31 (11.0%) of the women had a previous cesarean section scar. Only 7 (2.5%) participants reported a history of medical illness, with asthma accounting for 5 (1.8%) cases and hypertension for 2 (0.7%) cases. Most pregnancies were singleton 277 (98.2%). One-third of the respondents, 96 (34%), developed at least one complication during the current pregnancy. Among these complications, preeclampsia was the most common, occurring in 45 (46.9%) cases, followed by premature rupture of membranes (PROM) in 24 (25.5%). In terms of Rh status, the majority of participants were Rh-positive 263 (93.3%). With respect to haematocrit levels, 190 (67.4%) of the respondents had a haematocrit value greater than 33% (Table 2).

Table 2: Antepartum Characteristics of the respondents in public health facility of Asela town, Ethiopia. 2025

Variables	Category	Frequency	Percentage
Parity (n=282)	Nulliparous	29	10.3
	Primiparous	163	57.8
	Multiparous	90	31.9
ANC follow up (n=282)	Yes	269	95.4

	No	13	4.6
Number of ANC contact (n=269)	1-3 contact	123	45.7
	4-7 contact	131	48.7
	≥ 8 contact	15	5.6
Past bad obstetric history (n=282)	Yes	20	7.1
	No	262	92.9
Types of past bad obstetric history (n=20)	Early neonatal lose	15	5.3
	Still birth	5	1.8
Previous C/S scar	Yes	31	11
	No	251	89
History of medical illness (n=282)	Yes	7	2.5
	No	275	97.5
Types of medical illness	Asthma	5	1.8
	Hypertension	2	0.7
Pregnancy type	Singleton	277	98.2
	Multiple	5	1.8
Current pregnancy complication	Yes	96	34
	No	186	66
Types of current pregnancy complication (n=96)	APH	15	15.6
	PROM	24	25
	Preeclampsia	45	46.9
	Hydro-amnion	8	8.3
	Others	4	4.2
RH status	Positive	263	93.3
	Negative	19	6.7
Haematocrit level	<33	92	32.6
	≥ 33	190	67.4

5.3. Intrapartum characteristics of the respondents

Among the 282 deliveries, most women delivered at term (37–42 weeks), accounting for 245 (86.9%), while 34 (7.4%) were preterm and 16 (5.7%) post-term. A substantial proportion of participants were referrals from other health facilities (48.9%). Labor commenced spontaneously in 177 (62.8%) women, whereas 84 (29.8%) underwent induction and 21 (7.4%) had augmented labor.

Cephalic presentation predominated (96.1%). At admission, the majority of women were in the latent phase of the first stage of labor (89.7%), with fewer admitted in the active first stage (4.3%) or second stage (6.0%). Prolonged labor was documented in 89 (31.6%) cases. Amniotic fluid was clear in 43.6% of deliveries, while meconium-stained liquor was observed in 37.9%, predominantly grade II and III. Rupture of membranes lasting less than 12 hours occurred in 83.3% of women; however, 16.7% experienced prolonged rupture of membranes. The decision-to-delivery interval was below 30 minutes in more than half of the cases (56.7%).

Male neonates constituted 66.3% of births. Most neonates had a birth weight above 2,500 g (70.6%). Regarding mode of delivery, most women's (95%) delivered via cesarean section. Non-reassuring fetal heart rate status was more frequently characterized by tachycardia (58.9%) than bradycardia (41.1%), and was most commonly diagnosed during the latent phase of labor (72.3%). The majority of women (64.9%) had no documented intraoperative fetal complication during cesarean section; however, antepartum hemorrhage (18.4%), cephalopelvic disproportion (2.5%), nuchal cord (4.6%), cord prolapse (4.3%), chorioamnionitis (3.5%), and scar dehiscence (1.8%) were observed (Table 3).

Table 3: Intrapartum Characteristics of the respondents in public health facility of Asela town, Ethiopia. 2025.

Variables	Category	Frequency	Percentage
Gestational age (n=282)	<37 weeks	21	7.4
	37-42 weeks	245	86.9
	>42 weeks	16	5.7
Referred from other health facility (n=282)	Yes	138	48.9
	No	144	51.1
Onset and progress of labor (n=282)	Spontaneous	177	62.8
	Induced	84	29.8
	Augmented	21	7.4
Presentation (n=282)	Cephalic	271	96.1
	Breech	11	3.9
Stage of labor on admission (n=282)	LFSOL	253	89.7
	AFSOL	12	4.3
	SSOL	17	6
Duration of labor (n=282)	Prolonged	89	31.6
	Normal	193	68.4
Amniotic fluid status	Clear	123	43.6
	Meconium stained	107	37.9
	Blood and intact	52	18.4
Grade of meconium (n=107)	Grade I	7	2.5
	Grade II	79	28
	Grade III	21	7.4
Duration of ROM	<12 hrs.	235	83.3
	≥12 hrs.	47	16.7
Decision to delivery time	≤ 30 minute	160	56.7
	> 30 minute	122	43.3
Neonatal sex	Male	190	66.2
	Female	97	33.8
Birth weight	<2500 gram	84	29.3
	2500-3999 gram	202	70.7
Mode of delivery	CS	268	95
	Instrumental	14	5
NRFHRS status	Bradycardia	116	41.1

	Tachycardia	166	58.9
Stage of labor at the Dx of NRFHRS	LFSOL	204	72.3
	AFSOL	47	16.7
	SSOL	31	11
Intra partum and intraoperative complication during C/S	No	183	64.9
	APH	52	18.4
	CPD	7	2.5
	Nuchal cord	13	4.6
	Cord prolapse	12	4.3
	Chorioamnitis	10	3.5
	Scar dehiscence	5	1.8

The prevalence of immediate adverse neonatal outcome among neonates delivered at public health facilities in Asella town was 30.9% (87) (CI: 25.5%, 36.5%) out of them ARTH, AHC and HHC which accounts 29.4% (83), 1.1 %(3) and 0.4%(1) respectively. The remaining 69.1% (195) of neonates did not experience any immediate adverse neonatal outcome (Figure 3). Among those affected, the most common adverse outcome was admission to the neonatal intensive care unit (NICU), which occurred in 30.9% of cases. Respiratory distress was the second most frequent complication, affecting 13.8% of neonates. Neonatal sepsis, low APGAR scores (<7) at 5 minutes, HIE, and early neonatal death occurred were observed in 12.4%, 5.3%, 5.3%, and 3.2% of neonates, respectively (Table 4).

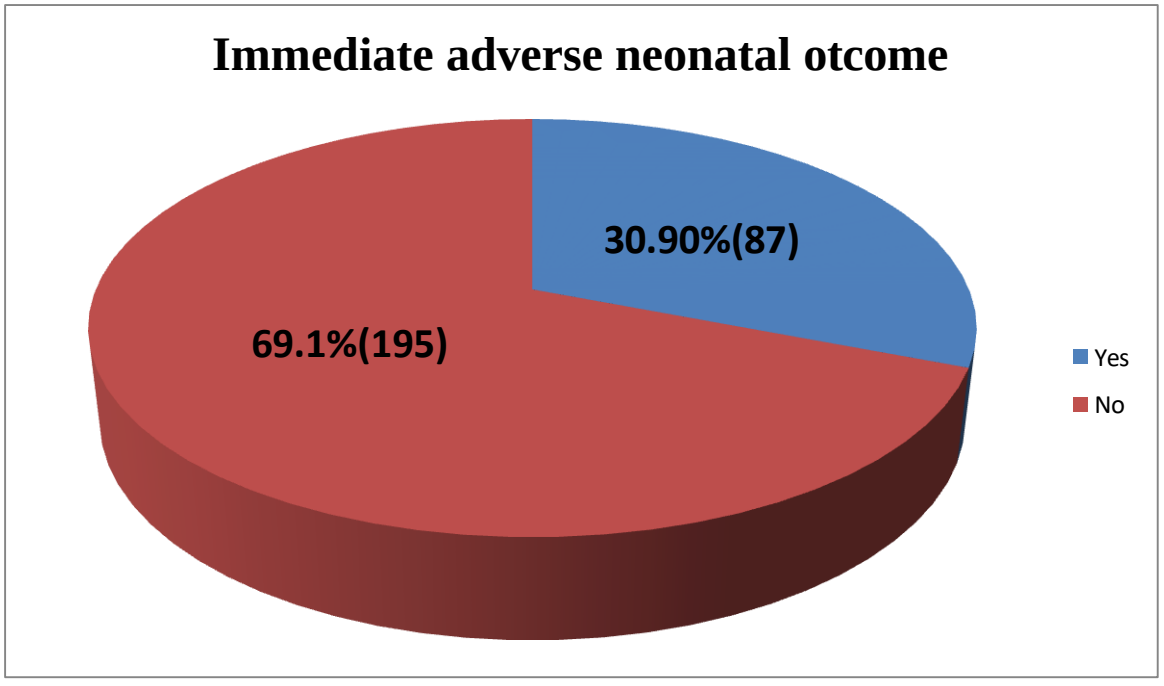

Figure 3: Prevalence of immediate adverse neonatal outcome

Table 4: The most common immediate adverse neonatal outcomes

Variables	Category	Frequency	Percentage
5th minute APGAR score	<7	15	5.3
	>=7	72	25.5
NICU admission	Yes	87	30.9
Early neonatal death	Yes	9	3.2
	No	78	27.7
Respiratory distress (Ventilation needed)	Yes	39	17.1
	No	48	13.8
Hypoxic-ischemic encephalopathy	No	72	25.5
	Stage I	6	2.1
	Stage II	7	2.5
	Stage III	2	0.7
Neonatal sepsis	Yes	35	12.4
	No	52	18.5

5.4. Factors associated with immediate adverse neonatal outcome during two variables analysis

Bivariate logistic regression analysis was used to select candidate factors for multivariate analysis. Age, parity, past bad obstetric history, past CS scar, Gestational age, referral from other health facility, presence of current pregnancy complication, stage of labor progress, neonatal sex, stage of labor on admission, Duration of ROM, Amniotic fluid status, types of NRFHRS, and Stage of labor at the diagnosis of NRFHRS were associated in the bivariate analysis.

Table 5: Bivariate analysis of factors associated with immediate adverse neonatal outcome, Ethiopia, 2025 (n = 282)

Variables	**Category**	**Immediate adverse neonatal outcome**		**COR (95% CI)**	**P value**
		No (%)	**Yes (%)**		
Age	≤ 20	26(9.2%)	16(5.7%)	1.61(0.81, 3.2)	**0.17**
	≥ 35	4(1.4%)	8(2.8%)	5.24(1.52, 18.01)	**0.009**
	21-34	165(58.5%)	63(22.5%)	1	
Residence	Urban	104(36.9%)	40(14.2%)	1	
	Rural	91(32.3%)	47(16.7%)	1.34(0.81, 2.23)	0.25

Mother education Status	Unable to read and Write	9(3.2%)	10(3.5%)	8.33(0.48, 16.9)	0.56
	Able to read and write	55(19.5%)	33(11.7%)	4.5(0.97, 20.9)	0.235
	Primary school	71(25.2%)	30(10.6%)	3.17(0.68, 14.72)	0.341
	Secondary school	45(16%)	12(4.3%)	2(0.4, 9.98)	0.221
	College and above	15(5.3%)	2(0.7%)	1	
Father Education Status	Able to read and write	25(9.8%)	18(7.1%)	2.21(0.95, 5.12)	0.26
	Primary school	58(22.7%)	38(14.9%)	2.01(0.98, 4.1)	0.32
	Secondary school	47(18.4%)	8(3.1%)	0.52(0.2, 1.35)	0.46
	College and above	46(18%)	15(5.9%)	1	
Income	Low-income	153(54.3%)	75(26.6%)	1.72(0.85, 3.45)	0.213
	Middle-income	42(14.9%)	12(4.3%)	1	
Parity	Nulliparous	19(6.7%)	10(3.5%)	0.87(0.36, 2.08)	0.75
	Primipara	120(42.6%)	43(15.2%)	0.59(0.34, 1.02)	**0.06**
	Multipara	56(19.9%)	34(12.1%)	1	
ANC Visit	No	8(2.8%)	5(1.8%)	0.7(0.22, 2.21)	0.545
	Yes	187(66.3%)	82(29.1)	1	
Number of ANC contact	1-3 contact	73(27.1%)	50(18.6%)	1.37(0.44, 4.25)	0.59
	4-7 contact	103(38.3%)	28(10.4%)	0.54(0.17, 1.72)	0.31
	>=8 contact	10(3.7%)	5(1.9%)	1	
Past bad obstetrics hx	No	186(66%)	76(27%)	1	
	Yes	9(3.2%)	11(3.9%)	2.99(1.19, 7.51)	**0.02**
Previous CS Scar	No	179(63.5%)	72(25.5%)	1	
	Yes	16(5.7%)	15(5.3%)	2.33(1.1, 4.96)	**0.028**
Current pregnancy complication	No	136(48.2%)	50(17.7%)	1	
	Yes	59(20.9%)	37(13.1%)	1.71(1.01, 2.88)	**0.046**
Rh status	Positive	188(66.7%)	75(26.6%)	1	
	Negative	7(2.5%)	12(4.3%)	4.3(0.63, 11.3)	0.33
Haematocrit Level	>=33	132(46.8%)	58(20.6%)	1	
	<33	63(22.3%)	29(10.3%)	1.05(0.6, 1.79)	0.865
GA (in week)	< 37	4(1.4%)	17(6%)	12.3(3.98, 37.87)	**0.001**
	≥ 42	9(3.2%)	7(2.5%)	2.25(0.8, 6.28)	**0.12**
	37-41	182(64.5%)	63(22.3%)	1	
Referral from health facility	No	113(40.1%)	31(11%)	1	
	Yes	82(29.1%)	56(19.9%)	2.49(1.48, 4.2)	**0.001**
Onset of labor	Spontaneous	116(41.1%)	61(21.6%)	1	
	Induced	62(22%)	22(7.8%)	0.68(0.38, 1.2)	**0.181**
	Augmented	17(6%)	4(1.4%)	0.45(0.14, 1.39)	**0.164**
Presentation	Cephalic	190(67.4%)	81(28.7%)	1	
	Breech	5(1.8%)	6(2.1%)	2.82(0.84, 9.5)	0.235

Stages of labor on admission	LFSOL	183(64.9%)	70(24.8%)	1	
	AFSOL	8(2.8%)	4(1.4%)	1.31(0.38, 4.48)	0.67
	SSOL	4(1.4%)	13(4.6%)	8.49(2.68, 26.94)	**0.001**
Duration of labor	Normal	134(47.5%)	59(20.9%)	1	
	Prolonged	61(21.6%)	28(9.9%)	1.04(0.61, 1.79)	0.88
Amniotic fluid status	Clear	90(31.9%)	33(11.7%)	1	
	Meconium stained	63(22.3%)	44(15.6%)	1.91(1.09, 3.32)	**0.023**
	Blood stained	42(14.9%)	10(3.5%)	0.65(0.29, 1.44)	0.29
Duration of ROM	≤12 hr	156(55.3%)	79(28%)	1	
	>12 hr	39(13.8%)	8(2.8%)	0.41(0.18, 0.91)	**0.028**
Decision to delivery time	>30 minute	85(30.1%)	37(13.1%)	0.96(0.58, 1.6)	0.868
	≤30 minute	110(39%)	50(17.7%)	1	
Neonatal sex	Male	123(43.6%)	64(22.7%)	1.63(0.93, 2.85)	**0.087**
	Female	72(25.5%)	23(8.2%)	1	
Birth Weight	<2500g	57(20.2%)	26(9.2%)	0.97(0.56, 1.68)	0.911
	>=2500g	138(48.9%)	61(21.6%)	1	
Type of NRFHRS	Bradycardia	124(44%)	42(14.9%)	1.87(1.12, 3.12)	**0.016**
	Tachycardia	71(25.2%)	45(16%)	1	
Stage of labor at the Dx of NRFHRS	LFSOL	156(55.7%)	47(16.7%)	1	
	AFSOL	24(8.5%)	23(8.2%)	3.21(1.66, 6.18)	**0.001**
	SSOL	14(5%)	17(6%)	4.06(1.86, 8.84)	**0.001**
Intra-op complication during CS	No	135(47.9%)	48(17%)	1	
	Yes	60(21.3%)	39(13.8%)	1.83(0.86, 3.08)	0.27

In multivariable analysis, maternal age ≥35 years was significantly associated with increased odds of immediate adverse neonatal outcome (AOR: 15.86; 95% CI: 1.97, 52.2, p: 0.009). A past bad obstetric history was also strongly predictive, with such mothers nearly ten times more likely to have an immediate adverse neonatal complication in the current birth (AOR 9.87, 95% CI: 1.61, 34.2, p:0.013). Current pregnancy problems further heightened risk; women with pregnancy complications had nearly a threefold increase in adverse neonatal outcomes (AOR: 2.78, 95% CI: 1.22, 6.33, p: 0.015). Concerning Gestational age, preterm neonates (<37 weeks) had fifteen times higher odds of immediate adverse outcome than term infants (37–41 weeks) (AOR 15.27, 95% CI: 3.45, 38.5, p: 0.001). Referral from another health facility was another major determinant, with referred mothers experiencing about five higher odds of adverse neonatal outcomes compared with non-referred mothers (AOR 5.39, 95% CI 2.2, 13.2, p: 0.001). Meconium-stained amniotic fluid was associated with more than a fourfold increase in adverse neonatal outcome compared with clear fluid (AOR 4.37, 95%

CI 1.86, 10.24, p: 0.001). Regarding duration of rupture of membrane, mothers who had prolonged rupture of membrane (>12hrs) had 1.22(1.03, 4.24) times higher odds of developing adverse outcome as compared to rupture of membrane <12hr. The timing of non-reassuring fetal heart rate was also crucial: diagnosis during the active first stage of labor increased the odds more than fourteen (AOR 14.1, 95% CI: 4.41, 32.3, p: 0.001), and during the second stage of labor nearly fifteen (AOR 14.7, 95% CI 3.35, 29.51,p: 0.001), relative to diagnosis in the latent first stage (Table 6).

Table 6: Multivariate analysis of factors associated with immediate adverse neonatal outcome, Ethiopia, 2025 (n = 282)

Variables	**Category**	**Immediate adverse neonatal outcome**		**COR (95% CI)**	**AOR (95% CI)**	**P value**
		No (%)	**Yes (%)**			
Age	≤ 20	26(9.2%)	16(5.7%)	1.61(0.81, 3.2)	2.3(0.83, 6.37)	0.11
	≥ 35	4(1.4%)	8(2.8%)	5.24(1.52, 18.01)	15.86(1.97, 52.2)	**0.009**
	21-34	165(58.5%)	63(22.5%)	1	1	
Parity	Nulliparous	19(6.7%)	10(3.5%)	0.87(0.36, 2.08)	0.54(0.15, 1.93)	0.34
	Primipara	120(42.6%)	43(15.2%)	0.59(0.34, 1.02)	0.46(0.17, 1.21)	0.115
	Multipara	56(19.9%)	34(12.1%)	1	1	
Past bad obstetrics hx	No	186(66%)	76(27%)	1	1	
	Yes	9(3.2%)	11(3.9%)	2.99(1.19, 7.51)	9.87(1.61, 34.2)	**0.013**
Previous CS Scar	No	179(63.5%)	72(25.5%)	1	1	
	Yes	16(5.7%)	15(5.3%)	2.33(1.1, 4.96)	0.29(0.07, 1.2)	0.087
Current pregnancy complication	No	136(48.2%)	50(17.7%)	1	1	
	Yes	59(20.9%)	37(13.1%)	1.71(1.01, 2.88)	2.78(1.22, 6.33)	**0.015**
GA (in week)	< 37	4(1.4%)	17(6%)	12.3(3.98, 37.87)	15.27(3.45, 38.5)	**0.001**
	≥ 42	9(3.2%)	7(2.5%)	2.25(0.8, 6.28)	0.47(0.12, 1.9)	0.29
	37-41	182(64.5%)	63(22.3%)	1	1	
Referral from health facility	No	113(40.1%)	31(11%)	1	1	
	Yes	82(29.1%)	56(19.9%)	2.49(1.48, 4.2)	5.39(2.2, 13.2)	**0.001**
Onset of labor	Spontaneous	116(41.1%)	61(21.6%)	1	1	
	Induced	62(22%)	22(7.8%)	0.68(0.38, 1.2)	1.31(0.56, 3.05)	0.53
	Augmented	17(6%)	4(1.4%)	0.45(0.14, 1.39)	0.4(0.08, 1.75)	0.22
Stages of labor on admission	LFSOL	183(64.9%)	70(24.8%)	1	1	
	AFSOL	8(2.8%)	4(1.4%)	1.31(0.38, 4.48)	0.79(0.14, 4.44)	0.79
	SSOL	4(1.4%)	13(4.6%)	8.49(2.68, 26.94)	0.86(0.12, 6.26)	0.885
Amniotic	Clear	90(31.9%)	33(11.7%)	1	1	

fluid status	Meconium Stained	63(22.3%)	44(15.6%)	1.91(1.09, 3.32)	4.37(1.86, 10.24)	**0.001**
	Blood Stained	42(14.9%)	10(3.5%)	0.65(0.29, 1.44)	0.22(0.06, 1.79)	0.06
Duration of ROM	≤12 hr	156(55.3%)	79(28%)	1	1	
	>12 hr	39(13.8%)	8(2.8%)	0.41(0.18, 0.91)	1.22(1.03, 4.24)	**0.007**
Neonatal sex	Male	123(43.6%)	64(22.7%)	1.63(0.93, 2.85)	1.18(0.54, 2.57)	0.69
	Female	72(25.5%)	23(8.2%)	1	1	
Type of NRFHRS	Bradycardia	124(44%)	42(14.9%)	1.87(1.12, 3.12)	0.49(0.21, 1.14)	0.097
	Tachycardia	71(25.2%)	45(16%)	1	1	
Stage of labor at the Dx of NRFHRS	LFSOL	156(55.7%)	47(16.7%)	1	1	
	AFSOL	24(8.5%)	23(8.2%)	3.21(1.66, 6.18)	14.1(4.41, 32.3)	**0.001**
	SSOL	14(5%)	17(6%)	4.06(1.86, 8.84)	14.7(3.35, 29.51)	**0.001**

6. Discussion

This study aimed to assess the magnitude of immediate adverse neonatal outcome and associated among delivery after NRFHRS at public health facility in Asella town, Ethiopia. Our study revealed that the prevalence of immediate adverse neonatal outcomes among deliveries complicated with NRFHRS in public Health Facilities of Asella Town was 30.9% (95% CI: 25.5%, 36.5%). This finding is in agreement with study conducted in Hawassa, which reported adverse neonatal outcome rate were 29.7% (36). This similarity may be due to comparable institutional setups and high referral case to manage high risk cases. However, our result is higher than the study conducted in Asossa General Hospital 26.7 % (37), Butajira (18.2%) (38), Hosanna (24.5%) (39), Harari (22%) (40). This discrepancy may be due to difference in characteristics of laboring mothers and also our study included only NRFHRS while the rest included all deliveries**.** In other hand study conducted in south Gonder, nearly half (46.8%) of neonates who was born after NRFHRS had unfavorable neonatal outcomes (25). Which is higher than this study might be due to study population sociodemographic and institutional setup difference.

The present study indicate that the common immediate adverse neonatal outcomes are NICU admission (30.9%), respiratory distress (13.8%), sepsis (12.4%), low Apgar score (<7) (5.3%), HIE (5.3%), and early neonatal death (3.2%). These findings are consistent with the studies from Tigray (42), Hawassa (37), Eastern Ethiopia (41), Northern Ethiopia (43), and Uganda (44). This high rate of adverse neonatal outcomes may be due to the study population. NRFHRS is a primary indication for immediate post birth surveillance, which necessitates high NICU admission rate, due to fetal hypoxia, academia and neurological depression associated with low apgar scor, resuscitation and early neonatal morbidity. The low neonatal death rate may suggest that the study may include only those neonate followed for short period of time and not include neonate delivered intrapartum complication other than NRFHRS.

Our study revealed that advanced maternal age, bad obstetric history, and presence of current pregnancy complications, prematurity, referral status, abnormal amniotic fluid, prolonged rupture of membrane and timing of fetal distress as key determinants of immediate adverse neonatal outcomes in this setting.

Advanced maternal age was significant predictors of adverse neonatal outcomes. Mother whose age was 35 and more had nearly 16 times more likely to had an adverse neonatal

outcome compared with those aged 21–34 years. Studies from Awi Zone and Addis Ababa show advanced maternal age approximately doubles the odds of composite adverse perinatal/neonatal outcomes and increases risks of preterm birth, low birth weight, low Apgar score and perinatal death (43,45). This finding also aligns with previous studies that report increased risks of placental insufficiency, hypertensive disorders, gestational diabetes, and chromosomal abnormalities among older mothers, all of which contribute to neonatal morbidity and mortality (46). This is may be due to increased risk of preterm delivery and increased risk of intrapartum complications associated with advanced maternal age

A history of bad obstetric outcomes was another strong predictor of immediate neonatal complications. Mothers with such histories were nearly ten times more likely to experience adverse neonatal outcomes in the current pregnancy. This aligns with evidence that prior preterm birth, stillbirth, neonatal death, and recurrent abortions substantially raise risk of preterm birth and other adverse perinatal outcomes (AOR ≈3–13 in India and Israel) (47–49). Northwest Ethiopian data also show that complications or "bad obstetric history" in earlier pregnancies are linked to higher rates of low birth weight, preterm birth and low Apgar scores (43). This may be because of some bad obstetric condition were recurrent. This association reinforces the importance of contact (positive maternity care) based current antenatal surveillance for early detection of problems in those women's with previous bad obstetric outcomes.

Pregnancy complications during the current gestation were associated with nearly a threefold increase in adverse neonatal outcomes. Similar findings have been reported in studies in Ethiopian(Awi Zone,East Gojjam and Ayder hospital) and study done in Israel even though the study design were different where hypertensive disorders, diabetes, bleeding, and infections elevate risks of preterm birth, low birth weight, and NICU admission (43,49,50,51). This supports the biological plausibility that placental dysfunction, fetal growth restriction, and preterm delivery drive immediate adverse neonatal outcome. Our study association is comparable to prior reports.

Gestational age emerged as one of the most influential determinants, with preterm neonates exhibiting fifteen higher odds of immediate adverse outcomes compared with term infants. This finding is in strong agreement with study done in America and Italy evidence identifying prematurity as a leading cause of neonatal morbidity and mortality due to respiratory distress and sepsis (51, 52). The extremely high compared with some population studies likely reflects that immediate adverse neonatal outcome in the study is dominated by NICU

admission, respiratory distress and sepsis among deliveries complicated by NRFHRS and also significant number of outcome where preterm neonate. This may be due to ante partum complication associated with pregnancy result in preterm deliveries and also might be due to suboptimal dating pregnancy result misclassified as preterm.

The current study also stated that mother, who referral from another health facility with NRFHRS has the odd is fivefold high risk of developing adverse neonatal outcomes as compared to others. This result is consistent with a study conducted in six hospital of Amhara region which revealed that mother who referred from rural health facility are at high risk of developing adverse neonatal out comes (54). This may be due to referral delays, lack of access transportation, lack of intrauterine resuscitation and poor communication between the health facilities, result in delay in interventions.

The meconium present in the amniotic fluid is associated with an increased incidence of complications in the neonate by more than four times the normal in relation to unfavorable outcomes. As suspected, it correlates with fetal distress, lack of oxygen, and meconium aspiration syndrome. Meconium-stained amniotic fluid is associated with approximately two- to three-fold higher risks of low Apgar scores, birth asphyxia, neonatal sepsis, NICU admission, and early neonatal death compared with clear amniotic fluid, in both Ethiopian and international studies (54–57)**.** The study indicate, among deliveries complicated with NRFHRS there is significant number of laboring mothers have intrapartum complication such as meconium stained amniotic fluid. Our finding correlate with different study conducted in Ethiopia and the effect may be due to the cause and effect relationship between the MSAF and NRFHRS.

With regard to the rupture of membranes, this study found that rupture for more than 12 hours had more association with increased adverse neonatal outcomes. This is consistent with A research from Uganda and two from Ethiopia reported that the risk of neonatal sepsis, near-miss, and mortality is elevated 3 to 10 times for rupture durations of 18 hours or more (44,58,59).This is may be due to increased risk intaamniotic infection result in neonatal sepsis . Furthermore, the timing of non-reassuring fetal heart rate patterns was critical; diagnosis during the active first stage or second stage of labor significantly increased the risk of adverse outcomes compared with detection during the latent phase. This finding aligns with prior studies demonstrating that late recognition of fetal compromise limits the window for effective intervention (60). This is may be due to referral institution delay from other

health facility, lack of transportation accessibility and constraints in intra partum monitoring capacity and also lack of man power.

Strength of the study

- ✓ The primary strength of this research lies in its high clinical relevance, as it directly addresses the critical window of labor where fetal heart rate patterns become non-reassuring.
- ✓ Furthermore, the identification of referral status as a key risk factor highlights a systemic bottleneck, providing a clear roadmap for improving the regional referral network to save newborn lives.

Limitation of the study

- ✓ Due to the cross-sectional study design, the cause and effect relationship were not seen. Additionally, the scope was limited to immediate outcomes, meaning the research does not account for early neonatal deaths or long-term complications that occur after the initial hospital stay.
- ✓ Finally, because the study was restricted to public health facilities in a specific urban area, the findings may have limited generalizability to rural settings or private centers where the available equipment and staff to patient ratios differ significantly.

7. Conclusion and Recommendation

In conclusion, nearly one-third of neonates among deliveries complicated by NRFHRS experienced immediate adverse outcomes in Asella. The common adverse outcomes were NICU admission, respiratory distress, neonatal sepsis, low APGAR scores, HIE, and early neonatal death. Advanced maternal age, a bad obstetric history, presence of current pregnancy complications, prematurity, and referral from other health facilities, meconium-stained amniotic fluid, prolonged rupture of membrane, and diagnosis of fetal compromise during AFSOL or SSOL were significant determinants of immediate adverse neonatal outcomes. Based on these findings, the followings are recommended:

- ✓ The health bureau in the Asella City and the healthcare providers should work on strengthening risk-based antenatal care and timely identification of risk factors and improving counseling services on antepartum and intrapartum complications
- ✓ Promoting women's education and informing health professionals about the importance of intrapartum fetal monitoring to decrease adverse neonatal outcome
- ✓ Besides this, the health care professional should give emphasis to improving referral systems and neonatal resuscitation capacity immediately after delivery.
- ✓ Further study has to be conducted using qualitative method to have in-depth information on immediate adverse neonatal outcomes after NRFHRSS

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ANNEX

Annex I: English version Consent form

Participant's information sheet and consent form

My name is__ _____. I am working as a data collector for the study on the "immediate adverse neonatal outcome and associated factor among delivery after NRFHRSS at Public health facility in Asella town, Ethiopia"

Purpose/aim of the study: The findings of the study will be used to design and implement solution about immediate neonatal outcome and associated factor among delivery after NRFHRSS based on the findings of the study area in the future.

Procedure and duration: I am requesting you to participate in the study which will require your cooperation for the interview openly. The interview will be completed within 10 minutes.

Risks and benefits: The risk of being participating in this study is only taking few minutes from your time.

Confidentiality: The information you will provide me will be confidential. Your name, address and the information provide during the interview will be kept confidential. The findings of the study will be general for the study community and will not reflect anything particular to you.

Rights: Participation for this study is fully voluntary. You have the right to declare to participate or not. If you decide not to participate, you have the right to withdraw from the study at any time and this will not liable you for any loss of benefits which you otherwise are entitled. You do not have to answer any question that you do not want to answer.

I have read the participant information sheet. I have clearly understood the purpose of the research, the risks and benefits, issues of confidentiality, the rights of participating and the contact addresses for any question. I have been given the opportunity to ask questions for things that may have been unclear. I was informed that I have the right to withdraw from the study at any time or not to answer any question that I do not want. Therefore, I declare my voluntary consent to participate in this study with my signature as indicated below.

Signature of participate:-_____Signature of data collector:-

Part I: Questions on Socio-Demographic Characteristics of Study Participants

Code	Questions	Choice of response	Skip
Q101	Age in years	_____	
Q102	Marital status	1. Single 2. Married 3. Divorced 4. Widowed 5. Separated	
Q103	Ethnicity	1. Oromo 2. Amhara 3. Gurage 4. Other: specify-----	
Q104	Religion	1. Orthodox 2. Muslim 3. Protestant 4. Catholic 5. Other(specify) ----------	
Q105	Place of residence	1. Urban 2. Rural	
Q106	Educational status of the mother	1. Unable to read or write 2. Able to read and write 3. Primary school 4. Secondary school 5. College and above	
Q107	Educational status of the husband	1. Unable to read or write 2. Able to read and write 3. Primary school 4. Secondary school 5. College and above	
Q108	Occupation of the mother	1. Housewives 2. Merchant 3. Farmer 4. Student 5. Government employee 6. Daily laborer 7. Other (specify)----------	
Q109	Occupation of the husband	1. Merchant 2. Farmer 3. Student 4. Government employee 5. Daily laborer 6. Other (specify)----------	
Q110	Monthly income	- ----------in Ethiopian birr	

Part II antepartum Characteristics of Study Participants

	ANC follow up	Yes	
		No	
	Frequency of ANC follow-up		
	Para	Nulliparita Primipara Multipara	
	Past bad obstetric history	Yes No	
	Types of past bad obstetric history	Early neonatal loss Stillbirth	
	Previous c/s scar	Yes No	
	History of medical illness	Yes No	
	Chronic diabetes mellitus	1. Yes 2. No	
	Gestational diabetes?	1. Yes 2. No	
	Chronic hypertension?	1. Yes 2. No	
	Anemia?	1. Yes 2. No	
	Asthma?	1. Yes 2. No	
	HIV status	Positive Negative ND	
	Pregnancy type	Single tone Multiple	
	Current pregnancy complication	Yes No	
	Types of current pregnancy complication	APH PROM Preeclampsia/eclampsia Hydraminous Others***	
	RH status	Positive Negative	
	HCT level	>=33% <33%	

Part III: Questions on intrapartum characteristics				
	GA	Unknown	known	
		<37 37-42 >42weeks	LNMP	Early US
	Referred	Yes No		
	Onset & progress of labor	Spontaneous Augmented Induced		
	Presentation	Cephalic Breech) Transverse Compound		
	Stage of labour on admission	Latent first stage Active first stage Second stage		
	Duration of labor	Prolonged Normal		
	Amniotic fluid status	Clear Meconium Blood & Intact		
	Grade of meconium	GradeIMSAF Grade II MSAF Grade III MSAF		
	Duration of ROM	>=12hrs <12hrs		
	Sex of neonate	Male Female		
	Birth weight	<2500gm 2500-3999gm >=4000gm		
	NRFHRSS	Yes No		
	Types of NRFHRS status	Tachycardia Bradycardia		
	Stage of labor at the Dx of NRFHRSS	LFSOL AFSOL SSOL		
	Current complication	No CPD Nuchal, entanglement or knot cord Cord prolapses Other*		
	Decision to delivery time	</=30min >/=30min		

Part IV: Questions on immediate neonatal outcome of NRFHRSS

	Immediate adverse neonatal outcome	YES NO	
	First minute APGAR score	<7 >=7	
	Fifth minute APGAR score		
	Ventilation needed	Yes No	
	NICU admission needed	Yes No	
	Still birth	Yes No	
	Neonatal death within 24hrs		
	HIE	Stage I Stage II Stage III	

Neonatal progresses follow up for immediate 24hrs check list(61)

Parameters			first 24hrs	Remark
APGAR Score	First min	<7		
		>/=7		
	Fifth min	<7		
		>/=7		
Weight	<2500gm			
	2500-3999 gm			
	>4000gm			
Diagnosis	Sepsis			
	HIE			
	RDS			
	hypothermia			
	MAS			
	Jaundice			
	Others			
Admission	Yes			
	No			
Referral	ARTH			
	HHC			

	AHC		
Progress	Improve		
	Deteriorating		
	Same		
	Neonatal death		
Discharged	Yes		
	No		

Declaration of Advisors

We, the undersigned Advisors, declare that this thesis is our original work in partial fulfilment of the requirement for the specialization in Obstetrics and Gynecology for the stated student above to our best knowledge. We confirmed that this thesis is ready for examination with our approval as the university advisor(s).

Name of primary Advisor:	**Signature**	**Date**
1. _____	_____	_____
Name of secondary Advisor:	**Signature**	**Date**
2. _____	_____	_____