Predictors of failed induction of labor among women delivering at Jinja Regional Referral Hospital: A prospective cohort study

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Abstract

Background: Induction of labor (IOL) is increasingly common in Ugandan referral hospitals but remains a clinical challenge due to its association with adverse maternal and perinatal outcomes. Identifying predictors of failed induction is crucial for optimizing patient care and outcomes. This study aimed to determine the incidence and predictors of failed induction of labor at Jinja Regional Referral Hospital.

Materials and Methods: A hospital-based prospective cohort study was conducted among 150 women undergoing labor induction at Jinja Regional Referral Hospital from July 4, 2023, to September 29, 2023. Participants were recruited using a consecutive sampling technique, and data were collected using a pretested questionnaire. A log-binomial regression model was utilized to estimate the relative risk of failed induction for each associated factor, controlling for potential confounders.

Results: The incidence of failed induction of labor was 35.33%. Nulliparity (P0) was associated with a heightened risk of failed induction compared to primi/multiparity (P1 or more), as indicated by an adjusted relative risk (aRR) of 1.68 (95% CI: 1.27-2.22, $p < 0.001$). A pre-induction Bishop score <6 significantly increased the risk, with an aRR of 2.44 (95% CI: 1.63-3.67, $p < 0.001$). Higher BMI (≥30 kg/m²) was found to pose a substantial risk, with an aRR of 1.87 (95% CI: 1.42-2.48, $p < 0.001$). Infants with a birth weight ≥3.5kg exhibited a notably elevated risk, with an aRR of 1.14 (95% CI: 1.13-1.14, $p < 0.001$).

Conclusion: The study found a fIOL incidence rate of 35.33%, consistent with the varying global trends, emphasizing the need for standardized definitions and protocols in assessing induction outcomes. Parity, pre-induction Bishop Score, birth weight, and BMI were identified as predictors of fIOL, highlighting the importance of considering maternal characteristics and obstetric factors in predicting induction outcomes.

1. Background

The definition of failed induction of labor (fIOL) has been subject to debate in obstetrics literature. Criteria for fIOL diagnosis usually include the absence of cervical change, failed descent of the presenting part, or inadequate uterine contractions (less than three contractions felt within 10 minutes after 6 to 8 hours of starting IOL process (1). Endpoints such as cesarean birth, not attaining vaginal birth within a set duration, or failure to establish the active labor phase have also been proposed (2).

A joint workshop organized by the American College of Obstetricians and Gynecologists (ACOG), the Society of Maternal-Fetal Medicine (SMFM), and the United States National Institute of Child Health and Human Development (UNICHD) suggested defining fIOL as the inability to produce regular contractions every three minutes and cervical change approximately 24 hours after oxytocin administration in recommended dosage and frequency (3).

Induction of labor (IOL) has evolved significantly over centuries, with early methods described by Hippocrates involving mammary stimulation and mechanical cervical dilation. Soranus, in the second century AD, employed various procedures like artificial rupture of membranes for labor induction(4). However, it was not until the 20th century, with the discovery of synthetic oxytocin and prostaglandins, that reliable and effective induction methods became available (5).

Edward Bishop's seminal work in the 1950s established criteria for elective induction, emphasizing its safety and efficacy (6). Despite these advancements, failed induction of labor (fIOL) remains a persistent challenge in modern obstetrics, with potentially adverse outcomes for both the mother and the baby(7,8) .

Induction of labor is a pivotal intervention in modern obstetrics, yet a significant proportion of inductions result in failed progression, necessitating alternative delivery methods. The commonest alternative mode is cesarean section, which has its associated morbidities and mortalities(9).

Globally, IOL has been a potential intervention in 25% of deliveries, with 20% resulting in eventual delivery by cesarean section in the developed world (7). According to a WHO report in 2010, about 10% of deliveries in selected African countries, including Uganda, were preceded by induction, with a failure rate estimated at 25% (7). The odds of cesarean section following induction of labor were twice compared to spontaneous labor (7).

Given the increasing reliance on IOL and the high rates of fIOL observed in certain populations, including in Uganda, there is a critical need to elucidate the predictors of fIOL. This research aims to address this gap in knowledge, with potential implications for obstetric practice and policy development aimed at improving maternal and neonatal health outcomes in the country.

2. Materials and Methods

2.1 Study design: Prospective cohort study.

2.2 Study site: This study was carried out at Jinja Regional Referral Hospital, a tertiary hospital in Uganda financed by the government of Uganda.

2.3 Sample size calculation: The formula proposed by Kish Leslie in 1965, which calculates sample size, was employed for this study. It is represented as $n = \frac{Z^2PQ}{D^2}$, where n denotes the desired sample size, Z represents the standard normal deviation at the 95% confidence level (here, $Z = 1.96$), P signifies the proportion of the target population estimated to experience fIOL, which was found to be 11% based on the failure rate observed by Caliskan and collegues(10).Q indicates the proportion of the population without fIOL $Q = 1 - P$, and D denotes the desired level of accuracy, set at 5%.

Substituting the given values into the formula yields $n = \frac{1.96^2 \text{ X}0.11\text{X}0.89}{0.05\text{X}0.05} = 150$, resulting in a calculated sample size of 150 participants.

3. Results

3.1 Study flow process: In Figure 1 below, the study flow process is illustrated.

Figure 1 Study flow chart.

3.2 Descriptive characteristics of study participants

Table 1: Presents the descriptive statistics of the study participants.

Variable	Category	Frequency (N=150)	Percent (%)
Age	<20	12	8.00
	20-29	100	66.67
	≥30	38	25.33
Gestational age	Preterm (<37wks)	62	41.33
	Term (37-<42wks)	76	50.67
	Post-term (≥ 42wks)	12	8.00
Parity	Nullipara (P0)	62	41.33
	Primi/Multipara (P1 or more)	88	58.67
Pre induction Bishop score	<6	51	34.00
	≥6	99	66.00
BMI	<30 kg/m^2	119	79.33
	≥30 kg/m^2	31	20.67
Birth-weight	<3.5kg	124	82.67
	≥ 3.5kg	26	17.33
Indications for induction	HDIP	47	31.33
	PROM	37	24.67
	Others	66	44.00

Kg-Kilograms, m – metres, ANC – Antenatal care, HDIP- hypertensive disorder in pregnancy, PROM-Prelabor Rapture of Membranes, IUFD- Intra Uterine Fetal Death.

Table 1 summarizes the characteristics of the study population.

3.3 Incidence of failed induction of labor.

Among the 150 total mothers who underwent induction of labor, 53 (35.33%) failed to achieve cervical dilation of ≥4cm, indicating a failure in the induction intervention (YES). Consequently, the incidence of failed induction of labor was determined to be 35.53%, with a 95% confidence interval of 27.7% to 43.0%. Conversely, 97 (64.67%) out of the 150 mothers achieved a cervical dilation of ≥4cm within 24 hours, indicating successful induction (NO). *(Figure 2)*

Figure 2: Pie-chart showing the incidence of failed induction of labor.

3.4 Analysis for predictors of failed induction of labor

Table 2: Multivariate analysis of predictors of failed induction of labor.

Variable	Category	Failed induction			
		NO n(%)	YES n(%)	cRR (95% CI)p	aRR (95% CI)p
Age	<20	7(58.33)	5(41.67)	Ref	
	20-29	68(68.00)	32(32.00)	0.77(0.37-1.59)0.477	
	≥30	22(57.89)	16(42.11)	1.01(0.47-2.17)0.979	
Gestational age	Preterm (<37wks)	41(66.13)	21(33.87)	0.86(0.55-1.34)0.501	
	Term (37-<42wks)	46(60.53)	30(39.47)	Ref	
	Post-term (≥ 42wks)	10(83.33)	2(16.67)	0.42(0.12-1.54)0.289	
Parity	Nullipara (P0)	33(53.23)	29(46.77)	1.72(1.11-2.64) **0.014***	1.68(1.27-2.22)**<0.001****
	Primi/Multipara (P1 or more)	64(72.73)	24(27.27)	Ref	Ref
Pre induction Bishop score	<6	19(37.25)	32(62.75)	2.96(1.92-4.57)**<0.001***	2.44(1.63-3.67)**<0.001****
	≥6	78(78.79)	21(21.21)	Ref	Ref
BMI	<30 kg/m^2	85(71.43)	34(28.57)	Ref	Ref
	≥30 kg/m^2	12(38.71)	19(61.29)	2.15(1.44-3.20)**<0.001***	1.87(1.42-2.48)**<0.001****
Birth-weight	<3.5kg	88(70.97)	36(29.03)	Ref	Ref
	≥ 3.5kg	9(34.62)	17(65.38)	2.25(1.52-3.33)**<0.001***	1.14(1.13-1.14)**<0.001****
Indications for induction	HDIP	27(57.45)	20(42.55)	Ref	
	PROM	25(67.57)	12(32.43)	0.76(0.43-1.35)0.352	
	Others	45(68.18)	21(31.82)	0.74(0.46-1.21)0.24	

*Ref=Reference category, cRR= crude relative risk, aRR=adjusted relative risk, CI= confidence interval, p=p value, HDIP=Hypertensive disease in pregnancy, PROM+Pre-labor Rapture of Membranes, kg=Kilograms, m=metres, *bivariate p less than 0.2 so carried to multivariate, **Statistically significant at multivariate.*

Multivariate analysis identified significant associations between several factors and failed induction of labor. Nulliparity (P0) was linked to a higher risk of failed induction compared to primi/multiparity (P1 or more), with an adjusted relative risk (aRR) of 1.68 (95% CI: 1.27-2.22, p < 0.001). Similarly, pre-induction Bishop score <6 was significantly associated with increased risk, showing an aRR of 2.44 (95% CI: 1.63-3.67, p < 0.001). Higher BMI (≥30 kg/m²) also posed a significant risk, with an aRR of 1.87 (95% CI: 1.42-2.48, p < 0.001). Moreover, infants with a birth weight ≥3.5kg exhibited a notably higher risk, with an aRR of 1.14 (95% CI: 1.13-1.14, p < 0.001). However, factors such as age, gestational age, and indications for induction did not demonstrate statistically significant associations with failed induction ***(****Table 2****).***

4. Discussion

4.1 The incidence of failed induction of labor.

The study has found the incidence of failed induction of labor in women delivering at Jinja Regional Referral Hospital to be 35.33%. This finding aligns closely with similar studies conducted in various settings. For instance, a study conducted at Kenyatta National Hospital, Kenya, reported an incidence range of 38% (13). Similarly, a WHO study across eight Latin American countries documented a pooled incidence of 30% (14), while research at Kathmandu Medical College found a rate of 34.6% (15).

However, the incidence observed in this study deviates from rates reported in other regions. For example, research conducted at Mbarara Regional Referral Hospital in Western Uganda indicated a lower incidence of 22.7% (16), and studies at Harare Maternity Hospital in Zimbabwe and in Northern Tanzania reported rates of 24.9% (8) and 19% (9) respectively. Several factors may contribute to these variations. Variances in the definition of fIOL play a crucial role; for instance, Kajabwangu and coleagues (16) defined failure of induction as the inability to achieve the active phase of labor within 12 hours, whereas other studies may have employed different criteria. Additionally, differences in study design, sample size, and population characteristics can influence incidence rates. Notably, the retrospective nature of the Tanzanian study (8), which defined fIOL based on cesarean section, and the inclusion criteria of gestational age ≥37 weeks in the Harare study may have contributed to the observed differences.

Moreover, methodological disparities, such as data collection techniques, also impact outcomes. In this study, a hybrid approach utilizing interview-administered questionnaires and patient records was employed, whereas many other studies relied solely on secondary data from patient files, potentially leading to differences in data completeness and accuracy (8).

Comparisons with studies conducted in other settings further highlight discrepancies in fIOL rates. Studies at Jimma University Specialized Hospital (17) and Adama Referral Hospital (18) reported lower rates of 21.4% and 29.6% respectively. These differences may stem from variations in study settings and the methods employed for labor induction. For instance, the use of different induction methods, such as combinations of artificial rupture of membranes (ARM) and oxytocin in other studies, contrasts with the predominant use of misoprostol in the current study setting. These discrepancies underscore the

multifactorial nature of fIOL and emphasize the importance of context-specific research to inform clinical practice effectively.

4.2 Predictors of failed induction of labor.

Understanding the factors that predict failed induction of labor (fIOL) is essential for identifying high-risk groups and tailoring interventions accordingly. In this study, parity, pre-induction Bishop Score, birth weight, and BMI emerged as predictors of fIOL.

4.2.1 Parity:

The analysis revealed that nulliparous women had a significantly higher likelihood of failing induction compared to primi/multiparous women. Specifically, nulliparous women exhibited a twofold increased risk of fIOL. This finding is comparable to previous research conducted in various settings aOR=2.34 (16), aOR=1.79 (9), aOR=1.5 (7). The increased risk among nulliparous women may be attributed to their unfavorable pre-induction cervical status, which is less responsive to ripening methods compared to multiparous women. Additionally, multiparous women may have increased myometrial sensitivity and contractility, enhancing their response to oxytocin and facilitating labor progression.

4.2.2 Pre-induction Bishop score:

A low pre-induction Bishop score was significantly associated with an increased likelihood of fIOL. Specifically, women with a Bishop score <6 had a 2.5 times higher risk of fIOL compared to those with a score ≥6. This finding aligns with previous studies conducted in Uganda (16), Ethiopia (7), Tikrit-city Iraq (19) and (8). It highlights the importance of cervical status in predicting induction success. An unfavorable cervix, characterized by parameters such as dilation, effacement, position, and consistency, hampers cervical stimulation and labor progression, contributing to induction failure.

4.2.3 Birth weight:

The study identified a strong association between birth weight ≥3.5kg and fIOL. Mothers with fetal weights ≥3.5kg had a 1.2 times higher likelihood of induction failure compared to those with lower fetal weights. This association is consistent with findings from other studies done in Pakistan (15), Thailand (20), and Tanzania (9). It can be attributed to factors such as poor fetal descent, malposition, and malpresentation in larger babies, hindering optimal application of the fetal head to the cervix and impeding cervical effacement and dilation.

4.2.4 Body Mass Index (BMI):

Elevated BMI (≥30kg/m2) was significantly associated with an increased risk of fIOL. Women with a BMI ≥30kg/m2 had a 1.7 times higher risk of induction failure compared to those with lower BMI values. This association has been observed in other studies done in Zimbabwe (8) and Tanzania (9). It may be attributed to mechanical obstruction caused by adipose tissue accumulation in the abdomen and pelvis

among obese women. Additionally, obesity can disrupt cervical moisture and collagen content, further impeding fetal descent and cervical effacement and dilation.

5. Conclusions

The study found a fIOL incidence rate of 35.33%, consistent with the varying global trends, emphasizing the need for standardized definitions and protocols in assessing induction outcomes.

Parity, pre-induction Bishop Score, birth weight, and BMI were identified as predictors of fIOL, highlighting the importance of considering maternal characteristics and obstetric factors in predicting induction outcomes.

6. Study limitations: The study's definition of failed induction may not align with other studies or clinical guidelines, potentially affecting the comparability of results. Variation in definitions across studies could limit the generalizability of findings.

7. Further area of study: Further investigation into the factors contributing to the varying incidence rates of fIOL across different healthcare settings, including the impact of healthcare infrastructure, provider expertise, and patient demographics. Future studies could explore the effectiveness of targeted interventions, such as cervical ripening agents or alternative induction methods, in reducing the risk of fIOL among high-risk populations identified by maternal parity, pre-induction Bishop Score, fetal birth weight, and maternal BMI.

8. Recommendations: Standardized protocols for defining and managing fIOL should be implemented to facilitate accurate assessment and comparison of induction outcomes across different settings. Healthcare providers should consider maternal parity, pre-induction Bishop Score, fetal birth weight, and maternal BMI when assessing the likelihood of fIOL, aiming to tailor induction strategies and interventions accordingly to improve outcomes of labor.

Declarations

9.1 Consent for publications: Not applicable to this study.

9.2 Availability of data and material: The datasets utilized in this study can be obtained from the corresponding author upon request. Please contact Musa Kasujja via email at musakasujja2@gmail.com

9.3 Conflict of interest: There are no conflicts of interest related to this study.

9.4 Funding: This study did not receive any grants or funding.

9.5 Author contributions: EOO served as the principal investigator, contributing to the study design, data collection, analysis, and initial manuscript drafting. **MK**, **JDDR**, **EO,** and **MO** contributed to the discussion

and interpretation of study findings. **AD**, **TH**, and **EE** supervised the study.

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9.7 Guarantor: Ephraim Oluoch Onanga

Abbreviations

Abbreviation	Meaning
IOL	Induction of Labor
fIOL	Failed Induction of Labor
ACOG	American College of Obstetricians and Gynecologists
SMFM	Society of Maternal-Fetal Medicine
UNICHD	United States National Institute of Child Health and Human Development
BMI	Body Mass Index
AD	Anno Domini (in the year of our Lord)
ANC	Antenatal Care
HDIP	Hypertensive Disorder in Pregnancy
PROM	Pre-labor Rupture of Membranes
IUFD	Intrauterine Fetal Death
ARM	Artificial Rupture of Membranes

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Figures

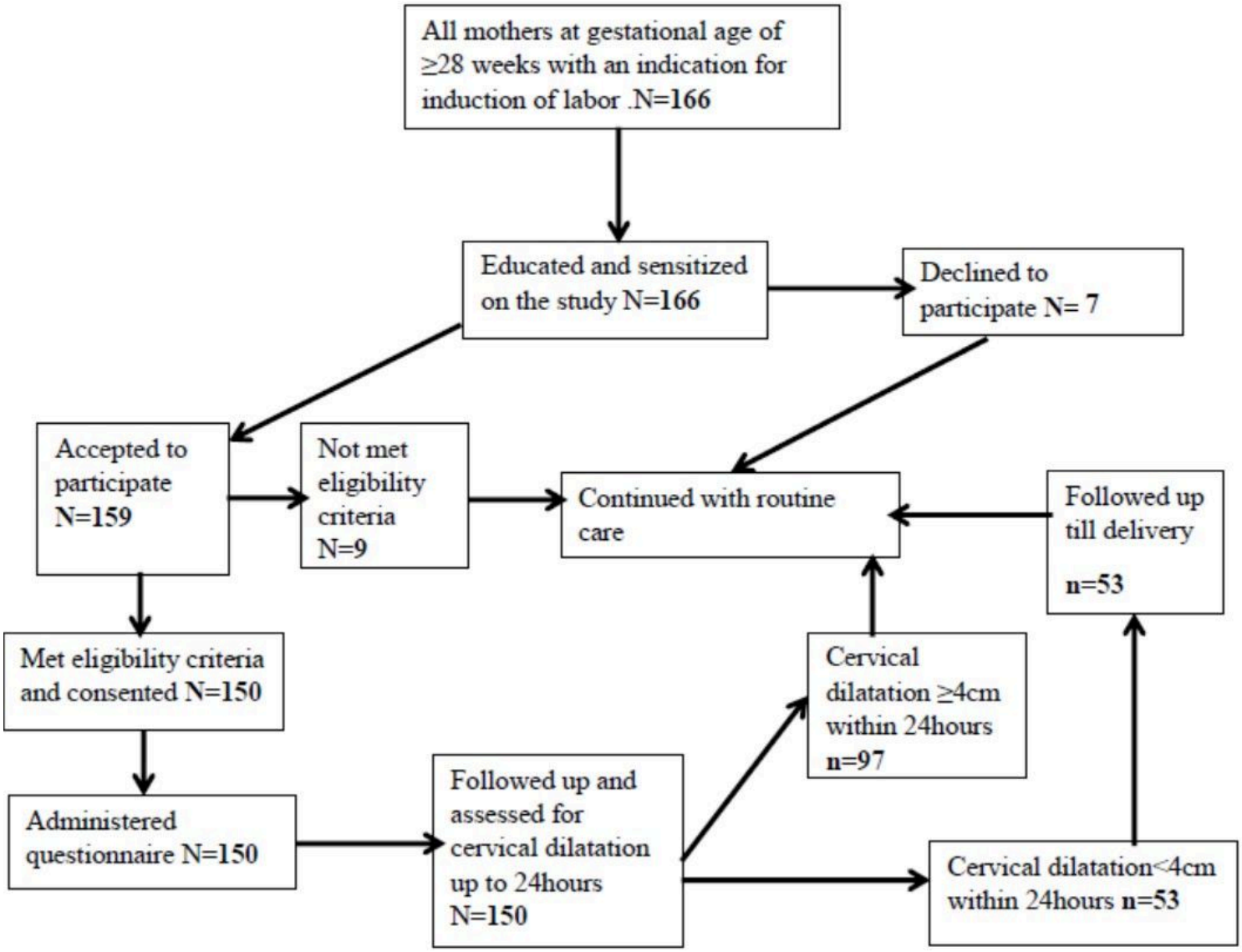

Figure 1

Study flow chart.

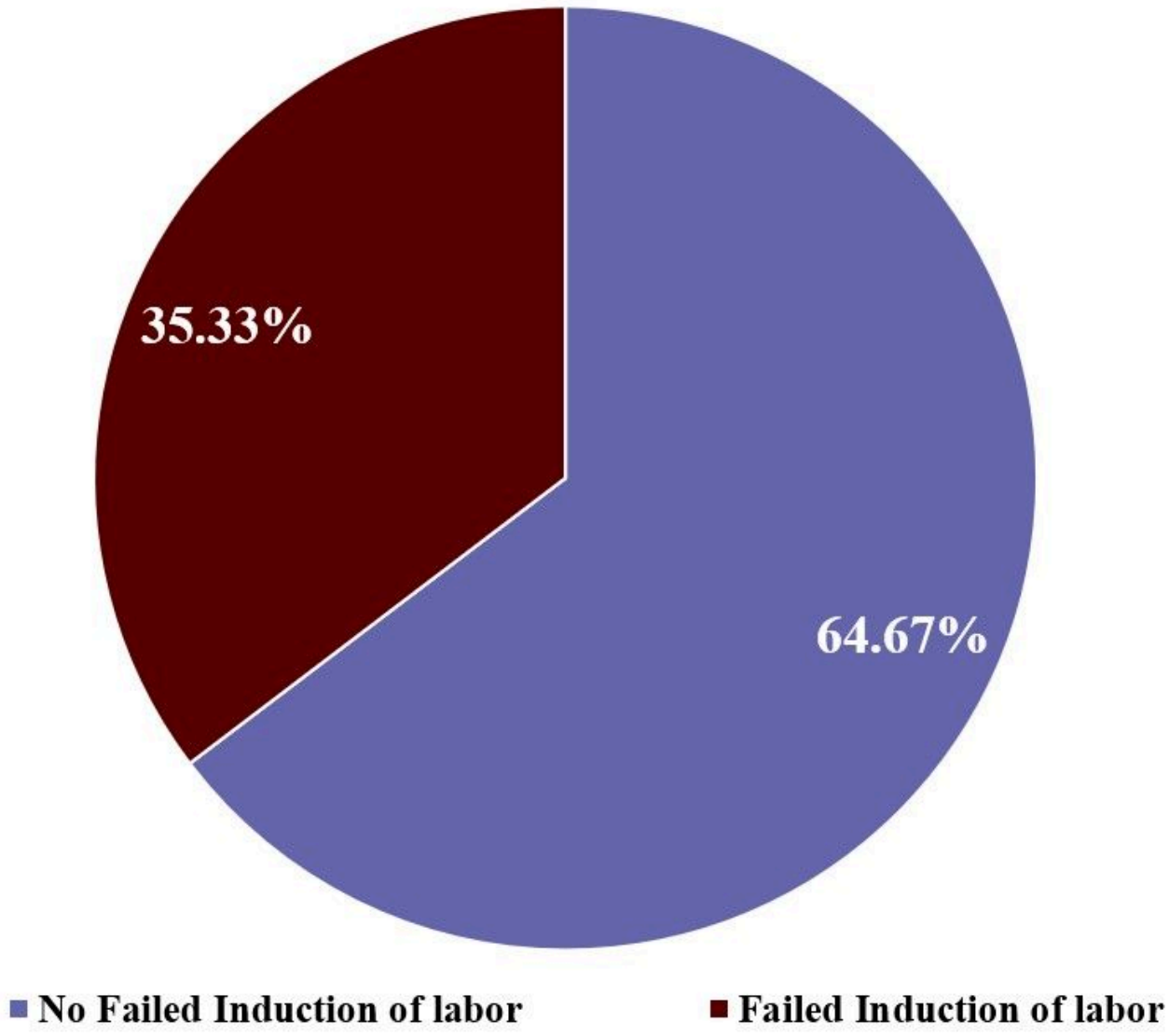

Figure 2

Pie-chart showing the incidence of failed induction of labor.