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MECONIUM-STAINED LIQUOR AND ITS NEONATAL OUTCOMES

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Abstract

Background: *Meconium-stained liquor (MSL) is frequently observed during labor, but its impact on neonatal outcomes remains debated. This study examined whether exposure to MSL is associated with increased risks of neonatal complications and adverse outcomes.*

Objectives: *To determine the association of adverse neonatal outcomes and meconium-stained liquor in pregnant women.*

Duration: *Six months w.e.f 16-03-2025 to 16-06-2025*

Methodology: *This six-month cohort study at Ghurki Trust Teaching Hospital enrolled 304 pregnant women, equally divided by MSAF exposure. Inclusion criteria ensured viable, term singleton pregnancies with cephalic presentation. Neonatal outcomes, including APGAR scores, perinatal asphyxia, sepsis, and death, were assessed by senior staff. Data were analyzed using chi-square tests and relative risks, with stratification by maternal age, gestational age, neonatal gender, and mode of delivery. Ethical approval and informed consent were obtained before enrollment. Standard protocols guided all clinical management.*

Results: *The study of 304 participants (mean maternal age 28.8 years, gestational age 39.37 weeks) found the exposed group had significantly lower 5th-minute APGAR scores (7.49 vs. 8.03, p=0.000), with higher risks of asphyxia (20.4% vs. 5.3%, RR=4.62), neonatal sepsis (20.4% vs. 6.6%, RR=3.63), and death (6.6% vs. 2.0%, RR=3.49).*

Conclusion: *Newborns exposed to meconium-stained liquor had significantly higher risks of poor APGAR scores, perinatal asphyxia, early onset neonatal sepsis, and neonatal death compared to non-exposed newborns. These findings emphasize the association between meconium-stained liquor and adverse neonatal outcomes in this study population.*

INTRODUCTION

Meconium is a dark green, sticky, and odorless substance present in the fetal intestines, beginning to form around 70 to 85 days of gestation.[1] It consists of various components including bile acids and salts, mucus, pancreatic secretions, exfoliated gastrointestinal cells, swallowed amniotic fluid, vernix caseosa, lanugo hairs, mucus glycoproteins, lipids, proteases, and blood, which accumulate in the fetal colon throughout pregnancy.[2]

The fetus may pass meconium either before or during labor, releasing a greenish viscous fluid known as meconium-stained amniotic fluid (MSAF). This condition is generally rare before

37 weeks of gestation but becomes more common as pregnancy progresses.[2,3] In fact, MSAF has been associated with increased fetomaternal complications, contributing to higher perinatal morbidity and mortality. Notably, approximately 27.3% of neonatal deaths have been linked to meconium passage during delivery.[4] MSAF occurs in about 12 to 16% of all deliveries.[5]

Pakistan ranks third among ten countries responsible for two-thirds of global neonatal deaths, with a neonatal mortality rate estimated at 49 per 1,000 live births.[5] Infants born through MSAF face a substantially increased risk about 100 times higher of developing respiratory distress compared to those born with clear amniotic fluid.[6] Furthermore, even low-risk pregnancies complicated by MSAF experience a fivefold increase in perinatal mortality compared to similar low-risk pregnancies without meconium staining.[6,7]

Tolu et al. in a study conducted in Ethiopia, reported a significant association between meconium-stained amniotic fluid (MSAF) and several adverse neonatal outcomes. Their findings showed that neonates born with MSAF had higher rates of 5-minute APGAR scores below 7 (36.8% vs. 13.7%; p=0.001), perinatal asphyxia (9% vs. 2.4%; p=0.002), early-onset neonatal sepsis (5.6% vs. 1.0%; p=0.005), admission to intensive care units (21.5% vs. 6.2%; p=0.001), and early neonatal death (9.0% vs. 1.0%; p=0.001) compared to neonates without MSAF. Based on these findings, it appears crucial to closely monitor neonates born through meconium-stained liquor from birth up to the neonatal period of four weeks, even when no immediate signs of complications are present. However, such intensive observation may be costly and challenging to implement in resource-limited settings like Pakistan. Therefore, it is important to consider other evidence before adopting this practice widely.

In contrast, Abate et al. also from Ethiopia, reported significant differences between cases and controls in terms of 5-minute APGAR scores below 7 (9.39% vs. 2.62%; p=0.0003), perinatal asphyxia (8.6% vs. 4.8%; p=0.006), and NICU admissions (53.7% vs. 22.8%; p<0.0001). However, they observed an inverse and statistically insignificant relationship regarding early-onset neonatal sepsis (14.8% vs. 21.2%; p=0.135).[9]

Given these conflicting findings and the lack of similar studies locally or internationally, this study aimed to validate the association between MSAF and neonatal outcomes. The results will be instrumental in developing cost-effective strategies for managing neonates born with meconium-stained amniotic fluid, thereby improving neonatal care and outcomes in resource-constrained settings.

METHODOLOGY

It was designed as a cohort study conducted at the Department of Obstetrics and Gynecology, Ghurki Trust Teaching Hospital, Lahore, over a period of six months following ethical approval. The sample size consisted of 304 pregnant women, divided equally into two groups: 152 exposed to MSAF and 152 non-exposed. This size was calculated to achieve 80% power and a 5% significance level, based on expected frequencies of perinatal asphyxia of 24% in the exposed and 9% in the non-exposed group.[4] Participants were selected through non-probability consecutive sampling. Inclusion criteria included pregnant women aged 18 to 40 years, with viable singleton pregnancies, cephalic presentations, and gestational age beyond 37 weeks. Women were classified into exposed or non-exposed groups based on the presence or absence of meconium-stained amniotic fluid, observed by the resident at delivery. Women with breech presentations, unknown gestational ages, fetal demise upon admission, or congenital fetal anomalies were excluded to control confounding variables. Meconium-stained amniotic fluid was operationally defined as the presence of yellow, brownish, or green particulate matter in the amniotic fluid during labor until delivery. Adverse neonatal outcomes were defined as follows: poor APGAR score as less than 7 at the first and fifth minutes after birth, perinatal asphyxia as an APGAR score of 6 or below at these same time points, early-onset neonatal sepsis identified within 24 to 48 hours after birth

by specific clinical signs, and neonatal death defined as death within the first 28 days of life. Data collection began after ethical approval, enrolling eligible women from the obstetric outpatient department. Written informed consent was obtained from all participants after explaining the study purpose. Demographic data were recorded on a structured proforma. The presence of MSAF was noted at delivery by the resident. Both groups were observed without any intervention beyond standard departmental protocols. Neonatal outcomes were assessed by a senior gynecologist to reduce bias, with findings documented by the resident. Confounding was minimized through strict exclusion criteria. For data analysis, SPSS version 25 was used. Numerical variables such as maternal age, gestational age, birth weight, and fifth-minute APGAR scores were summarized using means and standard deviations. Categorical variables, including newborn gender, poor APGAR scores, perinatal asphyxia, early-onset neonatal sepsis, and neonatal death, were described using frequencies and percentages. The chi-square test compared the frequency of adverse outcomes and modes of delivery between the exposed and non-exposed groups, with a significance threshold set at $p \leq 0.05$. Relative risks (RR) were calculated, considering an RR greater than 1 as significant. The data were further stratified by maternal age, neonatal gender, gestational age, and mode of delivery to evaluate potential effect modifiers. Post-stratification chi-square tests were applied within each stratum, again using $p \leq 0.05$ for significance and recalculating RR values accordingly.

RESULTS

The study included a total of 304 participants with a mean maternal age of 28.83 ± 4.44 years. The majority of mothers were aged between 18 and 30 years (61.5%), while 38.5% were between 31 and 40 years. The mean gestational age was 39.37 ± 1.04 weeks, with 54.9% of pregnancies lasting between 38 and 39 weeks and 45.1% extending to 40 weeks or beyond. Regarding the mode of delivery, spontaneous vaginal delivery was the most common, accounting for 53.1% of cases, followed by cesarean sections at 33.6%, and instrumental deliveries at 13.2%. Of the newborns, 54.6% were male and 45.4% were female. The average birth weight was 2.93 ± 0.14 kg, and the mean APGAR score at the 5th minute was 7.76 ± 1.05. Data is given in Table 1. Table 2 compares maternal and neonatal characteristics between the exposed (n=152) and non-exposed (n=152) groups. There were no significant differences in maternal age, gestational age, mode of delivery, newborn gender, or birth weight between the groups. Table 2 compares neonatal outcomes between the exposed and non-exposed groups. The exposed group had a significantly lower mean 5th-minute APGAR score (7.49 ± 1.18) compared to the non-exposed group (8.03 ± 0.82, $p = 0.000$). Poor APGAR scores were more frequent in the exposed group (20.4% vs. 5.3%, $p = 0.000$), with an odds ratio (OR) of 4.612 (95% CI: 2.043–10.407) and relative risk (RR) of 4.62. Similarly, perinatal asphyxia occurred in 20.4% of exposed newborns compared to 5.3% of non-exposed ($p = 0.000$), showing the same OR and RR values. Early onset neonatal sepsis was also significantly higher in the exposed group (20.4% vs. 6.6%, $p = 0.000$) with an OR of 3.638 (95% CI: 1.713–7.724) and RR of 3.63. Neonatal death was more frequent among exposed neonates (6.6% vs. 2.0%, $p = 0.047$), with an OR of 3.498 (95% CI: 0.943–12.970) and RR of 3.49. Statistical significance was determined using Chi-square tests with a p-value ≤ 0.05 and RR >1 indicating increased risk. Moreover, in stratified analysis on the basis of sub groups of maternal age, gestational age, gender of neonate and mode of delivery, non-exposed group had better outcomes than exposed group in all the sub groups with RR>1.

Table 1: Demographic Characteristics of Pregnant Women Included in the Study

Characteristics	Total (304)
Maternal Age (years)	28.83±4.44
• 18-30 years	118 (61.5%)
• 31-40 years	117 (38.5%)
Gestational Age	39.37±1.04
• 38-39 weeks	167 (54.9%)
• ≥40 weeks	137 (45.1%)
Mode of Delivery	
• Spontaneous Vaginal Delivery	162 (53.1%)
• Instrumental Delivery	40 (13.2%)
• Cesarean Section	102 (33.6%)
Gender of New Born	
• Boy	166 (54.6%)
• Girl	138 (45.4%)
Birth Weight (g)	2.93±0.14
APGAR Score (5th Minute)	7.76±1.05

Table 2: Comparison of Exposed and Non-Exposed Groups for Baseline Characteristics

Characteristics	Exposed Group (n=152)	Non-Exposed Group (n=152)	p-value
Maternal Age (years)	28.64±4.57	29.03±4.31	0.447
• 18-30 years	97 (63.8%)	90 (59.2%)	0.409
• 31-40 years	55 (36.2%)	62 (40.8%)	
Gestational Age	39.39±1.02	39.35±1.06	0.700
• 38-39 weeks	81 (53.3%)	86 (56.6%)	0.564
• ≥40 weeks	71 (46.7%)	66 (43.4%)	
Mode of Delivery			
• Spontaneous Vaginal Delivery	80 (52.6%)	82 (53.9%)	0.460
• Instrumental Delivery	17 (11.2%)	23 (15.1%)	
• Cesarean Section	55 (36.2%)	47 (30.9%)	
Gender of New Born			
• Boy	86 (56.6%)	80 (52.6%)	0.489
• Girl	66 (43.4%)	72 (47.4%)	
Birth Weight	2.94±0.14	2.93±0.13	0.561

Chi Square test/ Independent sample t test, taking p-value≤0.05 as significant.

Table 3: Comparison of Study Outcomes between the Groups

Characteristics	Exposed Group (n=152)	Non-Exposed Group (n=152)	p-value
APGAR Score (5th Minute)	7.49±1.18	8.03±0.82	0.000
Poor APGAR Score			
• Yes	31 (20.4%)	8 (5.3%)	0.000

• No	121 (79.6%)	144 (94.7%)	
ORR 4.612 (2.043-10.407), RR=4.62			
Perinatal Asphyxia			
• Yes	31 (20.4%)	8 (5.3%)	0.000
• No	121 (79.6%)	144 (94.7%)	
ORR 4.612 (2.043-10.407), RR=4.62			
Early Onset Neonatal Sepsis			
• Yes	31 (20.4%)	10 (6.6%)	0.000
• No	121 (79.6%)	142 (93.4%)	
ORR 3.638 (1.713-7.724), RR=3.63			
Neonatal Death			
• Yes	10 (6.6%)	3 (2.0%)	0.047
• No	142 (93.4%)	149 (98.0%)	
ORR 3.498 (0.943-12.970), RR=3.49			

Chi-Square test taking p-value≤0.05 as significant and RR >1 as significant.

DISCUSSION

Meconium-stained liquor (MSL) remains a common obstetric finding, often associated with fetal distress and adverse neonatal outcomes.[11-12] However, the relationship between MSL and neonatal morbidity and mortality is still debated in the literature. While some studies suggest that MSL is merely a sign of fetal maturity, others link it to increased risks such as perinatal asphyxia, poor APGAR scores, sepsis, and neonatal death.[8,9] This study aimed to assess and compare neonatal outcomes among newborns exposed and not exposed to MSL. By identifying significant differences in clinical outcomes, it contributes to the ongoing discussion regarding the true impact of MSL exposure.

The findings of this study, which showed significantly higher rates of poor APGAR scores, perinatal asphyxia, early-onset neonatal sepsis, and neonatal death among newborns exposed to meconium-stained liquor, align with several studies in the literature that establish MSAF as a risk factor for poor perinatal outcomes. Parween et al. in India found that 49% of patients in the MSAF group underwent lower segment cesarean section (LSCS), compared to 37% in the non-MSAF group. Neonatal intensive care unit (NICU) admissions were also notably higher in the MSAF group (30% vs. 13%), and adverse neonatal outcomes occurred in 22% of MSAF cases versus 12% in the non-MSAF group. Although they reported no statistically significant difference overall ($p < 0.001$), their conclusion was consistent with the present study that MSAF is associated with an increased frequency of operative deliveries, adverse neonatal outcomes, and greater NICU admission.[2]

Similarly, Shakya et al. in Nepal reported that out of 1,699 term deliveries, 5.35% had MSAF, and the majority of these cases (75.82%) required delivery via cesarean section. This also supports the notion that MSAF frequently leads to operative interventions.[13] Abate et al., in an Ethiopian case-control study, showed that newborns with MSAF had significantly worse outcomes, including a lower 5-minute APGAR score (<7 in 9.39% vs. 2.62%, $p = 0.0003$), higher rates of perinatal asphyxia (8.6% vs. 4.8%, $p = 0.006$), and more NICU admissions (53.7% vs. 22.8%, $p < 0.0001$). Interestingly, their study did not find a significant association between MSAF and early-onset neonatal sepsis, which contrasts with the present findings that showed a higher risk of sepsis in the exposed group.[9]

Tolu et al., also from Ethiopia, reported findings closely aligned with this study. They found significantly higher rates of low APGAR scores at 5 minutes (36.8% vs. 13.7%, $p = 0.001$), perinatal asphyxia (9% vs. 2.4%, $p = 0.002$), early-onset neonatal sepsis (5.6% vs. 1.0%, $p = 0.005$), NICU admission (21.5% vs. 6.2%, $p = 0.001$), and early neonatal death (9.0% vs. 1.0%, $p = 0.001$) in

MSAF-exposed neonates. These results corroborate the present study's findings and further reinforce the link between MSAF and adverse outcomes.[8]

In Pakistan, Mohammad et al. identified a strong association between thick MSAF and poor neonatal outcomes, including low APGAR scores, meconium aspiration syndrome (MAS), and increased emergency cesarean deliveries. They also noted maternal risk factors like anemia, pregnancy-induced hypertension (PIH), and gestational diabetes mellitus (GDM) as contributing to MAS.[4] Similarly, Singh et al. reported that MSAF significantly impacted neonatal morbidity and mortality, with 16% mortality among neonates, many of whom developed complications such as MAS, hypoxic-ischemic encephalopathy, and sepsis. Culture-proven sepsis occurred in 21.6% of cases, further highlighting the need for vigilance in MSAF cases.[14]

Divya et al. concluded that meconium-stained liquor substantially increases neonatal morbidity and mortality, consistent with this study.[15] Mahapatra et al. in India conducted a study involving 556 participants and found that 50% of the meconium-stained amniotic fluid (MSAF) group were primigravida. Labor was induced in 26.07% of cases, showing a significant association with meconium staining. Operative delivery was twice as likely in the stained group compared to the non-stained group. Adverse neonatal outcomes were more common, including low APGAR scores (36.8%), birth asphyxia (9%), neonatal sepsis (1%), and neonatal deaths (1%). Meconium aspiration syndrome occurred in 6.2% of cases. The study concluded that MSAF is linked to increased perinatal complications and NICU admissions.[16]

Dani et al. in Italy concluded that the severity and thickness of meconium-stained amniotic fluid (MSAF) are positively associated with adverse outcomes in term newborns. Their findings suggest that assessing and grading the degree of meconium staining during labor can help anticipate neonatal complications. This evaluation can guide the timely presence of a neonatologist during delivery, ensuring prompt and appropriate care for the newborn.[17]

Lastly, Kashikar et al. reported favorable outcomes in cases of thin meconium with reactive cardiotocography, but highlighted the dangers of thick meconium, especially when associated with abnormal fetal heart rates. This aligns with the current study's finding that exposure to meconium-stained liquor, particularly in its more severe forms, is linked with significantly worse neonatal outcomes.[18]

CONCLUSION

Newborns exposed to meconium-stained liquor had significantly higher risks of poor APGAR scores, perinatal asphyxia, early onset neonatal sepsis, and neonatal death compared to non-exposed newborns. These findings emphasize the association between meconium-stained liquor and adverse neonatal outcomes in this study population.

LIMITATIONS & RECOMMENDATIONS

A key strength of this cohort study is its prospective design, which enabled the assessment of temporal relationships between meconium-stained liquor exposure and neonatal outcomes. The equal group sizes and standardized data collection enhanced its reliability. However, being a single-center study without long-term follow-up or intervention limits generalizability. Future multicenter cohort studies with stratification based on meconium consistency and inclusion of long-term neonatal outcomes are recommended to strengthen the evidence base.

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Authors Contribution

Author 1

Substantial contributions to study design, acquisition of data

Analysis & Interpretation of Data, Manuscript writing

Has given final approval of the version to be published

Agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

Author 2

Substantial contributions to concept, study design

Data Analysis, Manuscript writing, Critical Review

Has given final approval of the version to be published

Agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

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