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A STUDY ON PREVALENCE OF MECONIUM-STAINED LIQUOR IN SINGLETON TERM PREGNANCY IN A TERTIARY CARE HOSPITAL

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ABSTRACT
Background: Meconium-stained liquor (MSL) is a common intrapartum finding in term pregnancies and is considered an important indicator of potential fetal compromise. Although meconium passage may occur as a physiological phenomenon in advanced gestation, thick meconium is associated with increased maternal intervention and adverse neonatal outcomes. Evaluating its prevalence and associated risk factors is essential for optimizing obstetric and neonatal care.
Materials and Methods: This hospital-based cross-sectional observational study was conducted in the Department of Obstetrics and Gynaecology at a tertiary care teaching hospital over 18 months. A total of 1,702 singleton term deliveries were screened, among which 312 women with meconium-stained liquor were included. Maternal demographic characteristics, obstetric variables, medical comorbidities, mode of delivery, and neonatal outcomes were recorded. Meconium-stained liquor was graded into Grade I, Grade II, and Grade III based on gross visual appearance. Statistical analysis was performed using SPSS version 21. Associations between categorical variables were analysed using the Chi-square test or Fisher's exact test, with p <0.05 considered statistically significant.
Results: The prevalence of meconium-stained liquor was 18.33%. Grade I, Grade II, and Grade III meconium accounted for 48.39%, 32.37%, and 19.23% of cases, respectively. Most women were aged 26–30 years (40.1%), 58.0% were primigravida, and 77.6% underwent labour induction. Maternal comorbidities, including gestational diabetes mellitus (16.0%), gestational hypertension (11.9%), preeclampsia (9.9%), and hypothyroidism (14.1%), were significantly more common among women with MSL (p<0.05). Emergency lower segment caesarean section was performed in 58.0% of cases. Neonatal outcomes showed 32.1% low Apgar scores, 35.5% NICU admissions, 24.0% meconium aspiration syndrome, and 0.3% neonatal mortality. Increasing grades of meconium were significantly associated with higher rates of NICU admission, meconium aspiration syndrome, and low Apgar scores (p<0.001).
Conclusion: Meconium-stained liquor is a relatively common intrapartum finding associated with increased neonatal morbidity, particularly in cases of thick meconium. Maternal metabolic and hypertensive disorders, labour induction, and higher meconium grades were associated with adverse perinatal outcomes. Meconium-stained liquor should not be interpreted in isolation but should be assessed in conjunction with fetal heart rate monitoring and overall maternal–fetal status. Early identification of maternal risk factors, standardized intrapartum surveillance, and timely neonatal intervention are essential to improve perinatal outcomes.

KEYWORDS: Meconium-stained liquor; Meconium aspiration syndrome; Singleton term pregnancy; NICU admission; Apgar score; Perinatal outcome; Maternal risk factors.

INTRODUCTION
Meconium-stained liquor (MSL), also known as meconium-stained amniotic fluid (MSAF), is one of the most frequently encountered intrapartum findings in obstetric practice and is widely regarded as an important marker of fetal wellbeing during labour. Meconium is the first intestinal discharge of the fetus and is composed of intestinal epithelial cells, lanugo, vernix caseosa, bile pigments, mucus, pancreatic secretions, and swallowed amniotic fluid accumulated during fetal life.[1] Under physiological conditions, meconium is passed after birth; however, its passage into the amniotic cavity before delivery may indicate either advancing fetal maturity or fetal compromise, particularly in singleton term pregnancies.[2]
The mechanisms responsible for intrauterine meconium passage are complex and multifactorial. Fetal hypoxia, umbilical cord compression, uteroplacental insufficiency, and vagal stimulation increase intestinal peristalsis and relax the anal sphincter, resulting in the release of meconium into the amniotic cavity.[3] Nevertheless, meconium passage is not always

pathological. Increasing gestational age is associated with physiological maturation of the fetal gastrointestinal tract, allowing spontaneous passage of meconium without evidence of fetal acidemia or hypoxia.[4] Once aspirated, meconium may obstruct the airways, inactivate pulmonary surfactant, induce chemical pneumonitis, and precipitate persistent pulmonary hypertension, ultimately resulting in meconium aspiration syndrome (MAS), one of the leading causes of neonatal respiratory morbidity.[5]

Globally, meconium-stained liquor complicates approximately 8–20% of all term pregnancies, with the incidence increasing progressively beyond 40 weeks of gestation because of advancing fetal maturity and placental ageing. Thick meconium is consistently associated with significantly higher rates of fetal distress, emergency caesarean delivery, low Apgar scores, neonatal intensive care unit (NICU) admission, and meconium aspiration syndrome compared with thin meconium. Consequently, MSL continues to represent an important clinical challenge for obstetricians and neonatologists worldwide.[6]

According to the World Health Organization (WHO), nearly 2.3 million neonatal deaths occur every year, accounting for approximately 47% of all deaths among children younger than five years of age.[7] Intrapartum-related hypoxic events remain one of the leading contributors to neonatal mortality, particularly in low- and middle-income countries. The presence of meconium-stained liquor frequently reflects fetal stress during labour and therefore warrants careful intrapartum surveillance to facilitate timely obstetric intervention and neonatal resuscitation when indicated.[8]

Modern obstetric management has evolved considerably over the past two decades. Earlier clinical practice frequently regarded meconium-stained liquor as an indication for immediate operative delivery. However, evidence now suggests that meconium alone has limited predictive value for fetal hypoxia and should always be interpreted in conjunction with fetal heart rate patterns and overall maternal–fetal condition. The American College of Obstetricians and Gynecologists (ACOG) recommends systematic interpretation of intrapartum fetal heart rate tracings to distinguish reassuring from non-reassuring fetal status, thereby avoiding unnecessary operative intervention while ensuring fetal safety.[9] Furthermore, ACOG Committee Opinion No. 689 clearly states that the presence of meconium-stained liquor in the absence of abnormal fetal heart rate tracings is not an indication for caesarean delivery or instrumental birth, highlighting the importance of individualized clinical decision-making.[10]

The management of newborns delivered through meconium-stained liquor has also undergone substantial revision. Updated Neonatal Resuscitation Program (NRP) guidelines jointly issued by the American Academy of Pediatrics and the American Heart Association recommend against routine endotracheal suctioning in vigorous infants born through meconium-stained liquor. Instead, priority is given to prompt assessment, maintenance of effective ventilation, and evidence-based neonatal resuscitation, resulting in fewer unnecessary invasive procedures without increasing the incidence of meconium aspiration syndrome.[11]

International clinical practice guidelines further reinforce evidence-based intrapartum care. The National Institute for Health and Care Excellence (NICE) recommends continuous electronic fetal monitoring in women with significant meconium-stained liquor, particularly when thick meconium or additional obstetric risk factors are present.[12] Similarly, the Royal College of Obstetricians and Gynaecologists (RCOG) advocates standardized interpretation of cardiotocography to improve early recognition of fetal compromise and reduce unnecessary operative deliveries.[13] The International Federation of Gynecology and Obstetrics (FIGO) has also developed globally accepted recommendations for intrapartum fetal monitoring, emphasizing integration of fetal heart rate assessment with clinical findings, including the presence and grade of meconium-stained liquor, to optimize maternal and neonatal outcomes.[14]

In India, improving intrapartum and newborn care remains an important public health priority. The India Newborn Action Plan (INAP) emphasizes strengthening labour surveillance, institutional deliveries, skilled birth attendance, and neonatal resuscitation to reduce preventable neonatal mortality. Likewise, the Indian Council of Medical Research (ICMR) recommends evidence-based maternal and newborn care practices, highlighting the importance of early recognition and appropriate management of intrapartum complications such as meconium-stained liquor.[15] Despite these recommendations, considerable variation exists in the prevalence of meconium-stained liquor and its associated maternal and neonatal outcomes across different healthcare settings. Therefore, generating institution-specific evidence regarding the prevalence, maternal risk factors, and perinatal outcomes of meconium-stained liquor in singleton term pregnancies is essential to strengthen obstetric practice, improve neonatal preparedness, and contribute to better maternal and perinatal health outcomes.

METHODOLOGY

The present study was conducted as a hospital-based cross-sectional observational study in the Department of Obstetrics and Gynaecology, Sree Balaji Medical College and Hospital, Bharath Institute of Higher Education and Research, Chennai, Tamil Nadu. The study was carried out over a period of 18 months (2024–2026) with the primary objective of determining the prevalence of meconium-stained liquor (MSL) in singleton term pregnancies and evaluating the associated maternal risk factors and perinatal outcomes. As a tertiary care teaching institution managing a large number of both low-risk and high-risk obstetric referrals, the hospital provided an appropriate setting for obtaining representative clinical data.

The study population comprised all eligible pregnant women admitted in labour during the study period. Both spontaneous and induced labour cases were considered for enrolment after screening according to predefined eligibility criteria. Pregnant women with singleton pregnancies in cephalic presentation between 37 completed weeks and 42 weeks of gestation, irrespective of parity and including pregnancies with or without fetal growth restriction (FGR), were included in the study. Women with multiple gestation, malpresentation, or gestational age less than 37 completed weeks were excluded to maintain a homogeneous study population and minimize potential confounding.

The sample size was estimated using the standard formula for prevalence studies:

$n = Z^2P(1-P)/d^2$

where n represents the required sample size, Z is the standard normal deviate corresponding to a 95% confidence level (1.96), P is the anticipated prevalence of meconium-stained liquor, and d is the allowable absolute precision. Based on previously published literature, the prevalence of meconium-stained liquor was assumed to be 20% (P = 0.20) with an absolute precision of 5% (d = 0.05), yielding a minimum calculated sample size of 246 participants. To enhance statistical power, compensate for possible incomplete observations, and improve the robustness of analysis, the final study sample was increased to 312 women with meconium-stained liquor. During the study period, 1,702 singleton term deliveries were screened, among which 312 women with MSL constituted the study population.

After obtaining approval from the Institutional Research and Ethics Committee, all eligible participants were informed about the purpose and nature of the study in their local language, and written informed consent was obtained before enrolment. Baseline maternal demographic and obstetric characteristics were recorded using a structured case record form. Information collected included maternal age, parity, gestational age, body mass index (BMI), obstetric score, mode of onset of labour, and associated medical disorders such as gestational diabetes mellitus, overt diabetes mellitus, gestational hypertension, pre-eclampsia, and hypothyroidism.

Following spontaneous rupture of membranes or artificial rupture of membranes, the amniotic fluid was examined visually for the presence of meconium. Meconium-stained liquor was classified according to its gross appearance into Grade I (thin meconium), characterized by light yellow discoloration without particulate matter; Grade II (moderate meconium), characterized by light green fluid containing few particulate particles; and Grade III (thick meconium), characterized by thick, dark green, paste-like fluid with abundant particulate matter. Grading was performed immediately after rupture of membranes by the attending obstetrician using standard institutional protocols.

All participants underwent continuous intrapartum monitoring throughout labour. Labour progression was monitored using the World Health Organization (WHO) partograph, which documented cervical dilatation, uterine contractions, fetal descent, and labour progress. Continuous fetal heart rate monitoring was performed using cardiotocography (CTG), and fetal heart rate tracings were interpreted according to institutional guidelines to identify non-reassuring fetal status suggestive of fetal compromise. Decisions regarding the mode of delivery were based on comprehensive clinical assessment, CTG findings, and labour progress. Women delivered either by normal vaginal delivery or emergency lower segment caesarean section, with fetal distress and non-progression of labour constituting the principal indications for operative intervention.

Immediately after delivery, neonatal assessment was performed by the attending pediatric team. Neonatal variables recorded included birth weight, Apgar score, presence of cord around the neck, congenital anomalies, need for neonatal intensive care unit (NICU) admission, occurrence of meconium aspiration syndrome (MAS), duration of NICU stay, neonatal complications, and neonatal outcome until discharge from the hospital. The primary outcome of the study was the prevalence of meconium-stained liquor among singleton term pregnancies, whereas secondary outcomes included maternal risk factors associated with MSL and perinatal outcomes such as mode of delivery, birth weight, Apgar score, fetal growth restriction, NICU admission, meconium aspiration syndrome, and neonatal mortality.

Data were compiled and entered into Microsoft Office and subsequently analysed using Statistical Package for the Social Sciences (SPSS) version 21. Continuous variables were expressed as mean ± standard deviation, whereas categorical variables were summarized as frequencies and percentages. Associations between categorical variables were evaluated using the Chi-square test or Fisher's exact test as appropriate. Multivariable regression analysis was planned to identify independent predictors of meconium-stained liquor. A p-value less than 0.05 was considered statistically significant. Participant confidentiality was maintained by assigning unique study identification numbers, and no personal identifiers were included during data analysis or reporting. The study was self-funded, and no external financial support was received.

RESULTS

TABLE 1. Maternal Characteristics of Women with Meconium-Stained Liquor (n=312)

Variable	Category	n	%
Age (years)	≤25	75	24.0
	26–30	125	40.1
	31–35	69	22.1
	>35	43	13.8
Parity	Primigravida	181	58.0
	Multigravida	131	42.0
Gestational age	37–39+6 weeks	141	45.2
	40–40+6 weeks	119	38.1
	41–41+6 weeks	52	16.7
BMI	Normal	106	34.0

	Overweight	119	38.1
	Obese	87	27.9
Labour onset	Spontaneous	70	22.4
	Induced	242	77.6

TABLE 2. Obstetric Characteristics and Maternal Comorbidities

Variable	n (%)
Total deliveries	1702
Meconium stained liquor	312 (18.33%)
Grade I	151 (48.39%)
Grade II	101 (32.37%)
Grade III	60 (19.23%)
GDM	50 (16.0%)
Gestational hypertension	37 (11.9%)
Preeclampsia	31 (9.9%)
Hypothyroidism	44 (14.1%)

TABLE 3. Delivery and Neonatal Outcomes

Variable	Category	n	%
Mode of delivery	Vaginal	109	34.9
	Instrumental	22	7.1
	Emergency LSCS	181	58.0
APGAR	≥7	212	67.9
	<7	100	32.1
Birth weight	<2.5 kg	87	27.9
	2.5–3.5 kg	96	30.8
	≥3.5 kg	129	41.3
NICU admission	Yes	111	35.5
MAS	Yes	75	24.0
Neonatal death	Yes	1	0.3
No complication	125	40.1	

TABLE 4. Association Between Grade of Meconium and Neonatal Outcomes

Grade	NICU (%)	MAS (%)	Low APGAR (%)	p-value
Grade I	18.5	6.0	13.3	<0.001
Grade II	38.6	22.8	33.7	<0.001
Grade III	75.0	71.7	76.7	<0.001

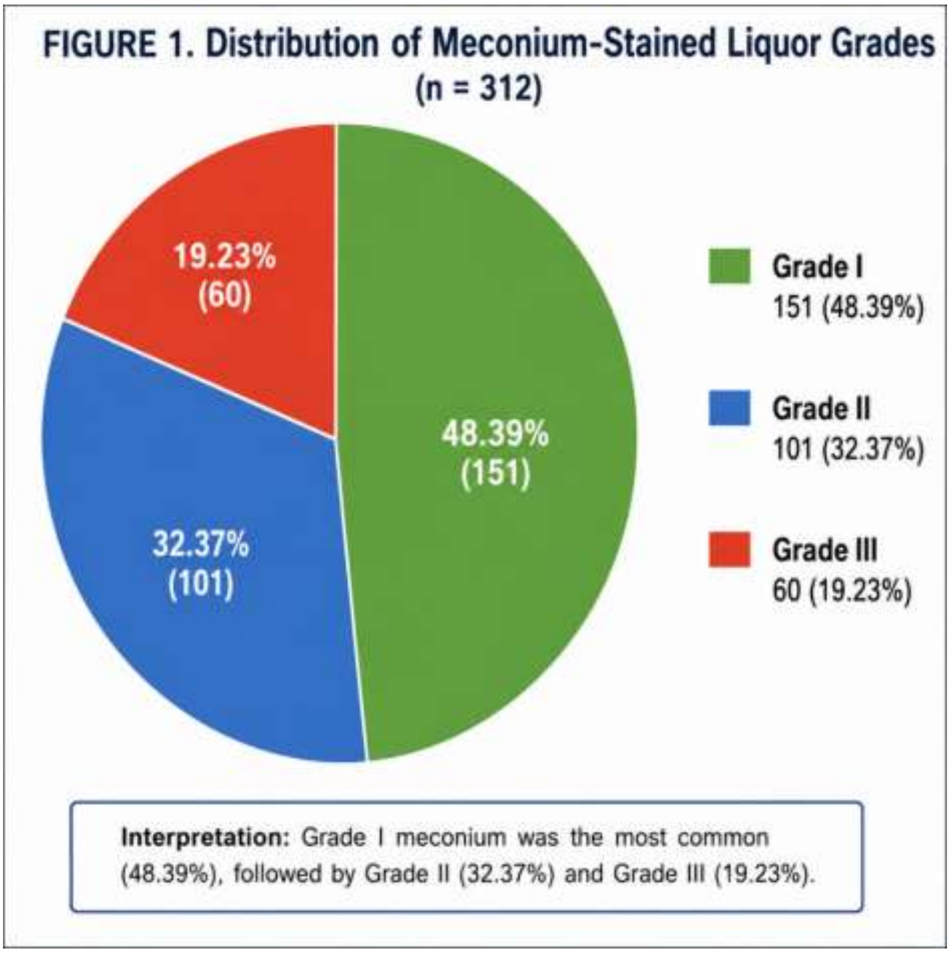
TABLE 5. Fetal Growth Restriction and Neonatal Outcomes

Variable	FGR	Non-FGR	p-value
NICU admission	76.5%	33.6%	<0.001
MAS	64.7%	21.7%	<0.001
Low APGAR	70.6%	29.8%	<0.001
Birth weight <2.5 kg	82.4%	24.8%	<0.001
Neonatal complication	88.2%	45.8%	<0.001

TABLE 6. Summary of Significant Risk Factors Associated with MSL

Risk factor	MSL (%)	Non-MSL (%)	p-value
GDM	16.0	7.8	0.001
Gestational hypertension	11.9	6.9	0.009

Preeclampsia	9.9	5.7	0.012
Hypothyroidism	14.1	8.7	0.044



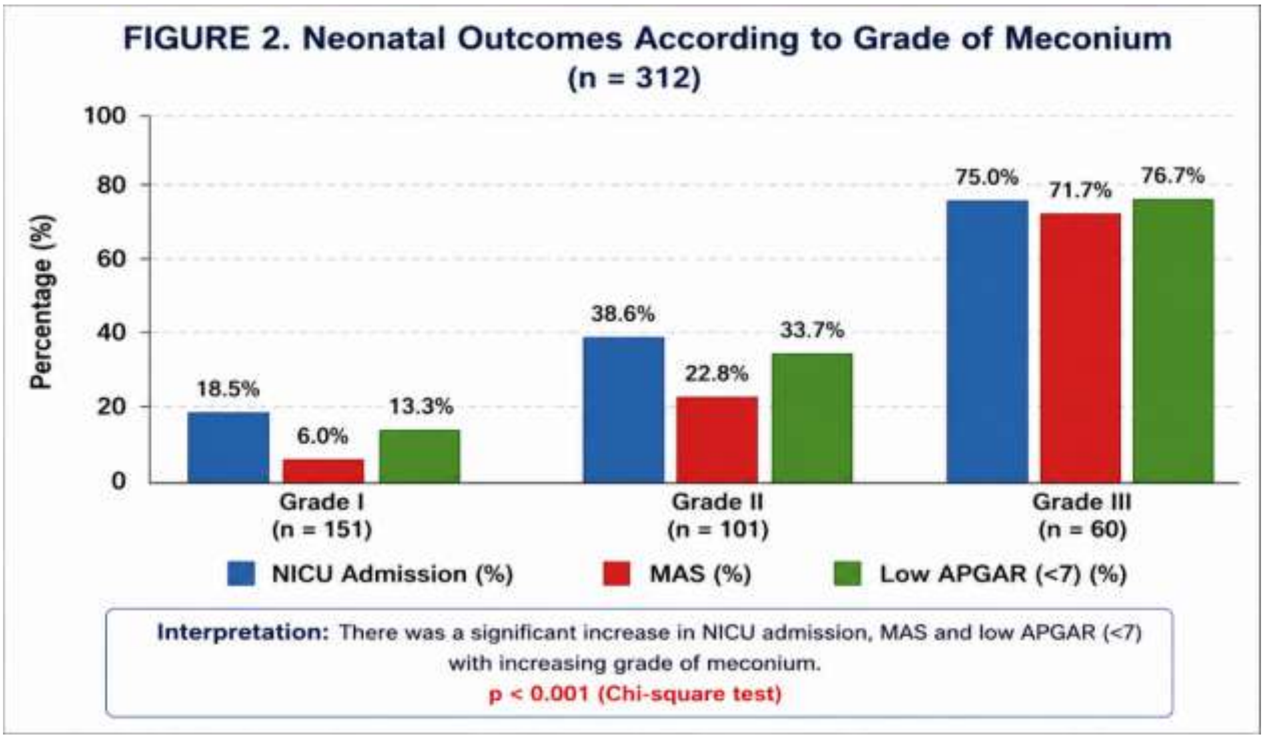
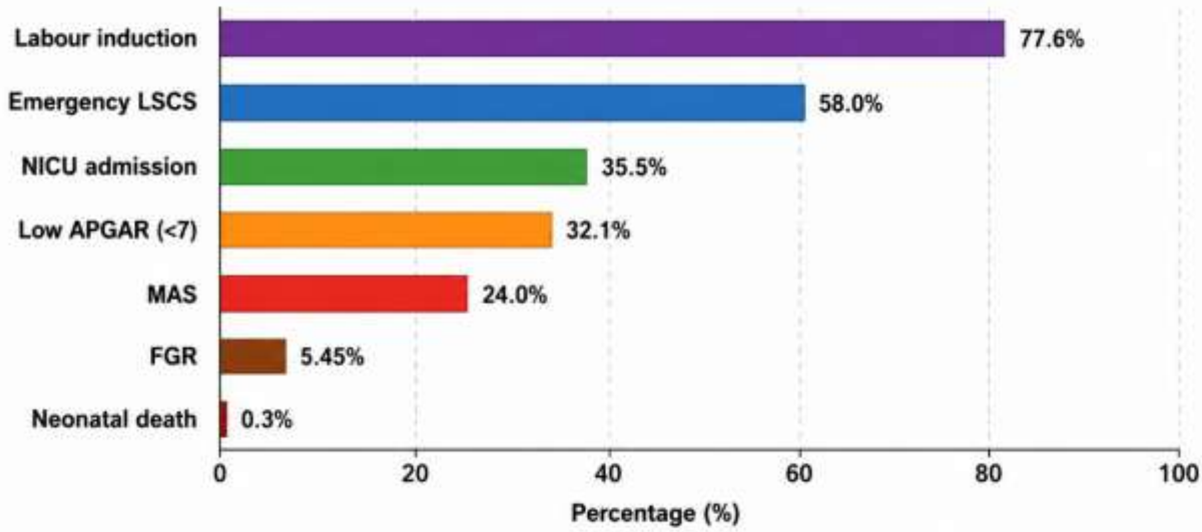


FIGURE 3. Maternal and Neonatal Outcome Profile (n = 312)



Interpretation:
Labour induction (77.6%) and Emergency LSCS (58.0%) were the most common maternal outcomes. Regarding neonatal outcomes: 35.5% required NICU admission, 32.1% had low APGAR (<7), 24.0% developed MAS, 5.45% had FGR and 0.3% resulted in neonatal death.

DISCUSSION

The present hospital-based cross-sectional study evaluated the prevalence of meconium-stained liquor (MSL) and its association with maternal risk factors and perinatal outcomes among singleton term pregnancies in a tertiary care hospital. Among 1,702 term deliveries, the prevalence of MSL was 18.33% (312 cases). Grade I meconium constituted 48.39%, Grade II 32.37%, and Grade III 19.23% of cases. Most women were aged 26–30 years (40.1%), 58% were primigravida, 77.6% underwent labour induction, and 66% were overweight or obese. Maternal comorbidities, particularly gestational diabetes mellitus (16.0%), gestational hypertension (11.9%), preeclampsia (9.9%), and hypothyroidism (14.1%), were significantly associated with MSL. Emergency lower segment caesarean section was required in 58.0% of women. Neonatal outcomes demonstrated 32.1% low Apgar scores, 35.5% NICU admissions, 24.0% meconium aspiration syndrome (MAS), and a neonatal mortality of 0.3%. Adverse neonatal outcomes increased significantly with increasing grade of meconium, particularly Grade III ($p<0.001$).

The World Health Organization Guidelines on Basic Newborn Resuscitation emphasize that prompt neonatal assessment and effective ventilation are the cornerstones of management for newborns delivered through meconium-stained liquor rather than routine invasive airway procedures.[16] The present study supports these recommendations, as although 24.0% of neonates developed MAS and 35.5% required NICU admission, the overall neonatal mortality remained very low (0.3%), suggesting that timely neonatal resuscitation and tertiary care support contributed to favourable survival despite substantial neonatal morbidity.

The Centers for Disease Control and Prevention identifies meconium aspiration syndrome as one of the important causes of neonatal respiratory distress among term infants exposed to MSL.[17] Our findings are consistent with this observation, with nearly one-fourth (24.0%) of neonates developing MAS. Furthermore, MAS increased progressively from 5.96% in Grade I to 71.67% in Grade III, clearly demonstrating that increasing severity of meconium staining markedly elevates the risk of respiratory complications.

The UNICEF report on child mortality highlights that intrapartum events continue to contribute significantly to neonatal morbidity and mortality worldwide despite improvements in obstetric care.[18] Although neonatal mortality in the present study was limited to 0.3%, the considerable proportions of NICU admission (35.5%) and low Apgar score (32.1%) indicate that MSL continues to represent an important cause of neonatal morbidity requiring specialized care even when mortality is minimized through modern neonatal services.

The Sample Registration System report of India emphasizes strengthening intrapartum monitoring and institutional deliveries to reduce preventable neonatal complications.[19] The present study reflects this national strategy, as all participants delivered in a tertiary care institution with continuous fetal surveillance. Nevertheless, the relatively high frequency of emergency LSCS (58.0%) and labour induction (77.6%) suggests that pregnancies complicated by MSL often require intensive obstetric management to optimize neonatal outcomes.

The World Health Organization Standards for Improving Quality of Maternal and Newborn Care advocate early identification of maternal risk factors, standardized labour monitoring, and prompt neonatal intervention.[20] The present findings reinforce these recommendations, demonstrating significant associations between MSL and gestational diabetes mellitus (16.0% vs 7.8%, $p=0.001$), gestational hypertension (11.9% vs 6.9%, $p=0.009$), preeclampsia (9.9% vs 5.7%,

p=0.012), and hypothyroidism (14.1% vs 8.7%, p=0.044), highlighting the importance of antenatal optimization of maternal comorbidities.
Saling first introduced amnioscopy as a technique for antenatal identification of meconium and proposed that visualization of amniotic fluid could provide insight into fetal wellbeing.[21] Although amnioscopy is no longer routinely practiced, the present study confirms the continuing clinical relevance of meconium assessment. Nearly half of the cases (48.39%) exhibited Grade I meconium, whereas 19.23% had thick Grade III meconium, demonstrating that grading of meconium remains valuable for risk stratification.
Eberle et al. demonstrated that alterations in maternal physiology during labour influence fetal heart rate patterns and may contribute to fetal compromise.[22] Although maternal positioning was not specifically evaluated in the present study, continuous cardiotocographic monitoring was employed throughout labour, allowing early recognition of fetal distress. This likely contributed to the high emergency caesarean section rate (58.0%) and the relatively low neonatal mortality despite significant neonatal morbidity.
Miller et al. were among the first investigators to demonstrate that meconium during labour is associated with fetal distress and adverse neonatal outcome.[23] The present findings strongly support their observations. Increasing meconium grade was associated with progressive deterioration in neonatal outcomes, with NICU admission increasing from 18.5% in Grade I to 75.0% in Grade III, while low Apgar scores increased from 13.3% to 76.7%, demonstrating a clear dose-response relationship.
Attali et al. reported increased neonatal morbidity among nulliparous women with prolonged pregnancies complicated by meconium-stained amniotic fluid.[24] Similarly, the majority of women in the present study were primigravida (58%), and a substantial proportion delivered beyond 40 weeks of gestation. The observed prevalence of adverse neonatal outcomes, particularly NICU admission (35.5%) and MAS (24.0%), further supports the association between MSL and neonatal morbidity.
Krebs et al. emphasized the importance of intrapartum fetal heart rate monitoring in identifying fetuses at risk during labour.[25] Consistent with their findings, continuous cardiotocographic surveillance formed an integral component of labour management in the present study and guided timely obstetric intervention, particularly in women demonstrating non-reassuring fetal status requiring emergency caesarean delivery.
Wiswell et al. concluded that improvements in neonatal care had substantially reduced mortality associated with meconium aspiration syndrome while morbidity remained significant.[26] Our findings parallel this observation. Although 24.0% of neonates developed MAS and 35.5% required NICU admission, neonatal mortality was limited to a single case (0.3%), reflecting advances in neonatal intensive care and resuscitation.
Grant et al. highlighted the importance of antepartum fetal surveillance in preventing intrapartum compromise.[27] In the present study, the high proportion of labour induction (77.6%) suggests careful obstetric surveillance and timely intervention in pregnancies considered at increased fetal risk, which may have contributed to the low mortality despite significant neonatal complications.
Wong et al. demonstrated that the risk of fetal distress increases with gestational age in pregnancies complicated by meconium-stained liquor.[28] The present study similarly observed that over half of the women were at or beyond 40 weeks of gestation, supporting the concept that advancing gestational age contributes to increased occurrence of MSL and associated adverse neonatal outcomes.
Shaikh et al. reported increased neonatal morbidity among deliveries complicated by meconium-stained liquor, particularly with respect to respiratory distress and NICU admission.[29] Comparable findings were observed in the present study, where 35.5% of neonates required NICU admission and 24.0% developed MAS, confirming that MSL remains an important determinant of early neonatal morbidity in tertiary care settings.
Naveen et al. identified maternal risk factors and adverse neonatal outcomes as important predictors in pregnancies complicated by MSL.[30] The present study similarly demonstrated significant associations between MSL and maternal metabolic and hypertensive disorders, elevated body mass index, labour induction, operative delivery, and adverse neonatal outcomes. Importantly, neonatal complications increased consistently with increasing meconium grade, reinforcing that the severity of MSL provides clinically meaningful prognostic information. Overall, the present findings support current evidence that meconium-stained liquor should not be considered an isolated indication for intervention but should be interpreted together with maternal risk factors, fetal heart rate monitoring, and comprehensive intrapartum assessment to optimize maternal and neonatal outcomes.

CONCLUSION

The present study demonstrated that meconium-stained liquor (MSL) occurred in 18.33% of singleton term pregnancies, making it a relatively common intrapartum finding in a tertiary care setting. Maternal factors such as primigravidity, labour induction, overweight or obesity, gestational diabetes mellitus, hypertensive disorders of pregnancy, and hypothyroidism were significantly associated with the occurrence of MSL. Although Grade I meconium was the most frequent presentation, increasing severity of meconium staining was associated with progressively poorer neonatal outcomes.
Neonates born through Grade III meconium had significantly higher rates of low Apgar scores, NICU admission, and meconium aspiration syndrome, demonstrating a clear severity-dependent relationship between meconium grading and adverse perinatal outcomes. However, despite the relatively high neonatal morbidity, neonatal mortality remained very low, reflecting the benefits of timely obstetric intervention, continuous fetal surveillance, and effective neonatal resuscitation in a tertiary care hospital.
Overall, the findings suggest that meconium-stained liquor should not be regarded as an isolated indication for operative delivery. Instead, management should be guided by comprehensive clinical assessment incorporating meconium grade,

maternal risk factors, fetal heart rate monitoring, and overall maternal–fetal status. Early identification of high-risk pregnancies, meticulous intrapartum monitoring, and prompt neonatal care are essential to minimize perinatal morbidity and improve neonatal outcomes. The present study provides institution-specific evidence that may assist in optimizing obstetric decision-making and strengthening evidence-based intrapartum care protocols.

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