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Incidence and Outcome of Labor Induction among Mothers Who Delivered in Al-Sabeen Hospital Sana'a city, Yemen

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Dedication

Gratitude to the Almighty for the gift of life and wisdom that enabled us to complete this study. Many thanks to our parents for always believing in us and for the much-needed encouragement during the entire course.

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ACOG	American College of Obstetricians and Gynecologists
AJOG	Americans Journal of Obstetrics and Gynecology
AMA	Advanced maternal age
ANC	Antenatal care
AOR	adjusted odds ratio
AVD	Assisted vaginal delivery
BPD	Biparietal diameter
CAPs	Certified authorization professional
CI	Confidence interval
CRL	Crown-rump length
CS	Cesarean section
EDD	Expected date of delivery
GDM	Gestational diabetes mellitus
IOL	Induction of labor
IUFD	Intrauterine fetal death
IUFD	Intrauterine fetal demise
Kg	kilograms
LMP	Last menstrual period
mcg	micrograms

ML	Milliliters
NEJM	The New England Journal of Medicine
NICU	Neonatal intensive care unit
OR	Odds ratio
PGDH	Prostaglandin dehydrogenase
PGE1	Prostaglandin E1
PGE2	Prostaglandin E2
PGHS-2	prostaglandin H synthase 2
PPH	Postpartum hemorrhage
PIH	Pregnancy-induced hypertension
PROM	Premature rupture of membrane
PPROM	Preterm pre-labor rupture of membrane
SPSS	Statistical package for the social science
SVD	Spontaneous vagina delivery

Abstract

Background: Despite the induction of labor (IOL) having had some undesired consequences, it also has several benefits for maternal and perinatal outcomes. This study aimed to assess the incidence and outcome of IOL among mothers who delivered in the Al-Sabien Hospital in Sana'a, Yemen.

Methods: A retrospective cross-sectional study was conducted from 1,6,2021 to 30,6, 2022, among mothers who gave birth in the study period, by reviewing their cards using a structured checklist to assess the prevalence and outcome of labor induction. A binary logistic regression analysis was computed to examine the association between outcome and independent variables.

Result: Of 10219 laborers,505 cases underwent labor inductions with a prevalence of 4.94%. The main age of participants was 26.99 ±6.24 years, and most of them (45.9%) were aged between 25-34 years. Most of the participants live in urban (73.9%) and had regular perinatal care visits (73.9%). The most reported indication for IOL was premature rupture of the membrane (65.1%). 42 (8.3%) were delivered by cesarean section and 19 (3.8%) needed instrumental vaginal delivery while 444 (87.9%) achieved vaginal delivery making the prevalence rate of successful IOL (87.9%) and the IOL failure 12.1%.In multivariate logistic regression, the odds ratio (OR) showed that mothers aged 25–34 years (OR: 0.46; 95% confidence interval [CI]: 0.26 – 0.84, p= 0.013), multiparity (adjusted [AOR]:0.24; 95% CI: 0.12 – 0.49, p> 0.001), Misoprostol users (AOR: 0.34; 95% CI: 0.18 – 0.65, p > 0.001), premature rupture of membranes (PROM) cases (AOR: 0.34; 95% CI: 0.15 – 0.78, p= 0.011), and oligohydramnios cases (AOR:0.19; 95% CI:0.04 – 1.00, p=0.050) were associated with IOL. Maternal complications occurance (OR: 1.41, 95% CI: 0.13 – 15.13), age older than 34 years (OR: 1.23; 95% CI: 0.48 – 3.19), gestational age between 37-40 weeks (OR: 1.28; 95% CI: 0.48 – 3.41) and more than 40 weeks (OR: 1.42; 95%CI: 0.36 – 5.53), baby weight between 2 kg-4 kg (OR: 1.39; 95% CI: 0.64 – 3.04), neonatal ICU admission(OR: 1.66; 95%CI: 0.31 – 8.85), post-term pregnancy (OR: 1.07; 95%CI: 0.32 – 3.49) were increased the chance for IOL failure.

Conclusion: The prevalence of induced labor and the prevalence of induction failure were comparable to other studies done in Yemen. This study found that mothers aged 25–34 years, multiparity, misoprostol users, premature rupture of membranes cases, and oligohydramnios cases were associated with IOL outcomes. Therefore, health professionals should consider these factors to enable safe care during delivery for as many women as possible.

Keywords: Bishop score, labor induction, outcome, prevalence, Yemen.

Chapter One

Introduction

Introduction:

Induction of labor (IOL) is an iatrogenic stimulation or initiation of uterine contraction before the spontaneous onset of labor, with or without rupture of the membranes. Globally, the prevalence of labor induction varies widely across countries (Diab 2005; Sanchez-Ramos 2005).

It is more commonly done in developed countries than in developing countries. IOL is done to achieve vaginal delivery before spontaneous labor starts, and it is recommended when the benefits of childbirth outweigh the risk of continuing the pregnancy (Frass et al. 2011; Tsakiridis et al. 2020).

Anatomy and Physiology

The uterus includes both the body and the cervix, with the body being composed of smooth muscle and the cervix predominantly collagen. The cervix undergoes dynamic changes during pregnancy and labor, such as shortening, thinning, and dilating. Mechanical and pharmacological methods of labor induction can be used to make these physiological cervical changes occur (Frass et al. 2011).

Its indication includes the mother's medical condition, pregnancy-related hypertension, post-term pregnancy, premature rupture of membrane (PROM), and intrauterine fetal death (IUFD) (Farah et al. 2023; Tsakiridis et al. 2020).

Indications

There are indications for a late preterm, early term, late-term, and post-term timing of delivery depending on a patient's obstetrical and medical history (Tsakiridis et al. 2020). IOL is indicated when it is thought that the outcomes for the fetus, the mother, or both are better than with expectant management, that is, waiting for the spontaneous onset of labor. The American College of Obstetricians and Gynecologists (ACOG) has an extensive list of recommendations on delivery timing, with some of the more common clinical scenarios listed below (ACOG committee opinion no. 560: Medically indicated late-preterm and early-term deliveries 2013; Lumbiganon et al. 2010; Yuan et al. 2023).

- Oligohydramnios with the timing at 36 0/7 to 37 6/7 weeks of gestation
- Fetal intrauterine growth restriction, with no abnormal Doppler, with the timing at 38 0/7 to 39 6/7 weeks of gestation

- Fetal intrauterine growth restriction, with the absent end-diastolic flow, with the timing at 34 0/7 weeks of gestation
- Fetal intrauterine growth restriction, with reversed end-diastolic flow, with the timing at 32 0/7 weeks of gestation
- Chronic hypertension, not on medications, with the timing at 38 0/7 to 39 6/7 weeks of gestation
- Gestational hypertension with the timing at 37 0/7 weeks of gestation or at the time of diagnosis if diagnosed later
- Preeclampsia without severe features with the timing at 37 0/7 weeks of gestation or at the time of diagnosis if diagnosed later
- Preeclampsia with severe features with the timing at 34 0/7 weeks of gestation or at the time of diagnosis if diagnosed later
- Pregestational diabetes is well-controlled, with the timing at 39 0/7 to 39 6/7 weeks of gestation
- Gestational diabetes (GDM), diet, or exercise controlled, with the timing at 39 0/7 to 40 6/7 weeks of gestation
- Preterm pre-labor rupture of membranes (PPROM) with the timing at 34 0/7 weeks of gestation or at the time of diagnosis if diagnosed late-term with the timing at 41 0/7 to 41 6/7 weeks of gestation
- Abruptio placentae
- Chorioamnionitis
- Intrauterine fetal demise (IUFD)

Labor may also be induced for logistic reasons, such as the risk of rapid labor, distance from the hospital, or psychosocial indications. In such circumstances, fetal lung maturity should be established. In the absence of appropriate clinical circumstances, a mature fetal lung test result before 39 weeks of gestation is not an indication for delivery (Farah et al. 2023; Lumbiganon et al. 2010; Tsakiridis et al. 2020).

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The induction of labor remains a controversial concept. The IOL influences the women's birth experience. It can be less efficient and is generally more painful than spontaneous labor. IOL involves medical interventions; increases hospital costs and should, therefore, be limited to medically indicated cases (Yosef and Getachew 2021).

Contraindications

Contraindications to IOL include but are not limited to the following (Farah et al. 2023; Yuan et al. 2023):

- Vasa previa or placenta previa
- Transverse fetal presentation
- Umbilical cord prolapses
- History of a prior classical cesarean section
- Active herpes infection
- A previous myomectomy breaching the endometrial cavity

Induction sometimes fails with potential risks of a higher rate of operative vaginal childbirth, cesarean birth, excessive uterine activity, abnormal fetal heart rate patterns, uterine rupture, maternal water intoxication, delivery of a preterm infant due to incorrect estimation of dates, and, possibly, cord prolapsed. But, most of the time, IOL is directly linked to reducing maternal mortality because it has a potential benefit in preventing maternal complications and improving pregnancy outcomes (Yosef and Getachew 2021). IOL may reduce the emotional burden on the mother associated with carrying a dead fetus, the slight possibility of chorioamnionitis, and disseminated intravascular coagulation when a dead fetus is retained for more than 5 weeks in the 2nd or 3rd trimester. The risk of fetal death is well-known to increase during post-term pregnancies. Hence, after 41 completed weeks of pregnancy, the IOL should be done to prevent fetal or neonatal death. Besides, when properly indicated, the procedure should also reduce the need for a cesarean section. It has been suggested that regions with high rates of induced labor tend to have lower rates of cesarean section (Tsakiridis et al. 2020).

Equipment

Two primary methods of induction of labor are mechanical and pharmacological. Cervical ripening agents are utilized primarily when the Bishop score is unfavorable (less than eight). Mechanical cervical ripening of the cervix can be done using a Foley catheter or double-balloon device (i.e., a Cook catheter) placed through the endocervical canal (Tsakiridis et al. 2020).

Osmotic dilators, laminaria, and synthetic dilators are also used for cervical ripening and placed in the cervical os. Pharmacological forms of IOL include synthetic prostaglandins and synthetic oxytocin. Prostaglandins are used for cervical ripening. Misoprostol, prostaglandin E1 (PGE1), and dinoprostone, prostaglandin E2 (PGE2), are used in various doses and routes of administration. Notably, prostaglandins should be used with caution in women with a history of a low transverse cesarean section due to concerns for uterine rupture. Oxytocin is administered intravenously in varying dosing regimens. Amniotomy is often used in combination with both mechanical and pharmacological labor induction methods (Adu-Bonsaffoh and Seffah 2022; Escobar et al. 2020).

Personnel

An inpatient obstetric care team includes, but is not limited to nurses, midwives, residents, obstetricians, anesthesiologists, neonatologists, pediatricians, and lactation services. All team members should work in harmony to create a safe environment for the pregnant woman and her fetus during labor and postpartum. A trained obstetrician capable of performing a cesarean section (CS) should be readily available anytime IOL is used if the need arises to proceed to CS (Escobar et al. 2020).

Preparation

The cervix is evaluated on dilation characteristics, station, consistency, effacement, and position using the bishop scoring system. This score is performed in the late third trimester and at IOL. A favorable cervix with a score of eight or more is likely to result in a vaginal delivery. However, if the score is three or less at the start of the IOL, then the chance of successful vaginal delivery is low. As a healthcare provider, it is crucial to review this information with pregnant women to help them better understand the process of IOL (Levine et al. 2016).

Before starting IOL, all pregnant women should have consented to the process and understand all benefits, maternal and fetal risks, and alternatives to IOL. Some of the are similar to that of spontaneous labor, including the need to perform a cesarean section, an operative vaginal delivery, chorioamnionitis, non-reassuring fetal heart rate tracing, and postpartum hemorrhage. Reviewing indications for cesarean section and operative vaginal delivery should be discussed before offering IOL. One indication for a cesarean section is a failure of IOL, where cervical dilation has not progressed or continued, despite the use of medications with or without amniotomy. American College of Obstetricians and Gynecologists (ACOG) recommends administrating oxytocin for 12 to 18 hours after the performance of the amniotomy before proceeding with a cesarean section for a failed IOL (Levine et al. 2016; Vogel et al. 2014).

During the consent process and while preparing women for IOL, reviewing the different methods of inducing labor is encouraged. As indicated above, mechanical and pharmacological methods can be used as a single agent or in combination. A 2016 published randomized control trial addressed this concept. When evaluating women with a singleton pregnancy in the vertex presentation with a Bishop score of less than six, those who received a combination of induction methods, such as a mechanical IOL using a Foley catheter combined with misoprostol or a Foley with Syntocinion, had a faster median time to delivery compared to those who received only misoprostol or a Foley catheter alone. However, when adjusting for further variables, a Foley with Syntocinon was not better than a single induction method (Kemper et al. 2021).

Additional studies and Cochrane reviews compare amniotomy to mechanical and pharmacological induction methods alone. It shows that mechanical induction with a balloon is probably as effective as labor induction with vaginal PGE2. However, a balloon seems to have a more favorable safety profile for the baby. More research on this comparison does not seem warranted. A balloon catheter may be slightly less effective than oral misoprostol, but it remains unclear if there is a difference in safety outcomes for the baby (Grobman et al. 2018). When compared to low-dose vaginal misoprostol, a balloon catheter may be less effective but probably has a better safety profile for the baby. Future research could focus more on safety aspects for the baby and maternal satisfaction (Grobman et al. 2018).

As noted above, cesarean section rates and indications for performing CS should be reviewed with all pregnant women before consenting to IOL. There is a strong emphasis on cesarean section rates in the United States in the medical literature and social media. The New England Journal of Medicine (NEJM) recently published the ARRIVE trial that compared cesarean risks of IOL

section rates and perinatal outcomes in nulliparous women undergoing elective IOL at 39 weeks of gestation to expectant management. Results demonstrated a significantly lower cesarean section rate in the induction group and that there were no statistically lower adverse perinatal outcomes (Tsakiridis et al.).

This study has received much attention in the obstetric literature and may potentially change induction practice patterns in the country. Additional published work has reviewed maternal outcomes, including cesarean section rates, with labor induction. A retrospective study published in 2013 found decreased odds of cesarean section in nulliparous and multiparous women being electively induced between 37 and 40 weeks of gestation (Darney et al.).

Moreover, it was found that women were not at increased risk of third or fourth-degree lacerations or operative vaginal deliveries, regardless of gestational age. Aside from these two articles, an extensive literature has been published analyzing cesarean section rates concerning variables such as parity, gestational age, and maternal characteristics (Yosef and Getachew).

Women being induced for a specific indication, such as fetal growth restriction, may inquire about the neonatal risks of IOL. The same 2013 retrospective study from California further analyzed neonatal outcomes and found no difference in fetal death, neonatal intensive care unit (NICU) admission, or respiratory distress across gestational age or parity. However, other literature has shown a possible difference in neonatal outcomes for fetuses delivered in the early term at 37 weeks gestation compared to at 38 or 39 weeks gestation. A 2009 NEJM study reviewed this topic from data at the Eunice Kennedy Shriver National Institute; it was found that there was a higher rate of both respiratory and non-respiratory complications with neonates delivered at 37 weeks of gestation via cesarean section compared to those delivered at 38 and 39 weeks of gestation (Yosef and Getachew).

Technique

As part of the induction process, mechanical dilation with a Foley catheter, a double-balloon catheter, or laminaria can be done. A Foley catheter is passed through the external and the internal cervical os. The balloon is then inflated, between 30 milliliters (mL) to 80 mL with normal saline, and the balloon exerts pressure on the internal os to help with cervical dilation.[

A 2012 American Journal of Obstetrics and Gynecology (AJOG) article demonstrated that an 80 mL inflation volume resulted in a faster induction and less need for syntocinon compared to a volume of 30 mL. With the double balloon, there is one balloon applying pressure to the internal os, and there is a second balloon applying pressure to the external os. Both balloons can be filled with different volumes of normal saline. Whether a Foley or a Cook catheter is used, both devices are generally removed once cervical dilation is three to four centimeters. Osmotic dilators are also available in different sizes and placed into the cervical os (2013).

For cervical ripening with misoprostol, there is a range of doses and routes of administration, such as orally, vaginally, or sublingually. Doses of misoprostol range from 25 micrograms (mcg) to 50 mcg (2009).

If IOL is planned in the setting of intrauterine fetal demise in the second trimester, ACOG supports higher doses of prostaglandins such as 400 mcg every three hours for a maximum of five doses. PGE2 (dinoprostone) is available as a vaginal insert and gel formulation. The gel formulation is available in 0.5 mg, and the insert is 10 mg (Levine et al.).

Further pharmacological methods include syntocinon, administered intravenously in varying dosing regimens. Dosing is often titrated so that contractions are two to three minutes apart to cause cervical dilation. Hospitals may have policies on the maximum dose of oxytocin used for pregnant women undergoing a trial of labor after a cesarean section. Amniotomy with an "amnio hook" can be performed any time the cervix is dilated and is done based on the provider's discretion. Factors considered before amniotomy include but are not limited to the fetal station, fetal head engagement, patient preference, and pain level at the time of amniotomy (Tsakiridis et al. 2020).

Complications

More and more women have labor-induced, and indications are often not urgent. This means that the safety aspects of induction methods become more important, although this could be at the expense of effectiveness. Mechanical methods could have advantages over pharmacological methods as they are widely available, are low in cost, and may have fewer side effects, such as excessive uterine contractions (uterine hyperstimulation) (ACOG committee opinion no. 560: Medically indicated late-preterm and early-term deliveries). This could potentially be safer for the baby because if contractions are too long or very close together, the baby may not receive sufficient oxygen. Pharmacological induction can cause uterine tachysystole, with more than five contractions in ten minutes. Tachysystole may lead to fetal decelerations or bradycardia; much literature has been published regarding the risks of uterine tachysystole with prostaglandins.

Further complications include intrapartum vaginal bleeding, presence of meconium-stained amniotic fluid, umbilical cord prolapse, pain not relieved with regional anesthesia, perineal lacerations, postpartum hemorrhage, chorioamnionitis, and postpartum endometritis (Levine et al.).

Clinical Significance

Induction of labor represents an opportunity to intervene in an ongoing pregnancy with the intent to influence delivery timing for either maternal or fetal benefit. There is rigorous research that has been published and continues to be published on both the maternal and fetal safety of induction of labor, especially as it relates to cesarean section rates. Ultimately, further top-quality research evidence should focus on the neonate and maternal satisfaction safety aspects (Chow et al.).

Enhancing Healthcare Team Outcomes

Pregnant women offered or undergoing IOL should be managed by a coordinated interprofessional team involving the obstetric provider, specialty-trained obstetric nurse, midwives, anesthetic staff, and a neonatology team. Ultimately, whenever there is a change in the pregnant woman's or the fetal status, a collaborative effort between all healthcare team members must be made to ensure the pregnant woman and her fetus(s). The nurses and the midwives play a very crucial role during the process of IOL (ACOG committee opinion no. 560: Medically indicated late-preterm and early-term deliveries 2013).

Clear communication among the interprofessional team members is vital for achieving the best standard of care that needs to be delivered to pregnant women undergoing IOL and their families. Witten patient information leaflets should be given to pregnant women offered IOL. They should be easy to understand, and women can also be referred to online resources to help them make informed decisions about their pregnancies (Escobar et al.).

Nursing, Allied Health, and Interprofessional Team Interventions

Depending on the acuity level of the facility, continuous electronic fetal monitoring is often done during labor. Many healthcare systems require regular documentation of the electronic fetal heart rate and tachometer and notations written for the performance of resuscitative interventions in the presence of a category two or fetal heart rate tracing. Nursing should alert obstetric providers and anesthetic staff about potential concerns and the possibility of proceeding with an operative vaginal delivery or cesarean section, depending on the patient's stage of labor and fetal heart rate tracing.

Nursing, Allied Health, and Interprofessional Team Monitoring

Most hospitals have policies or protocols regarding labor induction, medication administration, fetal heart rate monitoring, oral intake during IOL, pain control, maternal observations, and obstetric emergencies. As noted above, fetal heart rate should be monitored, along with the contraction pattern and adequacy of contractions if an intrauterine pressure catheter is present. Electronic medical records often have flowsheets and checklists available for nurses to record events during admission. Depending on the patient's medical history, such as hypertensive disorder or diabetes mellitus (gestational or pregestational), the hospital may have protocols for the frequency of blood pressure or blood glucose assessments, respectively (Dadi and Yarinbab).

Patients on high-alert medications during induction, such as antihypertensives, magnesium sulfate, or insulin, may need more frequent monitoring depending on the hospital's specific protocol. Changes noted by the nurse during these assessments warrant notifying the obstetric care provider to see if further intervention is required, such as administering additional antihypertensives or administering glucose in the setting of hypoglycemia. Other monitoring during IOL may include the timing of amniotomy and the color of amniotic fluid which can be crucial to inform further management (Chow et al.).

Yemen is also one of the least developed Middle Eastern countries in which maternal and prenatal morbidity and mortality rates remain very high (Dhaifalah et al.). This impedes efforts to achieve the 3rd sustainable development goal, which is health and wellness and effective action to improve the quality of health care (Levine et al.). Induction of labor can reduce specific clinical circumstances contributing to a greater or lesser degree of urgency, like chorioamnionitis, which has high-risk death for both the mother and the neonate (Wall). Even though some shreds of evidence are available in Yemen regarding IOL, all were conducted in nonacademic centers, which did not truly reflect the magnitude and factors associated with IOL in teaching hospitals (Dhaifalah et al. 2006). This study aimed to assess the proportion and outcome of IOL among mothers who delivered in Teaching Hospital (Al-Sabien Hospital) Sana'a, Yemen.

Objectives:

General objectives:

This study aimed to assess the incidence and outcome of IOL among mothers who delivered in the Al-Sabien Hospital in Sana'a ,City, Yemen.

Specific objectives:

1- To determining the main age of the mother with induction of labor.

2- To determining the main residence of the mother with induction of labor.

3- To determining the main gravidity, parity, and history of antenatal care follow-up of a mother with labor induction.

4- To determining the main gestational age at induction.

5- To determining the main Bishop Score before induction.

6- To determining the methods of the mother's induction with induction of labor.

7- To determining the main weights of the baby in the mother with induction of labor.

Hypothesis:

1-Is there a relationship between maternal age and induction of labor?

2-Is there a relationship between the mother's residence and induction of labor?

3-Is there a relationship between main gravidity, parity, and history antenatal care follow-up of mother and labor induction

4-Is there a relationship between gestational age at induction and labor?

5-Is there a relationship between the main Bishop Score before induction and labor?

6-Is there a relationship between the baby's main weights and labor induction?

7-Is there a relationship between methods of induction and outcome?

Chapter Two
Review of Article

History of Labor Induction

The history of labor induction dates back to Hippocrates's description of mammary stimulation and mechanical dilatation of the cervical canal. During the 2nd century AD, Soranus practiced a combination of procedures to induce labor including artificial rupture of membranes. Other labor induction methods were introduced during this period; Moshion was the first to describe manual dilation of the cervix, and Casis invented several instruments capable of cervical dilation (Drife 2021).

From the 2nd through the 17th centuries, mechanical methods to induce labor came into more common use. In 1756, at a meeting held in London, physicians discussed the efficacy and ethics of early delivery by rupturing the membranes to induce labor. In 1810, James was the first in the United States to utilize amniotomy to induce premature labor, Amniotomy and other mechanical methods remained the methods of labor induction most commonly employed until the 20th century. In 1906, Dale observed that extracts from the infundibular lobe of the pituitary gland caused myometrial contractions. Three years later, Bell reported their first experience with the use of pituitary extract for labor induction (Drife 2021).

With the introduction of pituitary extract as a hormonal method of induction of labor in 1913, the use of this method gained acceptance among obstetricians. However, due to the use of large doses and the impurity of the extract, numerous adverse effects were reported. Gradually, as the number of reported cases of uterine rupture increased, pituitary extract became discredited in many centers. Initially, oxytocin (pituitary extract) was administered as an intramuscular or subcutaneous route. In 1943, Page suggested that the pituitary extract oxytocin be given in the form of an intravenous infusion, and in 1949, Theobald reported his initial results with this form of administration. Fourteen years later, in 1953, the structural formula of oxytocin was discovered, and synthetic oxytocin was in use since 1955. In 1955, Karim and colleagues were the first to report the use of prostaglandins for labor induction. Since then, the use of prostaglandins, in different varieties and forms of administration, has become a common method of labor induction. More recently, synthetic prostaglandin analog misoprostol has gained acceptance as an effective and safe method of labor induction (Drife 2021).

The following are the sequential events in the history of induction of labor that have helped the modern obstetrics we know and practice:

1. Castor oil is a potent cathartic that dates back to ancient Egypt used to stimulate labor.
2. Nipple stimulation as a method of cervical ripening and labor induction.
3. Membrane stripping was initially suggested in 1810 by James Hamilton.
4. Massage of the uterus in 1820 by Ulsamer to induce labor.
5. Eggplant parmesan, herbs oregano, and basil are suggested to have stimulated uterine contractions.
6. Sex to induce labor using prostaglandins in semen.
7. Acupuncture / Acupressure by ancient Chinese on two-point finger widths above the inner ankle of the calf and the webbing between thumb and forefinger.

8. Laminaria tent used by Wilson in 1865. They are made from a seaweed root dried. When inserted in the cervix, they gradually swell several times by absorbing moisture from the cervix. Thus, the dilatation process is safe, gradual, and painless without harm to the cervix, and the cavity becomes softened and enlarged.
9. Extra amniotic fluid was used to induce labor by Cohen in 1846.
10. Scanzoni used a hot carbolic acid douche in 1856.
11. Kraus introduced bougies and fell into disuse due to the high sepsis rate. Schreiber in 1843 stimulated labor electrically.
12. Artificial rupture of the membranes was first used by Denman in 1756 and is known as the English method.
13. Pitocin was extracted from the posterior pituitary gland in 1906. Blair Bell described its application in the pregnant uterus in 1909. Its use for induction of labor was first reported by Theobald in 1952. In 1968, Turnbull and Anderson introduced the titration method for oxytocin administration.
14. Prostaglandin was first isolated from the seminal fluid of monkeys, sheep, and goats by Ulf Von Ehler.
15. Elias Corey synthesized dinoprostone in 1970. In 1971, Karim and Sharma reported the results of labor at term with the use of oral PGE2.
16. In 1975, Alder and Embrey gave PGE2 extra amniotically.
17. In 1977, Mellour et al, Wilson gave PGE2 intravaginally.
18. In 1980, Hefni and Louis gave PGE2 intracervically.
19. Buccellato1, in 2000, compared 50μg misoprostol with extra amniotic saline and gave similar outcomes.
20. Karim and his colleagues in Uganda, noted that PGF2α appeared in amniotic fluid during labor.
21. An interesting observation noted by Howie was that women receiving intravenous prostaglandin E2 or F2α for induction of labor exhibited oxytocin levels in the plasma similar to women in the late first stage of spontaneous labor. Extra amniotic saline infusion by balloon catheters was attributed to Barnes in 1863. In 1998, Hamlin and Muller reported catheter infusion to be more efficacious.

Physiology Of Labor

Labor is the process whereby the birth canal is prepared to allow the baby to pass from the uterine cavity to the outside world. In the normal course of events, it ends with a spontaneous or instrumental vaginal delivery or Cesarean section. Conventionally, it is divided into a first stage, during which the cervix passively dilates in response to uterine contractions, a second stage where the mother pushes the baby through the vagina, and a third stage where the placenta delivers (Grant et al. 2015).

Predicting the date of delivery

The length of pregnancy in mammals varies from under three weeks in mice to over 20 months in elephants. It has an obvious relationship to body size but within each species, the mean duration remains constant, though the range varies, with humans tending towards the upper end of variability (Jukic et al. 2013). The exact duration of human pregnancy has been studied from the classical era to the present day. Hippocrates defined pregnancy as a nine-month process. In classical Greece, there were several calendars, some based on the lunar month of about 29½ days. Nine lunar months add up to 266 days but Hippocrates, having considered whether pregnancy should be dated from the last menstrual period (LMP) or the date of conception, concluded that 280 days was the accurate duration (Tsoucalas and Sgantzos 2017). "Naegele's rule" When obstetrics emerged as a medical specialty in the 18th century, the prediction of the expected date of delivery (EDD) became a subject of scientific study. In 1744, Herman Boerhaave, Professor at Leiden, wrote: "Women, for the most part, are impregnated after the end of their period: Numerous experiments undertaken in France confirm this: one hundred births altogether, ninety-nine came about in the ninth month after the last menstruation by counting one week after the last period and by reckoning the nine months of gestation from that time" (Baskett and Nagele 2000). In 1812 Franz Naegele, professor at Heidelberg translated Boerhaave's Latin into German and formulated what became known as "Naegele's Rule". An English version appeared in an American textbook of 1871 as follows: "Imagine … The termination of the last menstrual period is to be on the 10th day of January; then count back three months, which will correspond to the 10th day of October, and add seven days this will bring you to the 17th day of October the day on which the labor will commence." (Baskett and Nagele 2000). Naegele was vague about which day of the LMP to count from but in 1847, in the seventh edition of his textbook, he specified counting from day one (Loytved and Fleming 2016).

Ultrasonography

Early in the 20th century, X-rays were used to assess fetal maturity but after the obstetric ultrasound was introduced in 1958 it became possible to make serial observations of fetal growth. The biparietal diameter (BPD) was measured, initially with a single beam of ultrasound and then by two-dimensional scans. BPD graphs from 13 weeks to term were constructed and the "ultrasound EDD" proved to be correct in 95 % of cases (Campbell 1969; Galal et al. 2012; Pystynen et al. 1967). As techniques improved, fetal crown-rump length (CRL) could be measured more accurately. A graph from 6 to 14 weeks of pregnancy was published in 1973 which could predict pregnancy maturity within three days. It remained in use until the 21st century. Real-time scanners enabled the measurement of other fetal dimensions, e.g. femur length, but the BPD remained the mainstay of gestation assessment. Routine ultrasound screening was introduced in Malmo in the mid-1970s. € By 1985 all antenatal patients at Kings College Hospital, London, were being scanned, and BPD measurements at 12e18 weeks "were significantly more accurate in gestational predictions than those based on menstrual history" (Campbell et al. 1985). In 1997, Gardosi, in a retrospective analysis of the files of 24,675 pregnancies, reported that most pregnancies undergoing post-term induction were not post-term by ultrasound dates. He advocated a policy of establishing the EDD based on ultrasound dates alone.

Uterine Changes:

The myometrial layer of the uterus is composed of bundles of smooth muscle cells surrounded by connective tissue, which is not terminally differentiated and hence is readily adaptable to environmental changes. In the myometrium, the thick and thin filaments are found in long, random bundles throughout the cells. This plexiform arrangement aids greater shortening and force-generating capacity. There is greater multidirectional force generation in the uterine fundus compared with that of the lower uterine segment which permits versatility in expulsive force directionality. The balance between myometrial relaxation and contraction is controlled by steroid- and peptide-hormone transcriptional regulation of key genes and their protein products. The myometrial contractility results from enhanced interactions between the actin and myosin proteins heightened excitability of individual myometrial cells; and promotion of intracellular crosstalk that allows synchronous contractions to develop (Drife 2021).

Phase 2 myometrial changes prepare it for labor contractions. This results from a shift in the expression of key proteins that control uterine quiescence to an expression of contraction-associated proteins described earlier. Of these CAPs, myometrial oxytocin receptors and gap junction proteins, such as connexin-43, markedly rise in number. These CAPs increase uterine irritability and responsiveness to uterotonics. Another critical change in phase 2 is the formation of the lower uterine segment from the isthmus. With this development, the fetal head often descends to or even through the pelvic inlet—so-called lightning (Abel et al. 2022; Shiferaw et al. 2022; Sohn et al. 2022).

Because of its long-standing application for labor induction, it seems logical that oxytocin must play a central role in spontaneous labor. Myometrial oxytocin receptor levels rise during phase 2 of parturition, and the level of oxytocin receptor mRNA in human myometrium at term is greater than that found in preterm myometrium (Baskett and Nagele 2000).

The development of gap junctions that allow communication between adjacent cells is one of the earliest changes occurring during the process of labor. Myometrial gap junctions begin to increase before term and their number becomes significantly higher during labor and falls rapidly in the postpartum period. Oestrogen and prostaglandins induce the formation of gap junctions and progesterone inhibits it. Oxytocin cannot induce the formation of gap junctions and cannot stimulate the myometrium in the absence of gap junctions (Drife 2021). The fundamental process involved in all myometrial contractions is actin-myosin interaction. Myosin is the principal protein of muscle contraction and the process is dependent on calcium. Myometrial contraction is an active process requiring energy in the form of ATP (Sohn et al. 2022).

Role Of Placenta:

The fetal membranes—amnion and chorion and adjacent decidua— make up an important tissue shell around the fetus that serves as a physiological, immunological, and metabolic shield to protect against untimely parturition initiation. The amnion provides virtually all of the fetal membranes' tensile strength to resist membrane tearing and rupture. This avascular tissue is highly resistant to penetration by leukocytes, microorganisms, and neoplastic cells. It also constitutes a selective filter to prevent fetal particulate-bound lung and skin secretions from reaching the maternal compartment (Garnica and Chan 1996). In this manner, maternal tissues are protected from amnionic fluid constituents that could prematurely accelerate decidual or myometrial activation or could promote adverse events such as amnionic fluid embolism (Garnica and Chan 1996).

The amnion synthesizes prostaglandins, and late in pregnancy, synthesis is augmented by increased phospholipase A2 and prostaglandin H synthase, type 2 (PGHS-2) activity. During pregnancy, the transport of prostaglandins from the amnion to maternal tissues is limited by the expression of the inactivating enzymes, prostaglandin dehydrogenase (PGDH), in the chorion. During labor, PGDH levels decline, and amnion-derived prostaglandins can influence membrane rupture and uterine contractility. The role of decidual activation in parturition is unclear but may involve local progesterone metabolism and higher prostaglandin receptor concentrations, thus enhancing uterine prostaglandin actions and cytokine production (Napso et al. 2018).

Role Of Prostaglandins

Prostaglandins are lipid molecules with varied hormone-like actions. In parturition, they play a prominent role in myometrial contractility, relaxation, and inflammation. Prostaglandins interact with a family of eight different G–protein–coupled receptors, several of which are expressed in the myometrium and cervix. The myometrial responses to prostaglandins stem from a balance between prostaglandin synthesis versus metabolism, from the relative expression of various prostaglandin receptors, or a switch in receptor signaling pathways (Challis et al. 1999).

Cervical Changes

Before contractions begin, the cervix must undergo extensive remodeling. This eventually leads to the cervix yielding and dilating from forceful uterine contractions. Cervical modifications during phase 2 principally involve connective tissue changes which are termed cervical ripening. The transition from the softening to the ripening phase begins weeks or days before labor. During this transformation, the cervical matrix changes its total amounts of glycosaminoglycans, which are large linear polysaccharides, and proteoglycans, which are proteins bound to these glycosaminoglycans (Hutchison et al. 2022).

Higher turnover of collagen during pregnancy allows the gradual replacement of mature cross-linked collagen fibrils with poorly cross-linked fibrils, which yields greater collagen disorganization. This increased turnover, rather than loss of collagen is responsible for cervical remodeling (Gill et al. 2022; Hutchison et al. 2022).

Effacement causes expulsion of the mucous plug as the cervical canal is shortened. Because the lower segment and cervix have less resistance during a contraction, a centrifugal pull is exerted on the cervix, creating cervical dilation. As uterine contractions cause pressure on the membranes, the hydrostatic action of the amnionic sac in turn dilates the cervical canal like a wedge. The process of cervical effacement and dilation causes the formation of the fore bag of amnionic fluid (Gill et al. 2022).

This is the leading portion of the fluid and amnionic sac located in front of the presenting part. In the absence of intact membranes, the pressure of the presenting fetal part against the cervix and lower uterine segment is similarly effective. Early rupture of the membranes does not retard cervical dilation so long as the presenting fetal part is positioned to exert pressure against the cervix and lower segment.

Cervical dilation is divided into latent and active phases. The active phase is subdivided further into the acceleration phase, the phase of maximum slope, and the deceleration phase (Friedman, 1978). The duration of the latent phase is more variable and sensitive to extraneous factors. For example, sedation may prolong the latent phase, and myometrial stimulation shortens it. The latent phase duration has little bearing on the subsequent course of labor, whereas the characteristics of the accelerated phase are usually predictive of labor outcome (Mohamoud et al. 2022).

Induction of labor has a great role in preventing neonatal and maternal mortality and morbidity. Despite its role, Induction sometimes fails with a potential risk of increased maternal and neonatal mortality and morbidity. In Ethiopia, Abel Shiferaw et al. investigated the outcome of labor induction and its associated factor among 444 laboring women at the dilchora referral hospital between 2014 and 2019. They found that a mother whose labor is induced by misoprostol, a mother whose labor is induced by both (oxytocin and misoprostol), and a non-reassuring fetal heart rate pattern were significantly associated with the success of induction and concluded that the prevalence rate of success of labor induction was found (83.6%) and the most common indications for labor inductions were premature rupture of membranes (PROM) and Post-term. Furthermore, the study described that the most common method of induction in Dilchora referral hospital is iv oxytocin and the minister of health should develop national evidence-based clinical practice guidelines for the labor of induction and enforce its implementation (Abel et al. 2022).

Recent reports from developing countries:

In Somalia, A. M. Mohamoud. investigated the epidemiology of induction of labor among women aged 15 - 49 who delivered at Shaafi Hospital in Hodon District. The study revealed that the prevalence of induction labor among women aged 15 -49shaadiad undergone induction of labor at Shaafi hospital for the period of six months from October 2019 to March 2020 was 40 women out of 370 women who were derived at Shaafi Hospital from October 2019 to 31 March 2020. The result showed that the majority of the respondents 18 (60%) were aged between 25 - 34 followed by 8 (27%) were aged between 25 - 34 yrs. While only 4 (8%) were between the ages of 35 - 44 yrs. While 21 (70%) were mixed, 11 (37%) were primary level, 7 (23%) were illiterate, 21 (70%) were housewives, followed by 4 (13%) were employed. 15 (50%) they're whose monthly income was between $300 - $400 monthly. The study showed that a total of 12 (40%) had undergone induction once time previously, followed by 8 (27%) who had undergone induction two times, 6 (20%) had undergone it previously three times, and 4 (13%) more than four times. 21 (70%) were delivered by spontaneous vaginal delivery (SVD), 6 (20%) were Cesarean section (CS) and 3 (10%) by instrumental vaginal delivery. The result showed that the outcomes of labor 22 (73%) gave a safe birth (a life newborn) through induced labor one time, followed by 2 (7%) two times. Followed by 6 (20%) who gave birth (dead newborn) through induced labor one time with their previous deliveries (Table 2). In addition, post-term 27 (90%), followed by responded intrauterine fetal death (IUFD) 2 (7%) Pregnancy induced hypertension (PIH) 1 (3%) were found to be the main reason for the visits induction of labor. The study revealed that the socio-demographic and obstetrical determinants such as age, and daily meal intake as well as antenatal care visits during pregnancies and reasons for induction; e.g. Post term (post-mature), intrauterine fetal death (IUFD) and pregnancy-induced hypertension (PIH) showed significant association to the induced labor while non-significant have been observed with mother's gestational age and their induction of labor (Mohamoud et al. 2022).

A systematic review and meta-analysis assessed if labor induction in advanced maternal age was associated with increased rates of cesarean delivery compared to expectant management. The authors suggested that induction of labor at term in a subgroup of women of advanced maternal age (AMA) does not significantly alter the risk of cesarean section, assisted vaginal delivery (AVD), or postpartum hemorrhage (PH) when compared to expectant management. Although the decision between elective induction of labor at 39–40 weeks of gestation or expectant management until 41 weeks of gestation should be individualized and ultimately discussed with women, these findings could help the decision-making of those clinicians who, despite considering that induction of labor could prevent fetal and neonatal severe complications, do not consider elective induction of labor due to its potential risk of cesarean section. In this subgroup of women with increased risk of one of the most feared pregnancy complications such as stillbirth, this evidence supports the theory that induction of labor at 39–40 weeks does not increase some of the most feared adverse maternal outcomes related to the time of delivery. Additional research is needed to confirm whether this intervention might positively prevent stillbirth, without increasing neonatal risks associated with labor induction (Fonseca et al. 2020).

Caughey et al. conducted a study of maternal and neonatal outcomes of elective induction of labor. The objective of this study was for the Stanford-UCSF Evidence-Based Practice Center to examine the evidence regarding four Key Questions: What evidence describes the maternal risks of elective induction versus expectant management? What evidence describes the fetal/neonatal risks of elective induction versus expectant management? What is the evidence that certain physical conditions/patient characteristics are predictive of successful induction of labor? How is a failed induction defined? the searches identified 3,722 potentially relevant articles, of which 76 articles met the inclusion criteria. Nine RCTs compared expectant management with elective induction of labor. We found that overall, expectant management of pregnancy was associated with approximately 22 percent higher odds of cesarean delivery than elective induction of labor (OR 1.22, 95 percent CI 1.07-1.39; absolute risk difference 1.9, 95 percent CI: 0.2-3.7 percent). The majority of these studies were in women at or beyond 41 weeks of gestation (OR 1.21, 95 percent CI 1.01-1.46). In studies of women at or beyond 41 weeks of gestation, the evidence was rated as moderate because of the size and number of studies, and the consistency of the findings. Among women less than 41 weeks of gestation, three trials reported no difference in risk of cesarean delivery among women who were induced as compared to expectant management (OR 1.73; 95 percent CI: 0.67-4.5, P=0.26), but all of these trials were small, non-U.S., older, and of poor quality. When we stratified the analysis by country, we found that the odds of cesarean delivery were higher in women who were expectantly managed compared to elective induction of labor in studies conducted outside the U.S. (OR 1.22; 95 percent CI 1.05-1.40) but were not statistically different in studies conducted in the U.S. (OR 1.28; 95 percent CI 0.65-2.49). Women who were expectantly managed were also more likely to have meconium-stained amniotic fluid than those who were electively induced (OR 2.04; 95 percent CI: 1.34-3.09). Observational studies reported a consistently lower risk of cesarean delivery among women who underwent spontaneous labor (6 percent) compared with women who had an elective induction of labor (8 percent) with a statistically significant decrease when combined (OR 0.63; 95 percent CI: 0.49-0.79), but again utilized the wrong control group and did not appropriately adjust for gestational age. We found moderate to high-quality evidence that increased parity, a more favorable cervical status as assessed by a higher Bishop score, and decreased gestational age were associated with successful labor induction (58 percent of the included studies defined success as achieving a vaginal delivery anytime after the onset of the induction of labor; in these instances, induction was considered a failure when it led to a cesarean delivery). In the decision analytic model, we utilized a baseline assumption of no difference in cesarean delivery between the two arms as there was no statistically significant difference in the U.S. studies or women before 41 0/7 weeks of gestation. In each of the models, women who were electively induced had better overall outcomes among both mothers and neonates as estimated by total quality-adjusted life years (QALYs) as well as by a reduction in specific perinatal outcomes such as shoulder dystocia, meconium aspiration syndrome, and preeclampsia. Additionally, induction of labor was cost-effective at $10,789 per QALY with elective induction of labor at 41 weeks of gestation, $9,932 per QALY at 40 weeks of gestation, and $20,222 per QALY at 39 weeks of gestation utilizing a cost-effectiveness threshold of $50,000 per QALY. At 41 weeks of gestation, these results were generally robust to variations in the assumed ranges in univariate and multi-way sensitivity analyses. However, the findings of cost-effectiveness at 40 and 39 weeks of gestation were not robust to the ranges of the assumptions. In addition, the strength of evidence for some model inputs was low, therefore our analyses are exploratory rather than definitive. The authors concluded that Randomized controlled trials suggest that elective induction of labor at 41 weeks of gestation and beyond may be associated with a decrease in both the risk of cesarean delivery and of meconium-stained amniotic fluid. The evidence regarding elective induction of labor before 41 weeks of gestation is insufficient to draw any conclusion. There is a paucity of information from prospective RCTs examining other maternal or neonatal outcomes in the setting of elective induction of labor. Observational studies found higher rates of cesarean delivery with elective induction of labor, but compared women undergoing induction of labor to women in spontaneous labor and were subject to potential confounding bias, particularly from gestational age. Such studies do not inform the question of how elective induction of labor affects maternal or neonatal outcomes. Elective induction of labor at 41 weeks of gestation and potentially earlier also appears to be a cost-effective intervention, but because of the need for further data to populate these models, our analyses are not definitive. Despite the evidence from the prospective, RCTs reported above, there are concerns about the translation of such findings into actual practice, thus, there is a great need for studying the translation of such research into settings where the majority of obstetric care is provided (Caughey et al. 2009).

Abdel Hamid et al. compared propranolol and misoprostol versus misoprostol alone for labor induction in primigravids in a Randomized clinical trial (Abdel Hamid et al. 2023). They conclude that propranolol, when used with misoprostol for induction of labor, results in augmentation of action of misoprostol and a significantly shorter induction-delivery interval (Abdel Hamid et al. 2023).

Hokkila et al. compared the efficacy of a 200-μg misoprostol vaginal insert vs oral misoprostol regarding the cesarean section rate and the time interval to vaginal delivery in nulliparous women with unfavorable cervix in a randomized national multicenter trial (Hokkila et al. 2019). The results in this study showed in the misoprostol vaginal insert group, the median time to vaginal delivery was shorter (24.5 hours vs 44.2 hours, $P < 0.001$), whereas no difference was found in the cesarean section rate (33.8% vs 29.6%, odds ratio [OR] 1.21, 95% confidence interval [CI] 0.66-1.91, $P = 0.67$). Other induction methods and labor augmentation with oxytocin and/or amniotomy were less frequent in the misoprostol vaginal insert group (OR 0.32, 95% CI 0.18-0.59, and OR 0.56, 95% CI 0.32-0.99, respectively). Need for tocolysis and meconium-stained amniotic fluid were more common in the misoprostol vaginal insert group (OR 3.63, 95% CI 1.12-11.79 and OR 2.38, 95% CI 1.32-4.29, respectively). Maternal and neonatal adverse events did not differ between groups.

the authors concluded that misoprostol vaginal insert proved to shorten the time to vaginal delivery and to reduce the use of other methods of labor induction and augmentation, but it did not reduce the cesarean section rate compared with oral misoprostol. The benefit of more rapid delivery associated with misoprostol vaginal insert should be weighed against the greater risks for uterine hyperstimulation and meconium-stained amniotic fluid (Hokkila et al. 2019).

Sharami studied the effects of maternal age on the mode of delivery following induction of labor in nulliparous term pregnancies in a retrospective cohort study. The results showed the median and interquartile ranges of gestational age were not significantly different, comparing the two groups ($p = 0.415$), although these variables were significantly different regarding maternal height among the two groups ($p = 0.007$). There was a significant relationship between the methods of labor induction among the two groups ($p = 0.005$). There was a prominent statistical relationship between (a) C/S deliveries and also (b) indications of C/S among the two groups ($p = 0.004$ and $p = 0.033$, respectively). Univariate logistic regression tests revealed maternal age groups, neonatal weight, and history of underlying diseases had significant results ($p < 0.05$). they concluded that increased maternal age is associated with higher rates of CS among nulliparous women with term pregnancies who underwent labor induction (Sharami et al. 2022).

Kamel RA et al. studied the predicting cesarean delivery for failure to progress as an outcome of labor induction in term singleton pregnancy. Univariate and multivariate analyses were used for the selection of potential predictors and model fitting. The independent predictive variables for cesarean delivery included maternal age (odds ratio, 1.12; P=.003), cervical length (odds ratio, 1.08; P=.04), angle of progression at rest (odds ratio, 0.9; P=.001), and occiput posterior position (odds ratio, 5.7; P=.006). We tested the performance of the prediction model on our cross-validation group. The calculated areas under the curve for the ability of the model to predict cesarean deliveries were 0.7969 (95% confidence interval, 0.71-0.87) and 0.88 (95% confidence interval, 0.79-0.97) for the developed and validated models, respectively. They concluded that maternal age and sonographic fetal occiput position, angle of progression at rest, and cervical length before labor induction are very good predictors of induction outcome in nulliparous women at term (Kamel et al. 2021).

Ejigu et al. studied the predicting factors of failed induction of labor in three hospitals in Southwest Ethiopia (Ejigu and Lambyo 2021). The result showed that premature rupture of the membrane was the most common cause of labor induction and the commonly used method of labor induction was oxytocin infusion. Cesarean section was done for 28.1% of induced women. Failed induction of labor was found to be 21%. Primiparous [AOR = 2.35 (1.35-4.09)], analgesia/anesthesia [AOR = 4.37 (1.31-14.59)], poor Bishop Score [AOR = 2.37 (1.16-4.84)], Birth weight ≥ 4 k grams [AOR = 2.12 (1.05-4.28)] and body mass index [AOR = 5.71 (3.26-10.01)] were found to be significantly associated with failed induction of labor. The authors concluded that the prevalence of failed induction of labor was found to be high. Preparation of the cervix before induction in primiparity women is suggested to improve the success of induction. To achieve the normal weight of women and newborns, proper nutritional interventions should be given to women of reproductive age. It is better to use analgesia/anesthesia for labor induction when it becomes mandatory and there are no other optional methods of no- pharmacologic pain management (Ejigu and Lambyo 2021).

Chapter Three Materials and Methods

Methods

Study design: A retrospective cross-sectional study was conducted among mothers who gave birth at Al Sabeen Maternal Hospital in Sana'a, Yemen between 1,6, 2021, and 30,6, 2022. Al Sabeen Maternal Hospital, also El Sabeen Maternity and Child Hospital, is a hospital in Sana'a, Yemen. It is located in the south of the city, immediately north of the ALshab Mosque. Al Sabeen Maternal Hospital established in 1986 is one of the oldest hospitals in the Republic of Yemen.

Source and Study Populations

Inclusion criteria: All women who gave birth at Al Sabeen Maternal Hospital in the specified period were the source population. All selected women who gave birth after 28 weeks of gestation within the specified period at Al Sabeen Maternal Hospital were the study population. The cards with appropriate indications and complete maternal data were included.

Exclusion criteria: The cards containing incomplete information were excluded.

Sample Size:

All pregnant patients who underwent labor induction between the period of 1,6, 2021 to 30,6,2022 were included.

Study Variables and Measurements

The dependent variables were the IOL and failed induction. The independent variables were age, residence, gravidity, parity, history of antenatal care follow-up, gestational age at induction, Bishop Score before induction, weights of the baby, and methods of induction.

Successful Induction

If a woman gave birth vaginally with or without the aid of a vaginal instrument after labor induction (Beshir et al.).

Failed Induction

If a woman delivers by C/S due to failure to acquire either adequate uterine contraction ($\geq$3 contractions and duration lasting $\geq$40 s in the 10-min period) or failed to show favorable cervical changes (reaches at least 4 cm in dilatation and fully effaced) despite being on oxytocin drip for at least 6–8 h) (Lueth et al.). A favorable Bishop score was defined as a Bishop score ≥ 9 (Mohammed et al.).

Data Collection Method and Tools

The data were collected through a review of records from patient cards, labor ward logbooks, discharge logbooks, and operation room logbooks using a structured checklist from June 1, 2021, to June 30, 2022. The checklist was composed of some sociodemographic and obstetric history profiles, mode of the labor onset, indication for induction of labor, outcomes of labor induction, and maternal complications after the induction. The quality of the data was maintained by training the data collectors and utilizing a structured and tested checklist. Furthermore, regular checks on the completeness and consistency of the data were carried out daily.

Statistical analysis

The mean± SD was used to describe the quantitative variables and the frequency (percent) was used for qualitative variables. The normality assumption of the variables in the study was assessed by the Kolmogorov-Smirnov test. For comparison, the equality of two mean values in qualitative variables and default equality of variances of the independent t-test is used or the non-parametric Mann-Whitney U test was applied. To evaluate the correlation between variables Pearson's correlation coefficient test was used. A binary logistic regression analysis was used to look for the association between outcome variables and independent variables. Variables with a p-value of <0.25 in the bivariate logistic regression were included in the multivariable logistic regression. Finally, variables in the multivariable logistic regression analysis with a $p < 0.05$ were considered as significantly associated with the outcome variables. Logistic regression analysis was used to examine separately (raw effects) and simultaneously (adjusted effects) the predictor variables of IOL and the main source of using IOL (independent variables) with success (dependent variable) and to show their relationship with each other. Since demographic characteristics and other clinical factors could affect this relationship, these variables were considered for adaptation in the multivariate analysis if they had a significance level of less than 0.4 in the univariate analysis, based on the cut-off point specified in the questionnaire instructions and the regression model; having failure was considered a consequence factor. The odds ratio (OR) and 95% confidence interval (CI) were used to show the effect size in this model. SPSS 20 was used to analyze the data, and $P< 0.05$ was considered as statistically significant. The data were analyzed by statistical software SPSS version 22 (SPSS Inc., Chicago, Illinois, USA).

Ethical approval: The study received ethics approval from 21 September University, Sana'a, Yemen, and the Medical Research Ethics Committee on 8, Jun 2022 with ID: H-08-E-08-

P12. All eligible participants were informed about the aims of the study; consent was signed before participation.

Chapter Four
Results

Result:

Socio-demographic and obstetric characteristics of the study participant:

Of 10219 laborers, 505 cases underwent labor inductions with a prevalence of 4.94%. The Chart retrieval rate was 100%. The main age of participants was 26.99 ±6.24 years, and most of them (45.9%) were aged between 25-34 years, followed by age less than 24 years in 185 (36.6%) patients **(Figure 1).** Of the total participants, 375 (73.9%) live in urban and most of the patients 484 (95.8%) were from Sanaa city **(Figure 2 and 3).** Multiparity was seen in 334 (65.1%) of patients while 171 (34.9%) were nulliparous **(Figure 4)**. The study also revealed that 334 (73.9%) of the participants had antenatal care visit follow-up during pregnancy and the rest 171 (26.1%) had no antenatal care visit follow-up **(Figure 5)**. The Socio-demographic and Obstetric Characteristics of the study participants are shown in table 1.

Table 1: Baseline characteristics of patients. (N= 505)

Variables	N (%)
Mean age (year), mean± SD	26.99 ±6.24
Age category	
less than 24 years	185 (36.6)
Between 25-34 years	233 (45.9)
More than 35 years	87 (17.4)
Parity	
Primipara	171 (34.9)
Multipara	334 (65.1)
Residence	
Rural	130 (26.1)
Urban	375 (73.9)
City	
Sanaa	484 (95.8)
IBB	3 (0.6)
Imran	10 (2.0)
Others	8 (1.6)
Antenatal care visit	
Yes	334 (73.9)
No	171 (26.1)

Characteristics of labor induction:

Most mothers 374 (84.4%) had a gestational age of 37-40 weeks followed by a gestational age of less than 36 weeks 76 (15.6%) **(Figure 6)**. Before induction time, 280 (55.4%) of the women had bishop scores less than 6, followed by bishop scores more than 6 in 192 (38%) pregnant women, and 33 did not have reported bishop scores **(Figure 7)**. The main indication of labor induction was premature rupture of a membrane in 329 (65.1%), followed by preeclampsia in 70 (13.9%) pregnant women **(Figure 8).** Mode of the labor onset was Oxytocin in 109 (21.6%) and Misoprostol in 396 (78.4%) **(Figure 9)**. Characteristics of labor induction are shown in Table 2.

Table 2: Characteristics of labor induction (N= 505)

Variables	
Bishop score before induction	
Less than 6	280 (55.4)
Greater than/equal to 6	192 (38%)
Missing	6.6%
Indication for induction	
Preeclampsia	70 (13.9)
Post-term pregnancy	44 (8.7)
Premature rupture of membrane	329 (65.1)
IUFD	22 (4.4)
Oligohydramnios	40 (7.9)
Gestational age at induction (weeks)	
less than 37 weeks	76 (15.6)
More than 37 weeks	374 (84.4)
Mode of the labor onset	
Oxytocin	109 (21.6)
Misoprostol	396 (78.4)

Outcomes of induction:

Mode of delivery after induction was spontaneous vaginal delivery in 444 (87.9%), instrumental vaginal delivery in 19 (3.8%), and Cesarean section in 42 (8.3%) **(Figure 10).** Maternal complications were presented in 6 cases, postpartum hemorrhage was seen in 3 (50%), and external genitalia tear in one (16.7%) case. Regarding child outcome, most of the newborns

395 (78.2%) had a birth weight between 2.5–3.9 kg **(Figure 11)**, and 12 (2.4%) neonates needed NICU admission **(Figure 12).**

Characteristics of Outcomes of induction are shown in Tables 3, 4, 5, and 6.

Table 3: Outcomes of induction (N= 505)

Variables	
Mode of delivery after induction	
Spontaneous vaginal delivery	444 (87.9)
Instrumental vaginal delivery	19 (3.8)
Cesarean section	42 (8.3)
Maternal complications	
Yes	6 (1.2)
No	499 (98.8)
Maternal complications types (n=6)	
Postpartum hemorrhage	3 (50.0)
External genitalia tear	1 (16.7)
Other	2 (33.3)
Admission to NICU	
Yes	12 (2.4)
No	493 (97.6)
Birth weight of newborns	
less than 2.5 kg	104 (20.6)
between 2.5–3.9 kg	395 (78.2)
more than ≥4 kg	6 (1.2)

Table 4: Mean distributions of Quantitative variables

Variable	Mean	Median	Min	Max
Age of mother (year)	26.99 (6.24)	26 (22 – 31)	16	45
Gestational age at induction	37.87(2.54)	38 (37 – 39)	26	42
Weight of baby (kg)	2.73 (0.54)	3 (2.5 – 3.0)	0.50	4.50

Table 5: Investigating the relationship of quantitative variables in the study

	Age of mother	Gestational age	Weight of baby
Age of mother	1		
Gestational age	r= -0.041	1	
Weight of baby	r= 0.097	r= 0.481	1
Statistical test used: Pearson correlation coefficient test			

Table 6: The relationship of quantitative variables according to Induction Outcome

	Induction Outcome		Mean difference (MD)	Confidence interval %95 CI	P value
	Success Mean (SD) n=444	Failure Mean (SD) n=61			
Age of mother	27.18±6.20	25.59±6.37	1.59	-0.08 to 3.26	0.062
Gestational age	37.82±2.55	38.23±2.47	-0.41	-1.09 to 0.27	0.239
Weight of baby	2.74±0.55	2.66±0.53	0.089	-0.058 to 0.23	0.235
The statistical test used: Independent Samples T-Test					

Associated factors with labor induction outcome:

Fisher's exact test and Chi-square showed that mothers' between (24 and 34 years), using misoprostol for induction, indication for induction, and multiparity were associated with IOL outcomes and were statistically significant (p less than 0.05) (Table 7).

Table 7: Factors associated with labor induction outcome in univariate analysis.

Variables	Categories	Induction outcome		P-value
		Success n=444 N (%)	Failed n=61 N (%)	
Maternal complications	no	439(88.0)	60(12.0)	0.540
	yes	5(83.3)	1(16.7)	
Age mother (year)	less than 24	154(83.2)	31(16.8)	**0.038**
	Between 25-34	213(91.4)	20(8.6)	
	More than 34	77(88.5)	10(11.5)	
Gestational age (weeks)	less than 37 weeks	69(90.8)	7(9.2)	0.279
	Between 37-40	330(88.2)	44(11.8)	
	More than 40 weeks	45(81.8)	10(18.2)	
Weight of baby (kg)	less than 2.5 kg	90(86.5)	14(13.5)	0.879
	between 2.5–3.9 kg	348(88.1)	47(11.9)	
	more than ≥4 kg	6(100.0)	0(0.00)	
Residence	Rural	111(85.4)	19(14.6)	0.303
	Urban	333(88.8)	42(11.2)	
Bishop score before induction	Less than 6	241(86.1)	39(13.9)	0.159
	Greater than/equal to 6	203 (89.1)	22(10.9)	
Antenatal care visit	No	150(87.7)	21(12.3)	0.921
	Yes	294(88.0)	40(12.0)	
Parity	Primipara	134(78.4)	37(21.6)	**> 0.001**
	Multipara	310(92.8)	24(7.2)	
Mode of the labor onset	Oxytocin	84(77.1)	25(22.9)	**> 0.001**
	Misoprostol	360(90.9)	36(9.1)	
Admission to NICU	No	435(88.2)	58(11.8)	0.167
	Yes	9(75.0)	3(25.0)	
Indication for induction	Preeclampsia	57(81.4)	13(18.6)	**0.008**

	Post-term pregnancy	33(75.0)	11(25.0)	
	Premature rupture of membrane	295(89.7)	34(10.3)	
	IUFD	21(95.5)	1(4.5)	
	Oligohydramnios	38(95.0)	2(5.0)	
The statistical test used: Fisher's exact test and Chi-square				

Associated factors with Maternal complications:

We evaluated the associated factors with maternal complications using Fisher's exact test and chi-square. However, no factors were associated with maternal complications and were statistically not significant (p more than 0.05) (Table 8).

Table 8: Associated factors with Maternal complications

Variables	**Categories**	**Maternal complications**		**P-value**
		No n=499 N(%)	Yes n=6 N(%)	
Induction Outcome	Success	439(98.9)	5(1.1)	0.540
	Failed	60(98.4)	1(1.6)	
Age mother (year)	less than 24	183(98.9)	2(1.1)	1.000
	Between 25-34	230(98.7)	3(1.3)	
	More than 34	86(98.9)	1(1.1)	
Gestational age (weeks)	less than 37 weeks	75(98.7)	1(1.3)	1.000
	Between 37-40	369(98.7)	5(1.3)	
	More than 40 weeks	55(100.0)	0(0.0)	
Weight of baby (kg)	less than 2.5 kg	102(98.1)	2(1.9)	0.637
	between 2.5–3.9 kg	391(99.0)	4(1.0)	
	more than ≥4 kg	6(100.0)	0(0.0)	
Residence	Rural	128(98.5)	2(1.5)	0.650
	Urban	371(98.9)	4(1.1)	
Bishop score before induction	Less than 4	276(98.6)	4(1.4)	1.000
	5-8	190(99.0)	2(1.0)	
	Greater than/equal to 9	33(100.0)	0(0.0)	
Antenatal care visit	No	169(98.8)	2(1.2)	1.000
	Yes	330(98.8)	4(1.2)	
Parity	Primipara	170(99.4)	1(0.6)	0.669
	Multipara	329(98.5)	5(1.5)	

Mode of the labor onset	Oxytocin	107(98.2)	2(1.8)	0.614
	Misoprostol	392(99.0)	4(1.0)	
Admission to NICU	No	488(99.0)	5(1.0)	0.135
	Yes	11(91.7)	1(8.3)	
Indication for induction	Preeclampsia	69(98.6)	1(1.4)	0.662
	Post-term pregnancy	43(97.7)	1(2.3)	
	Premature rupture of membrane	326(99.1)	3(0.9)	
	IUFD	22(100.0)	0(0.0)	
	Oligohydramnios	39(97.5)	1(2.5)	
The statistical test used: Fisher's exact test and Chi-square				

Multivariate Logistic Regression of Associated Factors with Labor Induction Outcome (IOL):

Univariate regression analysis showed that the chance of IOL failure in pregnant women who had complications was 46% (OR=1.46) more than in pregnant women without complications. Also, in the multivariate analysis, in the presence of all variables in the study, the chance of having an IOL failure in pregnant women with complications was 41% (OR=1.41) more than in pregnant women without complications. Even though having pregnancy complications increases the chance of an IOL failure and is a risk factor, these relationships were not statistically significant ($P>0.05$).

Regarding the relationship between IOL outcome and mother's age groups, the results of regression analysis showed that women between the ages of 25 and 34 had the least IOL failure. In univariate and multivariate regression analysis, the chance of IOL failure in women aged 25 to 34 compared to the age group less than 24 was 54% (OR=0.46) and 32% (OR=0.68) respectively and this relationship was statistically significant ($P < 0.05$). However, in the age group of more than 34 years compared to the age group of fewer than 24 years, this relationship was not statistically significant (P=0.261).

Regarding the relationship between IOL and gestational age, the regression analysis results showed that the chance of IOL failure was increased with increasing gestational age. The results of univariate and multivariate regression analysis, the chance of IOL failure in women with a gestational week (37- 40 weeks) compared to a gestational week (less than 37 weeks) was 31%

(OR=1.31) and 28% (OR=1.28), respectively and were more likely to have IOL failure. However, this relationship was not statistically significant (P=0.523).

The same relationship in pregnant women with a gestational week (more than 40 weeks) was observed. In multivariate analysis, the chance of IOL failure was 42% (OR=1.42), and in univariate analysis, the chance of IOL failure was more than 2 times (OR=2.19). However, this relationship was not statistically significant (P=0.138).

Regarding the relationship between IOL outcome and residents, the results showed that IOL failure was less in urban areas. The univariate and multivariate regression analysis results showed that the chance of IOL failure in urban residents was 27% (OR=0.73) and 18% (OR=0.82) less than in rural residents, respectively. However, this relationship was not statistically significant (P=0.305).

Regarding the relationship between IOL outcome and parity, the results showed that IOL failure was less in multiparous women. The results of univariate and multivariate regression analysis showed that the chance of IOL failure in multipara was lower than in primipara by 72% (OR=0.28) and 76% (OR=0.24), respectively, and this relationship was statistically significant (P < 0.001). Therefore, the parity variable was identified as an independent and strong predictive variable for IOL outcome.

Regarding the relationship between the IOL outcome and the mode of labor onset, the results showed that IOL failure was less in misoprostol users. The results of univariate and multivariate regression analysis showed that the chance of IOL failure in misoprostol users compared to Oxytocin users was 67% (OR=0.33) and 66% (OR=0.34), respectively, and this relationship was statistically significant (P < 0.001). Therefore, the mode of labor onset variable was identified as an independent and strong predictive variable for IOL outcome.

Regarding the relationship between IOL outcome and admission to NICU, the results showed that IOL failure was more common among mothers with neonate NICU admission. So, neonate NICU admission is a risk factor for IOL failure. Univariate regression analysis showed that IOL failure among mothers with neonate NICU admission was 66% (OR=1.66) higher than women without neonate NICU admission. In multivariate analysis, neonate NICU admission increased the chance of IOL failure by 2.5 times (OR=2.50). However, this relationship was not statistically significant (P=0.179) (Table 9 and 10).

Regarding the relationship between IOL outcome and the weight of the baby, univariate analysis showed the chance of IOL failure in women with children weighted between 2.5 and 4 kg was 14% less than in women with lower-weight children (less than 2.5 kg) (OR=0.86). But in the multivariate analysis, this result was reversed and none of these relationships were statistically significant.

Regarding the relationship between IOL outcome and Bishop score before induction, regression analysis showed that women with a Bishop score greater than 6 had less IOL failure. In univariate and multivariate regression analysis, the chance of an IOL failure in women with a Bishop score of 6 compared to a Bishop score of less than 6 was 25% (OR=0.75) and 34% (OR=0.66), respectively. Even though this relationship was not statistically significant; it was close to the significance level and had a significant effect size.

Regarding the relationship between IOL outcome and prenatal visit, the results showed that IOL failure was a little less common among women with a regular prenatal visit, so having a regular prenatal visit is a preventive factor for IOL failure. The results of univariate and multivariate regression analysis showed that the chance of IOL failure in women with regular prenatal visits was 3% (OR=0.97) and 20% (OR=0.80) less than in women who did not have a prenatal visit.

Regarding the relationship between IOL outcome and indication for IOL, the results in the univariate and multivariate regression analysis showed that the chance of IOL failure in women with post-term pregnancy was 46% (OR=1.46) and 7% (OR=1.07) more compared to preeclampsia women. In women with PROM, the chance of IOL failure was 50% (OR=0.50) and 70% (OR=0.30) less than in preeclampsia women, respectively, and this relationship was statistically significant (p= 0.011). Also, in univariate and multivariate regression analysis, the chance of IOL failure in women with IUFD was 80% (OR=0.20) and 83% (OR=0.17) less than the preeclampsia women, respectively, and this relationship reached the significance level or close. Further, in univariate and multivariate regression analysis, the chance of having IOL failure in women with oligohydramnios was 77% (OR=0.23) and 81% (OR=0.19) less than in preeclampsia women, respectively, and this relationship was also significant level was close (p= 0.050).

In conclusion, maternal complications (OR: 1.41, 95% CI: 0.13 – 15.13), age older than 34 years (OR: 1.23; 95% CI: 0.48 – 3.19), gestational age between 37-40 weeks (OR: 1.28; 95% CI: 0.48 – 3.41) and more than 40 weeks (OR: 1.42; 95%CI: 0.36 – 5.53), baby weight between 2 kg-

4 kg (OR: 1.39; 95% CI: 0.64 – 3.04), neonatal ICU admission(OR: 1.66; 95%CI: 0.31 – 8.85), post-term pregnancy (OR: 1.07; 95%CI: 0.32 – 3.49) were increased the chance for IOL failure.

Table 9: Multivariate binary logistic regression of associated factors for labor induction outcome (raw effects)

Variables	**Categories**	**B(SE)**	**Odds Ratio** (95%CI)	**P-value**
Maternal complications	no	Reference group		
	Yes	0.38(1.10)	1.46(0.16 – 12.73)	0.730
Age mother (year)	less than 24	Reference group		
	Between 25-34	-0.76(0.30)	0.46(0.26 – 0.84)	**0.013**
	More than 34	-0.43(0.39)	0.64(0.30 – 1.38)	0.261
Gestational age (weeks)	less than 37 weeks	Reference group		
	Between 37-40	0.27(0.42)	1.31(0.56 – 3.04)	0.523
	More than 40 weeks	0.78(0.52)	2.19(0.77 – 6.17)	0.138
Weight of baby (kg)	less than 2.5 kg	Reference group		
	between 2.5–3.9 kg	-0.14(0.32)	0.86(0.45 – 1.64)	0.665
	more than ≥4 kg	-19.34(1640)	0.0(0.0 – 0.0)	0.999
Residence	Rural	Reference group		
	Urban	-0.30(0.29)	0.73(0.41 – 1.32)	0.305
Bishop score before induction	Less than 6	Reference group		
	Greater than/equal to 6	-1.64(1.03)	0.19(0.02 – 1.45)	0.110
Antenatal care visit	No	Reference group		
	Yes	-0.03(0.28)	0.97(0.55 – 1.70)	0.921
Parity	Primipara	Reference group		
	Multipara	-1.27(0.28)	0.28 (0.16 – 0.48)	**< 0.001**
Mode of the labor onset	Oxytocin	Reference group		
	Misoprostol	-1.09(0.28)	0.33(0.19 – 0.59)	**< 0.001**
Admission to NICU	No	Reference group		
	Yes	0.91(0.68)	2.50(0.65 – 9.50)	0.179
	Preeclampsia	Reference group		

Indication for induction	Post-term pregnancy	0.37(0.46)	1.46(0.58 – 3.63)	0.414
	Premature rupture of membrane	-0.68(0.35)	0.50(0.25 – 1.02)	**0.056**
	IUFD	-1.56(1.06)	0.20(0.02 – 1.69)	0.143
	Oligohydramnios	-1.46(0.78)	0.23(0.05 – 1.08)	0.063

Table 10: Multivariate binary logistic regression of associated factors for labor induction outcome(adjusted effects)

Variables	Categories	B(SE)	Odds Ratio (95%CI)	P-value
Maternal complications	No	Reference group		
	Yes	0.34(1.20)	1.41(0.13 – 15.13)	0.773
Age mother (year)	less than 24	Reference group		
	Between 25-34	-0.38(0.35)	0.68(0.34 – 1.36)	0.278
	More than 34	0.21(0.48)	1.23(0.48 – 3.19)	0.657
Gestational age (weeks)	less than 37 weeks	Reference group		
	Between 37-40	0.24(0.49)	1.28(0.48 – 3.41)	0.618
	More than 40 weeks	0.35(0.69)	1.42(0.36 – 5.53)	0.610
Weight of baby (kg)	less than 2.5 kg	Reference group		
	between 2.5–3.9 kg	0.33(0.39)	1.39(0.64 – 3.04)	0.402
	more than ≥4 kg	-18.5 (1574)	0.0(0.0 – 0.0)	0.999
Residence	Rural	Reference group		
	Urban	-0.19(0.33)	0.82(0.43 – 1.57)	0.555
Bishop score before induction	Less than 6	Reference group		
	Greater than/equal to 6	-1.46(1.06)	0.23(0.03 – 1.84)	0.167
Antenatal care visit	No	Reference group		
	Yes	-0.21(0.31)	0.80(0.43 – 1.50)	0.503
Parity	Primipara	Reference group		
	Multipara	-1.40(0.35)	0.24(0.12 – 0.49)	**< 0.001**
Mode of the labor onset	Oxytocin	Reference group		
	Misoprostol	-1.06(0.32)	0.34(0.18 – 0.65)	**0.001**
Admission to NICU	No	Reference group		
	Yes	0.51(0.85)	1.66(0.31 – 8.85)	0.548
Indication for induction	Preeclampsia	Reference group		
	Post-term pregnancy	0.07(0.60)	1.07(0.32 – 3.49)	0.906
	Premature rupture of membrane	-1.05(0.41)	0.34(0.15 – 0.78)	**0.011**

	IUFD	-1.76(1.12)	0.17(0.02 – 1.54)	0.116
	Oligohydramnios	-1.62(0.82)	0.19(0.04 – 1.00)	**0.050**

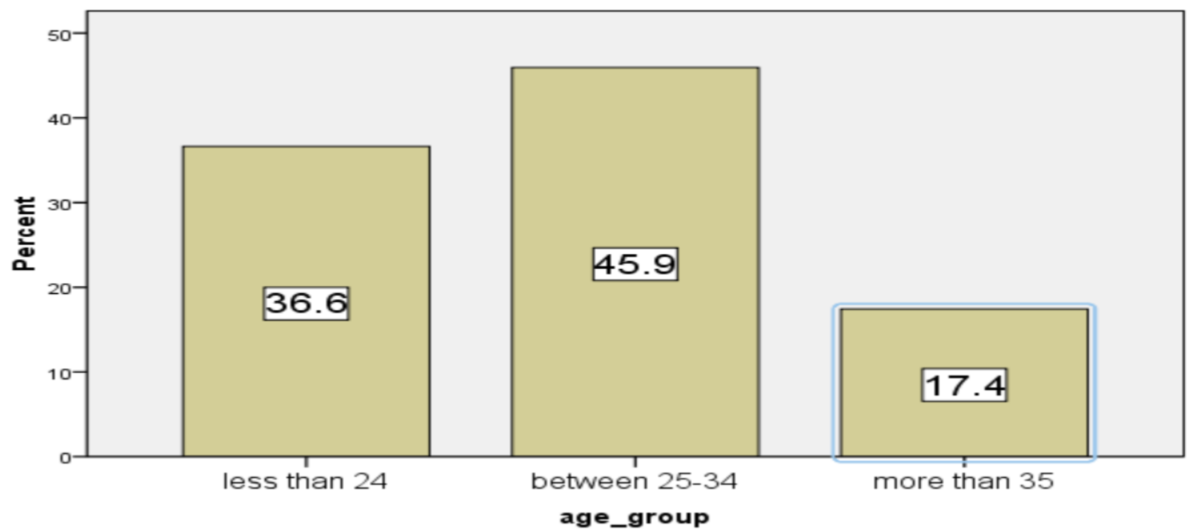

Figure 1: Showing the age of mothers (year).

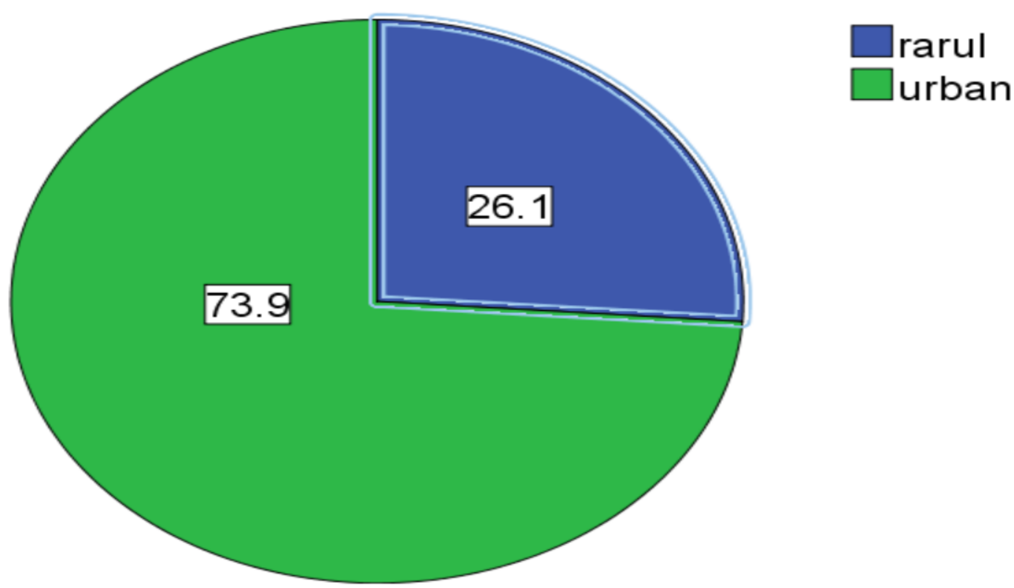

Figure 2: Showing the distribution of residence among patients.

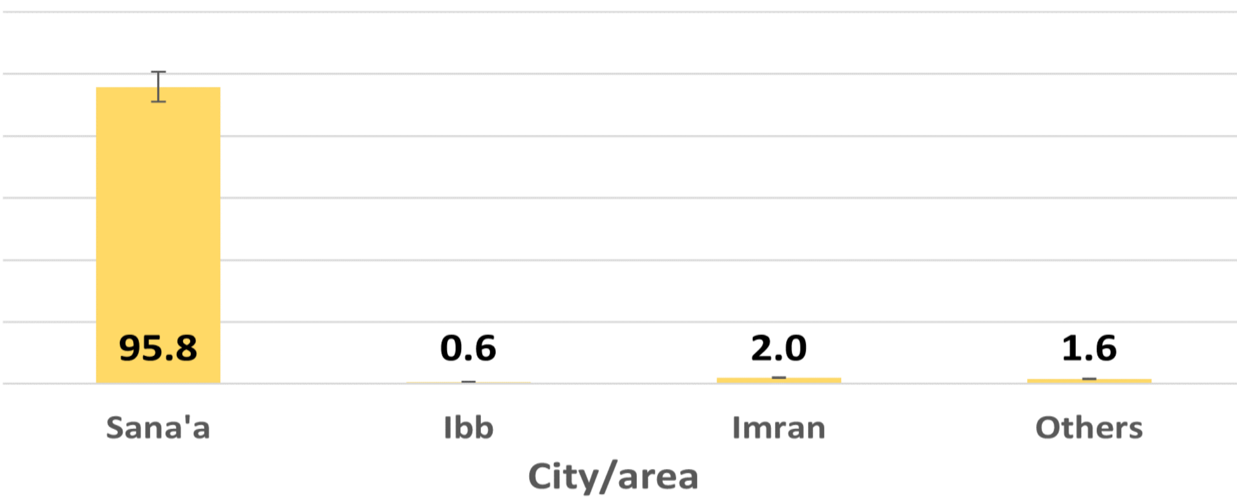

Figure 3: showing the cities / areas distribution.

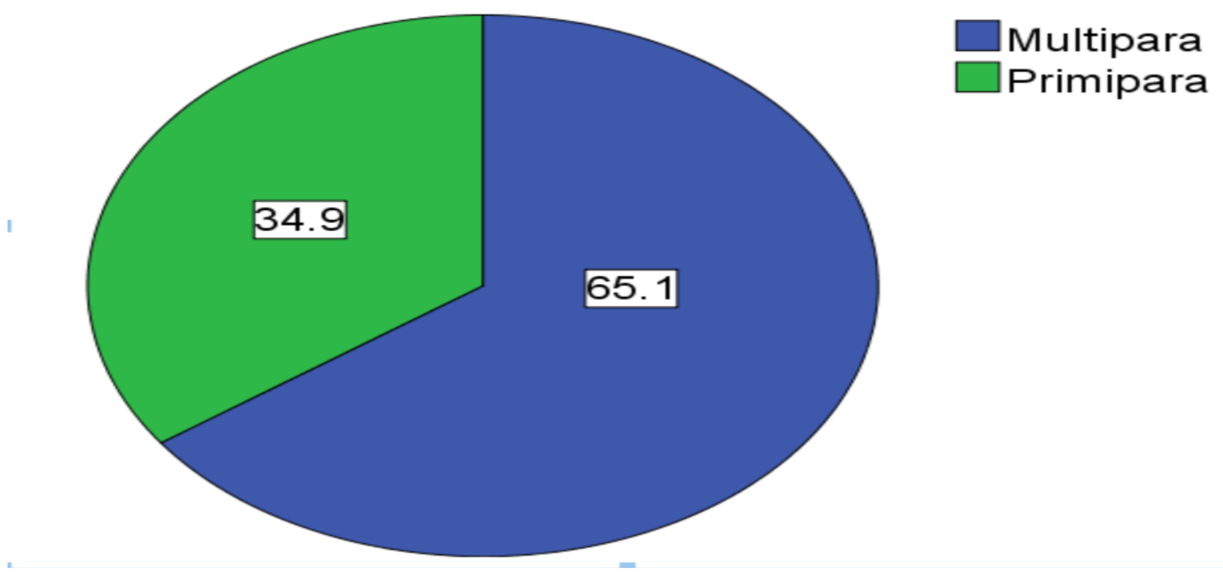

Figure 4: showing the parity distribution.

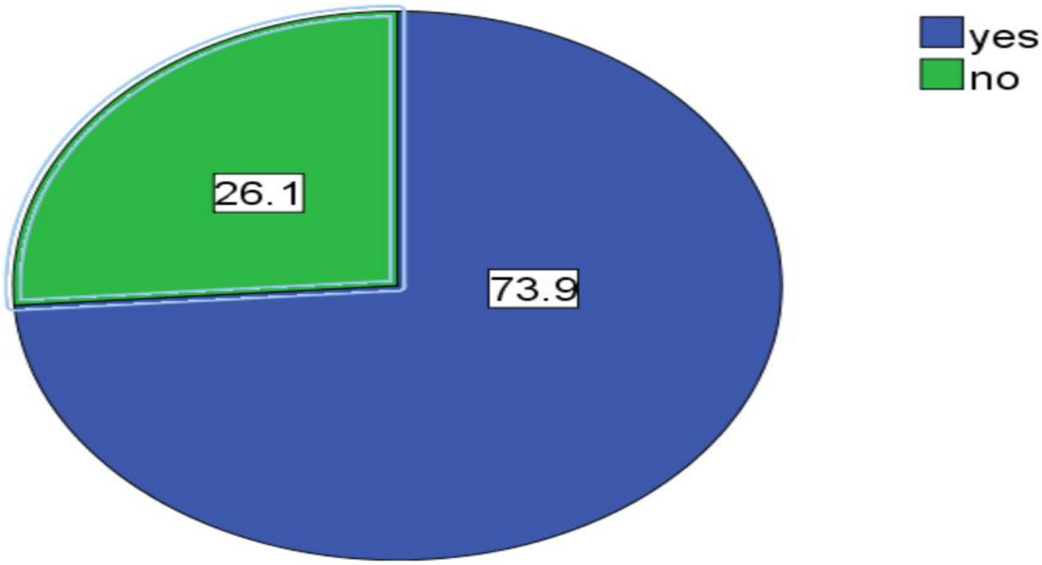

Figure 5: showing the antenatal care visit distribution.

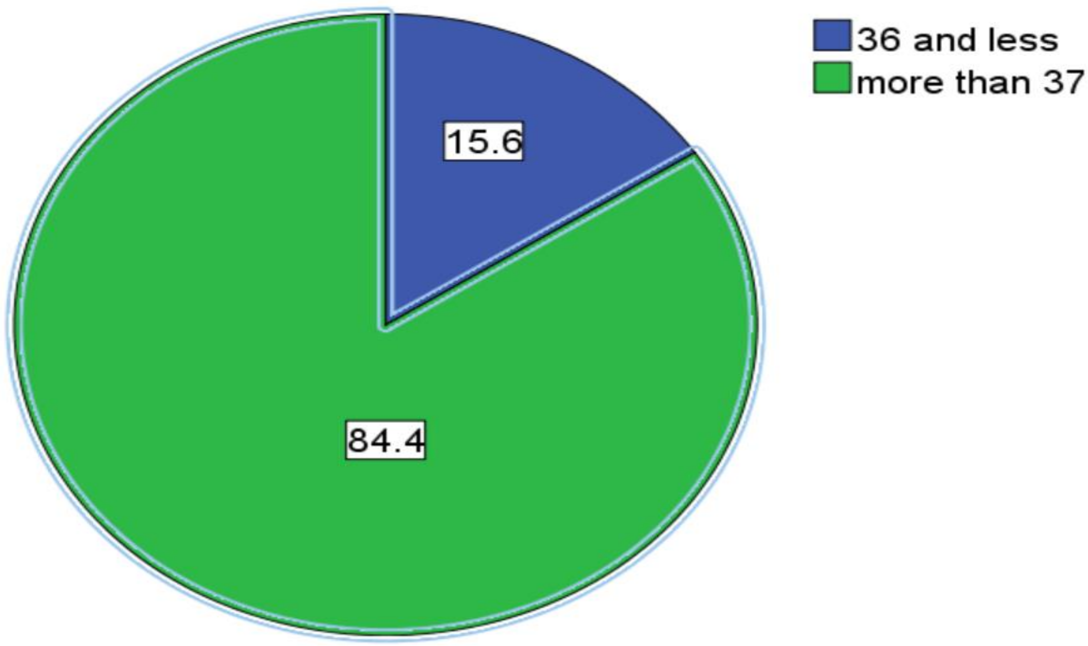

Figure 6: showing the gestational age (weeks) distribution

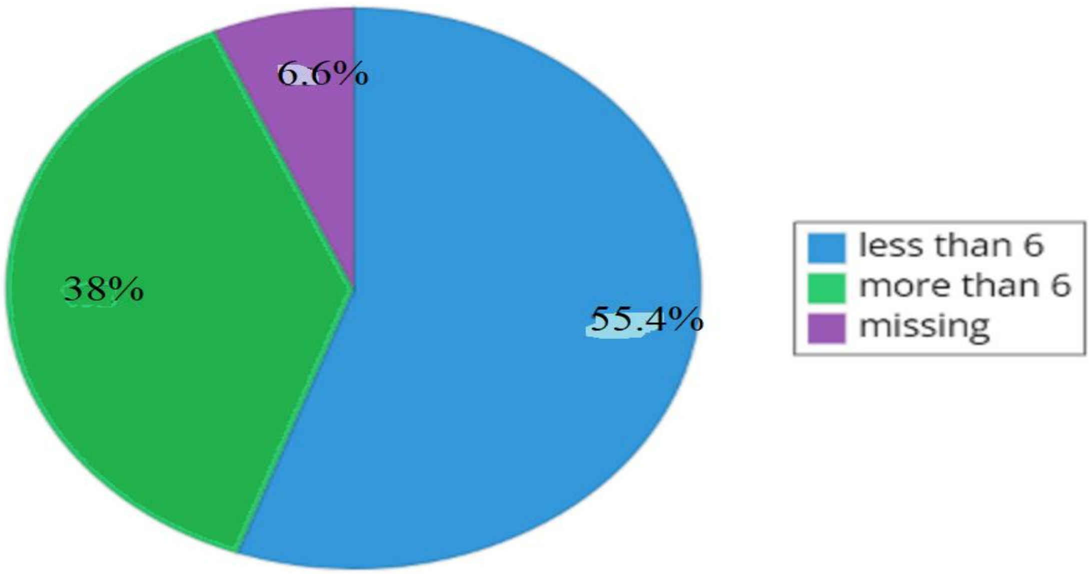

Figure 7: Showing the distribution of Bishop scores before induction.

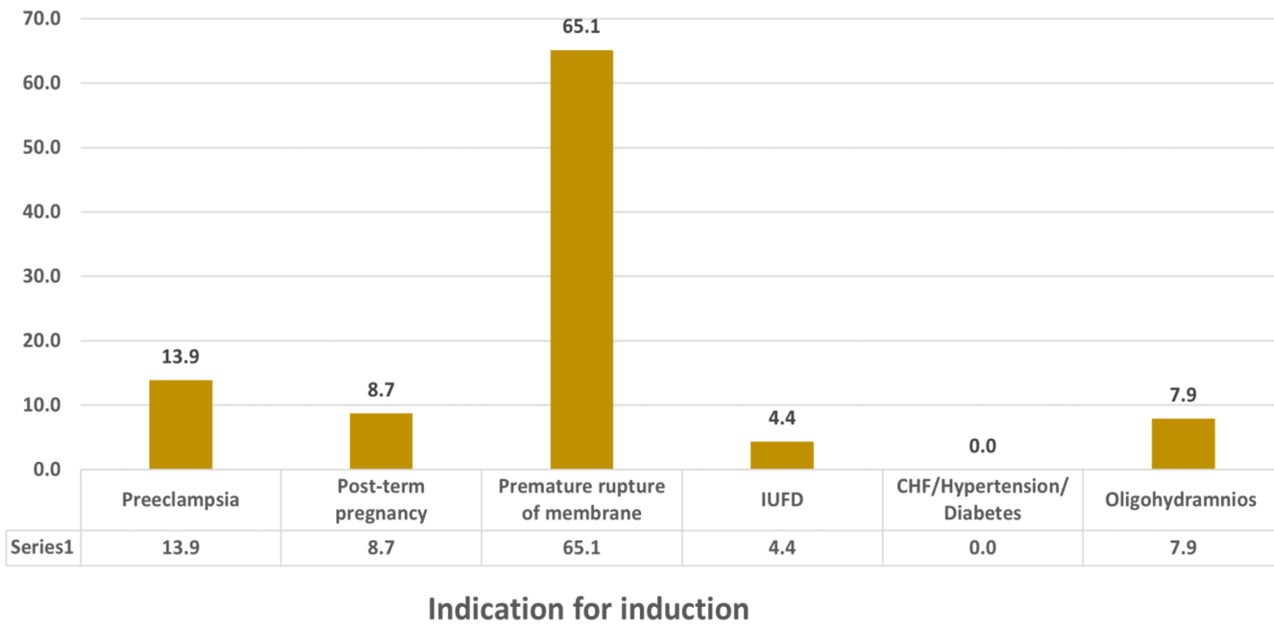

Figure 8: showing the distribution of indication for labor induction

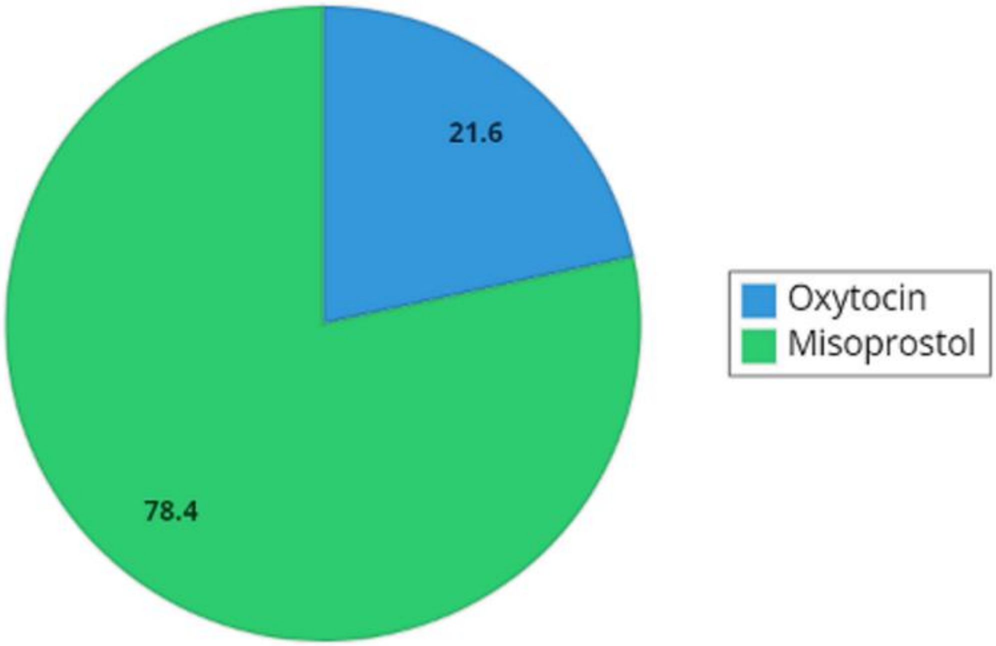

Figure 9: showing the mode of labor onset among patients

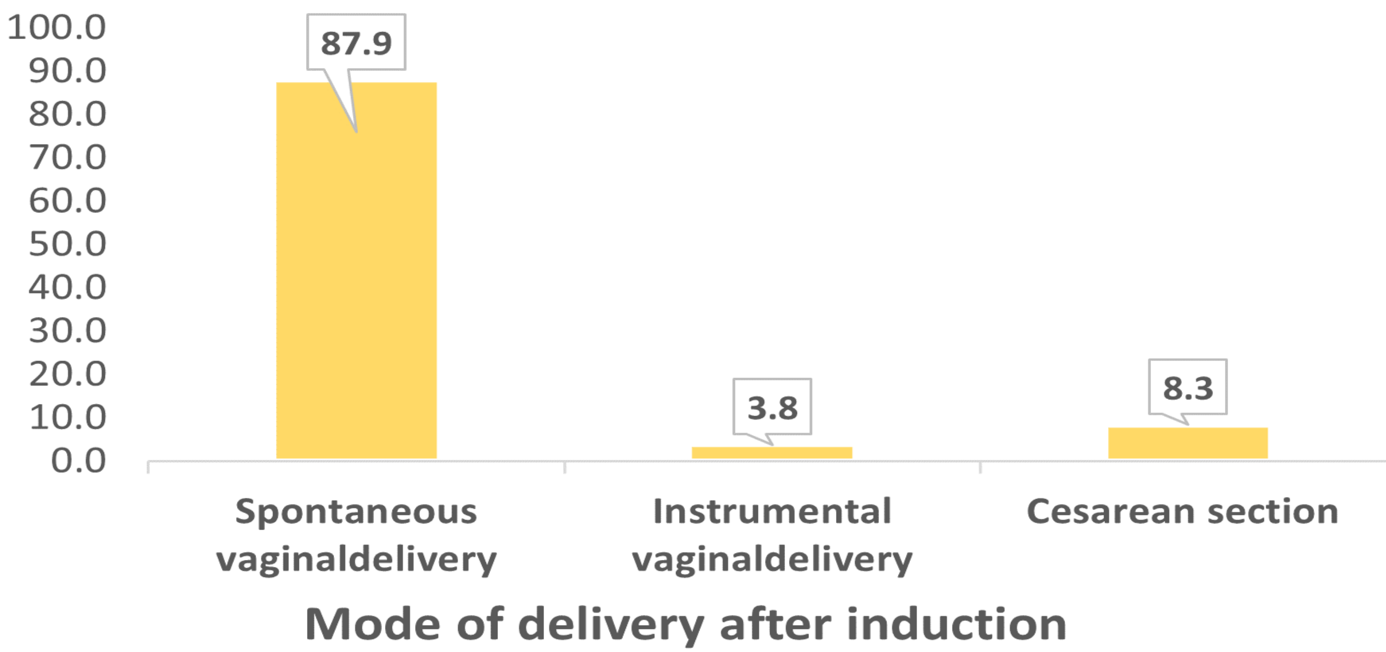

Figure 10: Showing the mode of delivery after induction

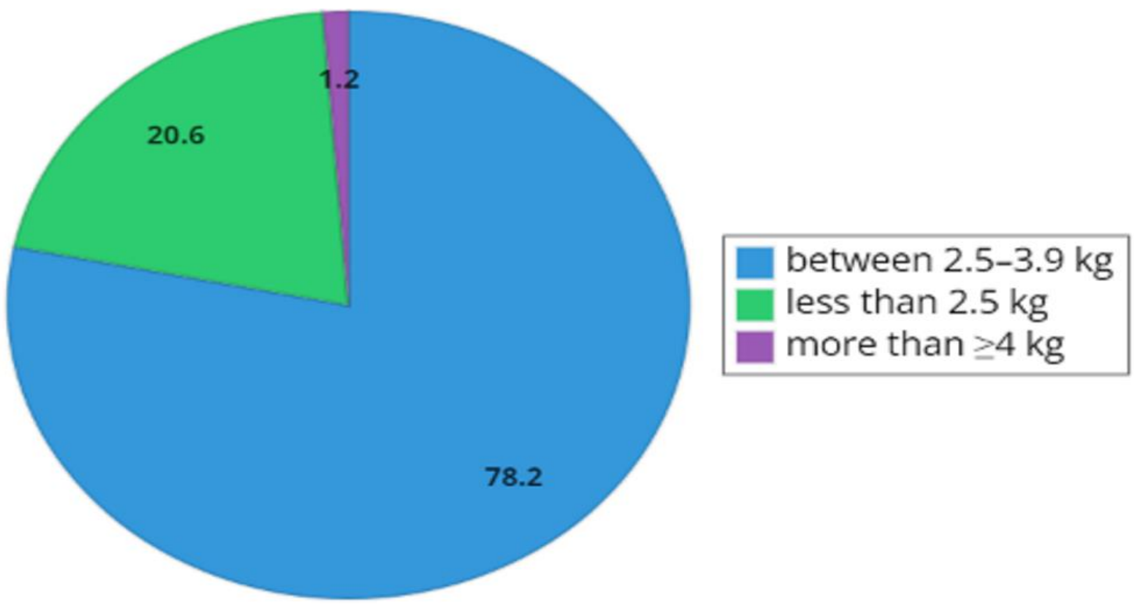

Figure 11: Showing the distribution of birth weight of newborns.

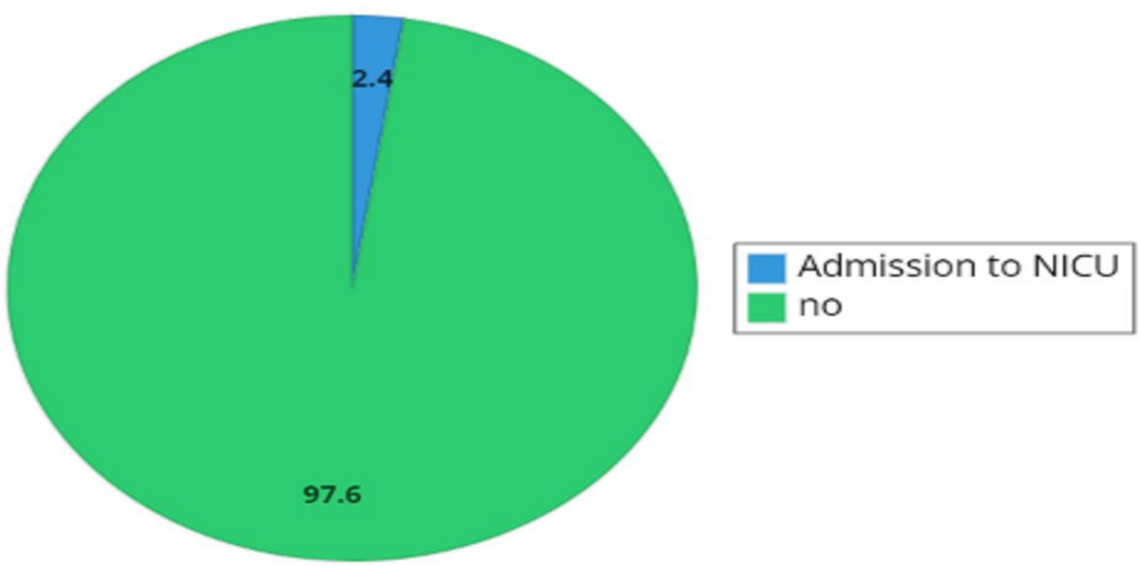

Figure 12: Showing the distribution of NICU admission among patients' babies.

Chapter Five

Discussion and Conclusion

Discussion:

The 505 cards reviewed in this study 42 (8.3%) of them were delivered by cesarean section and 19 (3.8%) needs Instrumental vaginal delivery while 444 (87.9%) achieved vaginal delivery making the prevalence rate of successful induction (87.9%). Mothers' age, Method of induction, and multiparity had a statistically significant rate of IOL success.

Successful inductions were 87% of all inductions; this rate is slightly higher than the studies of Addis Ababa Army Hospital (59.7%)(Melkie et al. 2021), public hospitals of MEKELLE town-(a hospital-based cross-sectional study) (76%) (Lueth et al. 2020), Jimma University Hospital (65.7%) (Girma et al.), Hawassa (61.6%) (Tadesse et al.). And it is comparable to a study done at Eastern Ethiopia Dilchora Referral Hospital (83%) (Shiferaw et al. 2022). These variations 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 Ethiopia study, explaining the comparability to this studies (Shiferaw et al. 2022).

Related to the factors associated with the success of IOL, the results of univariate and multivariate regression analysis showed that the chance of IOL failure in multipara was lower than in primipara by 72% (OR=0.28) and 76% (OR=0.24), respectively, and this relationship was statistically significant ($P < 0.001$). Therefore, the parity variable was identified as an independent and strong predictive variable for IOL outcome. A similar result was observed in Abel Shiferaw's study, however, the relationship was not statistically significant (Shiferaw et al. 2022). Additional similar findings were reported in the study done in a teaching hospital, in southwest Ethiopia (Guerra et al.). Increased parity had a favorable bearing on the outcome of induction. Also, labor will prolong in primipara women because the cervix was not tested for labor (Kazi et al. 2021).

This study's common indication for labor induction was PROM (65.0%) followed by preeclampsia (13.9%) and post-term (8.7%). This is in line with the study done by Abel Shiferaw (Shiferaw et al. 2022). In another study conducted by Yosef et al., the common indication for labor induction was preeclampsia (41.6%) (Yosef and Getachew). Contrasting to this the most common indication for labor Induction in Latin America was elective induction (30%) (Khan et al. ; Lumbiganon et al. 2010). This difference is because of the specific countries' socio-economic conditions and PROM was more common in low socioeconomic societies due to widespread nutrition and infection conditions that would facilitate the condition (Khan et al.). The multivariate regression analysis shows that post-term mothers were 7%vmore likely to be IOL failed than those women with the preeclampsia. PROM were 70% less likely induction to be IOL failed than those women with the preeclampsia and this relationship was statistically significant (p= 0.011). women with IUFD were 83% less likely induction to be IOL failed than those women with the preeclampsia. oligohydramnios women were 81% less likely to be IOL failed than those women with the preeclampsia. A similar result reported by Lueth et al.who reported the prevalence, outcomes and associated factors of labor induction among women delivered at public hospitals of MEKELLE town-(a hospital based cross sectional study) (Lueth et al. 2020).This may be related to when the mothers became post-term (Gestational age>42 weeks) there would be respectively big fetus (macrosomia) or decreased placental insufficiency potentially causing fetopelvic disproportion and non-reassurance fetal heartbeats, for induction of labor to fail (Shiferaw et al. 2022).

Regarding the relationship between IOL outcome and mother's age groups, the results of regression analysis showed that women between the ages of 25 and 34 had the least IOL failure. In univariate and multivariate regression analysis, the chance of IOL failure in women aged 25 to 34 compared to the age group less than 24 was 54% (OR=0.46) and 32% (OR=0.68) respectively and this relationship was statistically significant ($P < 0.05$). However, in the age group of more than 34 years compared to the age group of fewer than 24 years, this relationship was not statistically significant (P=0.261). A similar result of less IOL failure in pregnant women aged 25–34 and 35 years were reported by Yosef et al. (Yosef and Getachew). The increased age of pregnant women was statistically associated with the induction of labor. This finding was supported by studies done elsewhere (Yosef and Getachew). This could be due to the need to interrupt the pregnancy associated with intrauterine fetal death in women of older age (Yosef and Getachew).

Regarding the relationship between IOL outcome and prenatal visit (ANC), the results showed that IOL failure was a little less among women with a regular prenatal visit, so having a regular prenatal visit is a preventive factor for that IOL failure. The results of univariate and multivariate regression analysis showed that the chance of IOL failure in women with regular prenatal visits was 3% (OR=0.97) and 20% (OR=0.80) less than in women who did not have a prenatal visit. A similar result was reported by Yosef et al. and Sandall et al. (Sandall et al.). This could be because of the higher proportion of mothers who diagnosed with post-term pregnancy and intrauterine fetal deaths are associated with no history of ANC visit. That may increase the chance of induced labor among non-ANC followers (Yosef and Getachew).

Regarding the relationship between IOL outcome and Bishop score before induction, regression analysis showed that women with a Bishop score greater than 6 had less IOL failure. In univariate and multivariate regression analysis, the chance of an IOL failure in women with a Bishop score of 6 or more compared to a Bishop score of less than 6 was 25% (OR=0.75).

even though this relationship was not statistically significant; it was close to the significance level and had a significant effect size (Yan et al. 2022). Asimilar findings was reported by Yosef et al. (Yosef and Getachew). It was reported thar pregnant woman with an unfavorable Bishop score before induction had 1.9 times increased odds of having failed induction than those with a favorable bishop score before induction. Similarly, a study was done by Devarasetty et al. revealed that vaginal delivery after induction was high in pregnant women with a Bishop score ≥5 before induction (Devarasetty and Habeebullah 2019). A high Bishop score means that there is a greater chance that an induction will be successful. If the score is 8 or above, it is a good indication that spontaneous labor would start soon.

Regarding the relationship between the IOL outcome and the Mode of labor onset, the results showed that IOL failure was less in misoprostol users. The results of univariate and multivariate regression analysis showed that the chance of IOL failure in Misoprostol users compared to Oxytocin users was 67% (OR=0.33) and 66% (OR=0.34), respectively, and this relationship was statistically significant ($P < 0.001$). Therefore, the mode of labor onset variable was identified as an independent and strong predictive variable for IOL outcome. A similar finding was reported by Yosef et al. [7]. The use of oxytocin was strongly associated with a higher success rate of induction of labor. This study was supported by Vogel et al. that revealed that induction by oxytocin alone is associated with over an 80% success rate (Vogel et al.).

Regarding the relationship between IOL outcome and admission to NICU, the results showed that IOL failure was more among mothers with neonate NICU admission. So, neonate NICU admission is a risk factor for IOL failure. Univariate regression analysis showed that IOL failure among mothers with neonate NICU admission was 66% (OR=1.66) higher than women without neonate NICU admission. In multivariate analysis, neonate NICU admission increased the chance of IOL failure by 2.5 times (OR=2.50). However, this relationship was not statistically significant (P=0.179) (Table 9 and 10).

Regarding the relationship between IOL outcome and the weight of the baby, univariate analysis showed the chance of IOL failure in women with children weighted between 2.5 and 4 kg was 14% less than in women with lower-weight children (less than 2.5 kg) (OR=0.86). But in the multivariate analysis, this result was reversed and none of these relationships were statistically significant. This might be due to the wide confidence interval having more successful inductions and few who had failed.

Limitations

The current study had several limitations. The main limitation of this study could be a study based on secondary data where the quality of documentation, data, the retrospective nature, and record keeping are questionable. The exclusion of cards with incomplete data may introduce a selection bias. A prospective study with a large number and extended postoperative follow-up is recommended.

Conclusion

The prevalence of induced labor and the prevalence of induction failure were comparable to other studies done in Yemen. This study found that mothers aged 25–34 years, multiparity, misoprostol users, premature rupture of membranes cases, and oligohydramnios cases were associated with IOL outcomes. Therefore, health professionals should consider these factors to enable safe care during delivery for as many women as possible.

Recommendations

- This is a tertiary hospital-based study and therefore, the result may not reflect the findings in the general population.
- The result would be more representative and epidemiologically significant if the study was multi-centered.
- The assessment of cervical status is highly subjective, hence influencing the outcome of induction.
- Future prospective randomized studies with larger volumes in multicentric are required to evaluate the optimum misoprostol dose, dosing intervals, total number of doses, and various routes of administration. Additionally, long-term neonatal follow-up is needed.
- Pre-induction conditions must be taken into consideration to avoid unwanted effect of failed induction of labour.
- Induction protocols and guidelines must be given more emphasis.

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Questionnaire

Patient number :	**Mode of the labor onset:** **- Oxytocin** **- Misoprostol**
Age of mother (year) :	
City/area:	
Residence: **- Rural** **- Urban**	**Mode of delivery after induction:** **□Spontaneous vaginaldelivery** **□Instrumental vaginaldelivery** **□Cesarean section**
Gestational age at induction (weeks):	**Maternal complications:** **22. Postpartumhemorrhage** **23. External genitaliatear** **24. Uterinerupture** **25. Other**
Bishop score before induction: **□<6** **□ ≥6**	
Antenatal care visit : • **Yes** • **No**	
Parity: **1- Primipara** **2- Multipara**	**Weight of baby (kilogram):**
Indication for induction: **1- Preeclampsia** **2- Post-termpregnancy** **3- Premature rupture of membrane** **4- IUFD** **5- CHF/Hypertension/Diabetes** **6- Oligohydramnios**	**Admission to NICU:** **I. Yes** **I. No**