

**ORIGINAL ARTICLE****Meconium-stained Amniotic Fluid and Its Related Neonatal Outcomes in Mothers Who Delivered at Hawassa University Comprehensive Specialized Referral Hospital, Ethiopia: A Cross-sectional Study****Teshome Gebrehanna<sup>1</sup>, Temesgen Liranso<sup>2</sup>, Birhanu Ayele<sup>3\*</sup>****OPEN ACCESS**

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**ABSTRACT**

**BACKGROUND:** *The expulsion of meconium during labor increases the likelihood of adverse birth outcomes, with its detrimental effects being more pronounced in resource-constrained countries.*

**METHODS:** *A cross-sectional study was conducted between March and May 2022 to assess the prevalence of meconium-stained amniotic fluid (MSAF), associated risk factors, and related neonatal outcomes among 281 laboring mothers who delivered at Hawassa University Comprehensive Specialized Referral Hospital, Ethiopia. Study participants were selected using a systematic random sampling technique. Data were collected using a pretested questionnaire administered by trained BSc midwives, along with a checklist derived from medical records. Data entry and analysis were performed using SPSS version 23. Both descriptive and analytical statistics were computed. Statistical significance was set at  $P < 0.05$ , and the strength of association was assessed using adjusted odds ratios (AOR).*

**RESULTS:** *In this study, MSAF occurred in 57 (20.3%) of pregnancies. Low Apgar scores at the fifth minute, meconium aspiration syndrome, perinatal asphyxia, and neonatal intensive care unit admission were identified as the major adverse neonatal outcomes associated with MSAF. Factors such as maternal age, rural residence, gestational age greater than 42 weeks, prolonged labor duration, and obstructed labor were identified as potential risk factors for the development of MSAF.*

**CONCLUSIONS:** *Healthcare providers should evaluate women in labor for these risk factors and remain vigilant in the early identification of MSAF to improve outcomes for both the fetus and the mother.*

**KEYWORDS:** *Meconium-stained amniotic fluid, adverse neonatal outcomes, risk factors, Southern Ethiopia.*

## INTRODUCTION

Meconium-stained amniotic fluid (MSAF) is a condition in which meconium is present in the uterus during the antenatal period (1). This viscous, dense, dark green feces consists of cells, proteins, fats, and intestinal secretions, including bile. Babies typically pass meconium (mih-KOH-nee-em) in the first few hours and days after birth (2). This substance is sterile, dense, black-green, and odorless; it was initially identified in the fetal intestine at approximately 12 weeks of gestation and is retained in the fetal colon for the duration of pregnancy (3).

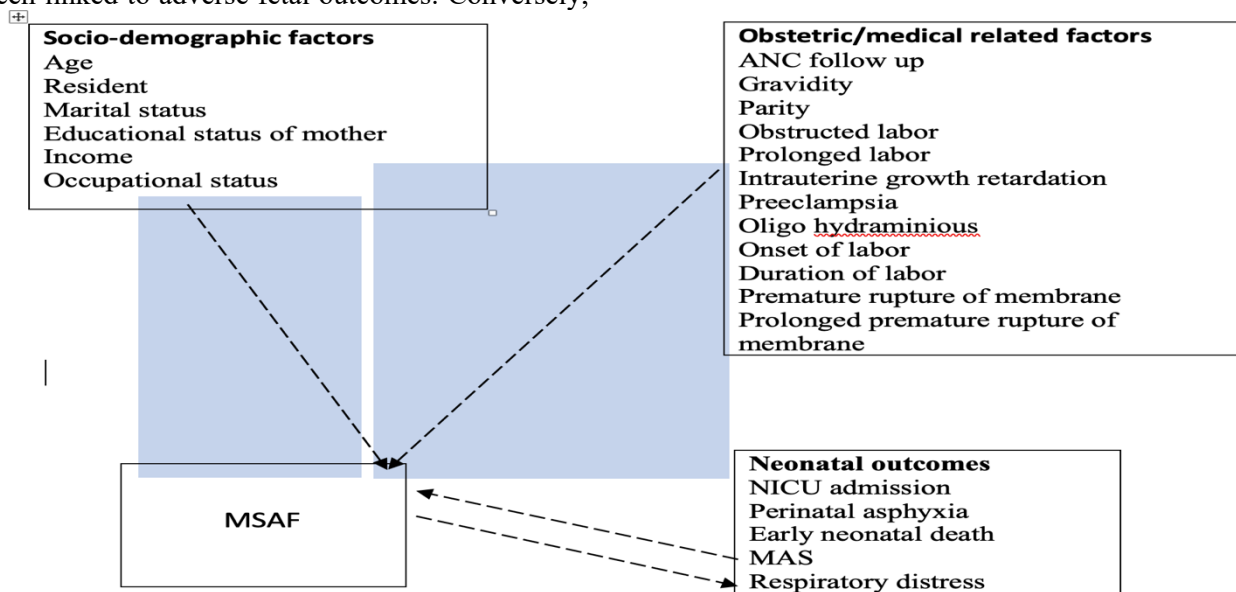
The specific cause of MSAF remains uncertain. However, earlier research has indicated that various obstetric factors—including prolonged labor, post-term pregnancies, low birth weight infants, oligohydramnios, intrauterine growth restriction, and hypertensive disorders during pregnancy—along with medical conditions such as pregnancy-related cholestasis and anemia, as well as sociodemographic and behavioral risk factors, significantly contribute to the occurrence of meconium in the amniotic fluid (2, 4, 5).

MSAF has traditionally been regarded as an indicator of fetal distress, particularly in cases where there are no breech presentations, and has been linked to adverse fetal outcomes. Conversely,

some experts consider the passage of meconium by the fetus as a normal physiological occurrence that may pose environmental risks to the fetus prior to birth [14]. Assessing whether the expulsion of meconium is a result of normal physiological development of the fetal gastrointestinal system or indicative of an underlying medical condition is crucial (3, 6-11). Furthermore, understanding the consequences for neonates exposed to meconium in utero, along with the potential risks linked to its development, is essential for enhancing perinatal care and minimizing adverse outcomes (11).

Although only a few studies have been conducted on this topic in specific regions of Ethiopia (12-16), there is a lack of data regarding neonatal outcomes for infants delivered through MSAF and the related risk factors in the southern region. Therefore, this study aimed to evaluate the prevalence of meconium-stained amniotic fluid, the associated risk factors, and the related neonatal outcomes among laboring mothers who delivered at Hawassa University Comprehensive Specialized Referral Hospital (HUCSRH).

**The conceptual framework of the MSAF:** Figure 1 presents the conceptual framework of the MSAF as adapted based on the literature review.



**Figure 1:** The conceptual framework of the MSAF—This conceptual framework outlines the occurrence of MSAF as influenced by various risk factors, including socio-demographic, obstetric, and medical factors, along with the related adverse outcomes for neonates.

## METHODS

**Study area:** This research was carried out at HUCSRH, Sidama, Ethiopia, between March and May 2022. HUCSRH is a public hospital and one of four federally supported cancer centers of excellence in the country. It functions as a referral center for a significant portion of southern Ethiopia, including the adjacent Oromia region and other southern states. The hospital is linked to various international research networks and has previously facilitated Phase IV clinical trials related to infectious diseases, gynecological issues, and surgical and neonatal conditions. HUCSRH serves a catchment population of approximately 18 million people.

The Department of Obstetrics and Gynecology has a labor ward with eight beds in the first-stage room, four delivery couches in the second-stage room, 22 beds in the postnatal room, and two operating rooms. The average number of deliveries per year is 4,433. The ward is staffed by obstetricians and gynecologists, postgraduate residents, interns, clinical nurses, and midwives who provide obstetric care services. The study area was selected because HUCSRH is a regional referral hospital and can be a true representative of the population.

**Study design:** This was an institutional hospital-based cross-sectional study conducted from March to May 2022 at HUCSRH, Hawassa, Ethiopia.

**Source population:** The total number of pregnant women who attended the delivery unit at HUCSRH.

**Study population:** All sampled laboring mothers who gave birth at term (gestational age >37 weeks) in the delivery unit at HUCSRH during the study period.

**Inclusion and exclusion criteria:** All women who gave birth at term (gestational age >37 weeks) at HUCSRH during the study period were included in the study. The exclusion criteria included refusal to give consent, gestational age <37 weeks, twin pregnancies, breech presentation, fetal death before or upon admission, pregnancy with unknown gestational age, and fetal congenital malformations. In this study, gestational age was determined on the basis of a verified last normal menstrual period or

an early ultrasound conducted prior to 24 weeks. Participants with an unknown date or those who did not undergo early ultrasound were excluded from the analysis.

**Sample size determination and sampling procedure:** The sample size was determined using a single population proportion formula, taking into account the prevalence of MSAF, which was found to be 12.1% in a prior study conducted at Saint Paul's Hospital Millennium Medical College in Addis Ababa, Ethiopia (15). The required statistical assumptions for determining the sample size were a 95% confidence level, a 5% margin of error, and a 10% nonresponse rate. Accordingly, 281 women were included in the current study. A systematic random sampling method was employed to identify the required number of participants. The sampling frame was created using maternal medical record numbers recorded in the delivery registration log over a six-month period, from September 1, 2021, to February 28, 2022. The total number of deliveries during this timeframe was 1,920. This figure was divided by the sample size of 281 to calculate the sampling interval, resulting in  $K = 6.8$ , which was rounded to approximately 7. Consequently, one woman was selected for every seven deliveries. The initial participant was chosen randomly through a lottery method. If the selected woman did not meet the inclusion criteria, the next eligible woman was selected.

**Data collection tools and procedures:** Data for this study were collected through a combination of a data checklist derived from maternal medical records and a questionnaire administered by four trained BSc midwives, supervised by two final-year residents. The questionnaire was organized into three coherent sections: sociodemographic factors, obstetric and medical factors, and labor and delivery outcome factors. The initial structured questionnaire was developed in English based on a literature review and subsequently validated by a group of experts. Following validation, the questionnaire was translated into Sidaamu Afoo and Amharic, the languages commonly spoken in the study area. To ensure translation accuracy, both the questionnaire and the consent form were back-translated into English. The questionnaire was then pretested for clarity and logical sequence on 5% of

the sample at HUCSRH before actual data collection began.

Information regarding sociodemographic characteristics and previous medical history, including chronic hypertension and diabetes mellitus, was collected through an interviewer-administered questionnaire at the time of maternal admission to the labor ward. Data related to obstetric variables—including the condition of the amniotic fluid, antepartum hemorrhage, premature rupture of membranes, pregnancy-induced hypertension, gestational diabetes mellitus, fetal growth restriction (FGR), oligohydramnios, polyhydramnios, nonreassuring fetal heart rate patterns (NRFHRP), and labor duration exceeding 15 hours—were collected after childbirth. These data were obtained from a checklist derived from maternal follow-up charts, medical records, laboratory tests, and the delivery registration logbook, covering the entire labor process up to delivery. Additionally, information related to the status of newborns was collected from the neonatal intensive care registration logbook and neonatal charts (12).

**Dependent variable** is meconium-stained amniotic fluid while **Independent variables** are Sociodemographic variables: age, residence, marital status, educational status of the mother, husband's educational status, religion, family size, current monthly income, and maternal occupation. Obstetric/medical-related variables: antenatal care (ANC) follow-up, gravidity, parity, obstructed labor/prolonged labor, duration of labor, intrauterine growth restriction (IUGR), preeclampsia/eclampsia, oligohydramnios, onset of labor, post-term pregnancy, fetal distress, and duration and mode of rupture of membranes. The perinatal outcome variables included perinatal asphyxia, early neonatal death, MAS, respiratory distress, and neonatal intensive care unit (NICU) admission.

**Data processing and analysis:** Data entry and analysis were performed using SPSS version 23. Data-processing tasks, such as data cleaning, categorizing, and transformation, were conducted to prepare the data for analysis. Both descriptive and analytical statistics were computed. Multiple logistic regression was fitted for MSAF, and the adjusted odds ratio (AOR), along with its 95%

confidence interval (95% CI), was calculated to determine factors associated with meconium-stained amniotic fluid. Variables with p-values  $\leq 0.25$  were retained in the model as potential confounders for multivariable analysis. Multivariable analysis was performed using the Hosmer - Lemeshow goodness-of-fit test with a 95% confidence interval. A backward conditional selection method was applied until all remaining variables were statistically significant at a p-value of  $<0.05$ .

**Ethics approval and consent to participate:**

Ethical approval was obtained from the HUCSRH Ethical Review Committee. Written informed consent was obtained from all participants, and confidentiality was maintained throughout data collection, analysis, and interpretation.

**The following operational definitions are used:**

**Meconium-stained amniotic fluid (MSAF):** The presence of yellow, brownish, or green particulate matter in the amniotic fluid of a laboring mother until delivery of the baby. Final-year residents assigned to the labor ward determined the presence or absence of MSAF throughout the course of labor (12, 14).

**Grade of MSAF:** There are three classifications: grade I (light staining, translucent in character, and light green or yellow in color), grade II (moderate staining, opalescent in character, and deep green or brown in color), and grade III (heavy meconium staining, thick, opaque, and dark green in color) (13).

**Adverse neonatal outcomes:** In this study, adverse neonatal outcomes refer to complications occurring during labor and within the first 7 days after delivery, such as nonreassuring fetal heart rate patterns, the need for neonatal resuscitation, NICU admission, intrapartum stillbirth, MAS, perinatal asphyxia, early neonatal death (END), and neonatal sepsis (13, 17, 18).

**Apgar score:** The Apgar score was calculated using five characteristics: heart rate, respiratory effort, muscle tone, skin color (oxygenation), and reflex response to stimuli. The score ranges from 0 to 10. A total score between 7 and 10 is considered "normal," whereas a score below 7 is classified as a "low Apgar score" (19, 20).

**Birth asphyxia:** In this study, birth asphyxia is defined as a 1st- and 5th-minute Apgar score of less than six and a clinical diagnosis of perinatal asphyxia (PNA) at the NICU.

**MAS:** In this study, MAS is defined as a clinical diagnosis of respiratory distress in a neonate born through MSAF, with signs of meconium aspiration, diagnosed at the NICU.

## RESULTS

**Socio-demographic characteristics:** A total of 281 laboring mothers were included in this study, with a response rate of 100%. Among them, over

90% (91.1%) were in the 20–35 years age group; 78 (27.8%) were rural dwellers, and almost all (98.9%) were married. The educational status of mothers and their mates revealed that the majority (37.7%) of laboring mothers had secondary education and that more than half of their mates (52.3%) had tertiary education (Table 1).

Over 45% (45.5%) were Protestant Christians; more than 56% (56.6%) had family sizes between 4 and 6 children; nineteen (6.8%) had monthly incomes less than 3000 ETB; and over 26% (26.4%) were housewives (Table 1).

Table 1: Sociodemographic characteristics of the respondents at HUCSRH, Sidama, Ethiopia, 2022(n=281).

Characteristics	Categories	N	%
Age	<20	9	3.2
	20-35	256	91.1
	>35	16	5.7
Residence	Urban	203	72.2
	Rural	78	27.8
Marital status	Married	278	98.9
	Single	1	0.4
	Divorced	2	0.7
Maternal Educational status	Can't read & write	5	1.8
	Primary education	100	35.6
	Secondary education	106	37.7
	Diploma & Above	70	24.9
Husband Educational status	Can't read & write	2	0.7
	Primary education	61	21.7
	Secondary education	71	25.3
	Diploma & Above	147	52.3
Religion	Orthodox	79	28.1
	Muslim	60	21.4
	Protestant	123	45.5
	Others	19	5
Family size	1-3	107	38.1
	4-6	159	56.6
	>7	15	5.4
Current monthly income	<3000 ETB	19	6.8
	3000-5000ETB	94	33.5
	>5000ETB	168	59.8
Maternal Occupation	House wife	72	25.6
	Daily laborer	18	6.4
	Merchant	124	44.1
	Government employ	47	16.7
	Private employ	11	3.9
	Student	9	3.2

**Obstetric and medical-related characteristics of the respondents:** The obstetric and medical-related characteristics of the respondents are described in Table 2. Among laboring mothers, the majority (79.7%) experienced labor pain. Most of them (37.4%) were primigravida, over 40% (40.6%) were nulliparous, 33 (11.7%) had post-term pregnancies, and almost all (99.3%) attended antenatal care (Table 2).

A limited number of individuals involved in this research were admitted with preliminary diagnoses of antepartum obstetric issues, including chronic hypertension (0.4%), gestational diabetes (1.1%), maternal anemia (0.7%), and antepartum hemorrhage (5%). Forty-two (15%) mothers had obstructed labor, 20 (7.1%) had prolonged labor, and more than 3% (3.2%) had intrauterine growth restriction (IUGR). However, more than 26% (26.3%) had pregnancy-related preeclampsia/eclampsia, and 57 (20.3%) were diagnosed with oligohydramnios (Table 2).

Table 1: Obstetric and medical characteristics of the respondents at HUCSRH, Sidama, Ethiopia, 2022 (n=281).

Characteristics	Category	N (%)
Present complaint	Labor pain	224(79.7)
	Vaginal bleeding	9(3.2)
	Passage of liquor	27(12.8)
	Others, specify	21(4.3)
Gravidity	Primigravida	105(37.4)
	GII	74(26.3)
	GIII	54(19.2)
	GIV	40(14.2)
	5-10	8(2.9)
Parity	Nulliparous	114(40.6)
	Para I	69(24.6)
	Multipara	97(34.5)
	Great grand para	1(0.4)
LNMP or U/S	37-38+6	49(17.4)
	39-40+6	91(32.4)
	41-42	109(38.8)
	>42	32(11.4)
	Gestational age	37-42
	>42	33(11.7)
ANC follow up	Yes	279(99.3)
	No	2(0.7)
Place of ANC follow up	Health center	173(61.6)
	Hospital	84(29.9)
	Private facility	23(8.2)
Number of C/S	No	229(81.5)
	Only once	41(14.6)
	More than once	11(3.9)

Table 2: continued...

Chronic hypertension	Yes	1(0.4)
	No	280(99.6)
Diabetes	Yes	3(1.1)
	No	278(98.9)
Cardiac disease	Yes	0(0)
	No	281(100)
Maternal Anemia	Yes	2(0.7)
	No	279(99.3)
Antepartum hemorrhage	Yes	14(5.0)
	No	267(95.0)
Obstructed labor	Yes	42(15.0)
	No	239(85.0)
Prolonged labor	Yes	20(7.1)
	No	261(92.9)
IUGR	Yes	9(3.2)
	No	272(96.8)
Pre-Eclampsia/Eclampsia	Yes	74(26.3)
	No	207(73.7)
Oligohydramnios	Yes	57(20.3)
	No	224(79.7)
Post term pregnancy	Yes	34(12.1)
	No	246(87.9)

\*IUGR: Intrauterine growth restriction, C/s: cesarean section, ANC: antenatal care, LNMP: Last normal menstruation period, U/S: Ultrasound

#### Labor and delivery outcome variables:

Table 3 presents information related to the labor and delivery outcome variables of the respondents at HUCSRH. The results indicated that the majority (85%) of mothers had spontaneous onset of labor, 222 (79%) had a duration of labor between 12 and 24 hours, and more than 72% (72.2%) had spontaneous rupture of membranes. Fifty-seven (20.3%) laboring mothers were found to have MSAF; of these, 24 (42%) had grade 3 MSAF, 44% had grade 2 MSAF, and 14% had grade 1 MSAF (Table 3).

In this study, the majority (53%) of mothers had spontaneous vertex delivery (SVD), followed by cesarean delivery (42.7%) and instrumental delivery (4.3%). Cesarean delivery was indicated for nonreassuring fetal heartbeat patterns (NRFHB) (14.9%), MSAF (8.9%), and obstructed labor (OL)/cephalopelvic disproportion (CPD) (6%). Additionally, instrumental delivery was indicated for MSAF (2.1%), nonreassuring fetal heart rate patterns (NRFHRP) (1.4%), and prolonged second-stage labor (SSOL) (0.7%).

In the current study, more than 30% (32%) of neonates exhibited irregular heartbeats, with 19.6% experiencing tachycardia, 7.1% showing bradycardia, and 5.3% presenting late decelerations. Over 92% (92.9%) had birth weights between 2.5–4 kg, and 80 (28.5%) had Apgar scores less than seven at the 1st and 5th minutes. Additionally, over 9% (9.6%) of

neonates required resuscitation, 29 (10%) had MAS, 36 (12.8%) had respiratory distress, 14 (5%) experienced neonatal sepsis, 21% experienced perinatal asphyxia, 6 (2.1%) experienced early neonatal death, and nearly 30% (29.5%) required NICU admission (Table 3).

Table 3: Labor and delivery outcome variables for the respondents at HUCSR, Sidama Ethiopia, 2022 (n=281).

Characteristics	Category	N	%
Onset of labor	Spontaneous	239	85
	Induced	42	15
Duration of labor	<12 hrs	36	12.8
	12-24 hrs	222	79.0
	>24 hrs	23	8.2
Mode of rupture of membrane	Spontaneous	203	72.2
	ARM	78	27.8
Duration of rupture of membrane	<12 hrs	231	82.2
	12-24 hrs	49	17.4
	>24 hrs	1	0.4
Status of liquor	Clear	224	79.7
	Meconium stained	57	20.3
Moment of detection of MSAF	Before onset of labor	1	1.8
	LFSOL	27	47.4
	AFSOL	19	33.3
	SSOL	6	10.5
Grade of MSAF	At the time of delivery	4	7
	Grade I	8	14
	Grade II	25	44
	Grade III	24	42
The time b/n detection of meconium and time of delivery	< 30 minutes	31	11.0
	30 minutes- 4 hrs	24	8.5
	Greater than Or equal to 4 hours	2	.7
Mode of delivery	SVD	149	53.0
	Instrumental delivery	12	4.3
	C/D	120	42.7
Indication for Cesarean delivery	OL/CPD	17	6.0
	NRFHRP	42	14.9
	MSAF	25	8.9
	Others	36	12.8
The type of Instrumental delivery	Forceps	3	1.1
	Vacuum	9	3.2
Indication for Instrumental delivery	NRFHRP	4	1.4
	MSAF	6	2
	Prolonged SSOL	2	0.7
FHR abnormality	Yes	90	32.0
	No	191	68.0
Type of FHB abnormality	Tachycardia	55	19.6
	Bradycardia	20	7.1
	Late deceleration	15	5.3
Time of NRFHB	After detection of meconium	31	11.0
	Before detection of meconium	23	8.2
FHB pattern after detection of meconium	120-160	16	5.7
	Tachycardia	21	7.5
	Bradycardia	13	4.6
	Late deceleration	7	2.5

Table 3: Continued...

Weight of the newborn	<2.5 kg	8	2.8
	2.5-4 kg	261	92.9
	>4 kg	12	4.3
APGAR Score at 5 <sup>th</sup> minute	<4	24	8.5
	4-6	56	20
	>6	201	71.5
Neonatal resuscitation	Yes	27	9.6
	No	254	90.4
MAS	Yes	29	10.3
	No	252	89.7
	Yes	36	12.8
Respiratory distress	No	245	87.2
Neonatal sepsis	Yes	14	5.0
	No	267	95.0
Perinatal asphyxia	Yes	59	21
	No	222	79
Early neonatal death	Yes	6	2.1
	No	275	97.9
NICU admission	Yes	83	29.5
	No	198	70.5

\*AFSOL: Active first stage of labor; ARM: Artificial rupture of membranes; CPD: Cephalopelvic disproportion; FHB: Fetal heartbeat; LFSOL: Latent first stage of labor; MAS: Meconium aspiration syndrome; MSAF: Meconium-stained amniotic fluid; NICU: Neonatal Intensive Care Unit; NRFHB: Nreassuring fetal heartbeat pattern; OL: Obstructed labor. SSOL: Second stage of labor; SVD: Spontaneous vertex delivery.

**Adverse neonatal outcomes associated with MSAF:** In this study, the adverse neonatal outcomes associated with MSAF included low Apgar scores at the fifth minute, 37 (13.2%);

meconium aspiration syndrome (MAS), 31 (11%); perinatal asphyxia, 39 (13.9%); and neonatal intensive care unit (NICU) admissions, 41 (14.6%) (Table 4).

Table-4: Obstetric and pregnancy-related factors associated with the MSAF among laboring mothers who gave birth at HUCSRH, Sidama, Ethiopia, in 2022 (n=281).

Characteristics	Categories	Meconium stained		Chi-square	p value
		Yes	No		
Gestational age	37-42 wks	37(13.2%)	211(75%)	6.54	0.047
	>42 wks	20(7%)	13(4.6%)		
ANC follow up	Yes	56(20%)	223(79.4%)	1.48	0.243
	No	1(0.4%)	1(0.4%)		
DM	Yes	1(0.4%)	2(0.6%)	2.203	0.45
	No	56(20%)	222(79%)		
Obstructed labor	Yes	18(6.4%)	4(1.4%)	11.45	0.028
	No	39(13.9%)	220(78.3%)		
Prolonged labor > 24 h	Yes	21(7.5%)	6(2.1%)	13.61	0.002
	No	36(12.8%)	218(77.6%)		
Duration of labor	Induced	10(3.6%)	50(17.8%)	9.75	0.089
	< 12 hrs	4(1.4%)	32(11.4%)		
	12-24 hrs	27(9.6%)	135(48%)		
	>24 hrs	16(5.7%)	7(2.5%)		
Mode of ROM	Spontaneous	36(12.8%)	167(59.4%)	1.73	0.85
	Artificial rupture	21(7.5%)	57(20.3%)		
Duration of ROM	<12 hours	37(13.2%)	194(69%)	3.61	0.152
	12-24 hours	20(7%)	29(10.3%)		
	>24 hours	0(0%)	1(0.4%)		
Mode of delivery	SVD	6(4%)	143(96%)	5.36	0.087
	IVD	10(83.3%)	2(16.7%)		
	Cesarean delivery	41(34.2%)	79(65.8%)		

Table 4: Continued...

Weight of new-born	< 2.5 kg	1(0.4%)	7(2.5%)	3.35	0.250
	2.5-4 kg	52(18.5%)	209(74.4%)		
	>or equal to 4 kg	4(1.4%)	8(2.8%)		
5th minute Apgar score <7	Yes	37(13.2%)	5(78%)	17.5	0.045
	No	20(7%)	219(0%)		
Neonatal resuscitation	Yes	21(7.5%)	6(2%)	1.58	0.470
	No	36(12.8%)	218(77.6%)		
Meconium aspiration syndrome	Yes	31(11%)	214(76.2%)	17.25	0.016
	No	26(9.3%)	10(3.6%)		
Neonatal sepsis	Yes	9(3.2%)	5(1.8%)	0.48	0.710
	No	48(17%)	219(78%)		
Perinatal asphyxia	Yes	39(13.9%)	222(79%)	16.25	0.004
	No	18(6.4%)	2(0.7%)		
Early neonatal death	Yes	5(1.8%)	1(0.4%)	1.32	0.152
	No	52(18.5%)	223(79.4%)		
NICU admission	Yes	41(14.6%)	20(7%)	15.36	0.005
	No	16(5.7%)	204(72.6%)		
Pre Eclampsia	Yes	23(8.2%)	43(15.3%)	6.22	0.233
	No	34(73.7%)	181(64.4%)		

\*IVD: instrumental vaginal delivery; SVD: spontaneous vertex delivery; DM: diabetes mellitus

#### Factors associated with meconium-stained amniotic fluid:

In this study, the association between demographic, obstetrical, medical history, and MSAF was assessed. Variables that showed an association in the bivariable analysis were maternal age, rural place of residence, monthly income, LNMP > 42 weeks, gestational age > 42 weeks, prolonged labor, obstructed labor, oligohydramnios, post-term pregnancy, maternal anemia, duration of labor, duration of rupture of membranes (ROM), mode of delivery, Apgar score, neonatal resuscitation, neonatal sepsis, perinatal asphyxia, early neonatal death, and NICU admission. These variables were included in the multivariable analysis to adjust for confounding factors. The adjusted odds ratio (AOR) revealed that maternal age, rural place of residence, gestational age > 42 weeks, prolonged labor, and obstructed labor were significantly associated with MSAF.

Mothers over the age of 35 were 23.42 times more likely to experience MSAF compared to those under 20 years old [AOR: 23.42 (95% CI 12.68–43.63)]. Mothers living in rural areas were three times more likely to have MSAF than their urban counterparts [AOR: 3 (95% CI 1.63–11.93)]. Compared to mothers with early-term pregnancies, those with post-term pregnancies (gestational age exceeding 42 weeks) had 8.76 times higher odds of developing MSAF [AOR: 8.76 (95% CI 4.27–18.4)]. Women whose labor lasted more than 24 hours had 10.5 times greater odds of MSAF

than those whose labor was 24 hours or less [AOR = 10.5, 95% CI = 8.34–45.3]. The likelihood of developing MSAF during obstructed labor was 9.4 times higher than in cases without obstructed labor [AOR: 9.4 (95% CI 2.26–17.39)] (Table 5).

#### DISCUSSION

In this study, the prevalence of meconium-stained amniotic fluid was found to be 20.3%. This result aligns closely with findings from studies conducted at Felege Hiwot Referral Hospital (17.8%) (13) and Jimma University Specialized Hospital (15.4%) (16) in Ethiopia. This might be due to similarities in sociodemographics, health institutions, and the quality of services they provide. The findings were also similar to those of a study from the Nigerian University Teaching Hospital (20.4%) (6), which may be attributed to similarities in accessibility and quality of services. However, the current findings were higher than those reported in Ethiopia (12.1%) (15), Israel (10.9%) (8), and Pakistan (7.7%) (21). These differences might be due to variations in study design, setting, and population. For example, the study in Israel used a retrospective design among women with low-risk pregnancies, and the study in Pakistan reported different incidences within the same population. On the other hand, our findings were lower than those reported at IPGMR Hospital, India (30.6%) (22). This difference could be attributed to the time gap

between the studies. Additionally, the Ethiopian government has given considerable attention to maternal and child health services

in recent years to improve maternal health programs, which may have positively impacted the health status of the population.

Table 5: Sociodemographic, obstetric and medical factors associated with meconium-stained amniotic fluid: bivariate and multivariable logistic regression analysis, HUCSRH, Sidama Ethiopia, 2022 (n=281).

Characteristic s	Categories	Meconium-stained amniotic fluid		COR (95% CI)	p value	AOR (95% CI)	p value
		Yes, N(%)	No, N (%)				
Maternal age	<20	1 (0.4)	8(2.8)	1			
	20-35	52(18.5)	204(72.6)	2.039(0.24- 16.67)	0.035	1.08(0.13- 3.79)	0.423
	>35	12 (4.3)	4 (1.4)	12.667(0.25-28.43)	0.035	23.42(12.68-43.63)	<0.001*
Current monthly income (ETB)	<3000	11(3.9)	7(2.5)	2.75(0.45- 6.55)	0.850	1.83(0.54- 9.56)	0.129
	3000-5000	25(8.9)	69(24.6)	1.24 (1.05-6.82)	0.015	0.91(1.14-15.54)	0.712
	>5000	21(7.5)	147(52.3)	1			
Residence	Urban	20(35.1)	58(25.9)	1			
	Rural	37(64.9)	166(74.1)	2.547(0.83-12.8)	0.080	3 (1.63- 11.93)	<0.001*
Pre-Eclampsia	Yes	23(8.2)	43(15.3%)	1.70(0.52- 5.61)	0.060	1.04(0.14- 6.05)	0.090
	No	34(73.7)	181(64.4)	1			
Early neonatal death	Yes	5(1.8%)	1(0.4%)	2.84(0.924- 8.75)	0.500	1.08(0.04- 1.58)	0.830
	No	52(18.5)	223(79.4)	1			
Duration of ROM	<12 hours	37(13.2)	194(69.0)	1			
	12-24 hours	20(7.0)	29(10.3)	0.6(0.0- 2.85)	0.771	1.21(0.14-7.55)	0.320
	>24 hours	0(0)	1(0.4)	3.61(1.85- 7.06)	0.455	1.73(1.14-16.25)	0.101
Prolonged duration of labor	< 12 hrs	4(1.4.0)	32(11.4)	1			
	12-24 hrs	37(13.2)	135(48.0)	1.60(0.53- 4.79)	0.039	1.2(1.1- 3.53)	0.025
	>24 hrs	16(5.7%)	7(2.5)	18.28(4.65- 71.76)	0.009	10.5(3.34- 45.3)	0.010*
Gestational age	37-42 wks	37(13.2)	211(75.0)	1			
	>42 wks	20(7.0)	13(4.6)	6.77(1.25-14.65)	0.010	8.76(4.27- 18.4)	0<0.001*
DM	Yes	1(0.4)	2(0.6)	2.203	0.450	1.12(0.33-17.25)	0.871
	No	56(20.0)	222(79.0)				
Obstructed labor	Yes	18(6.4)	4(1.4)	8.05	0.015	9.4(2.26- 17.39)	<0.001*
	No	39(13.9)	220(78.3)	1			

\*ROM: Rupture of membrane; DM: Diabetes mellitus

In the present study, 13.2% of neonates born with MSAF had Apgar scores less than seven, and neonates born with stained fluid were nearly four (3.8) times more likely to have low 5-minute Apgar scores than those born with clear liquor. The outcome of this study is comparable with that of Patil et al. (23). However, this finding contrasts with the study conducted by Sori DA et al. (16) at JUSH, which reported an Apgar score of less than seven in 88% of mothers with MSAF. With meconium-stained liquor, there is a greater likelihood of a decreased Apgar score due to the aspiration of meconium (24).

In the current research, meconium aspiration syndrome was identified in a considerable number of infants delivered with meconium-stained amniotic fluid (MSAF). This outcome was consistent with evidence obtained from Ethiopia (25), Nepal (7), and Belgaum (23). Meconium aspiration syndrome is neonatal respiratory distress that occurs in a newborn in the context of MSAF when respiratory symptoms

cannot be attributed to another etiology (26). Nevertheless, this finding contrasts with that of the study conducted by Sori DA et al. (16), in which a slightly higher incidence of MAS was reported.

In the present study, 39 (13.9%) neonates with MSAF had perinatal asphyxia. This finding correlates with the study conducted by Addisu et al. (14). Additionally, evidence from Iran (27) and Nepal (7) supports this finding, indicating that the incidence of perinatal asphyxia is significantly higher in MSAF cases than in those with clear fluid. When a baby passes meconium (first stool) into the amniotic fluid while still in the womb and then inhales it into the lungs during birth, it can lead to meconium aspiration syndrome. This may cause airway obstruction, respiratory distress, and even asphyxia (28).

In our study, over 14% (14.6%) of neonates born with MSAF were admitted to the NICU. This result was lower than outcomes reported from Lokmanya Tilak Municipal Medical College and Hospital, Mumbai (29), Khaleej-e-

Fars Hospital in Bandar Abbas, Iran (30), and Jawaharlal Nehru Hospital, Bhilai (31). The increased risk of NICU admission in cases of meconium-stained amniotic fluid may be due to meconium aspiration syndrome, infection risk, respiratory complications, low oxygen levels, difficulty maintaining body temperature, feeding difficulties, and other medical concerns (13).

Factors such as maternal age, rural residence, gestational age, prolonged labor, and obstructed labor were found to be significantly and independently associated with MSAF in the multivariable analysis. Mothers aged greater than 35 years were 23.42 times more likely to develop meconium-stained amniotic fluid during labor than those aged less than 35 years. This finding is consistent with results from a previous study at Indira Gandhi Medical College (32). A possible explanation is that, as women age, there may be reduced compliance of cardiovascular vessels, particularly uterine blood vessels, leading to arterial stiffness, insufficient placental perfusion, and in utero fetal hypoxia. This ultimately results in the passage of meconium into the amniotic fluid (13). Nevertheless, our findings contradict those reported by Shekari *et al.* (33).

Mothers residing in rural areas were three times more likely to have MSAF than those living in urban areas. This may be explained by the fact that women in rural areas are more likely to engage in labor-intensive work during pregnancy and may have limited access to healthcare due to geographical barriers, which could lead to maternal complications and fetal distress, resulting in MSAF (34, 35).

In this study, mothers with post-term pregnancies (gestational age exceeding 42 weeks) had nearly nine times higher odds of developing MSAF compared to those with early-term pregnancies. Our results are consistent with findings from other studies (12, 33, 36, 37). Possible explanations include maturation of the gastrointestinal tract and increased secretion of motilin as gestational age advances, leading to increased fetal bowel peristalsis and subsequent passage of meconium (38). However, further research is needed to draw definitive conclusions.

In our study, prolonged labor was significantly associated with meconium-stained amniotic fluid. This finding is comparable to that of a study conducted at SRM Medical College (10). This may be due to prolonged fetal stress, which can increase peristalsis of the fetal

gastrointestinal tract and relaxation of the anal sphincter, resulting in the passage of meconium (13).

In the present study, obstructed labor was significantly associated with the development of meconium. This finding is consistent with studies conducted at Bahir Dar Felege Hiwot Referral Hospital in Amhara, Ethiopia (13), and the Nigerian University Teaching Hospital (6). The possible explanation may be related to maternal dehydration, distress, and shock, which can lead to intrauterine fetal hypoxia secondary to poor placental perfusion and subsequent passage of meconium into the amniotic fluid (13).

In conclusion, this study found MSAF in 57 pregnancies, representing 20.3%. Low Apgar scores at the fifth minute, meconium aspiration syndrome, perinatal asphyxia, and admission to the neonatal intensive care unit were identified as the primary adverse neonatal outcomes associated with MSAF. Furthermore, there was a significantly higher risk of MSAF among older women, those residing in rural areas, those with post-term pregnancies, prolonged labor, and obstructed labor. Therefore, it is essential for healthcare professionals to focus on the management of women during labor to improve outcomes for both the mother and the fetus.

Nevertheless, this study has limitations inherent to cross-sectional designs, making it difficult to establish a temporal relationship between MSAF and the explanatory variables. Moreover, as the research was conducted in a single referral hospital, the findings may not be generalizable to other institutions or the wider community. We recommend conducting further studies using different research designs to better understand the temporal relationship between MSAF and the explanatory variables. Additionally, there is a potential risk of recall bias when assessing gestational age.

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#### REFERENCES

1. Mazor M, Hershkovitz R, Bashiri A, *et al.* Meconium stained amniotic fluid in preterm delivery is an independent risk factor for perinatal complications. *Eur J Obstet Gynecol Reprod Biol.* 1998; 81: 9-13.

2. Lee KA, Mi Lee S, Jin Yang H, et al. The frequency of meconium-stained amniotic fluid increases as a function of the duration of labor. *J Matern Fetal Neonatal Med.* 2011; 24: 880-5.
3. Jain P, Sharma R, Bhargava M. Perinatal outcome of meconium stained liquor in pre-term, term and post-term pregnancy. *Indian Journal of Obstetrics and Gynecology Research.* 2017; 4: 146-50.
4. Kumari R, Srichand P, Devrajani BR, et al. Foetal outcome in patients with meconium stained liquor. *J Pak Med Assoc.* 2012; 62: 474-6.
5. Lee J, Romero R, Lee KA, et al. Meconium aspiration syndrome: a role for fetal systemic inflammation. *Am J Obstet Gynecol.* 2016; 214: 366.e1-9.
6. David AN, Njokanma OF, Iroha E. Incidence of and factors associated with meconium staining of the amniotic fluid in a Nigerian University Teaching Hospital. *J Obstet Gynaecol.* 2006; 26: 518-20.
7. Ghimire B, Pathak P, Gachhadar R, et al. Immediate Fetal Outcome in Deliveries with Meconium Stained Amniotic Fluid. *J Nepal Health Res Councl.* 2022; 19: 681-87.
8. Hirsch L, Krispin E, Aviram A, et al. Effect of Meconium-Stained Amniotic Fluid on Perinatal Complications in Low-Risk Pregnancies at Term. *Am J Perinatol.* 2016; 33: 378-84.
9. Khatun MHA, Arzu J, Haque E, et al. Fetal outcome in deliveries with meconium stained liquor. *Bangladesh Journal of child health.* 2009; 33: 41-45.
10. Khazardoost S, Hantoushzadeh S, Khooshideh M, et al. Risk factors for meconium aspiration in meconium stained amniotic fluid. *J Obstet Gynaecol.* 2007; 27: 577-9.
11. Saint-Fleur AL, Alcalá HE, Sridhar S. Outcomes of neonates born through meconium-stained amniotic fluid pre and post 2015 NRP guideline implementation. *PLoS One.* 2023; 18: e0289945.
12. Abate E, Alamirew K, Admassu E, et al. Prevalence and Factors Associated with Meconium-Stained Amniotic Fluid in a Tertiary Hospital, Northwest Ethiopia: A Cross-Sectional Study. *Obstet Gynecol Int.* 2021; 2021: 5520117.
13. Addisu D, Asres A, Gedefaw G, et al. Prevalence of meconium stained amniotic fluid and its associated factors among women who gave birth at term in Felege Hiwot comprehensive specialized referral hospital, North West Ethiopia: a facility based cross-sectional study. *BMC Pregnancy Childbirth.* 2018; 18: 429.
14. Addisu D, Mekie M. Adverse Maternal and Perinatal Outcomes of Meconium-Stained Amniotic Fluid in Term Labor at Hospitals in South Gondar Zone, Northwest Ethiopia: A Prospective Cohort Study. *Biomed Res Int.* 2023; 2023: 8725161.
15. Hailemariam HA, Nigusse F, Gamshe EN. Prevalence and Contributing Factors of Meconium Stained Amniotic Fluid Among Women Delivered at St Paul's Hospital Millennium Medical College, Addis Ababa, Ethiopia. *J Med Physiol Biophys.* 2020; 67.
16. Sori DA, Belete A, Wolde M. Meconium Stained Amniotic Fluid: Factors affecting Maternal and Perinatal Outcomes at Jimma University Specialized Teaching Hospital, South West Ethiopia. *Gynecology & Obstetrics.* 2016; 6: 1-6.
17. Kassa GM, Arowojolu AO, Odukogbe AA, et al. Adverse neonatal outcomes of adolescent pregnancy in Northwest Ethiopia. *PLoS One.* 2019; 14: e0218259.
18. Wu Y, Chen Y, Shen M, et al. Adverse maternal and neonatal outcomes among singleton pregnancies in women of very advanced maternal age: a retrospective cohort study. *BMC Pregnancy Childbirth.* 2019; 19: 3.
19. Hung T-H. Advanced maternal age and adverse perinatal outcome: a call for investigations on Asian women. *Taiwan J Obstet Gynecol.* 2008; 47: 257-58.
20. Institute of Medicine Committee on Improving Birth O. In: Bale JR, Stoll BJ, Lucas AO, eds., *Improving Birth Outcomes: Meeting the Challenge in the Developing World.* Washington (DC): National Academies Press (US). Copyright 2003 by the National Academy of Sciences. All rights reserved., 2003.
21. Soni A, Vaishnav G, Gohil J. Meconium Stained Amniotic Fluid, its Significance and Obstetric Outcome. 2015.
22. Chakraborty A, Pk M, Seth S, et al. Study on risk factors of meconium stained amniotic fluid and comparison of pregnancy outcome in clear and meconium stained

- amniotic fluid ,in a tertiary care hospital ,kolkata. 2013.
23. PatilKamal P, Mk S, Samatha KJ. A one year cross sectional study of management practices of meconium stained amniotic fluid and perinatal outcome. 2006.
  24. Masood M, Shahid N, Bano Z, et al. Association of Apgar Score With Meconium Staining of Amniotic Fluid in Labor. *Cureus*. 2021; 13: e12744.
  25. Tolu LB, Birara M, Teshome T, et al. Perinatal outcome of meconium stained amniotic fluid among labouring mothers at teaching referral hospital in urban Ethiopia. *PLoS One*. 2020; 15: e0242025.
  26. Cleary GM, Wiswell TE. MECONIUM-STAINED AMNIOTIC FLUID AND THE MECONIUM ASPIRATION SYNDROME: An Update. *Pediatric Clinics of North America*. 1998; 45: 511-29.
  27. Darsareh F, Ranjbar A, Farashah MV, et al. Application of machine learning to identify risk factors of birth asphyxia. *BMC Pregnancy Childbirth*. 2023; 23: 156.
  28. Olicker AL, Raffay TM, Ryan RM. Neonatal Respiratory Distress Secondary to Meconium Aspiration Syndrome. *Children (Basel)*. 2021; 8.
  29. Unnisa S, Sowmya B, Rao SB, et al. Maternal and fetal out come in meconium stained amniotic fluid in a tertiary centre. *International journal of reproduction, contraception, obstetrics and gynecology*. 2016; 5: 813-17.
  30. Malakooti N, Mehrnoush V, Abdi F, et al. Development of a machine learning model to identify the predictors of the neonatal intensive care unit admission. *Sci Rep*. 2025; 15: 20914.
  31. Yengantiwar RP, Deshmukh AA, Chaudhari SD, et al. Perinatal Outcome in Relation to Meconium Stained Amniotic Fluid. 2017.
  32. Naveen SM, Kumar SV, Ritu S, et al. Predictors of meconium stained amniotic fluid: a possible strategy to reduce neonatal morbidity and mortality. 2006.
  33. Shekari M, Jahromi MS, Ranjbar A, et al. The incidence and risk factors of meconium amniotic fluid in singleton pregnancies: an experience of a tertiary hospital in Iran. *BMC Pregnancy Childbirth*. 2022; 22: 930.
  34. Strong K, Strong K. Health in rural and remote Australia: The first report of the Australian Institute of Health and Welfare on rural health. Australian Institute of Health and Welfare Canberra, 1998.
  35. Roberts CL, Algert CS. The urban and rural divide for women giving birth in NSW, 1990-1997. *Aust N Z J Public Health*. 2000; 24: 291-7.
  36. Osava RH, Silva FM, Vasconcellos de Oliveira SM, et al. [Meconium-stained amniotic fluid and maternal and neonatal factors associated]. *Rev Saude Publica*. 2012; 46: 1023-9.
  37. Anemia in Pregnancy: ACOG Practice Bulletin, Number 233. *Obstet Gynecol*. 2021; 138: e55-e64.
  38. Mitchell S, Chandraharan E. Meconium-stained amniotic fluid. *Obstetrics, Gynaecology & Reproductive Medicine*. 2018; 28: 120-24.
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