MEKELLE UNIVERSITY,

SCHOOL OF MEDICINE

COLLEGE OF HEALTH SCIENCES,

DEPARTMENT OF OBSTETRICS AND GYNECOLOGY

MAGNITUDE AND OUTCOMES OF INDUCTION OF LABOR: A PROSPECTIVE DESCRIPTIVE CROSS-SECTIONAL STUDY AT MEKELLE PUBLIC HOSPITALS IN NORTHERN ETHIOPIA

BY

WELDAY ABADI ABAY, M.D, YEAR-4 RESIDENT

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ADVISOR: DR. AMANUEL GESSESSEW (MD, ASSOCIATE PROFESSOR OF OBSTETRICS AND GYNECOLOGY)

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RESEARCH THESIS SUBMISSION FORM

Name of the principal investigator	Welday Abadi Abay, M.D, Year-4 Resident
Name of supervisors	Dr. Amanuel Gessessew (MD, Associate Professor Of Obstetrics And Gynecology)
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Adress of investigator	Cell Phone: +251-914-27-97-11 E-mail: weldayab11@gmail.com

Mekelle University

College of Health Sciences

Department of obstetrics and Gynecology

Advisor's Approval Sheet

This is to certify that the thesis paper entitled "Magnitude And Outcomes Of Induction Of Labor in ACSH and Mekelle General Hospital" is submitted in partial fulfillment of the requirements for the certificate for specialty in Obstetrics and Gynecology , College of Health Sciences of Mekelle University and has been carried out by

Welday Abadi ID No:_____under my supervision. Therefore, I recommend that the resident has fulfilled the requirements and hence here by can submit the thesis paper to the Department.

Dr. Amanuel Gessessew,MD _____ _____

(MD, associate professor) Signature Date

Declaration

I hereby declare that this thesis paper is my original work and has not been presented for a degree in any other university and all sources of material used for this thesis paper have been duly acknowledged.

Name: Welday Abadi Abay

Signature:_____

Date: _____

This thesis paper had been submitted for examination with my approval as thesis advisors.

Name: Dr.Amanuel Gessessew ,MD

Signature: _____ Date: _____

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List of table contents

Declaration 1

Acknowledgment 2

List Of Tables 5

Acronyms and Abbreviations 6

Abstract 7

Introduction 1

Background 1

1.2 Statement of the Problem 4

1.3 Significance of the study 5

Literature Review 5

2.1. Knowledge about Induction of labor 5

2.2 Methods of Induction of labor 6

2.3 Epidemiology of Induction of labor 7

2.4 Complications of Induction of Labor 8

2.4.1 Adverse Perinatal and maternal Outcome 8

2.4.2 Indications and predictors of induction of labor 9

2.5. Conceptual framework 10

3. Objectives of the study 11

General objective 11

Specific objectives 11

4. Methods and Materials 11

4.1 Study Setting 11

4.2 Study Period 12

4.3 Study Design 12

4.4 Study Population 12

4.4.1 Source Population 12

4.4.2 Study Population 12

4.5. Eligibility Criteria 13

4.5.1. Inclusion Criteria 13

4.5.2 Exclusion Criteria 13

4.6. Study variables 13

4.6.1 Independent variable....13
4.6.2. Dependent variables....13
5. Data collection process....14
Data Processing and analysis....14
Operational definitions and terminologies....14
6. Results....15
7. Discussion....28
References....31
11.Annexes....36
Annex 1: Data Extraction English Version....36
Annex 2: Data Extration Tigrygna Version....41
Assurance of Principal Investigators....44

List Of Tables

Table 1: Socio-Demographic Characteristics of Pregnant Mothers Who Underwent Induction of Labor in ACSH and MGH (July 1 – December 1, 2024). 16
Table 2: Obstetric profiles of pregnant mothers underwent induction of labor in ACSH and MGH from July 1st, to December 1st, 2024. 18
Table 3: Physical examination profiles of pregnant mothers underwent induction of labor in ACSH and MGH from July 1st, to December 1st, 2024. 19
Table 4: Methods of Cervical Ripening and Induction Profiles of Pregnant Mothers Who Underwent Induction of Labor in ACSH and MGH (July 1 – December 1, 2024). 21
Table 5: Outcomes of Labor Induction of Pregnant Mothers Who Underwent Induction of Labor in ACSH and MGH (July 1 – December 1, 2024). 23
Table 6: Intrapartum obstetric complications of pregnant mothers underwent induction of labor in ACSH and MGH from July 1st, to December 1st, 2024. 24
Table 7: Fetal/neonatal complications of pregnant mothers underwent induction of labor in ACSH and MGH from July 1st, to December 1st, 2024. 24
Table 8: Obstetric Profile, Maternal and Fetal complications in relation to the outcomes of induction of labor of pregnant mothers underwent induction of labor in ACSH and MGH from July 1st, to December 1st, 2024. ..... **Error! Bookmark not defined.**

Acronyms and Abbreviations

ACOG: American College of Obstetricians and Gynecologists;

ACSH: Ayder Comprehensive Specialized Hospital

APGAR: Appearance, Pulse, Grimace, Activity, and Respiration

APH: Antepartum Hemorrhage

CD: Cesarean Delivery

EOGBSD: Early onset group B Streptococcal disease;

ETB: Ethiopian Birr

FGR: Fetal growth restriction;

GBS: group B streptococcus;

GC: Gregorian Canader

HDP: Hypertensive Diseases in Pregnancy

IOL: Induction of labor

IUFD: Intrauterine fetal death

IUGR: Intrauterine Growth Restricted

MAS: Meconium Aspiration Syndrome

MSAF: Meconium Stained Amniotic Fluid

NICE: National Institute for Health and Care Excellence

N**ICU**: Neonatal Intensive Care Unit

OBGYN: Obstetrics and Gynecology

OR: Odd Ratio

PG: Prostaglandin

PGE2: Prostaglandin E2 (dinoprostone)

PPROM: Preterm prelabor rupture of the membranes

PROM: Prelabor rupture of the membranes

SCOG: Society of Obstetricians and Gynaecologists of Canada

SPSS: Statistical Package for Social Science

VD: Vaginal Delivery

WHO: World Health Organization

Abstract

Background: Induction of labor (IOL) is an artificial initiation of labor after the age of fetal viability and before the onset of spontaneous true labor to achieve vaginal delivery as a therapeutic option when the benefits of expeditious delivery outweigh the risks of continuing the pregnancy.

This research aims to assess magnitude of labor induction, associated factors and perinatal/maternal outcomes among mothers delivered at Mekelle public hospitals , Tigray, Northern Ethiopia.

Methods: A hospital based cross sectional study was conducted on 308 laboring mothers who delivered after induction of labor, from July 1st, to December 1st, 2024. Using structured questionnaire and quota sampling techniques, all eligible participants were immediately enrolled upon admission until the desired sample size was achieved. SPSS windows version 25.0 was used for analysis and both descriptive and inferential statistics were conducted; statistical significance to declare relationship between the dependent and independent variables was set at $p<0.05$.

Results: 308 of the 5173 women who gave birth in the study area were induced, representing a 5.9% magnitude of induction. Out of this, 236 (76.6%) were delivered vaginally, 3(1%) were operative vaginal deliveries and 69 (22.4%) by Caesarean delivery.The most prevalent indication for Caesarean delivery was NRFHRP 41(59.4%), and 239 (77.6%) of the inductions were successful, while 22 (7.1%) failed. A caesarean section was used to deliver all of the patients with failed induction. Oxytocin 169(54.9%) was the most popular method for inducing labor. Bishop's score after cervical ripening significantly predicted the success of induction [AOR=3.588(2.793,10.983)].

., and the two most common indications for induction were prelabor rupture of membrane 174(56.5) and oligohydraminos 39(12.7%).

Conclusion: While our successful induction rate (77.6%) is higher than that of similar institutions in Ethiopia but comparable to most African and Asian rates, our failed induction rate (7.1%) is lower than both local and regional settings. Bishop's score after cervical ripening significantly predicted the success of induction [AOR=3.588(2.793,10.983)]

KEYWORDS: Induction of labor, magnituide, Failed induction, Successful induction, Bishop Score, Oxytocin

Introduction

Background

Induction of labor (IOL) is an artificial initiation of labor or uterine contraction after the age of fetal viability and before the onset of spontaneous true labor to achieve vaginal delivery as a therapeutic option when the benefits of expeditious delivery outweigh the risks of continuing the pregnancy[1]. The procedure has been found to improve fetomaternal outcomes when timely and properly applied to pregnancies with high risk[2]. In line with the Sustainable Development Goals (SDG) 3, Induction of labour has been found to reduce maternal morbidity and mortality if the procedure is performed for clear indication[3].

The rate of labor induction differs across different locations and institutions, and there has been a noticeable increase in some developed countries, almost doubling the incidence. In the United States, labor induction is a commonly performed obstetric procedure, with approximately 31.4% of women undergoing induction in 2020. In certain institutions, the incidence can be as high as 40%. In contrast, Latin America reports a lower rate of 11.4%. Unfortunately, there is a lack of recent comprehensive global data on labor induction [4,5,6].

Africa has a very low rate of induction of labor but high maternal and perinatal morbidity and mortality. The unmet need for induction of labor is about 60-80.2% with an induction rate as low as 1.4-6.8% while 99% of all maternal death is reported in developing countries[4]. Besides, in some African countries, like Ethiopia, there is no satisfactory evidence of findings on fetal-maternal outcomes of the induction process during labor ,though a study from two teaching hospitals in Addis Ababa reported a prevalence of 4%[1].The prevalence in two Mekelle public hospitals based on the study done in 2017 is 9%[1].

In spite of the extreme diffusion of the procedure, there are still numerous unanswered questions, or questions that have not obtained an unanimous consensus in the scientific literature. In general, it is universally accepted that IOL is indicated when it is thought that the outcomes for the fetus, the mother, or both are better than with expectant management or waiting for the spontaneous onset of labor. In addition, IOL should be taken into consideration when the vaginal route is thought to be the most appropriate for delivery, a concept that is broader than the simple absence of contraindications to vaginal birth[5], [6]. Furthermore, being a medical procedure, IOL should be carried out only when there is informed consent and where the precursor for the induction, including specific risks and benefits and the choice of the method used, are clearly explained; furthermore, I personally believe that consent should be accompanied by data on the success of the procedure in the birth center[5].

A general concern is that IOL might increase the rate of cesarean delivery and have an impact on the experience of birth, unlike to this the recent ARRIVE Trial(A Randomized Trial of Induction versus Expectant Management), demonstrated that induction of labor lowered the frequency of cesarean delivery across wide variety of obstetrics settings and patient demographics[5][7], [8].When it comes to IOL, the factors to be taken into consideration and that can influence its success includes the precursor to induction, i.e. the clinical condition, present or absent, at the time the decision to induce is taken, the woman's characteristics, the method of induction used, and other factors that can predict the success of the induction. However, it should be borne in mind that the current literature is not unanimous in defining certain key points such as the definition for failed induction or even what to consider as the success of the induction[5].

Methods for induction of labor may be divided into mechanical and pharmacological both of which have their own advantages and drawbacks.The most commonly used methods of IOL are pharmacological methods,of which titerated oral misoprostole solution and oxytocin infusion are widely practiced. Choice among this methods depends on many factors, including cervical and membrane status, presence or absence of uterine scar, parity, available resources and obstetrician preference[1].

Induction is carried out by oxytocin in case cervix is favorable, that is, Bishop score of 6 or more, whereas in case the cervix is unfavorable, then usually a PG is placed in vagina or cervix to ripen the cervix to initiate the uterine contraction[9], [10].

PGs have been used for IOL since 1960s. Misoprostol, a prostaglandin E1 analogue, given in low doses orally is a highly effective method for labour induction in low resource settings. Oral administration of 25 μg every 2 h received a strong recommendation by WHO in 2011. The Cochrane review of oral misoprostol found that in low doses oral misoprostol is at least as effective as the commonly used vaginal dinoprostone gel. Misoprostol is also heat stable and less than 1% of the cost of dinoprostone gel. The Cochrane review concluded that "low-dose oral misoprostol probably has many benefits over other methods for labour induction." and that "a starting dose of 25 μg may offer a good balance of efficacy and safety." A recent network meta-analysis of all prostaglandins for labour induction supported these conclusions, finding that oral misoprostol solution (< 50mcg) was the safest in terms of risk of caesarean section.Their main adverse effect is excess uterine activity with or without cardiotocographic abnormalities, and these effects are route of administration and dose dependent[10], [11], [12]. Standard practice for labor induction involves using prostaglandin to ripen the cervix. Once active labor begins (cervical dilation of more than 3-4 cm) after the amniotic membranes rupture, the prostaglandin administration stops. If uterine stimulation is still needed, an intravenous infusion of oxytocin is started. The oxytocin infusion is gradually increased every 30 minutes to stimulate contractions for labor progression, while avoiding hyper stimulation and potential fetal hypoxia. Risks associated with oxytocin infusion include fetal asphyxia, uterine rupture, fluid retention, postpartum hemorrhage (PPH), and amniotic fluid embolism [14,16].

However, avoiding oxytocin and continuing low dose misoprostol into active labour may have a number of benefits for women and the health care system. Misoprostol is heat stable and an oral medication and thus easy to store, transport and administer; all particularly desirable in low resource settings.Moreover, the simplicity of the protocol, which eliminates the need to actively titrate an oxytocin infusion against contractions, may free up health care providers to assist with other aspects of a woman's care.There is a need, therefore, to compare the safety, efficacy, acceptability and prevalence of the two induction protocols[11].

In general there is no sufficient evidence regarding perinatal and maternal outcomes of both methods IOL in our setup in particular and in low resource countries in general and hence has always been area that needs further study[13], [14], [15].

1.2 Statement of the Problem

The proportions of induction of labor are generally lower in developing regions; however, in some settings, they can be as high as those observed in developed countries can. The frequency of labor induction in the United States was 31.4% in 2020, more than tripling since 1990 when it was 9.5%[16], [17].

Despite the fact that IOL is an essential practice in preventing neonatal and maternal mortality and morbidity, it is not always successful and can have unfavorable results[23]

A review of the literature showed that, among women who had IOL, only 84% of mothers in Saudi Arabia, 80.6% in India, 75.9% in Nigeria, and 59.7% in Ethiopia achieved a vaginal delivery[13], [16], [18], [19], [20][21].

When induction is not successful, the mode of delivery is the caesarian delivery which could be associated with a higher rate of excessive blood loss, puerperal sepsis, and maternal mortality. For the IOL to succeed, it is crucial to detect and improve the gap[21]. Although induction of labor is a daily practice at public and private health institutions in Ethiopia, including the study area, there is a limitation in undertaking a study on methods of IOL and associated maternal and perinatal outcomes[1].

In an area with a high rate of maternal mortality and morbidity due to poor access to comprehensive emergency obstetric care, knowing the methods available, prevalence, indications, and pregnancy outcomes following inductions of labor is crucial[21]. Therefore, this study aimed to determine the magnitude, methods of IOL and associated maternal and perinatal outcomes among mothers who had just given birth in Ayder comprehensive specialized Hospital (ACSH), Northern Ethiopia. As a result, the findings from this research could make it possible for women who require induction labor to get improved quality of care in hospitals.

Parallel to the increment in IOL, delivering mothers through cesarean delivery for failed IOL is also increasing based on different studies, including the study area. Based on the study done in Mekelle General Hospital and ACSH in 2017, the prevalence of failed induction was 3.3%[1]. Although there is no commonly, accepted definition of “failed labor induction.” the current practice acknowledges “allowing at least 12–18h of latent labor before diagnosing a failed induction may reduce the risk of cesarean delivery”. Ethiopian national guideline for induction recommends Cesarean section only after declared failed induction[1], [7], [17], [22], [23].

Although induction of labor is a daily practice at public and private health institutions in Ethiopia, including the study area, there is a limitation in undertaking a study on prevalence,associated factors and perinatal/maternal outcomes of IOL. Most of the studies concentrated on the success or failure rate of labor induction as a sole outcome, despite abundant literature on various outcomes[1].

Thus, This study aims to determine the magnitude of IOL, perinatal and maternal outcomes of the commonly practiced methods of IOL and associated factors among mothers who fulfill the inclusion criteria in Ayder Comprehensive Specialized Hospital and Mekelle General Hospital.

1.3 Significance of the study

To date, there is limited study on the prevalence, risk factors, perinatal and maternal outcomes of induction of labor in Mekelle public hospitals in general and in Ayder Comprehensive Specialized Hospital in particular. In addition to this, information on induction of labor in Ethiopian demographic health survey database is inadequate and this study will stimulate further studies and perhaps complement to nationwide evidences to address national rate of induction.

Ethiopian national protocol for induction recommends only Cesarean Delivery after declared failed induction, undertaking this study will help us knowing the contribution of failed induction into the overall institutional cesarean section rate as well as the other adverse outcomes. This can be used as evidence that we can build on with more well designed randomized control trials to help the policy makers revising the national guideline.

Knowledge of the outcomes of induction at the institutional level will be employed as a database to monitor the prevalence, common methods, indications and outcomes for future improvement of the quality of care as well as an evidence based information for counseling of mothers for induction.

Literature Review

2.1. Knowledge about Induction of labor

IOL is one of the most common procedures in obstetrics and nowadays it is one of the fastest growing procedures in the world especially in developed countries compared to the developing ones however, its complications are still observed in countries like Ethiopia[24].

IOL may be indicated by medical or obstetrical complications of pregnancy or may be requested or chosen for non-medical or social reasons. Some of the indications include post term pregnancy, hypertensive diseases of pregnancy, premature rupture of membrane, abruption placentae, chorioamnionitis, fetal demise, Premature Rupture of Membranes (PROM), maternal medical conditions like diabetes mellitus, renal disease, chronic pulmonary disease, chronic hypertension and fetal compromise as severe fetal growth restriction, iso-immunization, which may influence the success of IOL. IOL carries various risks including failed induction, fetal and neonatal abnormalities, infection, uterine rupture and bleeding after delivery. The outcome of labor induction will be either success or failure[8], [13], [17], [18], [21], [23], [25]

2.2 Methods of Induction of labor

A variety of pharmacological and non-pharmacological methods are used for IOL. Pharmacological methods include oxytocin, prostaglandin (PG) analogues and smooth muscle stimulants such as herbs or castor oil, whereas non-pharmacological methods include mechanical methods such as digital stretching of the cervix and sweeping of the membranes, hygroscopic cervical dilators, balloon catheters, artificial rupture of the membranes and nipple stimulation. The preferred method of induction could be selected based on the indications or the health care provider's decision. But, the most commonly used methods of induction in our setting is oxytocin infusion and misoprostole oral solution[14].

Historically, most trials have studied the vaginal route of administration of misoprostol for induction of labor. However, owing to concerns about the risk of uterine hyperstimulation with vaginal misoprostol, more recent trials have focused on studying lower doses of vaginal misoprostol and the oral route for its administration. In 2012, the International Federation of Gynecology and Obstetrics (FIGO) recommended an oral dose of 25 μg misoprostol solution every 2 hours to induce labor, citing the 2011 WHO recommendations for labor induction. The WHO strongly recommended this regimen by rating the quality of evidence as moderate and included data from the 2006 Cochrane Review by Alfrevic and Weeks. In 2014, a Cochrane review of oral misoprostol for induction of labor, which included nine trials comparing oral misoprostol with placebo, showed that women using oral misoprostol were more likely to give birth vaginally within 24 hours[26].

The induction procedure performed in Ethiopia also varies from institution to institution. The dose and methods of induction vary across the institutions. For example, 5 IU for primigravida and 2.5 IU for multigravida is the recommended initial dose in our study setting. However, in other institutions, the dose may be similar irrespective of gravida status[27].

2.3 Epidemiology of Induction of labor

Globally, over the past several decades, the rate of labor induction is steadily increasing and, in industrialized countries, approximately one out of four pregnant women has their labor induced[5]. The frequency of labor induction in the United States was 31.4% in 2020, more than tripling since 1990 when it was 9.5%[16], [17].

According to secondary analysis of World Health Organization (WHO) on the outcomes of IOL in 16 Asian African countries, the average prevalence of induction of labor was 4.4% in Africa (ranged from 1.4% in Niger to 6.8% in Algeria), and 12.1% in Asia (ranged from 2.5% in Cambodia to 35.5% in Sri Lanka).Oxytocin alone was the most common method (45.9% and 37.5%)[15], [17]. In Ethiopia, the prevalence of IOL is variable, 4% in two teaching hospitals in Addis Ababa, 20.4% in teaching hospitals of Southwest Ethiopia, 9% in two public hospitals of Mekelle town, 10.9% in Lemlem Karl hospital of Miachew town[1], [4], [13], [15], [28], [29].

A review of the literature showed that, among women who had IOL, only 84% of mothers in Saudi Arabia, 80.6% in India, 75.9% in Nigeria, 77% in Somaliland and 59.7% in Ethiopia achieved a vaginal delivery. Even in the Ethiopian context the success rate of IOL is variable, two Mekelle Public Hospitals (76%), Lemlem Karl Hospital in Miachew town (54.5%), East Gojjam zone public hospitals(58%) Wolliso St. Luke, Catholic Hospital (57.89%), and Wolaita Sodo (59.7%)[21], [27][30], [31], [32].

In Ethiopia, IOL is practiced widely in all hospitals; however, the pooled prevalence of failed labor induction is high compared with developing and developed countries respectively. Although some pieces of evidence are available in Ethiopia regarding induction outcomes, most were conducted using secondary data from card reviews. Assessing the determinants of successful IOL using primary data would help to improve the failure rate of IOL and its complications. The prevalence of failed induction was 3.3% in two public hospitals of Mekelle

town, 16.7% in teaching hospitals of Southwest Ethiopia, 25.4% in four teaching hospitals of Addis Ababa, Ethiopia, 21.4% in Jimma specialized hospital, Ethiopia, 42.1% in Wolliso St. Luke Catholic hospital, Ethiopia. Outside Ethiopia, the prevalence was found to be 24.1% in Catholic Maternity Hospital, Nigeria and 43.6% in Mahatma Gandhi Medical College and Research Institute Hospital, India[1], [3], [7], [17], [18], [19], [22], [23], [27].

Pregnant women who are induced by misoprostol were 1.5 times more likely to have failed induction than those who are induced by oxytocin. The use of oxytocin was strongly associated with a higher success rate of induction of labor. Vogel et al supported this study inthat the induction by oxytocin alone is associated with over an 80% success rate. A study done by Scapin SQ et al. revealed that induction by misoprostol was more associated with vaginal delivery. But another study concludes that the success rate of vaginal delivery after induction was very similar for oxytocin and misoprostol. The discrepancy finding was revealed in the observational study designs. To clear these two opposing ideas, a randomized control trial should be considered[10], [15][9].

2.4 Complications of Induction of Labor

2.4.1 Adverse Perinatal and maternal Outcome

Induction of labor (IOL) is an essential intervention to reduce adverse maternal and neonatal outcomes. It is also improved pregnancy outcomes, especially in resource-limited countries, where maternal and perinatal mortality is unacceptably high. The risk of adverse perinatal and maternal outcomes increases with gestational age, and although induction of labour may reduce these risks, the optimal timing of induction remains unknown[15].

Generally, induction may be is associated with significant maternal and perinatal risks. Therefore, the decision to prescribe the procedure to any pregnant women must be based on sound clinical justification, and the expected benefits should outweigh the potential harms associated with the intervention.

Retrospective study done in teritiary hospital in Gahana described that, the main maternal complications of IOL include increased risk of caesarean section with its associated potential consequences such as increased blood loss, uterine rupture in subsequent maternities, longer hospital stays and increased cost. On the other hand, perinatal risks include birth asphyxia with poor APGAR scores, NICU admission and perinatal demise[33][25], [34], [35].

Based on study done in two public hospitals in Mekelle town, adverse maternal outcomes of induction were 4.3% PPH, 2% precipitated labor, 1.4% intrapartum placental abruptions, 0.9% incomplete uterine ruptures, 0.3% uterine over activity and 0.3% maternal death. In regard to fetal /early neonatal complications, 17.9% of the neonates had NRFHRP, 0.6% IUFD, 10.9% low Apgar score, 3.2% Early onset neonatal Sepsis and out of this 59% were admitted to the neonatal intensive care unit and half of them stayed for 4–7 days at the NICU and 10.8% neonates died within the first 7 days of life. Two of the four early neonatal deaths were due to Hyaline membrane disease secondary to prematurity, one due to congenital malformation and another one for perinatal asphyxia[1][36], [37].

2.4.2 Indications and predictors of induction of labor

According to the World Health Organization's (WHO) recommendations, the practice of IOL should be performed only when there is a clear medical indication for it, and the expected benefits outweigh the potential harm. Researchers have found that post-term pregnancy, hypertensive disorders (pre-eclampsia/eclampsia) during pregnancy, pre-labor rupture of membrane (PROM), intrauterine growth restriction(IUGR), intrauterine fetal death (IUFD), abruption placenta, fetal congenital anomalies, and other medical disorders are some indications for the intervention of induction of labor and may influence the success of induction of labor. However, the level of evidence supporting these common indications varies widely, ranging from low to high[5].

In a retrospective study done in public Hospitals of Harari Regional State, Eastern Ethiopia, the most common indication for induction of labor was pre-eclampsia/eclampsia which accounted for 46.70%, followed by pre-labor rupture of membrane 33.50% and intrauterine fetal death 7.5% (Yimer Mohammed , 2021). Other study done in two public General Hospitals in Mekelle town reported that the commonest indications for inductions of labor are prolonged rupture of membranes(41.3%), post-term pregnancy(19.7%), hypertensive disorders(16.5%), oligohydramnios(8.4%), IUFD(7.5%), APH 18(5.2%), congenital malformations(0.9%) and IUGR(0.6%)[1], [17][35], [38].

Because of the risk of failed induction of labor, a variety of maternal and fetal factors as well as screening tests have been suggested to predict labor induction success. Certain characteristics of the woman (including place of residence, parity, age, weight, height and body mass index),

and of the fetus (including birth weight,fetal heart rate pattern and gestational age) are associated with the success of labor induction; with parous, favorable bishop score(assessed by most senior physician assigned during decision time), young women who are taller and lower weight with advanced gestational age having a higher rate of induction success. However, the overall sensitivity and specificity to predict vaginal delivery widely vary from 12% to 100% and 12% to 95%, respectively. Moreover, many published prediction models for predicting a successful vaginal delivery following induction are often limited in their scope (eg, methodology and performance) and generalizability[28], [39].

Therefore the delivery should be conducted under circumstances that allow appropriate support and intervention on behalf of the fetus and vaginal delivery necessiates continuous intrapartum fetal heart rate monitoring[40].

2.5. Conceptual framework

This is a conceptual framework for the study of magnitude, methods of induction of labor and associated maternal and perinatal outcomes for women delivered in ACSH, Northern Ethiopia. This conceptual framework shows the factors that affect the IOL and is adapted from different literatures.

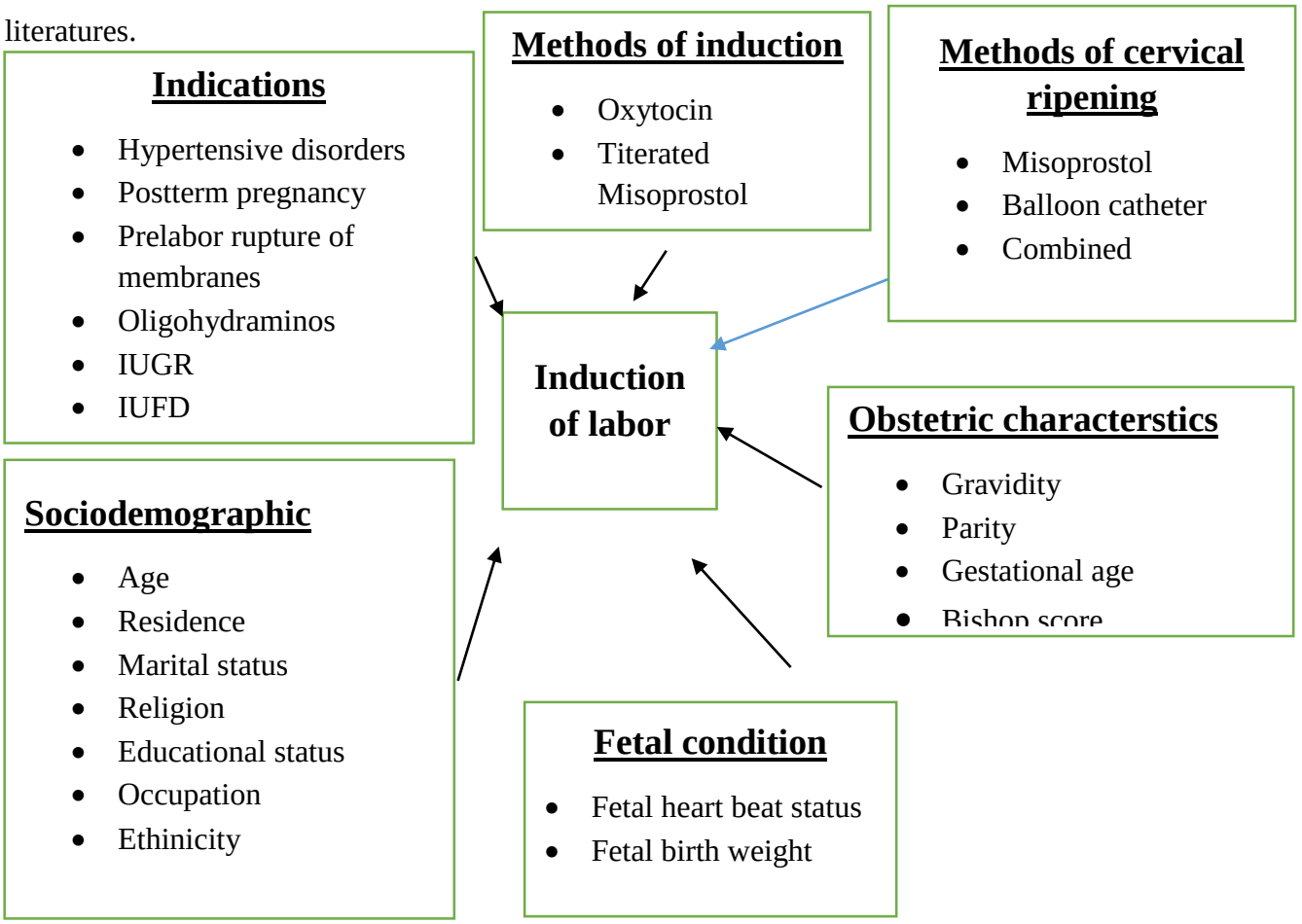

Figure 1: Conceptual framework for methods of induction of labor and associated factors

3. Objectives of the study

General objective

- To assesses the magnitude and outcomes of induction of labor:

Specific objectives

- To determine the magnitude of induction of labor at Mekelle public Hospitals in Northern Ethiopia from July1,2024 to December1,2024
- To assess the commonly practiced methods of induction at Mekelle public Hospitals in Northern Ethiopia from July1,2024 to December1,2024
- To determine adverse maternal and perinatal outcomes of inductions of labor at Mekelle public Hospitals in Northern Ethiopia from July1,2024 to December1,2024
- To determine the common indications for induction of labor at Mekelle public Hospitals in Northern Ethiopia from July1,2024 to December1,2024
- To asses success and failure rate of induction of labor at Mekelle public Hospitals in Northern Ethiopia from July1,2024 to December1,2024
- To assess factors associated with failed induction of labor at Mekelle public Hospitals in Northern Ethiopia from July1,2024 to December1,2024

4. Methods and Materials

4.1 Study Setting

Tigray is one of the northern most of nine regional state of the Federal Democratic Republic of Ethiopia. Mekelle is the capital city of Tigray and is located 780 km away from the capital city of Ethiopia, Addis Ababa. Mekelle has four governmental hospitals, ACSH, Mekelle General Hospital, Quiha General Hospital and Lekatit 11 Primary Hospital. The study will be conducted at Ayder Comprehensive Specialized Hospital.

Ayder comprehensive Specialized Hospital is found in Mekelle, it started as a referral and specialized medical center in 2008 G.C. It serves for more than 9 million populations in its catchment areas of Tigray, Northern Afar, and North-eastern part of Amhara regional states. It is the second largest tertiary hospital in the nation and has more than 500 inpatient beds in the four major departments (pediatric and child health, Internal medicine, Surgery and Obstetrics/ Gynecology) and other specialty units. It provides a comprehensive care of which obstetrics and gynecology care service provision is one of the main services. It has two separate Out Patient Departments; one offering services for low risk mothers and the other for high risk mothers. There are 78 inpatient beds in two wards, 5 delivery couches, 1 emergency room, 1 procedure room and 1 meeting hall for Obstetrics and Gynecology care services. There is there is separate Operation theatre for obstetrics and gynecology. There are 15 senior Obstetrician and Gynecologists (13 permanent staff and 2 honorary staff), 35 residents, and 92 midwives providing the care. It has 7000 deliveries per year.

The hospital also served as teaching hospital and research center for the College of Health Sciences, Mekelle University. This study is to be conducted at Ayder Comprehensive Specialized Hospital and Mekelle General Hospital found in Mekelle town, North Ethiopia.

4.2 Study Period

The study was conducted from July 1, 2024 to December 1, 2024

4.3 Study Design

A hospital based descriptive cross- sectional study was done

4.4 Study Population

4.4.1 Source Population

All mothers delivered at ACSH and Mekelle General Hospital during July 1, 2024 to December 1, 2024

4.4.2 Study Population

All womens undergone IOL, whose gestational age of pregnancy was greater than or equal to 28 weeks in ACSH and Mekelle General Hospital Mekelle, Tigray that fulfill the inclusion criteria and enrolled in the study during the data collection period.

4.5. Eligibility Criteria

4.5.1. Inclusion Criteria

- All mothers who were admitted for IOL after pregnancy of 28 weeks of gestational age at ACSH and Mekelle General Hospital, Mekelle, Tigray during the study period.

4.5.2 Exclusion Criteria

- Women who are critically ill to be interviewed
- Women with uncertain gestational age

4.6. Study variables

4.6.1 Independent variable

- Maternal age
- Gestational age
- Gravidity
- Parity
- Ethnicity
- Marital status
- Antenatal care
- Religion
- Educational level
- Place of residence
- Bishop score at admission
- Method of Induction of labor
- Mode of delivery
- Known medical illness
- Average family monthly income
- Fetal weight

4.6.2. Dependent variables

- Magnitude and Outcome of induction of labor

5. Data collection process

The data was collected from ACSH and Mekelle General Hospital within 6 hours after delivery from the labor ward medical record files, operating theatre and neonatal intensive care unit records using structured and comprehensive questionnaire designed for that. Oral interview was also used when necessary and missed information was resolved with the managing Physicians before discharge of the mother and her neonate. The data was collected by trained data collectors.

Data Processing and analysis

The collected data was cleared and checked by the principal investigator for completeness and consistency. Then the data was computed and analyzed using SPSS version 25 statistical software. Finally, the data is presented in tables and graphs

Operational definitions and terminologies

- Term pregnancy in this study stands for gestational age greater or equal to 37 weeks
- Reliable date in this study stands for a mother who remembers her date clearly, who had regular menstrual cycle at least for 3 months prior to her last date and she was not on any form of contraceptives at least for 3 months prior to her last date [41]
- Early ultrasound in this study stands for ultrasound taken at gestational age of 24 or below [42].
- Maternal outcome stands for mode of delivery and maternal condition at delivery
- Fetal outcome stands for fith minute APGARs score, admission to N-ICU, status of newborn at birth or on discharge
- Induction of labor refers to iatrogenic stimulation of uterine contractions before the onset of spontaneous labor[1]
- Failed induction defined as inability to achieve vaginal delivery after 6 to 8 hours of maximum maintained dose of induction [27]
- Favorable Bishop score stands for score 9 and above. Where as score less than 6 is unfavorable and score between 6 and 8 is intermediate.
- Maternal complication in this study stands for maternal morbidity or mortality associated with intervention for induction of labor.

Data quality assurance

Data analysis

Data was coded, entered, cleaned, and analyzed using Statistical Package for Social Science (SPSS) version 25. Magnitude, fetomaternal outcomes,maternal sociodemographic characteristics, obstetric history and physical examination findings, indication for induction and methods used for induction were described using graphs,tables,and texts.

Ethical consideration

Ethical clearance was obtained from the Institutional Review Board(reference number: MU-IRB 2062/2023) of Mekelle University College of Health Sciences. Names and other identifiers were not used in collecting the data, and confidentiality was maintained by keeping the data collection forms locked in a cabinet and the electronic data files kept on a password-protected computer.

6. Results

During the study period (July 1 – December 1, 2024), a total of 5,173 women gave birth in the study area, with 308 undergoing labor induction, resulting in an induction prevalence of 5.9%. Of this 1,344(26%) delivered via Caesarean deliveries, 76(5.7%) performed for failed induction. From those who undergone IOL 69(22.4%) delivered via cesarean delivery.

Sociodemographic characteristics of the participants

The ages of participants ranged from 18 to 45 years, with a mean age of 27.9 ±5.68years. More than half, 168 (54.5%), were enrolled from Ayder Comprehensive Specialized Hospital (ACSH), while 140 (45.5%) were from Mekelle General Hospital. The majority of participants were of Tigrayan ethnicity, 303 (98.4%), with a small representation from Amhara, 3 (1%), and Afar, 2 (0.6%). Most participants, 287 (93.2%), were from urban areas, while 21 (6.8%) came from rural areas.

Regarding marital status, nearly all participants, 297 (96.4%), were married, while a few were single, 6 (1.9%), divorced, 2 (0.6%), widowed, 2 (0.6%), and cohabiting, 1 (0.3%). In terms of education, 41 (13.3%) were unable to read and write, 56 (18.2%) were literate without formal

schooling, 157 (51%) had completed secondary-preparatory school, and 54 (17.5%) had attended college or higher education.

Occupation-wise, two-thirds of the respondents, 233 (75.6%), were housewives, while 38 (12.3%) worked in the private sector, 30 (9.7%) were government employees, and 7 (2.3%) were students. (Table_1):

Table 1: Socio-Demographic Characteristics of Pregnant Mothers Who Underwent Induction of Labor in ACSH and MGH (July 1 – December 1, 2024).

Variables	**Category**	**Frequency[n= 308]**	**Percent [%]**
Age	Mean(SD)	27.9	
	≤18	5	1.6
	18-34	250	81.2
	≥35	53	17.2
Site of research	Ayder	168	54.5
	MGH	140	45.5
Place of residency	Urban	287	93.2
	Rural	21	6.8
Marital status	Married	297	96.4
	Divorced	2	0.6
	Single	6	1.9
	Widowed	2	0.6
	Cohabited	1	0.3
Educational status of the mother	unable to read and write	41	13.3
	able to read and write	56	18.2
	secondary -preparatory school	157	51.0
	college and above	54	17.5
Occupation status	Housewife	233	75.6
	Student	7	2.3
	government employee	30	9.7
	private business	38	12.3
Ethnicity	Tigraweyti	303	98.4
	Amharayti	3	1.0

	Afar	2	0.6

Obstetric Profile and Physical Examination Findings

More than half of the participants, 181 (58.8%), were para one to four, while 105 (34.1%) were nulliparous, and 22 (7.1%) were grandparous. Nearly all pregnancies, 291 (94.5%), were planned, and 307 (99.7%) were wanted, whereas 17 (5.5%) were unplanned, and 1 (0.3%) was unwanted.

Regarding gestational age at delivery, 135 (43.9%) of pregnancies were full-term, 93 (30.1%) were early term, 31 (10.1%) were post-term, and 13 (4.2%) were preterm. Antenatal care (ANC) was booked by 302 (98.1%) of the participants, while 6 (1.9%) did not receive ANC. Among those who received ANC, the majority, 261 (84.7%), had one to seven contacts, 41 (13.3%) had eight or more contacts, and 6 (2.0%) had no ANC visits.

In terms of healthcare facility usage for ANC, 118 (38.3%) attended public health centers, 102 (33.2%) visited private hospitals or clinics, and 82 (26.6%) received care at public hospitals. However, 6 (1.9%) did not visit any healthcare facility.

Most participants, 138 (44.8%), had no known medical conditions. However, 104 (33.8%) had prolonged rupture of membranes (PROM), 41 (13.3%) had hypertension, 4 (1.3%) had diabetes, and 2 (0.6%) had asthma, intrauterine growth restriction (IUGR), or intrauterine fetal demise (IUFD). Additionally, 1 (0.3%) participant had each of the following conditions: chorioamnionitis, cardiac disease, thyroid disorder, epilepsy, and Rh-alloimmunization.

Almost all 287 (93.2%) of indications for IOL were maternal and the remaining 21 (6.8%) were fetal. From this, the leading reason for labor induction was prolonged rupture of membranes, affecting 174 (56.5%) of cases. Other indications included oligohydramnios in 39 (12.7%), hypertensive disorders in 31 (10.1%), post-term pregnancy in 31 (10.1%), placental abruption in 13 (4.2%), bad obstetric history (BOH) in 8 (2.6%), intrauterine growth restriction (IUGR) in 7 (2.3%), and IUFD in 6 (1.9%).

On physical examination, the majority of participants, 237 (76.9%), had an unfavorable Bishop's Score (<6), while 71 (23.1%) had a favorable score (≥6). Almost all 53(84.1%) of women with cervical dilatation of four centimeter and above and 18(85.7%) of cervical dilatation morethan sixty percent delivered vaginally respectivelly (Table_2 ,3 and 4)

Table 2: Obstetric profiles of pregnant mothers underwent induction of labor in ACSH and MGH from July 1st, to December 1st, 2024.

Variables	**Category**	**Frequency[n=308]**	**Percent [%]**
Parity	para-0	105	34.1
	Para 1-4	181	58.8
	Para- ≥5	22	7.1
Was pregnancy planned ?	Yes	291	94.5
	No	17	5.5
Was pregnancy wanted ?	Yes	307	99.7
	No	1	0.3
Gestational age at the date of delivery	28w-34w	5	1.6
	34-36w6d	8	2.6
	37w-38w6d	93	30.2
	39w-40w6d	135	43.9
	41w-41w6d	36	11.7
	≥42w	31	10.1
ANC	BOOKED	302	98.1
	Un BOOKED	6	1.9
Number of ANC contacts	0	6	1.9
	1-7	261	84.7
	≥8	41	13.3
Place of ANC booking	public hospital	82	26.6
	private hospital/clinic	102	33.2
	public health center	118	38.3
	NONE	6	1.9

Table 3: Obstetric indications for mothers underwent induction of labor in ACSH and MGH from July 1st, to December 1st, 2024.

Variables	**Category**	**Frequency[n=308]**	**Percent[%]**
Indications	Postterm pregnancy	31	10.1
	PROM	174	56.5
	HDP**	31	10.1
	Oligohydraminos	39	12.7
	Abruption**	13	4.2
	Others***	2	0.6
	BOH	8	2.6
	IUGR	7	2.3
	IUFD*	3	1.0

***includes:-DM,Cardiac Disease + RVI

**intrapartal IUFD

*Includes:- 2HDP ,1Rh sensitized mothers

Table 4: Physical examination profiles and outcomes of pregnant mothers who underwent induction of labor in ACSH and MGH from July 1st, to December 1st, 2024 [Before cervical ripening].

Variables	**Category**		**Frequency[n=308]**	**Percent[%]**
Pre induction bishop score-assessed by most senior physician	Unfavorable		237	77.0
	Favorable		71	23.0
	Cx-closed[n=103]	VD	80	77.7
		CD	23	22.3

Cervical dilation (in cm) and effacement (in %)	Cx 1-2cm[n=140]	VD	105	75.0
		CD	35	25.0
	Cx 3-4cm[n=63]	VD	53	84.1
		CD	10	15.9
	Cx >=5-6cm[n=2]	VD	1	50.0
		CD	1	50.0
Cervical effacement	0-30%[n=177]	VD	136	76.8
		CD	41	23.2
	40-50%[n=60]	VD	43	71.7
		CD	17	28.3
	60-70%[n=50]	VD	42	84.0
		CD	8	16.0
	>=80%[n=21]	VD	18	85.7
		CD	3	14.3
Station	-3[n=129]	VD	92	71.3
		CD	37	28.7
	-2[n=100]	VD	86	86.0
		CD	14	14.0
	-1,[n=79]	VD	61	77.2
		CD	18	22.8
Position of cervix	Posterior [n=128]	VD	92	71.9
		CD	36	28.1
	Midposition [n=100]	VD	77	77.0
		CD	23	23.0
	Anterior [n=80]	VD	70	87.5
		CD	10	12.5
Cervical Consistency	Firm [n=103]	VD	80	77.7
		CD	23	22.3
	Medium [n=134]	VD	99	73.9
		CD	35	26.1
	Soft [n=71]	VD	60	84.5
		CD	11	15.5

Methods of ripening and induction of labor

Cervical ripening was performed for 112 (47.3%) of participants with an unfavorable Bishop's Score. Among them, misoprostol was the most commonly used method, administered to 66 (59%) participants, while balloon catheter was used for 45 (40.2%). Morethan two-third

51(77.3%) of the misoprostole group and almost two-third 33(73.3%) of the transcervical balloon group participants delivered vaginally. A combination of misoprostol and balloon catheter was utilized in only one case (0.8%) and delivered vaginally.

Following cervical ripening, 99 (88.4%) of the participants achieved a favorable Bishop's Score. However, 13 (11.6%) experienced rupture of membranes and were subsequently assigned to the titrated misoprostol group. In general after cervical ripening, rate of favorability increased morethan twice from 71 (23%) to 170 (55.2%).

Oxytocin infusion was the most frequently used method for induction, applied in 170 (55.2%) of cases, while the remaining 138 (44.8%) were induced using titrated misoprostol. Among those who received oxytocin infusion, 109 (64%) required the third and maximum dose, 38 (22.5%) were maintained at the second dose, and 23 (13.5%) at the first dose. For those induced with titrated misoprostol, 38 (27.6%) received the seventh and maximum dose, 30 (21.7%) required the fourth dose, 28 (20.3%) reached the third dose, and 15 (10.9%) were maintained at the sixth dose. Majority of the oxytocin 133(78.2%) and titerated misoprostol 106(76.8%) group participants delivered vaginally.The mean induction-to-delivery time was 12 hours, with a maximum duration of 24 hours and a minimum of 1 hour (Table_5).

Table 5: Methods of Cervical Ripening and induction with their Outcomes for Pregnant Mothers Who Underwent Induction of Labor in ACSH and MGH (July 1 – December 1, 2024)[After Cervical Ripening].

Variables	**Category**		**Frequency**	**Percent[%]**
Was ripening of cervix done ? [n=308]	Yes		112	36.4
	No		196	63.6
Method of cervical ripening [n=112]	Misoprostol [n=66]	VD	51	77.3
		CD	15	22.7
	balloon catheter[n=45]	VD	33	73.3
		CD	12	26.7
	Combined[n=1]	VD	1	100.0
		CD	0	0.0

Method of induction after cervical ripening [n=308]	Oxytocin [n=170]	VD	133	78.2
		CD	37	21.8
	titerated misoprostole [n=138]	VD	106	76.8
		CD	32	23.2
Maintenance dose of induction of labor for oxytocin group [n=170]	First		23	13.5
	Second		38	22.5
	Third		109	64
Maintenance dose of induction of labor for titerated misoprostole group [n=138]	1st dose		2	1.4
	2nd dose		11	8.0
	3rd dose		28	20.3
	4th dose		30	21.7
	5th dose		14	10.1
	6th dose		15	10.9
	7th dose		38	27.6
Induction to delivery time in hours [n=308]	Mean		12.0	
	Median		11.0	
	S.D		5.45	
	Minimum		1.00	
	Maximum		24.00	

Outcomes of labor induction

Birth outcomes

Among the 308 mothers who underwent labor induction, the majority 236 (76.6%) had a spontaneous vaginal delivery, while 3 (1%) required operative vaginal delivery, and 69 (22.4%) underwent a Cesarean delivery(CD). More than half (37 out of 69, or 53.6%) of those who had a CD were from the oxytocin infusion group.

After excluding 46 cases where a CD was performed for reasons unrelated to failed induction, the overall success rate of induction was 239 (77.6%), while the failure rate was 69 (22.4%). Among those who underwent C-section, the primary indications were: Failed induction → 22

cases (30.6%), Non-reassuring fetal heart rate pattern (NRFHRP) → 46 cases (63.8%), Cephalopelvic disproportion (CPD) → 2 cases (2.8%), Meconium-stained amniotic fluid (MSAF) → 2 cases (2.8. In terms of neonatal birth weight, 273 (88.6%) of newborns weighed between 2500g and 3999g, 30 (9.7%) had a birth weight below 2500g and 5 (1.6%) weighed ≥4000g (Table_6).

Table 6: Outcomes of Labor Induction of Pregnant Mothers Who Underwent Induction of Labor in ACSH and MGH (July 1 – December 1, 2024).

Variables	**Category**	**Frequency**	**Percent[%]**
Mode of delivery [n=308]	SVD	236	76.6
	OVD	3	1.0
	CD	69	22.4
If delivery is other than SVD, list indication [n=72]	failed induction	22	30.6
	NRFHRP	46	63.8
	MSAF	2	2.8
	CPD	2	2.8
Oxytocin Group-CD indication [n=37]	Failed induction	8	21.6
	NRFHRP	27	73.0
	MSAF	1	2.7
	CPD	1	2.7
Titerated misoprostol gorup-CD indication [n=32]	Failed induction	14	43.8
	NRFHRP	16	50.0
	MSAF	1	3.1
	CPD	1	3.1
New born birth weight [n=308]	<2500gram	30	9.7
	2500-3999grams	273	88.7
	≥4kg	5	1.6

Obstetric intrapartum complications during the current pregnancy

Of the 262 participants, more than two thirds (85.1%) did not experience any intrapartum complications. 28 (9.1%) NRFHRP, 11 (3.6%) MSAF, 4 (1.3%) intrapartum placental

abruptions, 2 (0.6%) third/fourth degree perineal tears, and 1 (0.3%) PPH were among the intraparatal obstetric complications that were noted during the induction of labor (Table_7).

Table 7: Intrapartum obstetric complications of pregnant mothers underwent induction of labor in ACSH and MGH from July 1st, to December 1st, 2024.

Variables	**Category**	**Frequency**	**Percent[%]**
Intrapartum Obstetric complication in the current pregnancy [n=308]	MSAF	11	3.6
	intrapartum abruption	4	1.3
	3rd/4th degree perineal tear	2	0.6
	PPH	1	0.3
	NRFHRP	28	9.1
	None	262	85.1

Fetal/ neonatal peripartum out comes and complications

Seven (2.3%) of the 301 (97.7%) neonates were stillborn, while the remaining 301 were alive. Three (75%) of the stillbirths were caused by pregnancy-induced hypertension, three (42.9%) were IUFD from the start, and four (57.1%) were alive when induction began. Regarding early newborn outcomes, 13 (4.2%) had an APGAR score below seven, whereas 295 (95.8%) had an APGAR score greater than seven. Every infant with a poor APGAR score went to the NICU; 10 (76.7%) were kept there for 24 hours, 1 (7.7%) for 24 to 48 hours, and 2 (15.4%) for up to seventh day. All of the newborns admitted for 7days were diagnosed with early onset neonatal sepsis (Table_8).

Table 8: Fetal/neonatal complications of pregnant mothers underwent induction of labor in ACSH and MGH from July 1st, to December 1st, 2024.

Variables	**Category**	**Frequency**	**Percent [%]**

Newborn status at birth [n=308]	Alive		301	97.7
	Stillbirth [n=7(2.3%)]	Antepartum	3	42.8%
		Intrapartum	4	57.2%
Newborn 5th min APGAR scores [n=308]	<5		6	1.9
	5-7		3	1.0
	>7		299	97.1
Newborn admitted to NICU [n=308]	Yes		13	4.2
	No		295	95.8
Duration of stay in NICU [n=13]	<24hrs		10	76.9
	24-48hrs		1	7.7
	3rd-7th day		2	15.4

Association of maternal obstetric selected factors and maternal/ perinatal outcomes to the induction of labor outcomes

Cross tabulation and Logistic regression

Using the pearson chi-square test value, Maternal age, Residence, maternal height, BMI, parity, gestational age at the time of delivery, Bishop score at admission, whether cervical ripening was done or not, ripening agent used, Method of induction, bishop's score after ripening, newborn birth weight, newborn outcome, 5th minutes Apgar score, whether Neonate admitted to NICU or not, PPH, maternal third or fourth degree perineal tear and non reassuring fetal heart rate pattern were selected and analyzed for their possible association with the outcome of induction. It was found that residency (p value=0.160), parity (P value= 0.063), Bishop's score after cervical ripening (P value= 0.031) and NRFHRP (P value=0.000) are the only significant variable (Tables 9).

On Bivariate analysis, residency, parity, Bishop's score after cervical ripening and NRFHRP showed statistical significance, and Multiparous women were almost two times more likely to succeed induction than the primipara ones [COR=1.7, 95% CI= (0.78,1.522)]. Women delivered less than 3500grams achieved vaginal delivery twice than those who delivered three and half newborn birth weights [COR=1.984, 95% CI=(0.668,5.892)]. Women with favorable Bishop's score after cervical ripening were four times more likely to Succeed induction than those with unfavorable Bishop Score [COR=4.123, 95% CI=(1.518, 28.352)].

On Multivariate regression (variables that showed statistical significance in bivariate analysis were entered for Multivariate regression), NRFHRP and Bishop Score after cervical ripening persisted as significant predictor of successful induction and mothers with favorable Bishop's score after cervical ripening were almost four more likely to succeed induction than those with unfavorable Bishop's score. [AOR=3.588(2.793,10.983)].

Table 9: Obstetric Profile, Maternal and Fetal complications in relation to the outcomes of induction of labor of pregnant mothers underwent induction of labor in ACSH and MGH from July 1st, to December 1st, 2024.

Variables	**Category**	**Successful IOL**	**Failed IOL**	**Total**	**P-Value**
Age	18-34	196(76.9%)	59(23.1%)	255	0.773
	≥35	43(81.1%)	10(18.9%)	53	
Residency	Urban	220(76.7%)	67(23.3%)	287	0.160
	Rural	19(90.5%)	2(9.5%)	21	
Height	<165.1cm	13(100%)	0(0.0%)	13	0.946
	≥165.1cm	226(76.6%)	69(23.4%)	295	
BMI	<30kg/m2	11(68.8%)	5(31.2%)	16	0.387
	≥30kg/m2	228(78.1%)	64(21.9%)	292	
Parity	Primipara	75(71.4%)	30(28.6%)	105	0.063
	Multipara	164(80.8%)	39(19.2%)	203	
GA at delivery	Preterm	4(100%)	0(0.0%)	4	0.983
	Term	235(77.3%)	69(22.7%)	304	
Cervical Ripening Done?	Yes	83(74.8%)	28(25%)	111	0.373
	No	156(79.2%)	41(20.8%)	197	
Method of ripening	Misoprostol	50(75.8%)	16(24.2%)	66	0.825
	Balloon catheter	34(73.9%)	12(26.1%)	46	
Method of induction	Oxytocin	133(78.2%)	37(21.8%)	170	0.813
	Titerated misoprostole	106(76.8%)	32(23.2%)	138	
Bishop score after ripening	Favorable	133(78.2%)	37(21.8%)	170	0.031
	Unfavorable	106(76.8%)	32(23.2%)	138	
Newborn birth weight	<3.5kg	26(86.7%)	4(13.3%)	30	0.218
	≥3.5kg	213(76.6%)	65(23.4%)	278	
Newborn status	Alive	232(97.1%)	69(22.9%)	301	0.99
	Stillbirth	7(100%)	0(0.0%)	7	
5^{th} Minute APGAR sore	<7	8(88.9%)	1(11.1%)	9	0.423
	≥7	231(77.3%)	68(22.7%)	299	
Neonate admitted to NICU?	Yes	9(69.2%)	4(30.8%)	13	0.463
	No	230(78%)	65(22%)	295	
3^{rd} or 4^{th} Degree perineal tear	Yes	2(100%)	0(0.0%)	2	0.999
	No	237(77.4%)	69(22.6%)	306	
PPH	Yes	1(100%)	0(0.0%)	1	1.00
	No	238(77.3%)	69(22.7%)	307	
NRFHRP	Yes	2(6.1%)	31(93.9%)	33	0.000

	No	237(86.2%)	38(13.8%)	275	

Table 10: Predictors of successful induction of labor of pregnant mothers underwent induction of labor in ACSH and MGH from July 1st, to December 1st, 2024.

Variables	Category	COR(95% CI)	AOR(95% CI)
Residency	Urban	0.346(0.78,1.522)	0.147(0.016,1.348)
	Rural		
Parity	Primipara		
	Multipara	1.682(0.92,2.912)	1.056(0.507,2.199)
Bishop score after cervical dilatation	Favorable	4.123(1.518,28.6352)	3.588(2.793,10.983)
	Unfavorable		
Newborn birth weight	<3500grams	1.984(0.668, 5.892)	3.195(0.637,16.016)
	≥3500grams		

7. Discussion

In the study period, there were 5173 total deliveries; 1344 subjects (26%) were via CD, and 73 subjects (1.4%) were via operative vaginal deliveries. Out of 5173 deliveries, induction of labor was done in 308 subjects[5.9%]. The rate of successful induction constituted 76.6%, failed induction represented 7.1% with 1.6% contribution of failed induction into the overall institutional rate of cesarean deliveries during the study period. The two most common indications for induction were prelabor rupture of membranes and oligohydraminos; Bishop's score after cervical ripening was a significant predictor of successful induction.

The rate of labor induction (5.9 %) was found to be comparable to other studies done at two teaching hospitals in Addis Ababa (4%) [1]. Although it is not a nationwide study, it is also comparable to the average rate of induction in Africa (4.4%) ranging from (1.4%) in Niger to [6.8%] in Algeria. It is even lower than the previous study done in the same study area (9%)[1] and lower than to studies done in Miachew town's Lemlem Karl hospital (10.9%), Southwest Ethiopian teaching hospitals (20.4%)[4,13,15,28,29] and lower than the average rates

in Asia (12.1%), ranging from (2.5%) in Cambodia to 35.5% in Sri Lanka [25]. Induction of labor is directly relevant to the health related sustainable development goals (SDGs), Given the increasing attention to reducing perinatal and maternal morbidity and mortality, rates of induction of labor have continued to rise over the past few decades specially in the developed countries like USA (31.4%) [16,17], the issue that has contributed a lot in the reduction of their maternal and perinatal mortality and morbidity. According to the World Health Organization (WHO), the average rate of labor induction in developed countries is around 25% of all term deliveries, meaning that up to one quarter of births in developed countries involve induction of labor[17].

The induction rate of 5.9% reported in this study is even lower than the rate of some institutions in developed countries about thirty years back, confirming that our rate is still very low. Reasons for this low rate might be due to war related blackouts, poletical nstability and variation in practice since our national guidelines don't allow for elective induction, induction after cesarean section or high unmet need for induction. Cesarean delivery is one of adverse maternal outcomes of labor induction specially when it fails, the contribution of failed induction into the overall rate of cesarean deliveries in this study (1.6%) is lower than the previous study done in the same study area (3.3%) [1] and also very low comparing to other national studies, (21.4%) in Jimma Specialized Hospital, Ethiopia [24], and 42.1% of patients in Wolliso St. Luke Catholic Hospital [20].and also very lower than Catholic Maternity Hospital in Nigeria and Mahatma Gandhi Medical College and Research Insti tute Hospital in India were found to have 24.1% [2][26] .

Successful inductions were 77.6% of all inductions and goes to 92..39% if we exclude the other cesarean deliveries done for indications other than failed induction; this rate is higher than the studies of Jimma University Hospital (65.7%) [15], Hawassa reporting 61.6%, and the Addis Ababa Army Referral Hospital recording a 62.2% [13].But almost parallels to 84% of mothers in Saudi Arabia[16], 80.6% in India [16], 75.9% in Nigeria[18]; These variation can be due to the use of Oxytocin infusion as the most common method of induction in these local institutions, while titrated oral misoprostol was used as one of the methods of induction in our study area as well as the Nigerian study, explaining the comparability to this studies [43].

Unlike to many other local and regional institutions [1,25], prolonged rupture of membranes, 174(56.4%) was the most common indication for labor induction, while elective induction was the

most common indication in Asia [28]. This can be explained by the commonly shared risk factors for prolonged rupture of membranes both locally and regionally, and the difference in practice guidelines that allow elective induction as in Sri Lanka and United states. Bishops score after cervical ripening was found to be the only predictor of successful induction in this study hence induction is four times more likely to succeed if the Bishop's score is favorable, [AOR=3.588(2.793,10.983)]], unlike other studies that found BMI, Residency, age, parity and Bishop's score at admission [14, 15]. This might be due to the wide confidence interval having more successful inductions and few who had failed.

As a limitation of this study, cross sectional studies are of low level of evidence in comparison to other study designs and they cannot be taken as strong evidence to change practice. Another limitation was though we planned to take the most senior physicians bishop score but assessment of Bishop's score was done by more than one resident throughout the study period making it difficult to assess its precision.

Conclusion, the study revealed the prevalence of induction of labor to be 5.9%, which is very low in comparison to the rate of other institutions in developed countries. The rate of successful inductions (77.6%) is slightly higher than the rate of similar institutions in Ethiopia but comparable to the African and Asian rates, But the rate of failed induction (7.1%) is very low compared to both local and regional settings. Unlike most local and regional Hospitals, prolonged rupture of membranes was the most common indication for induction. Bishop's score after cervical ripening significantly predicted success of induction and induction was eight times more likely to succeed if the Bishop's score was Favorable[AOR=3.588(2.793,10.983)]],

Strength of the study

The strengths of this study include: the data was collected by trained data collectors; privacy and confidentiality were ensured; and regular supervision was provided by the principal investigator and research assistant. This enhanced the reliability and validity of data collection and results.

Limitation of the study

The limitations of the current study were , comparisons were not made with the control group; hence, statistical significance cannot be drawn for the predictors of success or failure of induction of labor. Substantial Socio-Demographic variables were missing from the patients

charts. A multicentric study from different centers can give a real picture of the magnitude , maternal, and fetal outcomes of the induction of labor. Excluding from the study for mothers started cervical ripening but directly labor established without induction of labor was another limitation.

Dissemination of findings

The findings of the study will be presented and submitted to the department of obstetrics and gynecology. It will also be presented in annual scientific meeting and conferences. The copy of the finding will be kept at Ayder Comprehensive Specialized hospital OBGYN department and given to Tigrai Regional Health Bureau. The findings of this study will be published in reputable journals.

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11.Annexes

Annex 1: Data Extraction English Version

'Methods of induction of labor and associated maternal and perinatal outcomes'

Data extraction checklist

Questions	Answers	Remark
Part I. Socio demographic characteristics		

1.Name of data collector		←Mention your name here
2.Site		
3. Date of decision for pregnancy termination		← in Ethiopian Calendar
4.MRN		
5.Cell phone		Her own/husbands
6.Age in years		
7. Residency	1. Urban 2. Rural	
8.Marital status	1. Married 2. Divorced 3. Single 4. Widowed 5. Cohabited	
9. Religion	1. Orthodox 2. Protestant 3. Muslim	
10.Educational Status of the mother	1. Anable to read and write 2. Able to read and write 3. Secondary & Preparatoy 4. College and above	
11.Educational Status of the father	1. An able to read and write 2. Able to read and write 3. Secondary & Preparatoy 4. College and above	
12.Occupation of the mother	1. Housewife 2. Student 3. Government Employee 4. Private Business	
13.Occupation of the father	1. Housewife 2. Student 3. Government Employee 4. Private Business	
14. Ethnicity	a. Tigraweyti b. Amharayti c. Afar	

15.Perceived wealth when you compare with your community or neighbor	1. Rich 2. Medium 3. Poor		
16.Maternal Anthropometry	1. Height:_____ 2. Weight:_____ 3. BMI: _____ 4. MUAC:_____		← List the pregestational weight and height
Part II: Obstetrics and Reproductive Health Background			
17.Reproductive History	Gravidity		
	Parity		←Mention how many alive and how many dead (alive,stillbirth, END, infant death etc)
	Abortion		← Pregnancies terminated before 28 weeks
	Ectopic pregnancy		
	GTD		
18. Was the Pregnancy Planned?	1. Yes 2. No		
19.If answer for Q18 is Yes	1. Wanted 2. Unwanted		
20.LNMP			← Mention if reliable or not
21. Gestational age at decision for termination of pregnancy			← Mention from what parameter it is calculated from (from reliable LNMP, Early Ultrasound
22.Gestational age at the date of delivery			
23.ANC	1. Booked 2. Unbooked		
24.Number of ANC contacts	1. No contacts 2. Number of contacts _____		

25.Place of ANC booking	1. Public Hospital 2. Private hospital /Private clinic 3. Public Health center	
26. Maternal vital signs at the time of admission for IOL	1. BP_____ 2. PR_____ 3. RR_____ 4. Temperature_____-	← Temperature measured objectively
27. Antepartum Obstetric complication in the current pregnancy	1. Diabetes Mellitus 2. Hypertension 3. Cardiac Illness 4. Asthma 5. Epilepsy 6. Thyroid Disorder 7. APH 8. PROM 9. Other:_____	
28.Indication for induction of labor	1. Postterm pregnancy 2. PROM 3. Hypertensive disorders of pregnancy 4. IUFD 5. IUGR 6. Oligohydraminos 7. Bad obstetric history 8. Abruption placenta 9. Fetal malformation 10. Others_____	←List the BOH if it was known
29.Pre-induction Bishop score(Asessed by most senior physician)	1. Unfavorable 2. Favorable	←List the score
30.Cervical dilatation(in cm),effacement(in%),Station, Position and Cervical Consistency		←List the membrane status
Part III: Induction Status and Mode of Delivery		

31.If the answer for Q29 is (a), Was rippening of the cervix done before induction?	1. Yes 2. No	
32. If the answer for Q31 is (yes), method of cervical ripening	1. Misoprostol 2. Balloon catheter 3. Combined	
33. If the answer for Q29 is (b), method of induction of labor	1. Oxytocin 2. Titerated Misoprostole	
34.Phase of IOL(for Oxytocin)	1. First 2. Second 3. Third	
35.Oxytocin drop per minutes per 1L in normal saline during delivery	1. 20 2. 40 3. 60 4. 80	
36. Phase of IOL(for oral misprostol)		←list amount (in ml) and number of doses taken
37.Duration of IOL till delivery		←list in hours
38.Mode of delivery	1. SVD 2. OVD 3. CD	
39.If delivery is other than SVD, list indication		←list indication for OVD or CD
Part IV: Intrapartum and postpartum circumstances		
40.Newborn birth weight		← fetal weight, sex
41.Newborn status at birth	1. Alive 2. Stillbirth	
42.Newborn 1st and 5th minute APGAR score		←list the APGAR score
43. Newborn Admitted to NICU?	1. Yes 2. No	←List the reason for admission to nicu
44.If answer to Q 38 is (yes), List NICU duration of stay and status at discharge		

45. Intrapartum Obstetric complication in the current pregnancy	1. MSAF 2. Intrapartum abruption 3. Perineal tear 4. PPH 5. Uterine rupture 6. NRFHRP of fetus 7. Other:_____	← List type of perineal tear specifically

Annex 2: Data Extration Tigrygna Version

□□□ I. □□□□ □□□□

ሕቶ	መልሲ	መግለፂ
1. □□□	_____	
2.እታ ኣዶ ንኽትወልድ ዝተወሰነሉ ዕለት		
3.ቑፅሪ መለለይ ካርዲ ሕክምና		
4.□□□□□ □□	1. □□□ 2. □□□	
5. ናይታ ኣዶ ስልኪ ቑፅሪ		
6. □□□□□	1. □□□□□□ 2.□□□□□□□ 3. □□□□ 4. □□□□ □□□_____	
7. □□□□ □□□	1.□□□□ □□□ 2.□□□□□□ 3.□□□ □□□□ 4. □□□ □□□ □□□ 5.□□□ □□□□	
8. □□□ □□□□□	1. □□□□□□□ 2. □□ 1□- 4□ □□□ □□□□□ 3.□□ 5□- 8□ □□□ □□□□□ 4. □□ 9□- 12 □□□ □□□□□ 5.□□□□ □□□□□	
9. □□□	1. □□□□ □□ 2. □□□□□	

	3. □□ □□□□□ □□□□□ 4. □□ □□□ □□□ 5. □□□□, □□□ _____		
10.□□□□ □□□	(□□□ □□□□□ □□□)		
11. □□□	1. □□□□ 2. □□□□ 3. □□□ 4. □□□ 5. □□□□, □□□ _____		
12. ኹነታት ጥንሲን ወሊድን	ቐፅሪ ጥንሲ		
	ቅድሚ ሕዚ ዝተወለዱ		
	ቅድሚ ሕዚ ዝተነፀሉ		
	ልዕሊ ማህፀን ጥንሲ		
	ጥንሲ ወይናወይኖ		
13. ናይ ወር□□ ፅ□□□ ዝተርኣየሉ (ናይ መወዳእታ ዑደት ናይ መጀመርታ መዓልቲ)			
14. ዕደመ ጥንሲ እታ ኣዶ ንኽትወልድ ኣብ ዝተወሰነሉ ግዘ			
15.ክትትል ጥንሲ ነይሩዋዶ?	ሀ/እወ ለ/ ኣይፋሉን		
16.□□ፅ□ 15 □□□□□ □□□ እወ □□□□ □□□□ □□□□ □□□□□ □□□□ □□□			
17. ኤ.ኣይ.ቪ	ሀ/እወ ለ/ ኣይፋሉን ሐ/ ኣይፍለጥን		
18.□□ □□□□ □□□□□□ □□	ሀ/ፀቕጢ ደም፡ _____		

	ለ/ መጠን ውቅዒት ልቢ፡ _____ ሐ/ መጠን ረስኒ፡ _____	
19. ቅደመ ወሊድ ዘጋጠሙ ፀገማት	ሀ/ስካር ለ/ ደም ፀቕጢ መጠን ውቅዒት ልቢ፡_____ ሐ/ መፍሰስቲ ደም ሐ/ ኣብዘይሰዓቱ ዝመፅእ ሕርሲ መ/ ካልኦት (ጥቐስ)	
20.□□□ □□□□□ □□□□□ □□□ፅ □□□□?		
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Assurance of Principal Investigators

I, the undersigned, agreed to accept all responsibilities for the scientific and ethical conduct of the research project and for the provision of required progress reports as per the terms and conditions of the requirements of the department. I provided timely progress report to my advisor and seeked the necessary advice and approved from my major advisor in the course of the research.

Name of the speciality trainee: Welday Abadi Abay, M.D.,

Signature: _____

Date: _____

Approval of the Major Advisor

Name of the Supervisor: Amanuel Gessessew, M.D, Associate Professor of Obstetrics and Gynecology

Signature: _____

Date: _____