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Determinants of meconium-stained amniotic fluid among women delivered at southwestern referral hospitals, Southwest Ethiopia: a multi-center case-control study

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Abstract

Background Meconium-stained amniotic fluid (MSAF) is a condition in which meconium is present in the uterus during ante-natal and complicates 10–15% of all live births. Scanty information is known about the determinants of meconium-stained amniotic fluid. Hence, this study aimed to identify determinants of meconium-stained amniotic fluid among women delivered at southwestern referral hospitals in southwest Ethiopia, in 2024.

Methods An institutional-based case-control study was employed from January 1, 2024, to June 30, 2024. The study was conducted in four southwestern referral hospitals in southwest Ethiopia. The final sample size includes 321(107 cases and 214 controls). The sample size was proportionally allocated for cases and controls for each referral hospital. Simple random sampling was used to select patient charts and data was collected from the chart using questions/tools developed after reviewing relevant literature. Data were entered using Epi-data version 3.1 and analyzed using SPSS version 25. Data was analyzed using binary logistic regression. All independent variables with P- the value of < 0.25 in univariable analysis were considered for multivariable logistic regression. Determinant factors of meconium-stained amniotic fluid were identified at a 95% confidence interval with a *p*-value < 0.05 was utilized to declare statistical significance.

Results A total of 107 cases and 214 controls were included in this study. The finding from this study stated that induction of labor [AOR = 2.37, 95% CI = 1.28–8.89], obstructed labor [AOR = 2.62, 95%CI = 1.1–6.79], duration of labor greater than 24 h [AOR = 2.8, 95% CI = 1.55–15.44], and premature rupture of the membrane [AOR = 2.98, 95%CI = 1.1–8.23] were found to be significantly associated with meconium-stained amniotic fluid.

Conclusion Conclusively, a mother with induced or obstructed labor, labor duration greater than 24 h, and premature rupture of membrane need special attention during delivery care to reduce potential risk factors to feto-maternal outcomes related to meconium-stained amniotic fluid.

Keywords Determinants, Meconium stained amniotic fluid, Southwest, Ethiopia

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Background

Meconium-stained amniotic fluid (MSAF) is a condition where meconium is present in the uterus during ante-natal [1]. Meconium is a non-infectious, thick, black-green, odorless material that is first recognized in the fetal intestine around twelve weeks of gestation and stored in the fetal colon throughout gestation [2–6] The passage of meconium normally occurs within 24 h to 48 h after birth [7, 8]. The exact causes of meconium-stained amniotic fluid were not clear [9, 10]. However, previous studies identify that neonate may pass meconium in amniotic fluid during pregnancy due to different maternal and fetal factors; Hypertension, gestational diabetes mellitus, maternal chronic respiratory or cardiovascular disease, post-term pregnancy, preeclampsia, eclampsia, oligohydramnios, intrauterine growth retardation, prolonged labor, low birth weight babies, anemia, high maternal age, maternal drug abuse especially tobacco and alcohol are the major risk factors for the passage of meconium into the amniotic fluid [3, 8–15].

Meconium-stained amniotic fluid results in short and long-term prenatal outcomes such as lower Apgar score, respiratory distress, meconium aspiration syndrome(MAS), neonatal sepsis (early onset neonatal sepsis and late-onset neonatal sepsis), and hyaline membrane disease. The meconium-stained amniotic fluid causes respiratory distress specifically meconium aspiration syndrome which results in morbidity and mortality of neonates [12, 15–22].

Globally, the neonatal passage of meconium leading to meconium-stained amniotic fluid is usually seen in 12 to 16% of deliveries and complicates 10–15% of all live births, out of which 5% are at risk of developing meconium aspiration syndrome [23–27]. Even in developed countries where the health system is good and contains extensive neonatal care units, the mortality rate from meconium aspiration syndrome arising from meconium-stained amniotic fluid remains as high as 3–5% [23, 27, 28, 30]. Due to factors associated with socioeconomic and quality of services, the ill effect of meconium-stained fluid is even worse in developing countries [26].

Even though, several studies were conducted on the magnitude of meconium-stained amniotic fluid information on its determinant factors including large-scale area studies was limited in Ethiopia. So, this study aimed to identify determinants of meconium-stained amniotic fluid among women delivered at southwestern referral hospitals in southwest Ethiopia.

Methods

Study setting, design, and population

A multi-center institutional based unmatched case-control study was conducted among women delivered at southwestern referral hospitals, in Southwest Ethiopia (Jimma Medical Center, Wallaga referral hospital, Ambo referral hospital, Mettu Karl referral hospital) from January 1, 2024, to June 30, 2024. All hospitals contain different departments like Surgery, gynecology and obstetrics, emergency, pediatrics, and internal medicine NICU (Neonatal Intensive Care Unit) which provide clinical services (prenatal, family planning, delivery services, and treatment of obstetric and gynecologic complications). The ward is staffed with gynecologists, residents of different years (levels), midwives, nurses, and a varying number of interns.

Study Population All women admitted to the labor room of southwestern referral hospitals, in Southwest Ethiopia (Jimma Medical Center, Wallaga University Referral Hospital, Ambo University Referral Hospital, and Mettu Karl Comprehensive Specialized Hospital).

Cases Include women of gestational age with ≥37 weeks in the labor or delivery ward and diagnosed with MSAF regardless of grading staining which was assessed by a senior obstetrician at the time of rupture of membrane or after rupture of the membrane at southwestern referral hospitals, Southwest Ethiopia.

Controls Include women of gestational age with ≥37 weeks in the labor or delivery ward who were not diagnosed with MSAF during a time of rupture of the membrane or after rupture of the membrane by a senior obstetrician at southwestern referral hospitals, Southwest Ethiopia.

Exclusions Those mothers with severe congenital malformations, intrauterine fetal death before the onset of labor, and multiple pregnancies were excluded.

Sample size determination

The sample size was calculated by taking risk factors for meconium-stained from previous studies and by using Epi-info version 7.2.0.1 statistical software for unmatched case-control study design. After using different significant risk factors in the previous studies, induced labor was one of the risk factors that had a maximum number for our sample size [12]. Based on the previous finding, the percent of induced labor in women with MSAF (cases) was 27% and the percent of induced labor of clear amniotic fluid (controls) was 12% [12]. Based on the assumption of two ratios of case to control and 95% confidence interval and power of 80%, the sample size was 291(97 cases and 194 controls), by adding a 10% non-response rate, the final sample size for this study was 321 (107 cases and 214 controls).

Sampling procedures

To get study participants, the average number of women who delivered during the data collection period was estimated based on the previous delivery, which was obtained by referring 2023 G.C HMIS, report over five months at selected four referral hospitals (Fig. 1).

Data collection tools and procedures

The data were collected through face-to-face interviews after data collection tools were adapted and modified from different literature (Supplementary material). The tool contains questions that address socio-demographic characteristics such as; Age, marital status, educational status, occupational status, residence and monthly income in USD), obstetric and medical history (Parity, Gestational age, ANC follow-up, Rh factors, Obstructed labor, IUGR, Preeclampsia, Oligohydramnios, Onset of labor, Fetal distress, PROM and Mode of delivery). Data were collected by using a combination of interviews and chart reviews by trained BSc midwives after diagnosis of cases and controls were done by at least two senior obstetricians and gynecologists in each study setting.

Data quality

To maintain the data quality the data collectors and supervisors were trained for two days on the aims and methods of the study. Then, a pretest was done on 5% of the sample at Agaro General Hospital to check the reliability and validity of the questionnaires. To reduce the selection bias senior experienced obstetrician confirms whether or not the amniotic fluid is stained with meconium.

Data processing and analysis

The collected data were checked for completeness and coded. Then entered into Epi data version 3.1 and then exported to SPSS version 23 for analysis. Data analysis was done by using both descriptive and logistic regression. Variables having a *p*-value of <0.25 in the bivariate model were subjected to multivariate analysis to avoid confounding variables effect. Multivariate logistic regression models were used to determine the degree of association between the outcome and predictor variables. The goodness of fit of the multivariate was checked with the Hosmer and Lemshow test ($p=0327$). Finally, *P*-value<0.05 was taken as statistically significant.

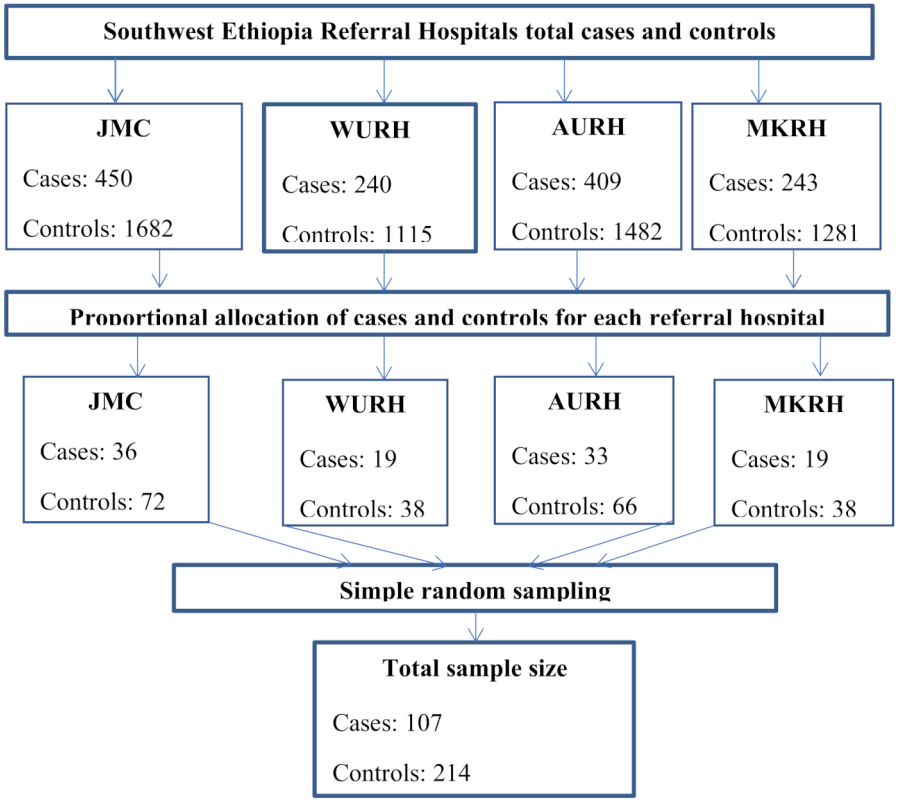

Fig. 1 The schematic diagram representation of sampling procedures to identify the determinants of MSAF at Southwestern referral hospitals, Southwest Ethiopia, 2024

Table 1 Socio-demographic characteristics of women for the study of MSAF at Southwestern referral hospitals, Southwest Ethiopia, 2024

Variables	Category	Cases *N* = 107 (%)	Controls *N* = 214 (%)
Age(in years)	< 18	5 (4.6)	28 (13.1)
	18–35	74 (69.2)	160 (74.8)
	≥ 35	28 (26.2)	26 (12.1)
Marital status	Married	101 (94.3)	198 (92.5)
	Others*	6 (5.7)	16 (7.5)
Religion	Muslim	23 (21.5)	46 (21.5)
	Orthodox	39 (36.4)	74 (34.6)
	Protestant	33 (30.8)	53 (24.8)
Others**	12 (11.3)	41 (19.2)	
Education status	Can't read and write	9 (8.4)	16 (7.5)
	Primary	49(45.7)	87 (40.6)
	Secondary	34 (31.7)	85 (39.8)
	College and above	15 (14.1)	26 (12.2)
Occupational status	Elementary Occupation	36 (33.6)	68 (31.7)
	Agriculture	23 (21.5)	51 (23.8)
	Craft and related trades workers	16 (14.9)	36 (16.8)
	Services and Sales Workers	11 (10.3)	24 (11.3)
	Professionals	21 (19.6)	35 (16.3)
Residence	Urban	44 (41.2)	82 (38.4)
	Rural	63 (58.8)	132 (61.6)
Income (USD)	< 35.14	44 (41.1)	87 (40.6)
	35.15 to 52.72	43 (40.2)	88 (41.2)
	≥ 52.73	20 (18.7)	39 (18.2)

Note: *Widowed, Single, Divorced, ** Wakefeta, Catholic

Results

Socio-demographic characteristics

The average age of respondents was 26±4.56 and 27±3.75 years for the cases and controls respectively. Most of the mothers who gave birth in the study area 101(94.3%) cases and 198 (92.5%) controls were married. Nearly one-third of 39(36.4%) cases and 74(34.6%) controls were followers of Orthodox, followed by protestant 33 (30.8%) cases and 53(24.8%) controls. One-third of cases 34(31.7%) and controls 85(39.8%) were attending secondary education. Regarding the economic status of the respondent, 44(41.1%) of cases and 87(40.6%) of control were found in the lower income category (Table 1).

Obstetrics-related determinants of MSAF

During the study period the incidence of meconium stained amniotic fluid was 24.13% (with a total 1342 cases of MSAF among 6902 total) women attend referral hospitals in the southwest Ethiopia. About 85(79.5%) of cases and 176(82.2%) of controls were multiparous. Most of the cases 100(93.5%) and 206(96.2%) were term in gestational age. Only 7(6.5%) of cases and 8(3.8%) of controls were post term. Accordingly, 18(16.8%) of cases and 10(4.6%) of controls were experienced obstructed labor in current delivery. Regarding preeclampsia 14(13.1%) of cases and 12(5.6%) of controls were diagnosed to have pre-eclampsia. In most of the cases 86 (80.4%) and controls 196(89.3%) gave their child through spontaneous vaginal delivery. Only 18(16.8%) of cases and 16(7.4%) of controls were undergoing cesarean section (Table 2).

Table 2 Obstetrics-related determinants MSAF of women at Southwestern referral hospitals, Southwest Ethiopia, 2024

Variables	Category	Cases *N* (%)	Controls *N* (%)
Parity	Primi parity	22(20.5)	38(17.8)
	Multi parity	85(79.5)	176(82.2)
Gestational age	37–42 weeks	100(93.5)	206(96.2)
	> 42 weeks	7(6.5)	8(3.8)
ANC follow up	Yes	82(76.6)	173(80.8)
	No	25(23.4)	41(19.2)
Total number of ANC follow-up	< 4 visit	80(74.7)	168(78.5)
	≥ 4 visit	27(25.3)	46(21.5)
Rh factors	Negative	107(100)	213(99.5)
	Positive	0(0)	1(0.5)
Obstructed Labor	Yes	18(16.8)	10(4.6)
	No	89(83.2)	204(95.3)
IUGR	Yes	1(0.9)	2(0.9)
	No	106(99.1)	112(5.3)
Preeclampsia	Yes	14(13.1)	12(5.6)
	No	93(86.9)	202(94.4)
Oligohydramnios	Yes	13(12.1)	8(3.7)
	No	94(87.8)	106(49.5)
Onset of labor	Spontaneous	86(80.4)	126(58.9)
	Induced	21(19.6)	88(41.1)
Duration of labor	≤ 24 h	86(80.4)	117(54.7)
	> 24 h	21(19.6)	97(45.3)
Fetal distress	Yes	8(7.4)	9(4.2)
	No	99(92.5)	205(95.8)
PROM	Yes	18(16.8)	8(8.5)
	No	89(83.2)	206(96.5)
Mode of delivery	Spontaneous vaginal delivery	86(80.4)	191(89.3)
	CS	18(16.8)	16(7.4)
	Instrumental delivery	3(2.8)	7(3.2)

Factors associated with meconium-stained amniotic fluid

The factors associated with MSAF, socio-demographic, and Obstetrics characteristics of a mother who gave birth in Southwestern Ethiopia were assessed. In bivariate logistic regression analysis variables like onset of labor, obstructed labor, duration of labor, PROM, Mode of delivery, preeclampsia, and oligohydramnios were found to have a *p*-value less than 0.25. However, women with induced labor at the onset of labor had 2.37 times higher odds of meconium-stained amniotic fluid than women with spontaneous labor [AOR = 2.37, 95%CI = 1.28–8.89]. Women who had a duration of labor > 24 h had 2.8 times higher odds of meconium-stained amniotic fluid than

women with labor duration ≤ 24 h [AOR = 2.86, 95% CI = 1.55–15.44]. Based on the duration of labor women with obstructed labor had 2.62 times higher odds of meconium-stained amniotic fluid than women with non-obstructed labor [AOR = 2.62, 95%CI = 1.1–6.79]. Furthermore, women with premature rupture of the membrane had 2.98 times higher odds of meconium-stained amniotic fluid than women with intact membrane [AOR = 2.98, 95%CI = 1.1–8.23]. The goodness of fit of the multivariate was checked with the Hosmer and Lemshow test (p = 0327). P-value < 0.05 was taken as statistically significant (Table 3).

Discussion

Meconium-stained amniotic fluid is a condition in which meconium is present in the uterus during intranatal conditions and complicates 10–15/100 of all live births. Furthermore, no study was conducted to assess the determinants of meconium-stained amniotic fluid in the study area. Therefore this study aims to assess the determinants of meconium-stained amniotic fluid among women admitted to labor or delivery wards in Southwest Ethiopia referral hospitals.

Table 3 Bivariate and multivariate logistic regression analysis with COR and AOR for factors associated with meconium-stained amniotic fluid among women delivered at southwestern referral hospitals, southwest Ethiopia, 2024

Variables	Category	MSAF		COR (95% C.I)	AOR (95% C.I)
		Cases (*N* = 107) (%)	Controls (*N* = 214 (%)		
Onset of labor	spontaneous	86(80.4)	126(58.9)	1	
	Induced/oxytocin	21(19.6)	88(41.1)	2.86[2.34–8.41]	2.37[1.28–8.89] *
Obstructed labor	Yes	18(16.8)	10(4.6)	4.12[1.34–6.51]	2.62[1.1–6.79] *
	No	89(83.2)	204(95.3)	1	
Duration of labor	≤ 24 h	86(80.4)	117(54.7)	1	
	> 24 h	21(19.6)	97(45.3)	3.39[2.43–10.13]	2.8[1.55–15.44] *
PROM	Yes	18(16.8)	8(8.5)	5.21[2.18–12.4]	2.98[1.1–8.23] *
	No	89(83.2)	206(96.5)	1	
Mode of delivery	Spontaneous vaginal delivery	86(80.4)	191(89.3)	1	1
	CS	18(16.8)	16(7.4)	2.4[1.21–5.18]	0.7[0.26–1.97]
	Instrumental delivery	3(2.8)	7(3.2)	0.95[0.42–3.76]	0.07[0.02–1.23]
Preeclampsia	Yes	14(13.1)	12(5.6)	2.53[1.12–5.69]	1.46[0.44–4.52]
	No	93(86.9)	202(94.4)	1	1
Oligohydramnios	Yes	13(12.1)	8(3.7)	1.83[1.42–8.82]	0.43[0.08–2.18]
	No	94(87.8)	106(49.5)	1	1

Note: *Significant value

The present study showed that induced labor, obstructed labor, duration of labor > 24 h, and Premature rupture of the membrane were significantly associated with meconium-stained amniotic fluid. A similar finding was reported from Northern Ethiopia and the United States of America [12, 13, 15]. The reason for this association might be that after induction of labor using oxytocin, increases uterine contraction and disturbs the normal physiology of the uterus. This further leads to inadequate placental perfusion and then intrauterine fetal hypoxia which increases parasympathetic stimulation by a vagus nerve that leads to passage of meconium to amniotic fluid [29].

Longer duration of labor greater than 24 h and obstructed labor were associated with meconium-stained amniotic fluid. This finding was in line with the study done in Israel, Northern Ethiopia, and Jimma [1, 12, 30]. This could be explained by when a baby does not exit the pelvis during childbirth due to physical block or due to many reasons, uterine contract normally the duration of the labor to become longer, and the child does not get enough oxygen which leads to inadequate placental perfusion and the stress environment to the baby, which may result in increased peristalsis of gastrointestinal tract and passage of meconium to amniotic fluid [31].

Premature rupture of the membrane was found to be significantly associated with meconium-stained amniotic fluid. This finding was a consistent study done in Addis Ababa and urban Ethiopia [2, 3]. This might be because, when an amniotic sac rapture there is a leakage of amniotic fluid and the baby becomes immature and the cord becomes compressed as a result, inadequate perfusion of the placenta, prolapsed placenta, persistent tachycardia, uterine contraction high and passage of meconium to amniotic fluid [32]. Preeclampsia, mode of delivery, and oligohydramnios were not significant in the current study. This study is contraindicated with studies done in different countries [9]. This difference might be due to differences in sample size, study setting, and study design.

Conclusions

Conclusively findings from this study stated that induced or obstructed labor, labor duration greater than 24 h, and premature rupture of membrane were significantly associated with meconium-stained amniotic fluid during delivery. Therefore healthcare provider attending delivery care for the mother with induced or obstructed labor, labor duration > 24 h, and premature rupture of membrane needs to give special attention to reduce potential risk factors to feto-maternal outcomes.

Limitations of the study

Even though the current study tried to minimize those biases by selecting cases and controls by at least two senior obstetrician confirmations, the nature of the study may be prone to recall and selection bias. Therefore the researcher recommends a large prospective study to evaluate the determinants of meconium-stained amniotic fluid.

Abbreviations

AOR	Adjusted Odd Ratio
AURH	Ambo University Referral Hospital
B.Sc	Bachelor of Science, HIMS: Health Information System
IUGR	Intrauterine Growth Restriction, JMC: Jimma Medical Center
MAS	Meconium Aspiration Syndrome
MKRH	Mettu Karl Referral Hospital
MSAF	Meconium Stained Amniotic Fluid
NICU	Neonatal Intensive Care Unit
PROM	Premature Rupture of membrane USD: United States Dollar, WURH: Wallaga University Referral Hospital

Supplementary Information

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Supplementary Material 1

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Author contributions

Rebuma Sorsa was involved in conceiving the idea, study design, data analysis, and interpretation, writing the manuscript, and managing the overall process of the study. UG, TA, KK, BL, DA, DD, HG, and DS were involved in study design, data analysis, and revising the manuscript. The final manuscript was read and approved by all authors.

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Data availability

The data set used and/or analyzed during the current study is available from the corresponding author upon reasonable request via rebumasorsa998@gmail.com.

Declarations

Ethical approval and consent to participate

The study was approved by the Jimma University Institutional Review Board (IRB). The data was collected after obtaining written informed consent from mothers. If the age of the participant was less than 17 years (minors), and those who can't read and write the consent was taken from immediate parents or other legal guardians. Personal identifiers like names were not recorded to maintain the confidentiality of the study participants.

Clinical trial number

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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