Original Article
DOI: https://doi.org/10.70749/ijbr.v3i1.562

INDUS JOURNAL OF BIOSCIENCE RESEARCH
https://induspublishers.com/IJBR
ISSN: 2960-2793/ 2960-2807

Neonatal Outcome in Babies Born to Mothers with Meconium-Stained Amniotic Fluid

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ARTICLE INFO

Keywords

Meconium-stained Amniotic Fluid, Neonatal complications, Hypoxic-Ischemic Encephalopathy, Meconium Aspiration Syndrome.

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Declaration

Author's Contributions: Dr. Najia Kasi led study design, data collection, and manuscript drafting. All authors contributed and approved the final manuscript.

Conflict of Interest: No conflict of interest.

Funding: No funding received by the authors.

Article History

Received: 04-10-2024
Revised: 31-12-2024
Accepted: 22-01-2025

ABSTRACT

Background: Meconium-stained amniotic fluid (MSAF) is a critical obstetric condition often associated with adverse neonatal and maternal outcomes. Despite the well-documented risks, the relationship between MSAF and complications such as Hypoxic-Ischemic Encephalopathy, Meconium Aspiration Syndrome, and other systemic neonatal issues remains an area of significant clinical interest. **Objective:** To evaluate the neonatal outcomes in babies born to mothers with meconium-stained amniotic fluid. **Study Design:** Cross-sectional study. **Duration and Place of Study:** The study was conducted from July 2023 to January 2024 in the Department of Obstetrics and Gynecology, CMH Multan. **Methodology:** A total of 207 neonates born to mothers with visible MSAF at or beyond 34 weeks of gestation were included. Preterm neonates, those with congenital malformations, twin pregnancies, or requiring surgical interventions, were excluded. Data collection covered demographic and clinical parameters, including gestational age, mode of delivery, birth weight, Apgar scores, and complications. Neonatal outcomes such as Meconium Aspiration Syndrome, Hypoxic-Ischemic Encephalopathy, Acute Renal Failure, and Necrotizing Enterocolitis were analyzed. **Results:** The mean gestational age at birth was 37.5 ± 2.21 weeks, and cesarean sections accounted for 71.5% of deliveries. Complications were prevalent, with Hypoxic-Ischemic Encephalopathy observed in 68.1% of neonates, Acute Renal Failure in 71%, and Meconium Aspiration Syndrome in 44.9%. The mortality rate was 21.7%. **Conclusion:** Meconium stained amniotic fluid is associated with a substantial burden of neonatal complications, emphasizing the necessity for vigilant monitoring, timely interventions.

INTRODUCTION

Meconium-stained amniotic fluid (MSAF) during labor generally is an indicator of either fetal distress or hypoxia.[1] Meconium aspiration syndrome (MAS), one of the severe neonatal conditions, has meconium present in the amniotic fluid that can aspirate into the lungs, resulting in respiratory distress, obstruction of the airway passage, chemical pneumonitis, and in severe conditions persistent pulmonary hypertension among severely affected infants.[2] Management of MAS needs urgent, though highly specialized, neonatal interventions in supplementary oxygen, mechanical ventilator therapy or rarely in instances, extracorporeal membrane oxygenation.[3]

It can be said that the neonates who are born with MSAF will also most likely be required to be admitted into a neonatal ICU.[4] The commonly observed complications in this case are a low Apgar score during birth, development of neonatal pneumonia or sepsis, and more.[5] The main steps to overcome all these possibilities would start from immediate resuscitative measures after birth with regard to clearing the airway, followed by adequate ventilation. However, such conditions may cause severe complications in their worst phase but can always be managed effectively through continuous monitoring and prompt treatment of conditions.[6]

Meconium-stained amniotic fluid is also associated with a rising cesarean section rate, especially once intrapartum fetal distress has been identified.[7] Cesarean section is done to prevent further complications from continued exposure to meconium-stained fluid.[7] Neonates delivered by cesarean section within the context of MSAF may still incur respiratory complications but timely delivery reduces the risk of severe hypoxia or aspiration.[8] Advances in intrapartum care have significantly improved neonatal outcomes in such scenarios.[8]

The consequences of MSAF, though neonatal morbidity can be significant, directly relate to the degree of meconium staining, the condition of the fetus during labor, and the timely medical interventions.[9] Proper antenatal and intrapartum monitoring and appropriate immediate postnatal care are also critical in preventing adverse outcomes for neonates born under these circumstances.[10]

According to Singh et al.[11] Meconium Aspiration Syndrome (MAS) occurred in 34% of neonates born to mothers with meconium-stained amniotic fluid, while neonatal mortality was observed in 16% of cases. Additionally, culture-proven septicemia was present in 21.6% of neonates, and respiratory distress developed within 30 minutes of birth in 56% of cases. Among the complications, Hypoxic-Ischemic Encephalopathy (HIE), Necrotizing Enterocolitis (NEC), and Acute Renal Failure (ARF) were each reported in 66% of neonates, while severe thrombocytopenia was observed in 55% of these cases.[11]

This study was necessary to evaluate the neonatal outcomes associated with meconium-stained amniotic fluid, a condition linked to significant perinatal morbidity and mortality as shown in above study. Understanding the prevalence of complications like Meconium Aspiration Syndrome, respiratory distress, septicemia, and associated neonatal mortality can help identify risk factors, improve clinical interventions, and guide effective management strategies to reduce adverse outcomes and improve neonatal care practices.

METHODOLOGY

This was a cross-sectional study design, undertaken from July 2023 to January 2024 in the Department of Obstetrics and Gynaecology, CMH Multan, which included 207 neonates that were born to mothers with meconium-stained amniotic fluid. Sample size calculation of 95% confidence level, 5% margin of error, considering the expected frequency of neonatal mortality by 16%.[11] In this study, the inclusion criteria consisted of live-born neonates with visible meconium-stained amniotic fluid, regardless of consistency (thin or thick), delivered at or beyond 34 weeks of gestation. Preterm neonates with congenital malformations, twin pregnancies, or those requiring surgical intervention for conditions such as intestinal obstruction, or neonates with multi-organ dysfunction were excluded. It is stated that parental consent was obtained before enrollment.

The data collection included demographic and clinical details of each patient regarding gestational age, mode of delivery, birth weight, gender, Apgar score at 1 and 5 minutes, and the onset of any complications. Measured outcomes included MAS (respiratory distress with radiographic evidence of aspiration pneumonia within 48 hours of birth); HIE is diagnosed clinically using the modified Sarnat staging; respiratory distress includes symptoms like grunting, nasal flaring, or chest retraction occurring within 30 minutes of birth; and NEC, as confirmed by Bell's criteria and further confirmed by radiographic findings indicating pneumatosis intestinalis. ARF was defined as either urine output less than 1 mL/kg/hour or serum creatinine ≥1.5 mg/dL and severe thrombocytopenia was defined as platelet count below 50,000/µL. Positive blood cultures taken within the first 72 hours of life documented culture-proven septicemia.

Neonates with MSAF were then admitted to the NICU for observation and treatment. Several clinical outcomes such as survival, NICU stay, and complications were recorded. The continuous variables included gestational age at birth and birth weight and were expressed as mean ± SD, whereas categorical variables comprised gender, mode of delivery, consistency-thin/thick-and neonatal outcome and were presented as frequencies and percentages. This was done in IBM SPSS version 27, where the level of significance was taken at $p < 0.05$.

RESULTS

Demographic characteristics included a mean gestational age of 37.5 ± 2.21 weeks, maternal parity of 2.7 ± 1.73, and average birth weight of 2.747 ± 0.60 kg. The patient cohort predominantly consisted of females (63.3%) with 36.7% males, and cesarean sections were the primary mode of delivery at 71.5% compared to 28.5% vaginal deliveries (Table-I).

Table 1

Patient Demographics

Demographics		Mean ± SD
Gestational Age at Birth (weeks)		37.512±2.21
Maternal parity		2.700±1.73
Birth weight (Kg)		2.747±0.60
Neonate gender	Male n (%)	76 (36.7%)
	Female n (%)	131 (63.3%)
Mode of delivery	C-section n (%)	148 (71.5%)
	Vaginal delivery n (%)	59 (28.5%)

n=207

Neonatal outcomes demonstrated significant medical challenges: Hypoxic-Ischemic Encephalopathy was most prevalent at 68.1%, followed closely by Acute Renal Failure (71%), Necrotizing Enterocolitis (61.8%), and Respiratory Distress (58.9%). Additional complications included Meconium Aspiration Syndrome (44.9%), Severe Thrombocytopenia (57%), Culture-Proven Septicemia (25.1%), and a mortality rate of 21.7% (Table-II).

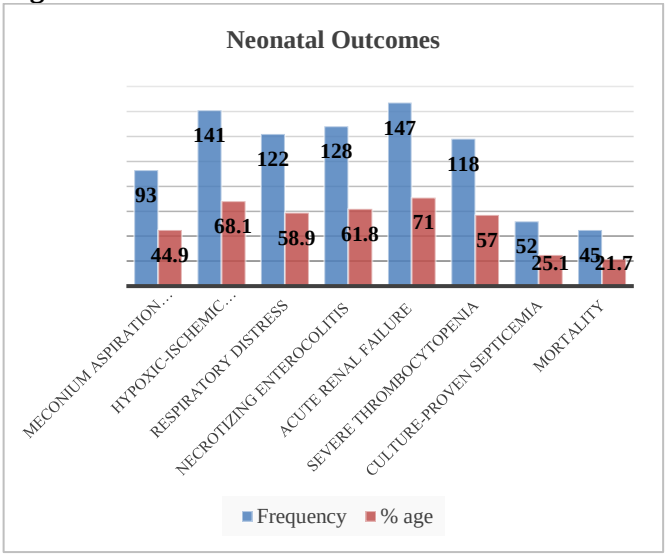
Table 2

Neonatal Outcomes

Neonatal Outcomes	Frequency	% age
Meconium Aspiration Syndrome	93	44.9
Hypoxic-Ischemic Encephalopathy	141	68.1
Respiratory Distress	122	58.9
Necrotizing Enterocolitis	128	61.8

Acute Renal Failure	147	71
Severe Thrombocytopenia	118	57
Culture-Proven Septicemia	52	25.1
Mortality	45	21.7

Figure 1



Critically, statistical analysis of outcomes stratified by delivery mode revealed no statistically significant differences across all measured conditions, with p-values consistently above 0.05, suggesting that mode of delivery did not significantly impact these neonatal health outcomes (Table-III).

Table 3

Stratification of neonatal outcomes with respect to mode of delivery

Mode of delivery	Meconium Aspiration Syndrome		p-value
	Yes n(%)	No n(%)	
C-section	62 (41.9%)	86 (58.1%)	0.164
Vaginal Delivery	31 (52.5%)	28 (47.5%)	
Hypoxic-Ischemic Encephalopathy			
C-section	101 (68.2%)	47 (31.8%)	0.950
Vaginal Delivery	40 (67.8%)	19 (32.2%)	
Respiratory Distress			
C-section	85 (57.4%)	63 (42.6%)	0.486
Vaginal Delivery	37 (62.7%)	22 (37.3%)	
Necrotizing Enterocolitis			
C-section	92 (62.2%)	56 (37.8%)	0.878
Vaginal Delivery	36 (61%)	23 (39%)	
Acute Renal Failure			
C-section	105 (70.9%)	43 (29.1%)	0.973
Vaginal Delivery	42 (71.2%)	17 (28.8%)	
Severe Thrombocytopenia			
C-section	83 (56.1%)	65 (43.9%)	0.671
Vaginal Delivery	35 (59.3%)	24 (40.7%)	
Culture-Proven Septicemia			
C-section	37 (25%)	111 (75%)	0.949
Vaginal Delivery	15 (25.4%)	44 (74.6%)	
Mortality			
C-section	29 (19.6%)	119 (80.4%)	0.236
Vaginal Delivery	16 (27.1%)	43 (72.9%)	

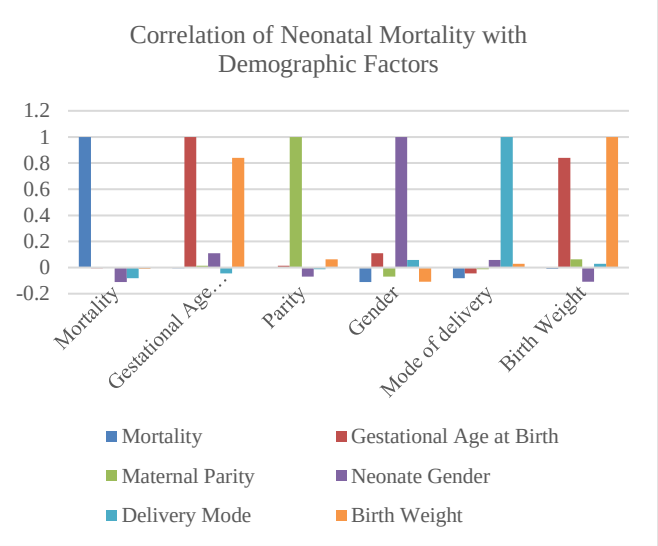
Mortality showed weak negative correlations with gestational age at birth (r=-0.005), maternal parity (r=-0.003), neonate gender (r=-0.110), delivery mode (r=-0.082), and birth weight (r=-0.011). Gestational age had a strong positive correlation with birth weight (r=0.839) but weak associations with other factors. Maternal parity had negligible relationships. Neonate gender correlated weakly with delivery mode (r=0.059) and birth weight (r=-0.109). Delivery mode showed a weak positive link to birth weight (r=0.029) as shown in Table-IV.

Table 4

Correlation of Neonatal Mortality with Demographic Factors

Variable	Mortality	Gestational Age at Birth	Maternal Parity	Neonate Gender	Delivery Mode	Birth Weight
Mortality	1	-0.005	-0.003	-0.11	-0.082	-0.011
Gestational Age at birth	-0.005	1	0.015	0.109	-0.045	0.839
Parity	-0.003	0.015	1	-0.068	-0.014	0.064
Gender	-0.11	0.109	-0.068	1	0.059	-0.109
Mode of delivery	-0.082	-0.045	-0.014	0.059	1	0.029
Birth Weight	-0.011	0.839	0.064	-0.109	0.029	1

Figure 2



DISCUSSION

Neonatal outcomes in infants born to mothers with MSAF depend on meconium aspiration into the airways, and complications include meconium aspiration syndrome. It is characterized by blockage of airways, inflammation of the lungs, and decrease in surfactant activity; this may lead to distress in breathing, low oxygen levels, and thereby present challenges such as respiratory distress, poor Apgar scores, and increased admissions in the NICU. Our study results showed high rates of Hypoxic-Ischemic Encephalopathy by 68.1%, Acute Renal Failure (71%), Necrotizing Enterocolitis (61.8%), and Respiratory Distress by 58.9%. Other complications were Meconium Aspiration Syndrome by 44.9%, Severe Thrombocytopenia (57%), Culture-

Proven Septicemia (25.1%), and mortality by 21.7. Meconium aspiration, can cause neurological damage and encephalopathy due to hypoxia and ischemia. Besides, meconium compromises renal perfusion, injures intestinal mucosa, and causes obstructive airway conditions. These are some of the contributors to the high incidence of renal failure, necrotizing enterocolitis, and respiratory distress. Contamination with meconium induces systemic inflammation, thus increasing the risk of developing sepsis and thrombocytopenia. In the study that we conducted, the mean gestational age at birth was 37.5 ± 2.21 weeks, and maternal parity was 2.7 ± 1.73. The mean birth weight in our study was 2.747 ± 0.60 kg, which are comparable to those reported by Singh et al.,[11] where the mean birth weight is indicated as 2.701 kg with 76.9% neonates having their birth weights falling within the range of 2.5-3.5 kg. Similarly, the neonates in our study showed a female predominance of 63.3%, which is consistent with the demographic proportion noted by Shrestha et al., though they did not highlight the gender distribution as explicitly.[12]

In our cohort, the rate of cesarean delivery was high at 71.5%, which contrasts with the reported rates by Bhasin et al. of 65.91% in cases of thick meconium labor.[13] Bhasin et al. also mentioned that MSAF cases often require operative deliveries to reduce neonatal outcome. However, our overall CS rates were much higher compared to those reported by Tolu et al., who stated that the rate for operative delivery in MSAF cases was approximately twice that in clear amniotic fluid cases but never exceeded 50%.[14] The difference in practice by institutions or a higher threshold for intervention could be a factor, particularly when interventions were performed electively due to fetal distress.

The neonatal complications included Hypoxic-Ischemic Encephalopathy with an incidence of 68.1%, Acute Renal Failure with 71%, and Meconium Aspiration Syndrome at 44.9% in our study. These rates are significantly higher compared to those reported by Porwal et al, in which MAS was noted in 25.87% of neonates with thick meconium and overall neonatal mortality was 0.86%.[15] The higher complication rates in our cohort may be due to differences in population baseline health, late referrals, or limited neonatal care resources.

We observed a mortality rate of 21.7%, which is remarkably different from what Mahapatra et al. recorded—a 6.2% mortality among cases with MSAF.[16] This is attributed to the higher coexistence of more serious comorbid states in our series, such as NEC and respiratory distress, which are not as commonly described in the literature. This weak negative correlation between mortality and gestational age in our results underlines the importance of improving prenatal care to achieve better results through timely intervention.

Our findings also showed that gestational age at birth and birth weight were positively correlated at a value of r = 0.839, which supports the findings of Dani et al., who stated that increased gestational age is associated with improved neonatal outcomes.[17] However, lower correlations between delivery modes and birth weights, with r = 0.029, and neonate gender with delivery mode, with r = 0.059, illustrate the complexity of demographic and clinical factors influencing neonatal outcomes.

Among the findings, an increased risk of MAS and its complications in thick MSAF cases was observed, aligning with studies by Attali et al. [18] and Parween et al. [19] where thick meconium was strongly associated with high neonatal morbidities and NICU admission rates. Furthermore, in the current study, the incidence of culture-proven septicemia was 25.1%, which was also concordant with Singh et al.'s report of 21.6%[11] reaffirming the universal risks linked to MSAF and the critical need for meticulous monitoring and timely interventions.

The variations in the severity and frequency of these complications reflect differences in healthcare infrastructures, population characteristics, and clinical practices across studies. For example, Dani et al. demonstrated lower figures for Hypoxic-Ischemic Encephalopathy, likely due to enhanced perinatal care and immediate neonatal resuscitation.[17] These differences highlight the need for adaptable care strategies based on contextual resource availability and population-specific needs. These findings emphasize the significant burden of MSAF-related complications and underscore the importance of vigilance in improving neonatal and maternal outcomes. Reducing healthcare disparities, optimizing perinatal care practices, and refining management protocols for MSAF will greatly contribute to mitigating adverse effects.

The major limitations of the study include it being conducted at a single center, which may limit generalizability to other settings with differing practices and resources. Additionally, the retrospective analysis introduces potential biases in data collection and evaluation. The relatively small sample size and lack of follow-up data beyond the point of discharge further restrict the ability to comprehensively assess the impact of MSAF on neonatal and maternal health. Future research should include larger, multicenter cohorts with prospective designs to validate our findings and provide a comprehensive understanding of MSAF outcomes.

CONCLUSION

Our study has established that meconium-stained amniotic fluid is related to significant neonatal and maternal complications, especially when combined with severe conditions such as Hypoxic-Ischemic Encephalopathy, Acute Renal Failure, and Meconium Aspiration Syndrome. While high cesarean section rates

do point to the addressing of delivery practices, the observed correlations in our study have again brought to light the multifactorial nature of MSAF-related complications.

Acknowledgments

We deeply appreciate the dedicated efforts of the medical staff in the department, whose meticulous record-keeping and systematic handling of patient data were instrumental to this research.

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