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Research Article

Magnitude of Meconium Aspiration Syndrome and Associated Factors Among Neonates Admitted to Neonatal Intensive Care Unit of Arsi Zone, Ethiopia 2023

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Abstract

Background: Meconium aspiration syndrome is a serious, potentially fatal condition that affects newborns with a high morbidity and mortality and continues to be a major contributor to neonatal respiratory distress, often resulting in respiratory failure and even death. Globally, around 4–22% of all births have meconium-stained amniotic fluid, and in 3-12% of those infants delivered eventually acquire meconium aspiration syndrome. Therefore, this study is aimed to assess the magnitude of meconium aspiration syndrome and associated factors among neonates admitted to neonatal intensive care units of public hospital in Arsi zone, Oromia, Ethiopia, 2023. *Methods:* An institutional-based cross-sectional study design was used to collect data among 345 participants from June 30 to August 30, 2023 in selected public hospitals of Arsi zone. The data was gathered through caregiver interviews and chart review. Systematic random sampling technique was used to select study participants. The collected data was entered into Epi-Data version 3.1 and exported to SPSS version 25. To analyze the data, first bivariable, then multivariable logistic regression model was used and those variables with $p < 0.05$ were considered to be statistically significant. The model of fitness was tested using the Hosmer-Lemesho goodness of fit. *Result:* The magnitude of meconium aspiration syndrome in this study was found to be 26.0%. Post-term (AOR=3.34 95% CI (1.41, 7.98)), Antepartum hemorrhage (AOR=7.72 95% CI (2.82, 21.15)), Preeclampsia (AOR=6.55 95% CI (2.63, 16.29)), Premature rupture of membrane (AOR=2.41 95% CI (1.32, 4.41)), First minute Apgar score < 7 (AOR=2.69 95% CI (1.36, 5.33)) were found to be significantly associated with meconium aspiration syndrome. *Conclusion:* The magnitude of meconium aspiration was moderate as compared to previous study. Post term, Antepartum hemorrhage, Preeclampsia, Premature rupture of membrane, First minute APGAR score < 7 were significantly associated with meconium aspiration syndrome. Therefore, early diagnoses and management of those factors are important for reducing the occurrences of meconium aspiration syndrome.

Keywords

Arsi, Magnitude, Meconium, Post Term

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1. Introduction

Meconium aspiration syndrome (MAS) is described as respiratory distress that appears soon after birth and is caused by mechanical obstruction and chemical inflammation brought on by meconium aspiration into the neonate's lower respiratory tract, along with radiographic evidence of aspiration pneumonitis and the presence of meconium-stained amniotic fluid [1].

Meconium aspiration syndrome is characterized by respiratory distress, hypoxemia, and acidosis, has been linked to higher rates of perinatal mortality and morbidity [2]. Generally, 10% of neonatal respiratory failure can be attributed to MAS [3]. Any sign of respiratory distress observed in infants delivered within one day after birth leads to MAS diagnoses. If required, a blood gas study and chest radiograph should be done to confirm MAS [4].

Globally, the neonatal mortality rate accounted for 44% of all child deaths in 2012 [5]. Approximately 80% of neonatal deaths happening in the early neonatal period, with MAS accounting for a sizeable portion of those deaths [6]. Globally, around 4–22% of all births have meconium-stained amniotic fluid (MSAF), and in 3–12% of those infants delivered, they eventually acquire MAS [7]. Infants who have Meconium Aspiration Syndrome (MAS) are more likely to experience respiratory morbidity, and one-third of the neonates who have meconium stains require intubation and mechanical ventilation [8].

In India, the prevalence of meconium aspiration syndrome is 15.9% among babies born with meconium-stained amniotic fluid that were admitted to the NICU [9], while the prevalence of MAS in China was 7% [10]. While In Pakistan 14.9% of neonates had MAS [11]. In Africa, Zimbabwe, and Cameroon the prevalence of meconium aspiration syndrome was 31%, and 2.34% respectively [12, 13].

Despite tremendous improvements in therapeutic, diagnostic, and even medical techniques, meconium management remains an organizational concern [14]. Three-quarters of infants with MAS experienced one or more complications. The worst prognosis for MAS is persistent pulmonary hypertension (PPHN) and chemical pneumonitis in terms of longer hospital stays and increased mortality, while patients with no problems had a fantastic prognosis with no recorded mortality [15].

Even though, sustainable development goal planned to lower the newborn mortality rate to 12 or fewer per 1000 live births by 2030, unfortunately, several nations are now making very little progress in achieving this goal [16]. A significant contributor to newborn morbidity and mortality in low- and middle-income nations is respiratory distress (related to pneumonia and meconium aspiration syndrome), with an incidence of 1.2% to 7.2% and have higher morbidity than in high-income nations [17].

Increased maternal age, term and post-term, premature rupture of membrane, small for gestational age, Apgar score, antepartum hemorrhage, preeclampsia, fetal distress, unsettling fetal heart rate tracing, cesarean delivery, intrauterine growth retardation, duration of labor, and obstructed labor were factors associated with MAS [18-20].

A study done at Wachemo University in Nigist Eleni, Ethiopia, showed that the magnitude of MAS was 30.6% [21]. Despite different MAS related a study has been conducted in different parts of Ethiopia, little research has been done in Ethiopia on the magnitude and associated factors related to MAS. However, no study was conducted particularly in the study area. One gap observed in previous studies conducted in Ethiopia was that they focused only on a single institution (only a university hospital) as the study site. But this study included different institutions (primary hospital, general hospital, and university hospital). Therefore, this study aimed to determine the magnitude of meconium aspiration syndrome and its associated factors among neonates admitted to Arsi zone government hospitals in Oromia, Ethiopia.

2. Methods

2.1. Study Area and Period

The study was conducted from June 30 to August 30, 2023 in Arsi zone, Oromia, Ethiopia.

2.2. Study Design

An institutional based cross-sectional study design was used.

2.3. Populations

All neonates admitted in NICU of Arsi zone public hospitals from June 30 to August 30, 2023 were source population whereas, all selected neonates admitted in NICU of selected Arsi zone public hospitals from June 30 to August 30, 2023 were study population.

2.4. Inclusion and Exclusion Criteria

All neonates who were admitted in NICU from June 30 to August 30, 2023 were included however, Neonates with incomplete chart information, Neonates mothers who had hearing impairments or unable to talk, and Neonates who were discharged early before data collection but only chart was available were excluded from the study.

2.5. Sample Size Determination and Sampling Procedure

2.5.1. Sample Size Determination

The sample size was calculated using a single population proportion formula and the proportion was taken from the

previous study done in Wolkite University hospitals in Ethiopia, which showed the magnitude of MAS was 28.7 [22].

Using the formula, $n = \frac{(Z\alpha/2)^2 \times p \times q}{d^2}$

Where presumption; with assumption of 95% confidence interval 5% desired precision

n = sample size.

Za/2= 95% confidence level at value under standard normal distribution which is equal to 1.96.

(Z value at alpha =0.05).

P = 0.287, established magnitude of meconium aspiration syndrome from previous study 28.7% [22], and q = 1-p,

d = 0.05, margin of error.

$$n = \frac{(Z\alpha/2)^2 \times p \times q}{d^2}, n = \frac{(1.96)^2(0.287)(0.713)}{(0.05)^2}$$

n=314

By adding 10% non-respondents the final sample size was estimated 345.

Since the final sample size of first objective is greater than the maximum sample size of the second objective (Table 1), which was 345>211, the final sample size was projected to be 345.

Table 1. *Sample size calculation on based specific objectives.*

Selected associated factors	P1=outcome in unexposed group	P2=outcome in exposed group	OR	Sample size	Non-response rate	Final sample size	References
Mode of delivery	13.64	34.62	3.35	148	14.8	162	(30)
Post pregnancy	21.49	54.39	4.35	78	7.8	86	(24)
Duration of labor	22.97	7.47	0.27	192	19.2	211	(21)

2.5.2. Sampling Procedure

To accommodate the study participants, out of eight hospitals, five hospitals (Arsi university specialized hospital, Bekoji hospital, Robe hospital, Gobesa hospital and Kersa hospital) were selected by lottery method. Sampling units were selected from each hospital based on their two-month hospital NICU admission report after proportional allocation. Based on an estimated number of two-month NICU admissions in each selected hospitals K interval was calculated to select sampling unit, since the final sample size was 345, k was calculated as N/n= 822/345= 2 interval. The study unit was determined by systematic random sampling techniques from the sampling frame of NICU registration book of the institutional list. Charts of the each included caregivers were also included. The first participant was chosen by lottery, and the rest were chosen at every 2 "K" interval for all hospitals until the desired sample size was reached.

2.6. Study Variables

2.6.1. Dependent Variables

Meconium Aspiration Syndrome.

2.6.2. Independent Variables

Sociodemographic characteristics of the mother (maternal age, residence, maternal occupation, household income, maternal education).

Maternal and obstetric related factors (parity, gravidity, ANC follow-up, Rh factors, maternal respiratory tract infection, anemia, APH, DM, Pregnancy-induced hypertension, preeclampsia).

Intrapartum related factors (mode of delivery, duration of labor, obstructed labor, time of ROM, non-reassuring fetal heart beat, induction or augmentation).

Neonatal related factors (newborn sex, neonatal age at admission, birth weight, gestational age, APGAR score, neonatal medical problems, multiple gestations, congenital abnormalities, and stage of meconium).

Health institution related factors (birth attendant, place of birth, level of health facility).

2.7. Operational Definitions

Meconium aspiration syndrome: Babies who are admitted to the NICU and who have been diagnosed with MAS by the attending clinicians, in accordance with the diagnostic criteria based on the evidence of meconium in the amniotic fluid at the time of birth, breathing difficulties requiring oxygen or assisted ventilation, and chest x-rays demonstrating hyperinflation with variable areas of atelectasis and diaphragm flattening [23].

Nonreassuring fetal heart rate pattern (NRFHRP): Is fetal heart rate less than 100 or greater than 160 beats per minute that persists for longer than 15 minutes using intermittent auscultations [24].

Thick meconium: Dense staining occurs when there is reduced amniotic fluid and excess of meconium, making the staining quite thick with a "pea soup" consistency [22].

Thin meconium: Amniotic fluid diluted with meconium, with a large to moderate amount of amniotic fluid. Just meconium stained amniotic fluid [22].

Apgar score assessment: It is carried out in the first-minute and resuscitation measures are made to improve and again measured at 5 min [20].

Incomplete chart information: A card that lacked complete details regarding neonates information, the mother's pregnancy status and prior obstetric history (where one or more study-related characteristics were missed) [25].

Premature rupture of membranes (PROM): Is rupture of the gestational membranes that occurred more than one hour before the beginning of labor [26].

Post-term: A pregnancy that exceeds 42 weeks or a gestational duration greater than 294 days [27].

2.8. Data Collection Tools and Procedures

A structured questionnaire was adopted and amended from different literature [20, 22, 24, 28-30]. Data was gathered by both interviewing the caregiver and neonate chart record reviews. A supervisor with MSc degree and five health professionals with BSc degrees collected the data. The tool contained five sections including sociodemographic characteristics of the mother, maternal medical and obstetric related factors, intrapartum related factors, neonatal related factors, and health institutional related factors. Questionnaires were prepared in English after a thorough literature review of previously validated published studies. Then it was translated to Afan Oromo and Amharic version and translated back to English version for its consistency, completeness and to reduce translation error of questionnaire by language expert.

2.9. Data Quality Assurance

In order to assure the quality of data, the questionnaire was pre-tested on 5% of the sample (17 neonates) before data collection at Dodola general hospital outside study area. After the pre-test necessary modifications were done based on the results of the pre-test to ensure its reliability and validity. Data collectors and supervisor were trained for one day on how to interview and review record. Completeness of data was checked every day after the data collection was completed. Regular monitoring and supervision of the overall activity were conducted by the supervisor and investigator.

2.10. Data Processing and Analysis

On the final date of data collection, the data was checked and then entered into the statistical program Epi Data version 3.1. The prepared data was exported, and then the analysis was performed using IBM SPSS version 25. To assess the association between independent variable with dependent variable, first bivariable analysis was used. Variables with a significant association at $p < 0.25$ in the binary analysis were entered into multivariable analysis using the enter method to determine the determinants of the MAS and those variables with $p < 0.05$ were considered to be statistically significant. The model of fitness was tested using the Hosmer- Lemesho goodness of fitness test. Finally the analyzed data was summarized as frequency, percentage, mean, and standard deviation. Strength of association was expressed using crude and Odds Ratio (OR) with 95% confidence interval.

3. Result

3.1. Sociodemographic Characteristics of Mothers

Three hundred thirty-eight mothers with their respective neonates were included in this study with a response rate of 98%. Majority of the mothers were between 21-25 age and more than half (50.9%) of neonatal mothers were from Urban residencies. Nearly one-third of mothers had a secondary type of educational status, 29% of mothers had primary school education and 21% of mothers had no formal education. Around two-third (60.1%) of maternal occupations were house wives (Table 2).

Table 2. *Sociodemographic characteristics of mothers of neonates admitted at NICU of selected Arsi zone public hospitals, Oromia, Ethiopia, 2023 (n=338).*

Variable		Frequency	Percent
Maternal age	< 20	21	6.2
	21-25	225	66.6
	26-30	67	19.8
	>31	25	7.4
Place of residence for mothers	Urban	172	50.9
	Rural	166	49.1

Variable		Frequency	Percent
Maternal education	No formal education	71	21.0
	Primary	98	29.0
	Secondary	106	31.4
	Diploma	40	11.8
	Degree and above	23	6.8
Maternal Occupation	House wife	203	60.1
	Government employee	50	14.8
	Private worker	60	19.5
	Others*	19	5.6
Maternal house hold income	< 1000	74	21.9
	1000-5000	215	63.6
	> 5000	49	14.5

*: daily laborer, non-governmental organization

3.2. Neonatal Related Factors

Out of 338 neonates, around 230 (68.0%) had an age less than 7 days. More than half of neonates were male. From a total neonates about three-fourth (76.6%) of neonates were term neonates and only 13.9%, 9.5% of neonates were pre-term and post term respectively. About one-third of newborns had a birth weight less than 2.5 kg and almost three-fourth (72.5%) of newborns had a birth weight between 2.5-4 kg. A majority neonates about 69.1% of newborns had a first-minute APGAR score less than 7 followed by 30.9% of newborns having an APGAR score between 7-10. About three-fourth (80.6%) of newborns had a fifth-minute APGAR score between 7-10 and 19.4% of newborns had fifth-minute APGAR score less than 7. From a total pregnancies 94.4% of pregnancies were single and only 5.6% of pregnancies were multiple (twin). One-tenth of neonates were born with birth defects (Table 3).

Table 3. *Neonatal characteristics of neonates admitted at NICU of selected Arsi zone public hospitals, Oromia, Ethiopia, 2023 (n=338).*

Variable		Frequency	Percent
Age of neonate	< 7 days	230	68.0
	> 7 days	108	32.0
Sex of neonate	Male	183	54.1
	Female	155	45.9
Gestational age	Preterm	47	13.9
	Term	259	76.6
	Post term	32	9.5
Birth weight of neonate	< 2.5 kg	92	27.2
	2.5-4 kg	245	72.5
	> 4 kg	1	0.3
Was APGAR Score done	Yes	320	94.7
	No	18	5.3
First minute APGAR Score	< 7	221	69.1

Variable		Frequency	Percent
Fifth minute APGAR Score	7-10	99	30.9
	< 7	62	19.4
	7-10	258	80.6
Was current pregnancy multiple	Yes	19	5.6
	No	319	94.4
Birth defect	Yes	35	10.4
	No	303	89.6
Did the neonate diagnosed with MAS	Yes	88	26.0
	No	250	74.0

3.3. Maternal Medical and Obstetric Related Factors

From a total sample, about (63.0%) was occupied by multigravida, followed by 23.1% by primigravida. About 63.9% of parity was multiparous, followed by 24.3% primiparous, and only 11.8% of parity was grand multiparous. Around 96.2% of pregnant mothers had ANC follow-up during pregnancy from this three-fourth (75.4%) had full ANC follow-up while only one-fourth had ANC Visit less than four. Out of 338 mothers, about 79 had a medical pregnancy problems with anemia having the highest number (31) followed by respiratory tract infection (29) cases. From the preexisting medical pregnancy problems preeclampsia, Pregnancy-induced hypertension and antepartum hemorrhage were the leading one, with 31, 26, and 21 cases, respectively, out of those 96 mothers who had the cases (Table 4).

Table 4. *Maternal and obstetric characteristics of neonates admitted at NICU of selected Arsi zone public hospitals, Oromia, Ethiopia, 2023 (n=338).*

Variable		Frequency	Percent
Gravidity	Primigravida	78	23.1
	Multigravida	213	63.0
	grand multigravida	47	13.9
Parity	Primiparous	82	24.3
	Multiparous	216	63.9
	Grand multiparous	40	11.8
Interpregnancy interval less than 2 years	Yes	50	14.8
	No	288	85.2
ANC follow up	Yes	325	96.2
	No	13	3.8
Number of ANC visit	< 4	83	24.6
	> 4	242	75.4
Did you have any medical problem diagnosed during pregnancy	Yes	79	23.4
	No	259	76.6
Respiratory tract infection	Yes	29	8.6
	No	309	91.4

Variable		Frequency	Percent
Diabetes	Yes	11	3.3
	No	327	96.7
HIV/AIDS	Yes	9	2.7
	No	329	97.3
Anemia	Yes	31	9.2
	No	307	90.8
Heart disease	Yes	14	4.1
	No	324	95.9
Other*	Yes	2	0.6
	No	336	99.4
RH factors	Positive	241	71.3
	Negative	85	25.1
	Unknown	12	3.6
Have you been diagnosed with preexisting medical pregnancy?	Yes	96	28.4
	No	242	71.6
Antepartum haemorrhage	Yes	21	6.2
	No	317	93.8
Placenta previa/abruption placenta	Yes	6	1.8
	No	332	98.2
Pregnancy induced hypertension	Yes	26	7.7
	No	312	92.3
Gestational diabetes	Yes	12	3.6
	No	326	96.4
Amniotic fluid problem	Yes	4	1.2
	No	334	98.8
Preeclampsia	Yes	29	8.6
	No	309	91.4
Other**	Yes	16	4.7
	No	322	95.3

*: Urinary tract infection, kidney disease
**: Eclampsia, uterine rupture, ovarian cyst

3.4. Intrapartum Related Factors

Nearly two-thirds (64.5%) of the rapture of the membrane occurred intrapartially (during the first hour) of birth, about 29.9% occurred during PROM, and 5.6% occurred PPROM. For about 338 (92%) of mother's rapture of the membrane occurred spontaneously, and only 8% of ROM occurred with artificial rupture of membrane. Majority of the labor (65.7%) ended within 12 hours, and 34.5% of a total sample had a labor lasting more than 12 hours. About 5.9% of labor was induced and 8.0% of labor was augmented. Three-fourths (72.5%) of the modes of delivery were done by spontaneous vaginal delivery and the remaining 21%, 5.3% were delivered through Cesarean section and instrumental delivery (Table 5).

Table 5. *Intrapartum related characteristics of neonates admitted at NICU of selected in Arsi zone public hospitals, Oromia, Ethiopia, 2023 (n=338).*

Variable		Frequency	Percent
When did ROM occurred during birth	PPROM	19	5.6
	PROM	101	29.9
	Intrapartial (within an hour)	218	64.5
How was ROM occurred	Spontaneous	311	92.0
	Artificial rupture of membrane	27	8.0
Was the labor induced	Yes	20	5.9
	No	318	94.1
Was the labor augmented	Yes	27	8.0
	No	317	92.0
Duration of labor in hour	< 12	222	65.7
	> 12	116	34.3
Mode of delivery	Spontaneous vaginal delivery	249	73.7
	Cesarean section	71	21.0
	Instrumental delivery	18	5.3

3.5. Health Institution Related Factors

The majority of neonates births were done in government hospital; about 41.0% were delivered in level I health facilities (healthy centers and primary hospitals). Out of the total 338 neonatal delivery seventeen (5%) of neonates were delivered at home. About 94.4% of births were attended by skilled health professionals, with more than half by midwife staff followed by 16.9% by residents, and 11% by integrated emergency surgery and obstetrics (IESO). Among neonates born in health facilities 14% of the care given was Oropharnngeal aspiration while 86% underwent routine new born care (Table 6).

Table 6. *Health institution related characteristics of neonates admitted at NICU of selected Arsi zone public hospitals, Oromia, Ethiopia, 2023 (n=338).*

Variable		Frequency	Percent
Place of birth	Health center	43	12.7
	Government hospital	278	82.3
	Home	17	5.0
Level of health facility that the neonate have been delivered in	Level I (health center and primary hospital)	130	41.0
	Level II (general hospital)	89	28.1
	Level III (university hospital)	98	30.9
Birth attendant	Skilled health professional	319	94.4
	Health extension worker	2	0.6
	Untrained birth attendant	8	2.4
	Others	9	2.6

Variable		Frequency	Percent
Type of skilled health professional attended delivery	Midwives students	16	5.0
	Midwives staff	178	55.8
	Medical intern students	23	7.2
	Resident	54	16.9
	IESO	35	11
	Senior gynecologists	13	4.1
Care given by health care professional in the delivery room for the newborn	Routine new born care	277	86.0
	Oropharnngeal aspiration	45	14.0

*: Street delivery, delivered without support

3.6. Magnitude of Meconium Aspiration Syndrome

According to this study the magnitude of meconium aspiration syndrome was found to be 26.0% (95% CI: 21.2-30.3). From a total of 338 neonates enrolled, 88 neonates developed MAS while 250 neonates had no MAS (Figure 1).

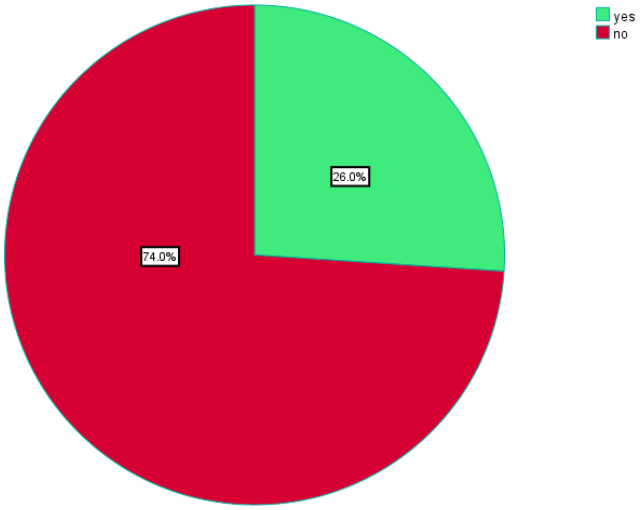

Figure 1. *Magnitude of meconium aspiration syndrome among neonates admitted at NICU of Arsi zone public hospital, 2023.*

3.7. Factors Associated with Meconium Aspiration Syndrome

The association between dependent and independent variables was analyzed. In the binary logistic regression, male sex of neonates, maternal age less than 20 years, term, post-term pregnancy, new born delivered with birth defects, antepartum hemorrhage, placenta previa/abruption placenta, preeclampsia, First-minute APGAR Score less than 7, Fifth-minute APGAR Score less than 7, PPROM, PROM, augmented labor, duration of labor greater than 12 hour, mode of delivery (caesarian section and instrumental delivery), and type of Care given by health care professionals in the delivery room (Oropharnngeal aspiration) for the newborn were factors associated with MAS at p value less than 0.25.

Out of those in the multi variable analysis this study signifies that neonates born within post term pregnancy were about 3.34 times more likely to develop meconium aspiration syndrome (MAS) compared to those born within term and preterm pregnancies (AOR=3.34, 95% CI: 1.41, 7.98). Neonates born from mothers who had premature rapture of membrane were about 2.41 times more likely to develop MAS compared to those born from mothers who did not have premature rapture of membrane (AOR=2.41, 95% CI: 1.32, 4.41).

Neonates that were born from mothers who had antepartum hemorrhage were about 7.72 times more likely to develop MAS compared to those born from mothers who did not have antepartum hemorrhage (AOR=7.72, 95% CI: 2.82, 21.15). Neonates that were born from mothers who had preeclampsia were about 6.55 times more likely to develop MAS compared to those born from mothers who did not have preeclampsia (AOR=6.55, 95% CI: 2.63, 16.29). Neonates who born within first-minute APGAR score less than 7 were about 2.69 times more likely to develop meconium aspiration syndrome compared to those who born within First-minute APGAR score between 7-10 (AOR=2.69, 95% CI: 1.36, 5.33) (Table 7).

Table 7. *Bivariable and multivariable association of meconium aspiration syndrome and associated factors among neonates admitted in NICU in selected Arsi zone public hospitals, Oromia, Ethiopia, 2023 (n=338).*

Variable(n=338)		MAS		COR(95% CI)	AOR(95% CI)	P-Value
		Yes n (%)	No n (%)			
Maternal age						
< 20		3(14.3)	18(85.7)	4.00(0.93, 17.24)	7.69(1.12, 52.91)	0.058
21-25		61(27.1)	164(72.9)	1.79(0.76, 4.20)	2.28(0.79, 6.59)	0.129
26-30		14(20.9)	53(79.1)	2.52(0.93, 6.82)	2.71(0.81, 9.02)	0.104
> 31		10(40.0)	15(60.0)	1	1	
Sex of neonates						
Male		53(29.0)	130(71.0)	0.72(0.44, 1.17)	0.98(0.53, 1.79)	0.939
Female		35(22.6)	120(77.4)	1	1	
Gestational age						
Term	Yes	61(24.0)	193(76.0)	0.67(0.39, 1.15)	2.14(0.82, 5.54)	0.118
	No	27(32.1)	57(67.9)	1	1	
Post term	Yes	19(59.4)	13(40.6)	5.02(2.36, 10.68)	3.34(1.41, 7.98)*	0.006
	No	69(22.5)	237(77.5)	1	1	
Neonatal birth defect						
Yes		12(34.3)	23(65.7)	1.56(0.74, 3.28)	1.55(0.64, 3.75)	0.333
No		76(25.1)	227(74.9)	1	1	
Labor augmented						
Yes		11(40.7)	16(59.3)	2.09(0.93, 4.69)	2.34(0.93, 5.91)	0.071
No		77(24.8)	234(75.2)	1	1	
PPROM						
Yes		7(38.9)	11(61.1)	1.88(0.704, 5.01)	2.54(0.71, 9.07)	0.152
No		81(25.3)	239(74.7)	1	1	
PROM						
Yes		36(35.6)	65(64.4)	1.97(1.18, 3.28)	2.41(1.32, 4.41)*	0.004
No		52(21.9)	185(78.1)	1	1	
Antepartum hemorrhage						
Yes		13(61.9)	8(38.1)	5.24(2.09, 13.13)	7.72(2.82, 21.15)*	0.000
No		75(23.7)	242(76.3)		1	
Placenta previa/abruption placenta						
Yes		3(50.0)	3(50.0)	2.91(0.58, 14.67)	5.07(0.84, 30.73)	0.078
No		85(25.6)	247(74.4)	1	1	
Preeclampsia						
Yes		18(62.1)	11(37.9)	5.59(2.52, 12.38)	6.55(2.63, 16.29)*	0.000
No		70(22.7)	239(77.3)	1	1	

Variable(n=338)	MAS		COR(95% CI)	AOR(95% CI)	P-Value
	Yes n (%)	No n (%)			
Mode of delivery					
SVD	57(22.9)	192(77.1)	1	1	
Cesarean section	24(33.8)	47(66.2)	2.14(0.79, 5.78)	0.89(0.42, 1.923)	0.776
Instrumental delivery	7(38.9)	11(61.1)	1.25(0.43, 3.63)	0.59(0.18, 2.00)	0.402
First minute Apgar score					
< 7	72(32.6)	149(67.4)	2.93(1.56, 5.52)	2.69(1.36, 5.33)*	0.005
7-10	14(14.1)	85(85.9)	1	1	
Fifth minute Apgar score					
< 7	22(35.5)	40(64.5)	0.60(0.33, 1.08)	0.68(0.31, 1.47)	0.322
7-10	64(24.8)	194(75.2)	1	1	
Duration of labor					
< 12 hour	48(21.6)	174(78.4)	1	1	
> 12 hour	40(34.5)	76(65.5)	0.52(0.32, 6.86)	.735(0.38, 1.41)	0.356
Routine new born care	70(25.3)	207(74.7)	1	1	
Oropharnngeal aspiration	16(35.6)	29(64.4)	0.61(0.31, 1.19)	1.12(0.48, 2.55)	0.813

*: significant at p-value < 0.05

4. Discussions

This study assessed the magnitude of meconium aspiration syndrome (MAS) and its contributing factors in neonates admitted to the NICU of Arsi zone public hospitals. According to this study, the magnitude of meconium aspiration syndrome was found to be 26.0%. The findings of this study were in line with the study done at Wolkite University specialized Hospital in Ethiopia 28.7% [22]. This finding was higher when compared to another study done in Iran in which the prevalence of MAS is 21.1% [31], South Africa 4.4% [32], and Jimma Ethiopia 19.9% [30]. This variation may be due to different socio-cultural factors and variation in quality of care in different health facilities. It might also due to differences in sample size and the nature of the study design used. The result of this study is lower when compared to the study done in India 34% [32], Zimbabwe 31% [12], Wachemo University Nigist Eleni comprehensive hospital, southern Ethiopia 30.6% [21]. This variation may be due to socio-economic differences, differences in sample size, and the nature of the study design used.

This study found that there is a significant association between post-term pregnancy (gestational age ≥42 weeks) and MAS. The odds of meconium aspiration syndrome increased about 3.34 times more compared to neonates borne within post-term pregnancy than who borne within term and preterm pregnancies. This finding is similar to the study done in Ranchi [33], Nepal [23]. Meconium passage often occurs in deliveries after 42 weeks of pregnancy because of a physiological change in the infant's gastrointestinal tracts [18]. This may be due to the fact that as gestational age increases, the fetus secretes more of the hormone motilin. Since the motilin level is highest during post-term gestations, it is known that the majority of meconium passage occurs during this time [23].

This study revealed that the odds of MAS increased about 7.72 times more when comparing neonates born from mothers who had antepartum hemorrhage during pregnancy to those whose mothers did not have antepartum hemorrhage during pregnancy. This finding is consistent with the study done at Wachemo University hospital [21], Nigist Eleni Mohammed Memorial Comprehensive Specialized Hospital, South Ethiopia [20]. The possible explanation might be due to uteroplacental ischemia brought on by fetal distress secondary to antepartum hemorrhage, which has a strong correlation with the release of meconium into the uterus. Additionally, mothers who had APH might have had more cesarean sections than spontaneous vaginal deliveries, as this mode of delivery has a higher incidence and is linked to meconium release [24].

This study also revealed that neonates born from mothers who had preeclampsia were about 6.55 times more likely to

develop meconium aspiration syndrome compared to those born from mothers who did not have preeclampsia. This finding is consistent with the study done at Nigist Eleni Mohammed Memorial Comprehensive Specialized Hospital, South Ethiopia [21]. The reason might be explained by the possibility of placental insufficiency in preeclampsia that leads to intrauterine fetal hypoxia or intestinal ischemia. This intrauterine hypoxia finally weakens the action of rectal sphincters, and leading to the passage of meconium that the newborn will aspirate [34].

This study found that neonates born from mothers who had premature rupture of membrane were about 2.41 times more likely to develop meconium aspiration syndrome compared to those born from mothers who did not have premature rupture of membrane. This finding is in line with the study done in India [18], Wachemo University [20]. The possible justification may be that when the membrane is ruptured before to labor, there is a greater likelihood that the fetus may ingest the amniotic fluid. This may lead to the fetus being in a prolonged stressful situation, which could lead to increased fetal gastrointestinal tract peristalsis and anal sphincter relaxation, which would then allow the meconium to flow through [29].

This study also found that the odds of MAS increased by about 2.69 times comparing newborns who had a first-minute Apgar score less than 7 after birth to those who had first minute Apgar score of 7-10 after birth. This study is in line with study done at Kamineni Institute of Medical Sciences, Narketpally [18], Jimma university hospital, and Wolkite university specialized hospital [22, 30]. The possible justification may be that as the aspiration of meconium is sufficiently massive, it will result in alveolar and bronchial obstruction, which leads to respiratory distress, and finally, low Apgar score could occur in response to this distress.

5. Conclusion and Recommendation

The magnitude of meconium aspiration was moderate; nearly a quarter of neonates admitted to the NICU had meconium aspiration syndrome. Post-term, antepartum hemorrhage, preeclampsia, premature rupture of membrane, first-minute Apgar score less than 7 were factors significantly associated with increased risk of meconium aspiration syndrome. It is possible that prevention, early detection, and proper therapy of these disorders will reduce the incidence of MAS.

Furthermore, it is advisable to adhere to established protocols for preeclampsia follow-up charts for mothers who have preeclampsia and to enhance the feedback process at their local health facility. There is a need for further research on MAS to identify approaches from health services to address this condition, as MAS is a frequent cause of newborn morbidity and increased NICU admission.

According to the findings from this study, the following recommendations have been proposed to different stakeholders:

For health professionals

1) Health professionals would have better to track the status of pregnancies to consider inducing labor before 42 weeks of gestation and stripping the membranes in order to prevent the harmful effects of post-term pregnancy.
2) During ANC follow-up, labor, and delivery, the health professionals should increase their provision of health care services including screening and managing antepartum hemorrhage, preeclampsia and premature rupture of the membrane.
3) Prompt follow-up of a newborn born within the first minute Apgar score.

For mothers

Mothers who faced premature rupture of membrane and antepartum hemorrhage, would go to the nearby health institution and take prompt action in seeking medical help.

For Arsi zonal health department

Should better to prioritize providing more support for enhancing the maternal education program and supporting health professionals through addressing different guidelines and training in ways to raise their awareness of the risk factors of MAS in order to manage it accordingly.

For Federal and Oromia regional health offices

Perform follow-up studies, audit the care given, and pool them for guideline development to improve the management of meconium aspiration syndrome by incorporating the findings of this study.

For researchers

Researchers would do better to conduct a high-quality longitudinal study with the same title.

Abbreviations

AOR	Adjusted Odd Ratio
APGAR	Appearance, Pulse, Grimace, Activity, Respiration
CI	Confidence Interval
COR	Crude Odd Ratio
MAS	Meconium Aspiration Syndrome
MSAF	Meconium Stained Amniotic Fluid
PROM	Premature Rupture of Membrane
ROM	Rupture of Membrane
SDG	Sustainable Development Goal
UNICEF	United Nation Children‘s Emergency Fund
WHO	World Health Organization

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Author Contributions

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All data supporting this manuscript are available in this published article.

Conflicts of Interest

The authors declare no conflicts of interest.

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