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Vaginal delivery following induction and associated factors among laboring women at South Wollo Zone Public Hospitals of Ethiopia, 2023

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Improving maternal and perinatal outcomes can be achieved by identifying factors affecting successful vaginal delivery following induction of labor, particularly in developing countries with low rates of induction. Besides this, evidence regarding the magnitude of successful vaginal delivery following induction and associated factors is limited in Ethiopia. Therefore, this study aimed to assess the magnitude of vaginal delivery following induction and associated factors among laboring women at South Wollo Zone Public Hospitals of Ethiopia, 2023. An institutional-based cross-sectional study was conducted among 385 from April 1 to June 15, 2023. A systematic random sampling method was used to select each participant. A pretested structured interviewer-administered questionnaire and checklist were used to collect data. Epi-Data version 4.6 and SPSS version 26 software were used for data entry and analysis, respectively. Multivariable binary logistic regression was used to identify associated factors and an adjusted odds ratio with a 95% confidence interval was used to identify significant variables. Model fitness was checked using the Hosmer-Lemeshow goodness of fit test. The study reported that 75.6% of participants gave vaginal delivery following induction with a 95% CI (71.00-79.80). Mid-upper arm circumstance 23–28 cm (AOR = 2.55, 95% CI: 1.19–5.47), multiparty (AOR = 3.01, 95% CI: 1.430–6.33), favorable bishop (AOR = 3.79, 95% CI: 1.74–8.26), oxytocin with cervical ripening method (AOR = 3.74, 95% CI: 1.99–7.04), and birth weight less than 4000gram (AOR = 5.40, 95% CI: 1.54–18.91) were factors significantly associated with successful vaginal delivery following induction. Therefore, obstetric caregivers should consider pre-induction assessments such as bishop score of the cervix and fetal weight estimation and improving the nutritional status of pregnant women.

Keywords Associated factors, Induction of labor, Vaginal delivery, Ethiopia

Abbreviations

AOR	Adjusted odds ratio
CI	Confidence interval
COR	Crude odd ratio
IOL	Induction of labor
IUFD	Intra uterine fetal death
MUAC	Middle upper arm circumference
PROM	Premature rupture of membrane
SPSS	Statistical package for product solution
SVD	Successful vaginal delivery

Starting labor artificially, known as induction of labor (IOL) is stimulating uterine contractions at ≥28 of gestational weeks before the spontaneous onset of labor to achieve vaginal delivery. It is a crucial life-saving

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intervention that reduces adverse outcomes in modern obstetrics[1–3]. IOL can be elective or emergency[4,5]. It can be done using surgical (artificial rupture of membranes (ARM), balloon catheter insertion, cervical stripping, and laminaria or medical methods (oxytocin and prostaglandins), which may decrease the requirement for oxytocin induction and shorten the time interval between induction and delivery[2,4].

WHO recommends induction only when there is a clear medical indication that continuing with a pregnancy poses a greater risk to the mother or fetus than the risk of inducing labor in a condition like post-term pregnancy, premature rupture of membranes (PROM), hypertensive disorders of pregnancy like preeclampsia or eclampsia, diabetes mellitus, renal diseases, cardiac disease, chorioamnionitis, abruption placenta, suspected intrauterine growth restriction (IUGR), oligohydramnios, and fetal congenital anomalies are the main indications for induction labor[6–8].

For a safe and timely vaginal delivery, induction of labor should be based on the latest evidence and adapted to the individual's specific situation and needs[9]. Successful vaginal delivery (SVD) following induction is the process of giving birth within 12 h from the beginning of induction infusion through the birth canal that may be spontaneous or assisted by an instrument that indicates the exact goal of induction[4,9].

SVD following induction reduces the risk of cesarean delivery, shortens recovery time, lowers maternal complications (e.g. infections and hypertensive disorders), and improves neonatal outcomes such as reduced rates of respiratory problems and intensive care unit admission. Additionally, it has been linked to increased rates of breastfeeding initiation and continuation, which is beneficial for both mother and infant by promoting bonding and better nutritional outcomes of the newborn[10]. Furthermore, it enhances a woman's sense of empowerment and satisfaction with her birthing experience. This psychological benefit can improve maternal mental health and result in future positive pregnancy experiences[11].

In contrast, Failed SVD following induction, resulting in a cesarean section, increases the risk of maternal and neonatal complications, leads to a longer hospital stay and higher costs, and can have an emotional impact on the mother[12]. Along with these negative effects, it also causes uterine rupture, non-reassuring fetal heart rate tracing, postpartum hemorrhage, stillbirth, and severe birth asphyxia[13].

Globally, approximately 20% of pregnant women undergo an IOL to initiate childbirth. 80% (80%) of women who had induction gave delivery vaginally[14]. The rate is substantially higher in developed countries[15] compared to low- and middle-income countries, 4.4% in Africa, 12.1% in Asia, and 20% in the United States and the United Kingdom[14]. A study in Ethiopia reported that the magnitude of SVD following induction was 65%[6]. SVD following induction is affected by factors such as maternal age, parity, place of residence, cervical condition, birth weight, gestational age, pregnancy complications, and induction methods used[6,11,12,16].

SVD following the induction of labor is an essential intervention to reduce adverse maternal and neonatal outcomes, especially in resource-limited countries, where maternal and perinatal mortality is unacceptably high. However, evidence is scarce regarding the magnitude of SVD following induction and its associated factors in low-income countries like Sub-Saharan Africa including Ethiopia[6]. Besides this, studies conducted in Ethiopia were on the magnitude of failed induction and its associated factors rather than on the magnitude of SVD following induction and its contributing factors. Even if studies conducted on the magnitude of SVD and its associated factors were using secondary data. Furthermore, evidence regarding the magnitude of SVD following induction and its associated factors is limited in the study setting and Ethiopia. Therefore, the study aimed to assess the magnitude of successful vaginal delivery following induction and its associated factors among women who gave birth in the South Wollo zone public health hospitals, Ethiopia, 2023.

Methods

Study area and period

The study was conducted at south Wollo zone public hospitals, Amhara region, North-east Ethiopia from April 1- June 15, 2023. South Wollo zone is one of 14 zones in the Amhara region of Ethiopia and bordered on the south by North Shewa and the Oromia zone, on the west by east Gojjam, on the Northwest south Gondar, on the North by North Wollo, on the Northeast by Afar region, and the East by the Oromia special zone and the Argoba special woreda and located at an altitude of 2,470 m above sea level in low-shrouded mountains and hills. Dessie town is the capital city of the south Wollo zone that is 401kms far from Addis Ababa, the capital city of Ethiopia, and 475kms far from Bahir Dar, the capital city of Amhara region. This zone covers 17,067.78 km2. Based on the 2007 Central Statistical Agency of Ethiopia (CSA), the zone had an estimated total population of 2,993, 729. There are 20 woredas and 14 public hospitals (One comprehensive specialized, four general and nine primary hospitals),138 health centers, two nongovernment clinics, and four privately owned hospitals giving obstetric and gynecologic care and five higher clinics in the south Wollo zone.

Study design and population

A multi-center institutional-based cross-sectional study design was conducted. The source population of the study was all induced mothers who delivered at 28 weeks and above gestation age in South Wollo zone public hospitals. All induced mothers who gave birth at 28 weeks and above gestation age in selected public hospitals during data collection time were the study population.

Inclusion and exclusion criteria

All mothers who had serial IOL (induction continues after a time rest i.e. a second or third attempt at IOL after the first full phases of IOL were completed with no initiation of labor) were excluded from the study.

Sample size determination

The sample size was determined using a single population proportion formula using the proportion of women who gave SVD following induction was taken from related studies in Harari regional state public health

institutions and it was 65%[6], with a 5% margin of error, a value for 95% confidence interval ($Z_{0.05/2}$=1.96). Sample size determined by using the formula as follows;

$n = \frac{(Z_{\alpha/2})^2 * P * (1-p)}{d^2}$; Where P is the proportion of women who experienced SVD following induction, and d is marginal error. Thus, $n = \frac{(Z_{\alpha/2})^2 * P * (1-p)}{d^2} = \frac{(1.96)^2 (0.65(1-0.65)}{(0.05)^2} \approx 350$. Thus, the final sample size of the study 385 after considering a 10% non-response rate.

Sampling technique

A simple random sampling technique (lottery) was used to select seven public hospitals from 14 public hospitals; Dessie Comprehensive Specialized Hospital (DCSH), Boru Meda General Hospital, Akesta General Hospital, Kombolcha General Hospital, Haik Primary Hospital, Mekaneselam General Hospital, Tenta Primary Hospital, Wogdi hospital, Saint hospital, Delanta hospital, Jamma hospital, Kelala hospital, Worebabo hospital, and Mekdela hospital. The sample was then distributed proportionally across the hospitals based on monthly case flow. Finally, each participant was selected using the systematic random sampling technique with the sampling interval "k=2" by selecting the first study unit using the lottery random sampling technique (Fig. 1).

Selected seven7 hospitals

Dessie Comprehensive Specialized Hospital (DCSH), Boru Meda General Hospital, Akesta General Hospital, Kombolcha General Hospital, Haik Primary Hospital, Mekaneselam General Hospital and Tenta Primary Hospital.

Study variables

Dependent variable

SVD following induction.

Independent variables

Socio demographic factors Age, residence, occupation and MUAC.

Obstetrics factors Parity, bishop score, gestational age, birth weight and bad obstetrics history.

Methods of induction

Pharmacological, surgical or mixed methods.

Health facility-related factors

Health professional such as Midwife, Medical student (intern and GYN/OBS resident), General practitioner (GP), IESO and GYN/OBS senior, type of health facility, Protocol adherence and type of induction (elective or emergency).

Operational and terms definition

Vaginal delivery following induction is the process of giving birth through the vagina canal within 12 h of oxytocin administration which may be spontaneous vaginal delivery or assisted delivery[6,17].

Successful induction of labor is the achievement of good/adequate contraction or there has been cervical change after 6 to 8 h of oxytocin administration and use the maximum dose for at least one hour[5]. It is represented by the achievement of a vaginal birth may including operative delivery, does not always result in vaginal delivery, without a defined time limit whatever the outcome of maternal and newborn[4].

Favorable cervix cervical status enrolled by bishop score that is ≥ 6[3].

Bad obstetrics history if a woman had experienced any of the following events two or more occasions in the past; consecutive spontaneous abortions, early neonatal death, stillbirth, intrauterine fetal death, intrauterine growth restriction and congenital anomalies in the fetus[8].

National induction protocol Standardized induction protocol stated in the management protocol of Ethiopia.

Institutional induction protocol Induction protocol implemented by respective health facility according to healthcare setting and clinical experiences.

Data collection tools and techniques

A structured pre-tested interviewer administered questionnaire and data extraction checklist were used to collect the data. The questionnaire was adapted from reviewed literature[5–7,18]. Socio-demographic and obstetrics characteristics of participants were collected using a structured pre-tested interviewer administered questionnaire. Data extraction checklist was used to collect information on details of induction, and its outcome (indication, methods, mode of delivery, duration of induction, and newborn condition) and MUAC of each participants was measured. Data collection and supervision were done by seven trained diploma and three[3] MSc midwives, respectively.

Data quality assurance and analysis

To assure the quality of the data, the questionnaire was developed in English and then translated into Amharic and back into English by a language expert. The training was given to data collectors. Before actual data, a pretest was conducted at Woldia Hospital with 5% of the study population. Data was entered using Epi-Data version 4.6 and analyzed using Statistical Product and Service Solutions (SPSS) version 26 software. Descriptive statistics were computed to determine frequencies and summary statistics (percentage) of participants' socio-

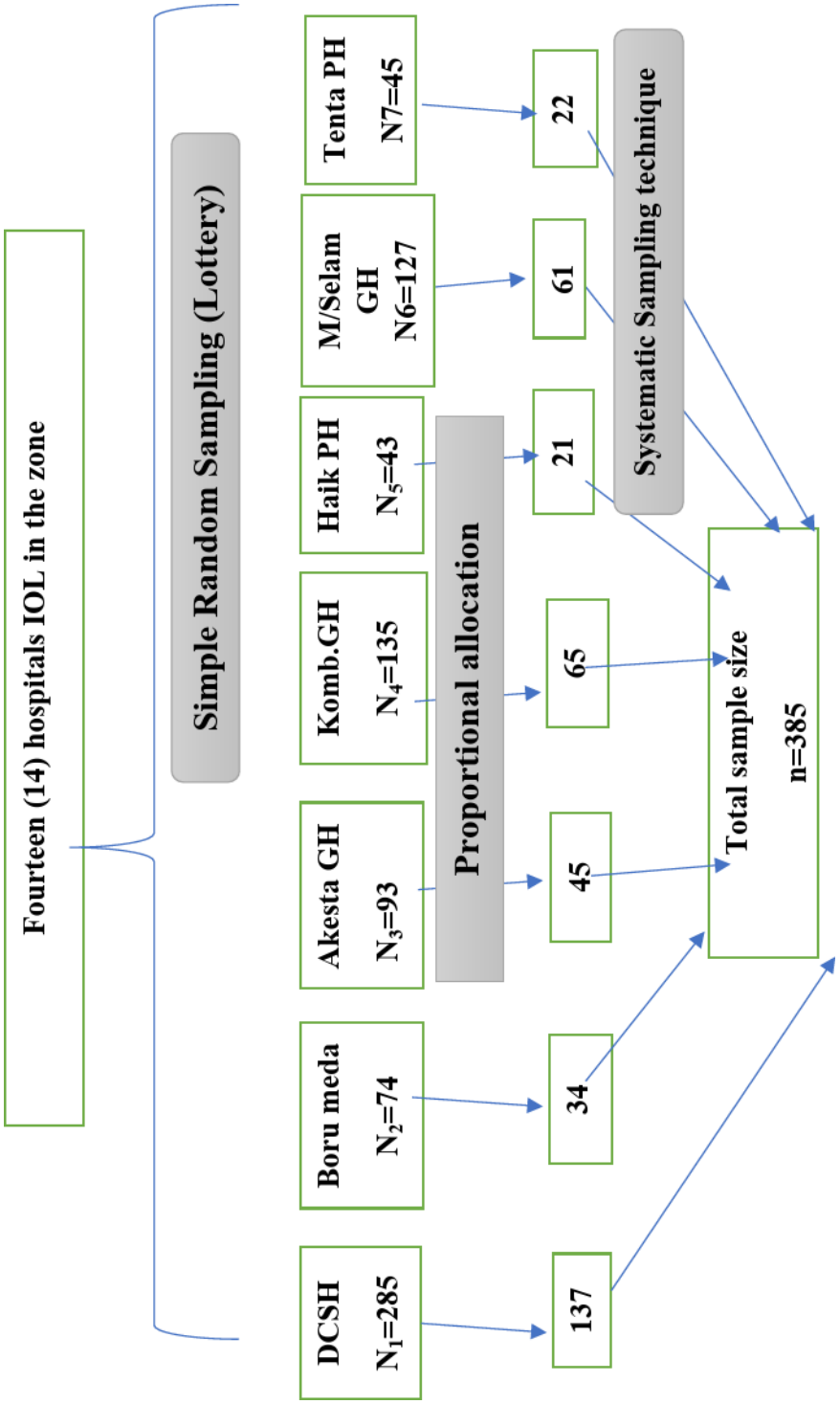

Fig. 1. Representation of sampling procedure in South wollo zone, Amhara Region, Northeast Ethiopia, 2023.

demographic and other related characteristics. To control for potential confounders and overall model fitness, we include more variables in multivariate logistic regression by considering variables with a p-value less than 0.25 in bivariate logistic regression. Variables with p-values less than 0.05 were considered statistically significant in multivariate logistic regression. The Hosmer-Lemeshow goodness of fit test (0.498) gave a high p-value (> 0.05), indicating that the model fits the data.

Ethical consideration and clearance

Ethical clearance was obtained from the ethical review committee of Debre Markos University, College of Medicine and Health Science (Ref. No. *HSC/RCS/137/11/15/).* A permission letter was secured from the South Wollo Regional Health Bureau. Then, a Letter of cooperation was written to each selected hospital. Written informed consent was obtained from each participant. Finally, the confidentiality of the data was maintained and each participant was assured that their participation was voluntary and had every right to withdraw to give information at any time. The study was conducted in accordance with the declaration of Helsinki.

Results

Socio-demographic characteristics of study participants

Of the 385 participants, 47.5% were aged between 25 and 29 years, and more than half (50.4%) were housewives. In addition, 68.3% of the mothers were urban residents. Moreover, the MUAC levels of 76.6% of the mothers ranged from 23 to 28 cm (Table 1).

Obstetric characteristics of study participants

Among the participants, 68.1% were 37–41 weeks pregnant, and 74% of the mothers were multiparous. Two hundred fifty-one (65.2%) respondents had no previous poor obstetrics history. In this study, the most common indications for IOL were preeclampsia/Eclampsia (29.9%) and PROM (29.4%). Of all the induced mothers, 89.6% had a favorable Bishop Score. Of the studied mothers, 96.4% of babies had birth weights less than 4000 g (Table 2).

Methods of induction and clinical practice

Almost 70% (268) of participants were induced by emergency. The majority of the hospitals where the study was done (six out of seven) used institutional protocols for oxytocin dose, and the majority of admitted mothers (94.3%) according to institutional protocols for oxytocin dosage. The majority of respondents (82.1%) had their inductions handled by midwives, while over half (53%) of mothers delivered at general hospitals. Approximately 82.3% of participants induced used oxytocin with cervical ripening methods of induction (Table 3).

Outcomes of induction of labor

More than three forth (75.58%) of induced mothers had a successful vaginal delivery (SVD) following induction. More than half (59.9%) of the mothers gave birth before the 8-hour IOL by oxytocin infusion. More than three-fourth (300) of newborns had an Apgar score of seven or higher, and about 91% were alive. Of the induced mothers, 44.2% experienced problems. Asphyxia and NIUC admission had the highest rates, accounting for 13.2% and 10.1%, respectively (Table 4).

Magnitude of successful vaginal delivery following

The overall magnitude of successful vaginal delivery (SVD) following induction was 75.6% with a 95% confidence interval between 71.00 and 79.80.

Variables	Category	Frequency (%)
Maternal Age (in years)	$19-24$	72 (18.7%)
	25 −29	183 (47.5%)
	30 −34	94 (24.4%)
	$35-40$	36 (9.4%)
Occupation	Farmer	52 (13.5%)
	Merchant	44 (11.4%)
	House wife	194 (50.4%)
	Civil servant	85 (22.1%)
	Others*	10 (2.6%)
Residence	Urban	263 (68.3%)
	Rural	122 (31.7)
MUAC	< 23 cm	46 (12%)
	23–28 cm	295 (76.6%)
	$\geq$ 28 cm	44 (11.4%)

Table 1. Socio-demographic characteristics of the women under study hospitals, South Wollo, Amhara region, Ethiopia, 2023 ($n = 385$). Others* =Daily laborer.

Variables	Categories	Frequency (%)
Gestational age	< 37 weeks	67 (17.4%)
	37-41weeks	262 (68.1%)
	≥ 42 weeks	56 (14.5%)
Parity	Multipara	285 (74.0%)
	Nulliparous	100 (26.0%)
Bad obstetrics history	Yes	134 (34.8%)
	No	251 (65.2%)
Indication of Induction	Post term pregnancy	57 (14.8%)
	Preeclampsia/Eclampsia	115 (29.9%)
	PROM	113 (29.4%)
	Oligohydramnios	48 (12.5%)
	Congenital anomalies	9 (2.3%)
	Abruption placenta	31 (8.1%)
	IUFD	12 (3.1%)
Bishop status	Favorable	345 (89.6%)
	Unfavorable	40 (10.4%)
Birth weight	< 4000grms	371 (96.4%)
	≥ 4000grms	14(3.6%)

Table 2. Obstetric characteristics of study participants at Hospital South Wollo, Amhara, Ethiopia, 2023 ($n = 385$).

Variables	Categories	Frequency (%)
Type of induction	Emergency	268 (69.6%)
	Elective	117 (30.4%)
Protocol adherence for dose of oxytocin	National	22 (5.7%)
	Institutional	363 (94.3%)
Health caregivers	Midwife	316 (82.1%)
	Medical student	42 (10.9%)
	IESO	25 (6.5%)
	GYN/OBS senior	2 (0.5%)
Type of hospital	Comprehensive specialized hospital	137 (35.6%)
	General hospitals	204 (53.0%)
	Primary hospitals	44 (11.4%)
Methods of induction	Oxytocin with cervical ripening	317 (82.3%)
	Only one method	68 (17.7%)

Table 3. Clinical practice and methods of induction among study participants, South Wollo, Amhara region, Ethiopia, 2023 ($n = 385$).

Factors associated with successful vaginal delivery following induction

In binary logistic regression gestational age, maternal age, residence, MUAC, parity, birth weight, bishop status, bad obstetric history, method of induction, level of institution, and protocol adherence were factors associated with SVD following induction. But MUAC, parity, bishop status, induction method, and birth weight remained significantly associated with SVD following induction in multivariable logistic regression.

The odds of SVD following induction among mothers having MUAC between 23 and 28 cm were 2.55 times more likely to have successful vaginal delivery compared to mothers having MUAC measures 28 cm and above (AOR = 2.55, 95% CI: 1.19–5.47). Similarly, multiparous mothers were 3.01 times more likely to have SVD compared to their counterparts (AOR = 3.01, 95%CI: 1.43–6.33).

Mothers with favorable bishop score were 3.79 times more likely to have SVD following induction compared to their counterparts (AOR = 3.79, 95% CI: 1.74–8.26). Mothers induced with oxytocin and cervical ripening method were 3.74 times more likely to have SVD following induction than induction with one method only (AOR = 3.74, 95% CI: 1.99–7.04). Mothers with a newborn birth weight of fewer than 4000 g had a 5.40 times higher risk of SVD after induction compared to counterparts (AOR = 5.40, 95%CI: 1.54–18.91) (Table 5).

Variables	Categories	Frequency (%)
Mode of delivery	Spontaneous Vaginally	249 (64.67%)
	Instrumental	42 (10.91%)
	C/S	94 (24.4%)
Duration of IOL by oxytocin infusion	<8 h	230 (59.7%)
	8–12 h	146 (37.9%)
	> 12 hours	9 (2.3%)
APGAR score at 5 min	<7	85 (22.1%)
	≥ 7	300 (77.9%)
Newborn status	Alive	350 (90.9%)
	Dead	35 (9.1%)
Complication	No	215 (55.8%)
	Yes	170 (44.2%)
Type of complications	Uterine hyper stimulation	11 (2.9%)
	PPH	34 (8.8%)
	Uterine rupture	6 (1.6%)
	Asphyxia	51 (13.2%)
	NIUC Admission	39 (10.1%)
	≥ 2 complications	29 (7.5%)

Table 4. Outcomes of induction of labor among the women who gave birth following induction in study hospitals at South Wollo, Amhara Region, Ethiopia, 2023 ($n = 385$).

Discussion

Despite IOL-recommended obstetrical practice, it is not always risk-free, and many women find it uncomfortable. It has cost considerations and clinical complications, including higher maternal and neonatal complications due to their unpredictable duration and the probability of a successful vaginal birth[19–21]. Identifying factors associated with successful vaginal delivery using primary data would help to decrease the failure rate of SVD following IOL and the adverse effects of induction.

The study reported that the magnitude of SVD following induction was 75.58% with a 95% CI (71.29–79.87). This finding is in line with studies in Pennsylvania USA (75.2%)[22], South India (74.69%)[23], Mekelle town public hospitals (76%)[24], Adama medical college hospital (70.4%)[13], Somaliland in Hargeisa maternity hospital (77%)[25], Maichew Lemlem Karl hospital (73.8%)[26], North Tanzania tertiary hospital (73.25%)[27], Worabe comprehensive specialized hospital (77.8%)[28] and Uganda (76.5%)[17]. But, this finding was higher than studies in Thailand (56.6%)[11], Jordan (62.6%)[20], Nigeria (70%)[29], Pakistan (69.7%)[30], Addis Ababa, Ethiopia (62.2%)[31], Wolliso St. Luke catholic hospital (57.9%)[32], Hawassa (61.56%)[33], Jimma teaching hospital (65.7%)[4] and Jigjiga teaching hospital (63.2%)[34]. The disparity may be due to the difference in study settings and data sources (secondary) from studies in Nigeria and Thailand[11,29]. The difference in socio-demographic characteristics of participants, health facility-related factors, and quality of intrapartum care may also contribute to the discrepancy[10,11,29]. Furthermore, the disparity from studies in Ethiopia may be due to improvements in the quality of intrapartum care over time and study period difference.

On the other hand, findings from Saudi Arabia (84%)[35], Mizan Tepi Teaching Hospital (83.3%)[36], Tigray Axum St. Mary hospital (88.2%)[21] and Dire Dawa Hospital (83.6%)[37] higher compared to this finding. Differences in the quality of intrapartum care across health facilities and health facility-related factors might be the source of this discrepancy. Compared to developed countries like Saudi Arabia, better quality intrapartum care resulting a higher magnitude of SVD after induction.

The study revealed that mothers with MUACs between 23 and 28 cm were 2.55 times more likely to have SVD following induction than women with MUACs of 28 cm or higher. This could be due to obese pregnant women having an increased risk of failed induction, even when using a standardized labor induction protocol[38,39]. Hormone changes in obese women may lead to a decrease in myometrium contractility, raising the risk of failed induction and resulting in a lower rate of SVD following induction. Studies in Thailand Bangkok Tertiary Hospital and Southwest Ethiopia supported this evidence[11,18].

This study showed that multiparous mothers were 3.01 times more likely to give SVD following induction of labor compared to nulliparous mothers. This might be due to the fact multiparous mother uterine muscles can be more easily stimulated and contracted than nulliparous. Multiparty affirms adequacy of uterine pelvic. Studies in Thailand Bangkok Tertiary Hospital, North Tanzania, Addis Ababa teaching hospitals, Jigjiga, Harari, Worabe, Arsi zone, Adama, Mekelle, Tigray Axum St. Mary Hospital and Gondar teaching hospital supported this finding[2,5,6,11,13,21,27,28,31,34].

This study found that mothers who had favorable bishop score were 3.79 times more likely to have SVD following induction than unfavorable bishop score. The reason for this is that a high bishop score indicates that the cervix is more favorable for labor, which may be associated with a better success rate for SVD following induction. This is also because the cervix is already dilated and effaced, women with higher bishop score are more likely to have successful vaginal deliveries following induction, which facilitates the natural progression

Variables	Categories	Mode of delivery		COR (95%CI)	AOR (95%CI)	P-Value
		SVD (%)	C/S (%)			
Maternal age	≤24 years	48 (66.67)	24 (33.33)	0.4 (0.15–1.09)	0.74 (0.19–2.80)	0.66
	25–29 years	140 (76.5)	43 (23.5)	0.65 (0.25–1.67)	0.74 (0.25–2.16)	0.57
	30–34 years	73 (77.7)	21 (22.3)	0.7 (0.26–1.89)	0.57 (0.19–1.76)	0.33
	≥35 years	30 (83.3)	6 (16.7)	1	1	
Residence	Urban	205 (77.9)	58 (22.1)	1.48 (0.91–2.41)	1.61 (0.89–2.92)	0.112
	Rural	86 (70.5)	36 (29.5)	1	1	
MUAC	<23 cm	37 (80.4)	9 (19.6)	3.75 (1.47–9.59)	2.83 (0.96–8.38)	0.060
	23–28 cm	231 (78.3)	64 (21.7)	3.27 (1.72–6.33)	2.55 (1.19–5.47)	0.016
	≥28 cm	23 (52.3)	21 (47.7)	1	1	
Gestational age	<37 weeks	58 (86.6)	9 (13.4)	3.31 (1.35–8.09)	2.40(0.88–6.52)	0.09
	37–41 weeks	196 (74.8)	66 (25.2)	1.53 (0.82–2.83)	1.25 (0.61–2.59)	0.54
	≥42 weeks	37 (66.1)	19 (33.9)	1	1	
Parity	Multipara	231 (18.9)	54 (81.1)	2.85 (1.73–4.69)	3.01 (1.43–6.33)	0.004
	Nulliparous	60 (60)	40 (40)	1	1	
Bad obstetric history	Yes	106 (79.1)	28 (20.9)	1.35 (0.82–2.23)	1.22 (0.67–2.24)	0.515
	No	185 (73.7)	66 (26.3)			
Bishop status	Favorable	272 (78.8)	73 (21.2)	4.19 (2.10–8.07)	3.79 (1.74–8.26)	0.001
	Unfavorable	19 (47.5)	21 (52.5)	1	1	
Methods of induction	Oxytocin with cervical ripening methods	255 (80.4)	62 (19.6)	3.66 (2.11–6.34)	3.74 (1.98–7.04)	0.000
	Only one method	36 (52.9)	32 (47.1)	1	1	
Birth weight	<4000 g	286 (77.1)	85 (22.9)	6.06 (1.98–18.56)	5.40 (1.54–18.91)	0.008
	≥4000 g	5 (35.7)	9 (64.3)			
Protocol Adherence	National	14 (63.6)	8 (36.4)	0.54 (0.22–1.34)	1.49 (0.34–6.57)	0.60
	Institutional	277 (76.3)	86 (23.7)	1	1	
Type of health institution	CSH	110 (80.3)	27 (19.7)	2.33 (1.11–4.90)	1.85 (0.57–6.01)	0.31
	General hospital	153 (75)	51 (25)	1.71 (0.86–3.42)	1.368 (0.45–4.18)	0.58
	Primary hospital	28 (63.6)	16 (36.4)	1	1	

Table 5. Bivariate and multiple binary logistic regression results of associated factors of successful vaginal delivery following induction of participants at South Wollo Public hospitals, North East Ethiopia, 2023 ($n=385$). *CSH* comprehensive specialized hospital.

of labor. Studies in Adama[13], Arsi zone[5], Southwest Ethiopia[18], Jigjiga[34], Worabe Comprehensive Specialized Hospital[28], Axum St. Mary Hospital in Tigray[21], Oromia[40]and Wolayta Sodo[9] supported this evidence.

Moreover, this study found that mothers induced by using oxytocin with cervical ripening methods were nearly four times more likely to have SVD following induction compared to those induced using one method only. It is due to the essential role of cervical ripening in preparing the cervix for labor and delivery and its role in the success of vaginal delivery following induction. Studies conducted in Uganda[17], Harari regional state referral hospitals[6], Amhara regional state referral hospitals[8], and Gondar University Teaching Hospital[2] supported this finding.

Finally, this study found that mothers who delivered a newborn weighing < 4000 g were 5.40 times more likely to give SVD following induction compared to their counterparts. This may be because fetal weight greater than or equal to 4000 g is likely to cause cephalopelvic disproportion, which leads to obstructed labor and makes vaginal delivery difficult. As a result, complications such as fistulas, hemorrhage, uterine rupture, infection, anemia, and maternal death may occur. Therefore, estimating fetal weight before induction is critical to avoiding unnecessary clinical intervention and maternal and fetal complications. Studies in Nigeria's teaching hospital[29], Four selected hospitals in Oromia[40], Adama Medical College Hospital[13], and Southwest Ethiopia supported this finding[18].

Conclusion

The magnitude vaginal delivery following induction was lower compared to some studies conducted in Ethiopia. Maternal MUAC at time of delivery, parity, cervical status, oxytocin induction with cervical ripening, and birth weight were factors affecting SVD following induction. These parameters are crucial for clinical application, hence a pre-induction general assessment is required before beginning induction to improve outcomes. Therefore, obstetric caregivers and other concerned bodies should give a great emphasis on cervical status and select more effective induction method to increase the rate of SVD following induction and prevent problems as

much as feasible. Additionally, interventions to promote a healthy weight for women before pregnancy should be considered.

Strength and limitation of this study

A prospective and multicenter setting nature of the study could enhance the quality of the data. The findings provide valuable insights into the factors contributing to successful vaginal delivery following induction and can inform clinical practice in Ethiopia. Despite these strengths, this study also has certain limitations. This study was cross-sectional study design and hence, unable to establish causal relationships between the study variables. Moreover, the study did not include private health facilities, which restrict its scope.

Clinical and policy implications

This study has important clinical implications for increasing the rate of successful vaginal delivery following induction by conducting pre-induction assessment, including evaluating the Bishop score of the cervix and estimating fetal weight, to predict the success of induction by obstetric caregivers. This is because it will help to identify women who are more likely to have a successful vaginal delivery following induction. It is also important to highlight the importance maintaining optimal MUAC levels in clinical practice. In terms of policy, it provide an important clue to include more effective induction methods such inducing with oxytocin along with cervical ripening. It is also critical for policymakers to invest in training and capacity-building of obstetric caregivers to familiarize with the more effective induction methods.

Data availability

"All data included in the manuscript can be accessed through the corresponding author at email address keralemante2010@gmail.com".

Received: 13 June 2024; Accepted: 27 September 2024
Published online: 24 October 2024

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Acknowledgements

We would like to express our gratitude to Amhara regional state health office for providing financial support. We also thank South Wollo Zonal health office for their participation in providing information about study hospitals and the study Hospital facilitating the data collection process. We are also grateful to the data collectors and study participants for their assistance and cooperation.

Author contributions

S.A designed the study, participated in the data collection and validation, performed analysis and interpretation of results, drafted the paper and prepared the manuscript. Bishaw, KA. and A.T assist the design and development of the proposal, supervise the data collection, analysis and revised the manuscript. All authors read and approved the manuscript.

Funding

This study was funded by Debre Markos University's postgraduate office through student grants. A small payment is granted to postgraduate students to cover their expenses for data collectors and stationery. No other grants were received for this study.

Declarations

Competing interests

The authors declare no competing interests.

Additional information

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1038/s41598-024-74589-w.

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