

# Failed induction of labor and associated factors in Adama Hospital Medical College, Oromia Regional State, Ethiopia

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## Abstract

**Background:** Failed induction of labor continues to be a public health challenge throughout the world. This failed induction of labor is associated with a higher rate of maternal and fetal morbidity because it increases the unwanted effect of emergency cesarean section. It is also associated with an increased risk of numerous adverse maternal and perinatal outcomes such as uterine rupture, nonreassuring fetal heart rate tracing, postpartum hemorrhage, stillbirth, and severe birth asphyxia. Thus, this study was aimed to assess the failed induction of labor and associated factors in the Adama Hospital Medical College, Oromia Regional State, Ethiopia.

**Methods:** A facility-based cross-sectional study was conducted from 1 to 30 December 2020 in Adama Hospital Medical College, Ethiopia. A total of 379 women who underwent labor induction in the Adama Hospital Medical College from December 2019 to November 2020 were enrolled in the study. The participants' charts were selected using a simple random sampling technique. Data were collected using a pretested and validated structured questionnaire. Descriptive statistics were carried out using frequency tables, proportions, and summary measures. Predictors were assessed using a multivariable logistic regression analysis model and reported using adjusted odds ratio with 95% confidence interval. Statistical significance was considered at a  $p$  value  $<0.05$ .

**Results:** Of 379 induced labor included in the study, the proportion of failed induction was found to be 29.6% (95% confidence interval (25.2, 34.3)). Prelabor rupture of the membrane was found to be the most common indication for induction of labor (46.4%) followed by a hypertensive disorder of pregnancy (21.6%). In the final model of multivariable analysis, predictors such as: nulliparity (adjusted odds ratio=2.32, 95% confidence interval (1.08, 5.02)), unfavorable cervical status (adjusted odds ratio=3.46, 95% confidence interval (1.51, 7.94)), prelabor rupture of membrane (adjusted odds ratio=2.60, 95% confidence interval (1.14, 5.91)), hypertensive disorder of pregnancy (adjusted odds ratio=3.01; 95% confidence interval (1.61, 5.58)), preinduction membrane status (adjusted odds ratio=3.63; 95% confidence interval (1.48, 8.86)), and birth weight of greater than 4000 g (adjusted odds ratio=4.33; 95% confidence interval (1.44, 13.02)) were statistically associated with failed induction of labor.

**Conclusion:** The prevalence of failed induction of labor was relatively high in this study area because more than a quarter of mothers who underwent induction of labor had failed induction. This calls for all stakeholders to adhere to locally available induction protocols and guidelines. In addition, pre-induction conditions must be a top priority to improve the outcome of induction of labor.

## Keywords

Labor induction, failed induction, the outcome of induction, associated factors, Ethiopia

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## Introduction

Failed induction of labor (IOL) remains an important public health challenge throughout the world in the clinical setting.<sup>1</sup> Universally, there is no standard definition for failed IOL; however, the literature in both observational and randomized trials defined it as failure to achieve vaginal delivery or failure to enter into active phase after IOL.<sup>2-4</sup>

Globally, over the past several decades, the incidence of IOL for shortening of the duration of pregnancy has been increased. In the developed world, the proportion of IOL is about 25% of all deliveries at term. These proportions are generally lower in developing regions; however, in some settings, they can be as high as those observed in developed countries.<sup>5</sup> For instance; a secondary analysis of World Health Organization (WHO) on the outcomes of IOL in 16 Asian and African countries, indicated the average prevalence of failed induction as 4.4% in Africa (ranged from 1.4% in Niger to 6.8% in Algeria) and 12.1% in Asia (ranged from 2.5% in Cambodia to 35.5% in Sri Lanka).<sup>6</sup> In Ethiopia, the proportion of failed IOL was higher than the average rate of Asian and African countries. For instance, previous few studies that have been conducted in Ethiopia reported a proportion of failed IOL as 19.7% in Dessie Referral Hospital,<sup>7</sup> 21.4% in Jimma University Hospital,<sup>8</sup> 25.4% in Addis Ababa teaching hospitals,<sup>9</sup> and 42.1% in Wolliso St. Luke Catholic Hospital.<sup>10</sup>

Worldwide, researchers have found that post-term pregnancy, hypertensive disorders (preeclampsia/eclampsia) during pregnancy,<sup>11</sup> prelabor rupture of membrane,<sup>10</sup> Intrauterine fetal growth restriction (IUGR),<sup>12</sup> intrauterine fetal death (IUFD), abruption placenta, fetal congenital anomalies, and other medical disorders are some indications for the intervention of IOL, which may influence the success of IOL.<sup>13,14</sup>

Although IOL for termination of pregnancy is acceptable and effective, sometimes it has negative consequences on the health of the mother and unborn fetus.<sup>12,15</sup> For instance, failure to achieve adequate uterine contractions after IOL is associated with an increased risk of numerous adverse maternal and perinatal outcomes such as uterine rupture, nonreassuring fetal heart rate tracing, postpartum hemorrhage,<sup>2</sup> endometritis,<sup>3</sup> stillbirth, and severe birth asphyxia.<sup>16</sup> Similarly, studies have shown that failed IOL has been associated with intrauterine infections such as chorioamnionitis and endometritis.<sup>2</sup> In addition, a higher rate of maternal and fetal morbidity is associated with cesarean delivery for failed induction and other obstetric complications like non-progress of labor and fetal distress. For example, studies have shown that failure of IOL poses a two- to three-fold greater risk of mortality related to cesarean delivery compared to vaginal birth.<sup>4,12</sup>

Furthermore, researchers have found that several factors are associated with the success or failure of IOL to achieve vaginal delivery. For instance, factors such as nulliparity,<sup>17</sup> birth weight (BW) >3500 g, maternal age <30 years, methods of induction,<sup>16</sup> nonreassuring fetal heart rate tracing,

cephalopelvic disproportion (CPD), high body mass index (BMI),<sup>11</sup> unfavorable cervix,<sup>4,8</sup> and unripened cervix<sup>3</sup> reduce the success rate of IOL. In contrast, factors like multiparity,<sup>9</sup> BW <3500 g,<sup>18</sup> and high Bishop score (a score of 8 or higher) increase the likelihood of success rate of IOL.<sup>19</sup> However, a Bishop score of 6 or lower increases the likelihood that induction will fail to result in vaginal delivery.<sup>7,20</sup>

In Ethiopia, although few studies have been conducted in the last 5 years, almost all previous researchers were selective to central and northern parts (Addis Ababa, Amhara, and Tigray regions),<sup>7,9,21</sup> rarely to the southern and Oromia regions,<sup>10,22</sup> and neglecting other parts of the country, particularly Afar, Harari, and Somali regions. Furthermore, to the best knowledge of the researchers, there is limited evidence regarding the outcome of IOL in this study area. Therefore, we aimed to estimate the failed IOL and its associated factors among mothers who underwent labor induction in Oromia Regional State, Ethiopia.

## Methods

### Study setting, period, and design

A facility-based cross-sectional study (a retrospective analysis) was conducted from December 1 to 30, 2020, in the Adama Hospital Medical College (AHMC), Oromia Regional State, Ethiopia. AHMC is the only public and teaching Hospital found in Adama city of Oromia Regional State, Ethiopia. Adama city is located at 100 km, east of the capital, Addis Ababa. According to the 2007 national census conducted by the Central Statistical Agency (CSA), the Adama town has an estimated total population of 388,925 (196,407 males and 192,518 females). Of the 192,518 total female population, about 86,069 are women of the reproductive age group.<sup>23</sup> Adama city administration has eight governmental health facilities, (one public Hospital and seven health centers), six nongovernmental health centers, four private hospitals, and 101 private clinics.

According to the AHMC annual report of 2018, a total of 16,324 recorded deliveries were reported, of which 1469 (9%) were induced and the remaining 14,855 (91%) were spontaneous labor. Regarding mode of delivery, the majority, 11,510 (70.5%) deliveries were spontaneous vaginal delivery followed by cesarean section (3836; 23.5%) and assisted instrumental delivery (978; 6%). Of the total deliveries, 15,900 were live births and 424 were stillbirths. The national cesarean section rate increased from 0.7% in 2000 to 1.9% in 2016, with an increment shown across seven of the 11 administrative regions of Ethiopia.<sup>24</sup>

### Population, eligibility criteria, and sample size calculation

The required sample size for this study was determined by using statistical software of Epi-info version 7.2 (USA,

2020) by considering the following assumptions. The proportion of failed IOL ( $p=17.3\%$ ) that was taken from previous a study conducted in public health facilities of Hawassa town, Southern Ethiopia,<sup>25</sup> a 95% confidence level (CI) ( $Z=1.96$ ), 4% tolerable margin of error ( $d=0.04$ ), and by adding 10% contingency for nonresponse rate, the final sample size of the study was 383. This sample represents 33% of the IOL of the random sample. Initially, the Hospital registration logbook of the labor ward was reviewed and 1278 women who underwent IOL at the gestational age of 28 weeks and more in AHMC from December 2019 to November 2020 were identified. Thus, all women who underwent IOL including those mothers who delivered with C/S due to uterine inertia (failure to achieve adequate uterine contraction) were included in the study. However, of 1278 induced labors, 29 women who underwent cesarean section (C/S) for indications such as nonreassuring fetal heartbeat pattern (NRFHBP) after commencement of IOL were excluded from the study. In addition, women who underwent IOL, but lacking pertinent information from their charts or with incomplete documentation was also excluded from the study.

### *Sampling technique and procedure*

AHMC was selected as the study site because AHMC is the only referral and teaching Hospital hosted by Adama Medical College as a teaching institution for a medical specialty in Adama city administration. According to the Hospital health management and information system (HMIS), the total annual number of deliveries attended at AHMC in 2018 was 16,324. Similarly, the previous information obtained from the Hospital's delivery and discharge registration logbooks revealed that 1278 (8% of the total recorded deliveries) women were managed with the IOL from December 2019 to November 2020. Based on the above information, we used a simple random sampling (SRS) technique to select study participants. Thus, following the serial numbers of women's medical record numbers (MRNs) who underwent IOL, all charts were listed, and a sampling frame was developed. Then, the medical records of mothers were randomly selected to enroll 383 eligible participants. Finally, the patients' charts were retrieved and data were collected until the required sample size was obtained.

### *Data collection tool and procedures*

Data were collected through a review of medical records of mothers' and labor ward logbooks using validated structured questionnaires and checklists adapted and customized from Ethiopian Demographic and Health Survey (EDHS) data collection tools<sup>24</sup> and developed by reviewing different literature.<sup>8,21,25</sup> Initially, two obstetricians and one neonatologist expert validated the content of the questionnaire. Then, the questionnaire pretest was conducted in a similar setting

and refined accordingly. Data were collected by two diploma (10 + 3) midwives who had previous data collection experiences. One supervisor (Master of Public Health profession (MPH)) was recruited for close supervision of the data collectors and the data collection process. Informed voluntary signed consent was taken from authorized bodies of the AHMC. All medical records were manually searched using patients' MRNs from where they were previously stored and filed in the board cabinets. Then, eligible charts were randomly selected and retrieved.

### *Study variables and measurements*

In this study, the dependent variable was the outcome of IOL. This dependent variable was dichotomized into binary outcomes as "Failed" and "Success." In the SPSS analysis, this binary outcome was recoded as "one (1)" and "zero (0)." Thus, "failed IOL was recoded as 1" and "Success of IOL was recoded as 0." The success IOL is defined as if a woman delivered vaginally either spontaneously or by instrument after IOL<sup>5</sup> and failed IOL is failure to initiate adequate uterine contraction and is diagnosed if adequate uterine contractions are not achieved after 6–8 h of oxytocin administration and use of the maximum dose for at least 1 h.<sup>9,26</sup> In this study, women with spontaneous rupture of membrane (SROM) would be recommended to undergo IOL after 8 h of rupture of membrane. In this study, the explanatory variables were categorized as: sociodemographic factors (maternal age and residence), obstetrics-related factors (antenatal care (ANC), prior fetal/neonatal demise, gravidity, parity, gestational age status, and Bishop score status), obstetric indications related factors (hypertensive disorder of pregnancy (preeclampsia/eclampsia), post-term pregnancy, the pre-labor rupture of the membrane (PROM), oligohydramnios, abruption placenta, and intrauterine fetal death), fetal-related factors (NRFHBP, BW, and fetal sex and fetal congenital anomalies), methods of IOL-related factors (methods for induction (medical: oxytocin infusion, prostaglandin analogs, mechanical: artificial rupture of the membrane (ARM), ballooned catheter, laminaria and the time interval from initiation of induction till delivery of the fetus, and type of induction (elective and emergency)).

### *Measurements*

Bishop score system: The Bishop score predicts the likelihood of vaginal delivery after induction with Oxytocin. With this scoring system, a number ranging from 0 to 13 is given to rate the conditions of the cervix and fetal station. Interpretation of the Bishop's score: Score  $\leq 4$ : It is unfavorable cervix which is unlikely to yield for induction, and cervical ripening is needed for the success of induction IOL or postponing the induction for next week if possible or use cervical ripening and plan induction for the next day. Score 5–8: Intermediate, Score  $\geq 9$ : is favorable cervical condition

and induction is likely to succeed and there is no need for cervical ripening, and induction can be planned for the next day. Oxytocin dosage protocol: According to the Ethiopia Federal Ministry of Health (FMOH, 2010), the national induction protocol was adopted and modified based on the WHO recommendation for IOL. According to this protocol, the oxytocin dosage is given in three doses for both primigravida and multigravida. This was identified in supplementary file one which was adapted from Ethiopia Hospital guideline (Supplementary file 1).

### *Operational definitions*

Failed induction is failure to initiate adequate uterine contraction and it is diagnosed if adequate uterine contractions are not achieved after 6–8 h of oxytocin administration and use of the maximum dose for at least 1 h.<sup>9,26</sup> Residency is the living place of the study participants, which can be categorized as urban and rural settings. Cervical ripening is one of the methods used for IOL by using pharmacological agents or mechanical interventions to soften, efface, or dilate the cervix to increase the likelihood of vaginal delivery.<sup>26</sup> ANC follow-up is defined as the complex of interventions that a pregnant woman receives from organized healthcare services.<sup>27</sup> Post-term pregnancy is a pregnancy that advances beyond 42 completed weeks or 294 days of gestation from the last normal menstrual period.<sup>26</sup> Favorable cervical status is defined as when a Bishop score of  $\geq 9$ .<sup>9</sup> Chorioamnionitis is an intra-amniotic infection commonly characterized by maternal fever, fetal tachycardia (FHB  $> 160$  beats/min), tender uterus, purulent cervical discharge, leukocytosis, and/or positive bacterial culture.<sup>14</sup> NRFHR is defined according to the definitions of the American College of Obstetricians and Gynecologists (ACOG) and the Society for Maternal-Fetal Medicine (SMFM). Accordingly, NRFHR tracing is defined as changes in fetal heart rate patterns with at least one of the followings: baseline FHR between 100 and 120 beats/min with no accelerations  $> 15$  beats/min for  $> 15$  s and/or baseline FHR  $< 100$  beats/min with accelerations and/or tachycardia  $> 160$  beats/min with variability  $< 5$  beats/min or variable decelerations with a relative drop of  $\geq 70$  beats/min or an absolute drop to  $\leq 70$  beats/min for  $> 60$  s.<sup>28</sup> Moreover, the literature defined the term NRFHR tracing as progressive fetal hypoxia and/or acidemia secondary to inadequate fetal oxygenation, and is a term that is used to indicate changes in fetal heart patterns, reduced fetal movement, fetal growth restriction, and the presence of meconium-stained fluid.<sup>29,30</sup> Oligohydraminous is diagnosed when amniotic fluid index (AFI) values  $\leq 5$  cm or single deepest pocket  $< 2$  cm. The AFI is the sum of the vertical depth of fluid measured in each quadrant of the uterus.<sup>31,32</sup>

### *Data quality control*

A structured questionnaire was first prepared in the English language. Then, one-day training was given for data collectors

with a supervisor. The contents of the training were the purpose of the study, study tool, data collection procedures, and data handling and storage. A pretest was conducted on 25 samples (6% of the total sample size) to ensure the validity of the tool, and to refine the contents. The principal investigator and supervisor were checking and reviewing the collected data to ensure completeness and consistency of the information and immediate action was taken accordingly. Double data entry was conducted by two independent data clerks, and the consistency of the entered data was cross-checked. Simple frequencies were run to check any missing values or outliers and cross-checked with hard copies of the questionnaire.

### *Data processing and analysis*

The collected data were checked, coded, and entered into Epi-info version 7.2 (USA, 2020). Then, they were exported to SPSS windows version 24 (IBM SPSS Statistics, 2016) for further analysis. Descriptive statistics were carried out using simple frequency tables, proportions, and summary measures. A bivariable logistic regression analysis was conducted to identify the association between each independent variable and the outcome variable. All variables having a  $p$  value of  $\leq 0.25$  in the bivariable analysis were included in the final model of multivariable analysis to control for potential confounders. Multicollinearity was checked using variance inflation factor (VIF) and tolerance and no collinearity effect was detected. Hosmer–Lemeshow goodness of fitness test was used to check for model fitness and the result was found to be insignificant ( $p=0.677$ ) which indicates the model was well fitted. In the final model of multivariable logistic regression analysis, the adjusted odds ratios (AORs) with 95% CI were computed to identify the effects of independent variables on the outcome of IOL. The level of statistical significance was declared at a  $p$  value  $< 0.05$ .

### *Ethical approval and consent to participate*

An ethical clearance letter was obtained from the Institutional Review Board (IRB) of Adama General Hospital and Medical College (Ref No: AGHMC/45/01/12). A supportive letter was written to AHMC. Informed voluntary, written, and signed consent was obtained from legally authorized representatives of the hospital before the study was conducted. Confidentiality of patient information was assured by omitting their names and using card numbers instead. Data confidentiality was maintained through anonymity by removing any personal identifiers.

## **Results**

### *Sociodemographic and obstetrics-related characteristics of the participants*

In this study, 383 records of women who underwent labor induction in AGHMC were retrieved, and 379 were



**Table 1.** Sociodemographic and obstetric related characteristics of women who underwent labor induction in Oromia Regional State, AHMC, Ethiopia, 2021.

Characteristics	Categories	Frequency (n)	Percentage (%)
Age (years) (mean = 24.51, SD ± 6.86)	<20	134	35.4
	20–34	202	53.3
	35–49	43	11.3
Residence	Urban	314	82.8
	Rural	65	17.2
Parity	Multiparity	162	42.7
	Nulliparity	217	57.3
Gestational age (weeks) (mean = 37.81, SD = ± 3.31)	<37	108	28.50
	37–42	232	61.20
	>42	39	10.3
Pre-induction for prior fetal/neonatal demise	Yes	28	7.4
	No	351	92.6
Pre-induction admission for a post-term pregnancy	Yes	39	10.3
	No	340	89.7
Pre-induction Bishop score	Favorable (≥8 scores)	66	17.4
	Unfavorable (<8 score)	313	82.6
Pre-induction membrane status	Intact	164	43.3
	Ruptured	215	56.7
Pre-induction admission for PROM	Yes	205	54.1
	No	174	45.9
Preinduction admission for HDP	Yes	112	29.6
	No	267	70.4
Pre-induction admission for oligohydramnios	Yes	62	16.4
	No	317	83.6
Intrauterine growth restriction	Yes	43	11.3
	No	336	88.7

AHMC: Adama Hospital Medical College; HDP: hypertensive disorder of pregnancy; PROM: prelabor rupture of membrane.

successfully extracted making the response of 98.9%. Four charts were excluded from the analysis because of incompleteness and lack of pertinent information. The mean age of the participants was 24.5 years (SD ± 6.86) ranged from 16 to 44 years. Three hundred-fourteen (82.8%) of the participants were from the urban setting. More than half, 217 (57.3%) of the women were nulliparous, and the majority, 351 (92.6%) had no prior fetal /neonatal demise. The median gestational age of the pregnancy was 37.8 weeks (SD ± 3.31). Concerning pre-induction conditions, the PROM was the most common obstetric admission (205; 54.1%) followed by a hypertensive disorder of pregnancy (112; 29.6%), and the least common pre-induction obstetric complication was IUGR (43; 11.3%). The majority, 313 (82.6%) of the mothers had unfavorable cervical status (Bishop score less than 8), and more than half, 215 (56.7%) of them had a pre-induction ruptured fetal membrane (Table 1).

### Methods of IOL and birth outcome

Of 379 induced mothers who enrolled in the study, 307 (81%) of them underwent cervical ripening, of which 189 (61.6%) were induced by using mechanical methods (an

intracervical balloon catheter). The most common type of induction method was the oxytocin intravenous drip regimen (355; 93.70%). Nearly two-thirds, 240 (63.3%) of the mothers gave birth through spontaneous vaginal delivery (SVD) followed by cesarean section (C/S) (112; 29.6%). The majority of mothers' neonates were in the normal BW of 2500 to 4000 g with a mean BW of 3246.2 (SD ± 573.4) (Table 2).

### Magnitude of failed induction and indications for IOL

In this study, the proportion of failed IOL was 29.6% (95% CI (25.2, 34.3)) (Figure 1). Concerning indications for labor induction, of 379 randomly selected induced labor in AHMC, the most common indication for IOL was the PROM (176; 46.4%) followed by a hypertensive disorder of pregnancy (HDP) (82; 21.6%) and post-term pregnancy (36; 9.5%) (Figure 2).

### Factors associated with failed IOL

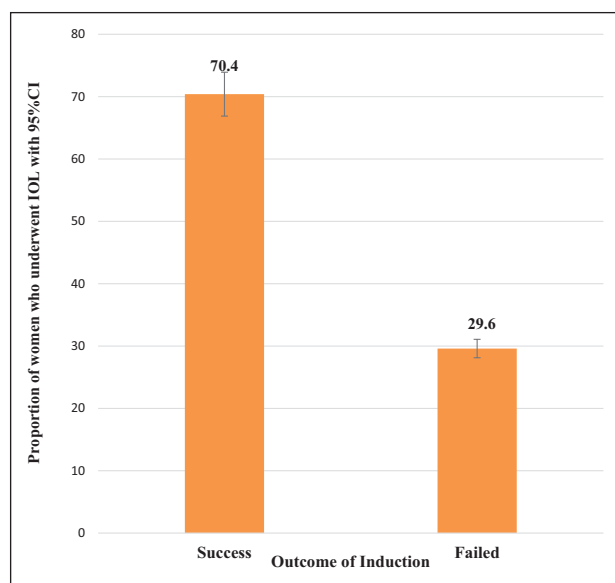
In this study, from all predictor variables recruited in the bivariable logistic regression analysis, variables such as

**Table 2.** Methods of IOL and delivery outcome among mothers who underwent IOL in Oromia Regional State, AHMC, Ethiopia, 2021.

Characteristics	Categories	Frequency (n)	Percentage (%)
Pre-induction cervical ripening (n = 379)	Yes	307	81.0
	No	72	19.0
Methods of cervical repining (n = 307)	Mechanical*	189	61.6
	Medical/misoprostol	118	38.4
Routes of misoprostol (n = 118)	Vaginal	40	33.9
	Sublingual	78	66.1
Methods of induction (n = 379)	Oxytocin only method	355	93.7
	Jointly oxytocin + ARM	24	6.3
Duration of induction till delivery	Less than 10h	331	87.3
	Greater than 10h	48	12.7
Mode of delivery after IOL (n = 379)	Spontaneous vaginal delivery	240	63.3
	Instrumental vaginal delivery	27	7.1
	C/S delivery	112	29.6
Birth weights of newborn (g), (mean = 3246.2, SD = 573.4)	<2500	58	15.30
	2500–4000	278	73.4
	>4000	25	11.3
Meconium-stained amniotic fluid status	Yes	11	2.9
	No	368	97.1
Apgar score at first minutes	Less than 7	97	25.6
	7 and above	282	74.4

AHMC: Adama Hospital Medical College; IOL: induction of labor.

\*Balloon catheter.

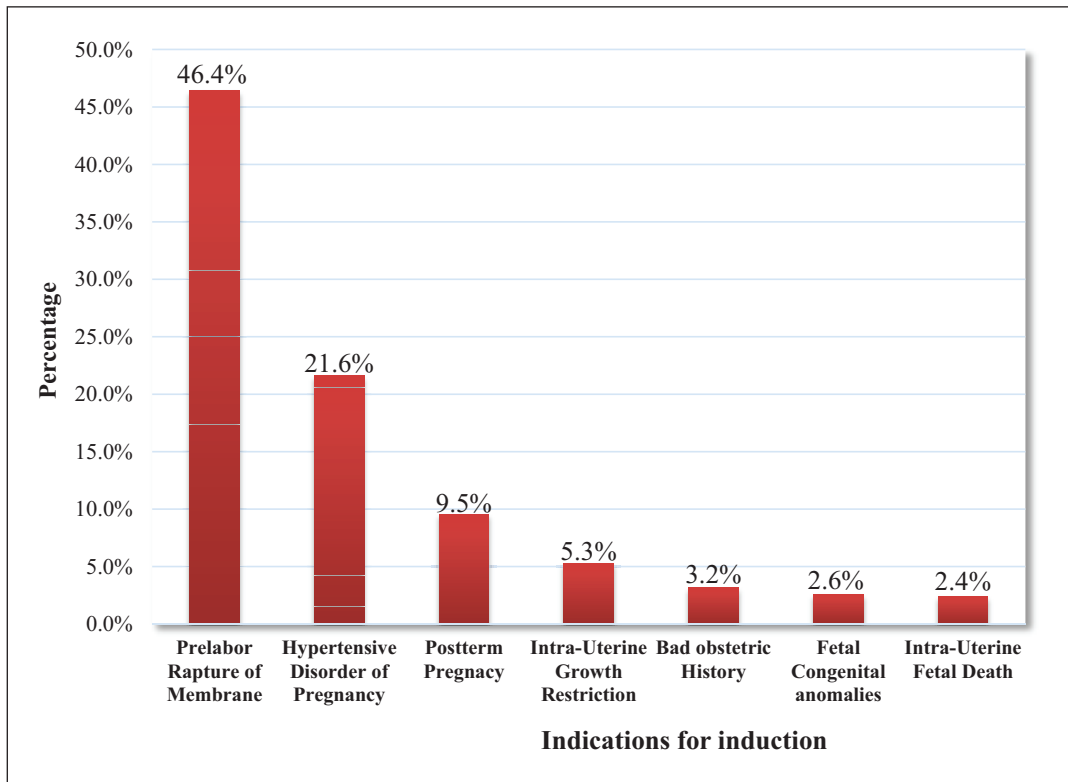


**Figure 1.** Magnitude of the outcome of induction of labor among women who underwent labor in Adama Hospital Medical College, Oromia Regional State, Ethiopia, 2020.

maternal age less than 20 years (crude odds ratio (COR) = 2.47, 95% CI (1.09, 5.57)), nulliparity (COR = 3.43, 95% CI (2.08, 5.66)), nonreassuring fetal heartbeat pattern (COR = 2.50, 95% CI (1.35, 4.63)), unfavorable cervix (COR = 3.11, 95% CI (1.48, 6.52)), preinduction ruptured membrane

(COR = 4.65, 95% CI (2.75, 7.85)) (1.12, 2.86) and BW of greater than 4000 g (COR = 3.65, 95% CI (1.58, 8.41)) were statistically associated with failed IOL (Table 3).

In the final model of multivariable analysis, all predictor variables having a *p* value  $\leq 0.25$  were entered in the final model of multivariable logistic regression analysis. In this final model analysis, predictor variables like nulliparity, unfavorable cervical status, pre-induction PROM, HDP, pre-induction membrane status, and BW of greater than 4000 g were remained significantly associated with failed IOL. Accordingly, the odds of failed IOL were more than two times higher in nulliparous mothers compared to multiparous women (AOR = 2.32, 95% CI (1.08, 5.02)). The likelihood of failed IOL was more than three times higher among mothers who had unfavorable cervical status compared to their counterparts (those who had favorable cervix) (AOR = 3.46, 95% CI (1.51, 7.94)). Likewise, the odds of failed IOL was 2.6 times higher among mothers who had prelabor rupture of membrane compared to those who had not PROM (AOR = 2.60, 95% CI (1.14, 5.91)). Similarly, the likelihood of failed IOL was 3.6 times higher in women with pre-induction ruptured fetal membrane compared to those whose fetal membrane was intact (AOR = 3.63, 95% CI (1.48, 8.86)). In addition, the odds of failed IOL was three times higher among women who had a hypertensive disorder of pregnancy compared to their counterpart (those who had not HDP) (AOR = 3.01, 95% CI (1.61, 5.58)). Finally, mothers whose fetal weight was greater than 4000 g were four



**Figure 2.** Indications for induction of labor among women who underwent labor induction in Adama Hospital Medical College, Oromia Regional State, Ethiopia, 2020.

times more likely to have failed IOL than those whose fetal weight was less than 2500 g (AOR=4.33, 95% CI (1.44, 13.02)) (Table 4).

## Discussion

In this study, the overall magnitude of failed IOL among women who underwent IOL in AHMC was found to be 29.6%, and the most common indication for labor induction was PROM (46.4%). This current proportion of IOL is nearly comparable to previous research reports like 26.5% in Wolaita Sodo teaching hospital, Southern Ethiopia,<sup>22</sup> 32.3% in Nigeria,<sup>33</sup> 25.4% in Addis Ababa,<sup>9</sup> and 28% in Portugal.<sup>34</sup> However, the proportion of failed IOL reported in this study was higher compared to previous studies conducted in different parts of Ethiopia like 21.4% in Jimma University Hospital,<sup>8</sup> Dessie Referral Hospital (19.7%),<sup>7</sup> and Hawassa public health facilities (17.9%), Ethiopia.<sup>25</sup> These differences in the proportion of failed induction might be attributed to the lower utilization of prostaglandins as a primary method of induction was observed in our study site when compared to studies conducted in Dessie Referral Hospital and Hawassa public health facilities. Similarly, the proportion was also higher compared to studies conducted in Tanzania (19%),<sup>18</sup> Saud Arabia (16%),<sup>35</sup> and Le Scotte Siena Hospital, Italy (19.3%).<sup>17</sup> These discrepancies may be because the majority of the study participants in previous studies were multiparas

and misoprostol was the predominant method for cervical ripening, whereas in the current study setting, the majority of the study participants were nulliparous and the predominant method for cervical ripening was an intracervical balloon catheter. The other possible justifications for differences in prevalence are because of the lack of a universally accepted definition of failed IOL.

On the contrary, the result of this study is encouraging as the current prevalence of failed IOL is comparatively lower than previous studies conducted in different countries like Nigeria (36.5%),<sup>36</sup> South Africa (49.3%),<sup>11</sup> Oromia, Ethiopia (42.1%),<sup>10</sup> France (37.5%),<sup>37</sup> Addis Ababa, Ethiopia (40.3%),<sup>38</sup> and Odisha city of eastern India (50.5%).<sup>39</sup> The lower prevalence observed in the current study is because mothers who delivered through the cesarean section for indications other than failed induction were excluded from the study. In addition, the difference in estimate might be attributed to the time gap between study periods, the geographical setting of the study population, and the difference in the sample size of the studies. Other possible justification for this discrepancy might be due to the nature of the study designs, and methods of data collection procedures. In addition, definitions of failed induction per protocol might be attributed to these observed variations. For instance, the type of methods of inductions, cervical ripening methods, maintaining the oxytocin concentration, and dose adjustment while changing the infusion of bag might be different per protocol.

**Table 3.** Bivariable logistic regression analysis of factors associated with failed IOL in Oromia Regional State, AHMC, Ethiopia, 2020.

Characteristics	Categories	Outcome of induction		COR (95% CI)
		Failed	Successful	
Age (years)	<20	53 (39.6)	81 (60.4)	2.47 (1.09, 5.57)*
	20–34	50 (24.8)	152 (75.2)	1.24 (0.56, 2.78)
	35–49	9 (20.9)	34 (79.1)	1
Residence	Urban	86 (27.4)	228 (72.6)	1
	Rural	26 (40.0)	39 (60.0)	1.77 (1.02, 3.08)*
Parity	Multiparity	26 (16.0)	136 (84.0)	1
	Nulliparity	86 (39.6)	131 (60.4)	<b>3.43 (2.08, 5.66)**</b>
Post-term pregnancy	Yes	9 (23.1)	30 (76.9)	1
	No	103 (30.3)	237 (69.7)	1.45 (0.66, 3.16)
NRFHBP	Yes	23 (47.9)	25 (52.1)	<b>2.50 (1.35, 4.63)*</b>
	No	89 (26.9)	242 (73.1)	1
Pre-induction Bishop Score	Favorable ( $\geq 8$ scores)	9 (13.6)	57 (86.4)	1
	Unfavorable (<8 score)	103 (32.9)	210 (67.1)	<b>3.11 (1.48, 6.52)**</b>
Pre-induction cervical ripening	Yes	97 (31.6)	210 (68.4)	1
	No	15 (20.8)	57 (79.2)	0.57 (0.307, 1.06)
Preinduction PROM	Yes	89 (43.4)	116 (56.6)	<b>5.04 (2.98, 8.46)*</b>
	No	23 (13.2)	151 (86.8)	1
Pre-induction membrane status	Intact	22 (13.4)	142 (86.6)	1
	Ruptured	90 (41.9)	125 (58.1)	<b>4.65 (2.75, 7.85)*</b>
Hypertensive disorder of pregnancy	Yes	43 (38.4)	69 (61.6)	1.8 (1.12, 2.86)
	No	69 (25.8)	198 (74.2)	1
Prior fetal/neonatal demise	Yes	5 (17.9)	23 (82.1)	0.50 (0.18, 1.34)
	No	107 (30.5)	244 (69.5)	1
Birth weight (g)	<2500	16 (27.6)	42 (72.4)	1
	2500–4000	71 (25.5)	207 (74.5)	0.91 (0.48, 1.70)
	>4000	25 (58.1)	18 (41.9)	<b>3.65 (1.58, 8.41)**</b>

AHMC: Adama Hospital Medical College; CI: confidence interval; COR: crude odds ratio; IOL: induction of labor; NRFHBP: nonreassuring fetal heartbeat pattern; PROM: prelabor rupture of membrane.

\* $p$  value < 0.01, \*\* $p$  value < 0.001.

In the final model of multivariable analysis, maternal parity was independently associated with failed IOL. Thus, the odds of failed IOL were more than two times higher in nulliparous compared to multiparous women. This result is also supported by previous studies conducted in different settings such as Dessie Referral Hospital, Ethiopia,<sup>7</sup> Saud Arabia,<sup>35</sup> Jimma University Hospital Ethiopia,<sup>8</sup> and France,<sup>37</sup> which indicated a higher proportion of failed induction in nulliparous women. This might be because direct initiation of induction before cervical ripening and doing ARM after the active phase of the first stage of labor in nulliparous mothers may increase the likelihood of failed induction. Other possible justifications might be attributed to multiparity because as the parity of the mother increases, the likelihood of failed IOL decreases as uterine muscles can be easily stimulated and contracted in multiparous women.

In this study, cervical favorability was found to be an independent predictor of failed IOL. Thus, the likelihood of failed IOL was more than three times higher among mothers who had unfavorable cervical status compared to their counterparts. This finding is in line with previous literature's report from Woliata Soda teaching hospital, Ethiopia,<sup>22</sup>

France,<sup>37</sup> and Le Scotte Siena Hospital of Italy.<sup>17</sup> It is also supported by another study conducted in Addis Ababa Army referral Hospital,<sup>38</sup> in which a higher proportion of failed induction was observed in mothers with lower Bishop scores. The possible justification is explained by the scientific finding of different kinds of literature that the condition of the cervix at the initiation of induction is an important predictor, with the modified Bishop score which is a widely used scoring system that includes four cervical parameters (cervical consistency, effacement, position, and dilatation) and the station of presenting part of the fetus. This indicates that the unripened cervix is highly associated with failed induction because the unfavorable cervix is less likely to be affected by uterine muscle contractility and pressure of the fetal present part compared to the favorable cervix.

Furthermore, the odds of failed IOL was 2.6 times higher among mothers who had PROM compared to those who had no PROM. This finding is also supported by studies conducted in St. Luke Catholic hospital,<sup>10</sup> Hawassa public health facilities,<sup>25</sup> and Nigeria.<sup>36</sup> The possible justification for this might be because whenever pregnant women encounter gushing of amniotic fluid per vagina, there is a risk of



**Table 4.** Multivariable analysis of factors associated with failed IOL in AHMC, Ethiopia, 2020.

Characteristics	Categories	Outcome of induction		COR (95% CI)	AOR (95% CI)
		Failed, N (%)	Successful, N (%)		
Age (years)	<20	53 (39.6)	81 (60.4)	2.47 (1.09, 5.57)	1.14 (0.35, 3.66)
	20–34	50 (24.8)	152 (75.2)	1.24 (0.56, 2.78)	0.96 (0.36, 2.71)
	35–49	9 (20.9)	34 (79.1)	1	1
Residence	Urban	86 (27.4)	228 (72.6)	1	1
	Rural	26 (40)	39 (60%)	1.77 (1.02, 3.08)	2.21 (0.94, 4.64)
Parity	Multiparity	26 (16.0)	136 (84.0)	1	1
	Nulliparity	86 (39.6)	131 (60.4)	3.43 (2.08, 5.66)	<b>2.32 (1.08, 5.02)**</b>
Post-term pregnancy	Yes	9 (23.1)	30 (76.9)	1	1
	No	103 (30.3)	237 (69.7)	1.45 (0.66, 3.16)	0.88 (0.29, 2.62)
NRFHBP	Yes	23 (47.9)	25 (52.1)	2.50 (1.35, 4.63)	1.92 (0.89, 4.14)
	No	89 (26.9)	242 (73.1)	1	1
Pre-induction Bishop score	Favorable ( $\geq$ )	9 (13.6)	57 (86.4)	1	1
	Unfavorable ( $<8$ )	103 (32.9)	210 (67.1)	2.38 (1.20, 4.75)	<b>3.46 (1.51, 7.94)**</b>
Pre-induction cervical ripening	Yes	97 (31.6)	210 (68.4)	1	b*
	No	15 (20.8)	57 (79.2)	0.57 (0.307, 1.06)	—
Preinduction PROM	Yes	89 (43.4)	116 (56.6)	5.04 (2.98, 8.46)*	<b>2.60 (1.14, 5.91)*</b>
	No	23 (13.2)	151 (86.8)	1	1
Pre-induction membrane status	Intact	22 (13.4)	142 (86.6)	1	1
	Ruptured	90 (41.9)	125 (58.1)	4.65 (2.75, 7.85)	<b>3.63 (1.48, 8.86)*</b>
Hypertensive disorder of pregnancy	Yes	43 (38.4)	69 (61.6)	1.8 (1.12, 2.86)*	<b>3.01 (1.61, 5.58)</b>
	No	69 (25.8)	198 (74.2)	1	1
Prior fetal/neonatal demise	Yes	5 (17.9)	23 (82.1)	0.50 (0.18, 1.34)	1.21 (0.33, 3.40)
	No	107 (30.5)	244 (69.5)	1	1
Birth weight (g)	<2500	16 (27.6)	42 (72.4)	1	1
	2500–4000	71 (25.5)	207 (74.5)	0.91 (0.48, 1.70)	0.58 (0.26, 1.34)
	>4000	25 (58.1)	18 (41.9)	3.65 (1.58, 8.41)	<b>4.33 (1.44, 13.02)**</b>

1: reference category; AHMC: Adama Hospital Medical College; AOR: adjusted odds ratio; b\*: removed from the final model analysis because collinearity effect with pre-induction Bishop score variable; CI: confidence interval; COR: crude odds ratio; NRFHBP: nonreassuring fetal heartbeat pattern; PROM: prelabor rupture of membrane.

\*p value < 0.01, \*\*p value < 0.001.

ascending infection, which may result in chorioamnionitis, and this can cause an NRFHBP. This intrauterine hostility may exacerbate the condition of failed induction due to fetal distress. Similarly, HDP was found to be an independent predictor of the failed IOL. Thus, the odds of failed IOL was three times higher among women who had a hypertensive disorder of pregnancy compared to their counterpart. This is also supported by previous research reporting in Referral Hospital in Tanzania.<sup>18</sup> The possible explanation for this might be because the HDP increases the risk of uteroplacenta insufficiency. As a result, when placenta function is compromised, the placenta hormones do not respond to uterotonic drugs and which may increase the likelihood of failed IOL.

Moreover, in the final model of multivariable analysis, BW was statistically associated with failed IOL. Thus, mothers whose fetal weight was greater than 4000 g were four times more likely to have failed IOL than those whose fetal weight was less than 2500 g. This result is consistent with a previous research report in Aga Khan University Hospital,<sup>40</sup> and Le Scotte Siena Hospital of Italy,<sup>17</sup> which showed a higher proportion of failed induction in women with larger

BW. The possible reason is that whenever the weight of the fetus is greater than 4000 g, it can cause CPD, which leads to uterine dysfunction and difficult labor. This uterine inertia may increase the failure rate of IOL.

### Limitations of the study

We collected data from a secondary source; some independent variables might be missed. The study was conducted only in public health hospitals; pregnant women who attended the IOL at private health facilities were not included in the study. In addition, we did not look into the association of maternal BMI, and some general medical conditions, which may influence the outcome of IOL. In this study, we have not done elective induction because of limited data in the study site.

### Conclusion

In this study, more than a quarter of mothers who underwent IOL had failed induction, and PROM was found to be the most common indication for IOL. Nulliparity, unfavorable

cervical status, pre-induction PROM, HDP, and BW of greater than 4000 g were statistically associated with failed IOL. This calls for all stakeholders to adhere to locally available induction protocols and guidelines. In addition, pre-induction conditions must be a top priority to improve the outcome of IOL. More specifically, due consideration must be given to pre-induction conditions with the emphasis being placed on cervical status, and the specific method of IOL. Early identification and management of women with obstetrics complications can improve maternal and perinatal outcomes among mothers who undergo IOL. Close monitoring of maternal and fetal status before the initiation of IOL is also very crucial. Finally, we recommend longitudinal studies to identify the true causal association of failed IOL.

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### Author contributions

All authors have made a significant contribution to the conception, study design, data collection, data analysis, and interpretation of the findings. The authors also took part in writing the manuscript, reviewed the draft, and finally agreed on the journal to which the article has to be published. All authors read and approved the final draft of the manuscript and agreed to be accountable for all contents of the manuscript under any circumstances.

### Consent to participate

Written informed consent was obtained from legally authorized representatives before the study. Data anonymity was maintained by removing any personal identifiers. This study was conducted following the Declaration of Helsinki.

### Data sharing statement

The datasets used for analysis are available from the corresponding author on reasonable request.

### Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

### Ethical approval

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### Informed consent

Informed voluntary, written, and signed consent was obtained from legally authorized representatives the hospital before the study.

Confidentiality of patient information was also assured by omitting their names and using card numbers instead. This study was conducted following the Declaration of Helsinki.

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### Supplemental material

Supplemental material for this article is available online.

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