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The Implication of Different Volumes of Amniotic Fluid in Predicting Neonatal Outcome

Najia Kasi[1], Shaista Ambreen[1], Shazia Awan[1], Arshad Khushdil[1], Lubna Noor[1], Nidda Yaseen[1], Sehrish Raja[1]

[1]Department of Obs and Gynae, Combined Military Hospital (CMH), Multan, Punjab, Pakistan.

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Corresponding Author: Najia Kasi, Department of Obs and Gynae, Combined Military Hospital Rawalpindi (CMH), Multan, Punjab, Pakistan.
Email: najia.kasi@gmail.com

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ABSTRACT

Background: Amniotic fluid index (AFI) variations has been associated with adverse perinatal outcomes, including increased cesarean delivery rates and neonatal complications. Accurate monitoring of AFI is essential for predicting and managing high-risk pregnancies effectively. **Objective:** To evaluate the predictive value of AFI for adverse perinatal outcomes, including neonatal morbidity and delivery mode, in term pregnancies. **Study Design:** Prospective cohort study. **Duration and Place of Study:** The study was conducted from June 2023 to December 2023 at the Department of Obstetrics and Gynaecology, CMH Multan. **Methodology:** A total of 60 term pregnancies were included, divided into two groups: Group A (AFI <5 cm) and Group B (AFI >5 cm). Patients were aged 18–40 years with singleton, non-anomalous pregnancies at ≥37 weeks gestation. Exclusion criteria included pre-existing medical conditions, multiple pregnancies, and prior cesarean delivery. AFI was measured using the four-quadrant technique, and neonatal outcomes such as Apgar scores, birth weight, NICU admissions, and respiratory distress were assessed. Non-stress test (NST) reactivity and delivery mode were also recorded. **Results:** Group A exhibited significantly higher rates of cesarean deliveries (66.7% vs. 20%, p<0.05), low Apgar scores (73.3% vs. 36.7%, p=0.004), and NICU admissions (80% vs. 46.7%, p=0.007) compared to Group B. Non-reactive NSTs were more frequent in Group A (33.3% vs. 6.7%). While low birth weight was more common in Group A (50% vs. 30%), the difference was not statistically significant (p=0.114). **Conclusion:** Low AFI predicts adverse perinatal outcomes, including higher cesarean rates and NICU admissions, emphasizing the importance of routine monitoring in obstetric care.

INTRODUCTION

Amniotic fluid is a crucial factor in maintaining the proper intrauterine environment that is necessary for fetal development.[1] It cushions the fetus from mechanical injury and facilitates the exchange of nutrients, water, and biochemical signals.[2] As such, amniotic fluid volume is one of the dynamic markers of fetal well-being throughout the course of gestation.[3] The variations from normal volumes—both low, or oligohydramnios, and high, or polyhydramnios—are possible complicating conditions.[4] Assessment of the volume of amniotic fluid allows clinicians to determine fetal well-being, make informed predictions regarding neonatal outcomes, and plan for timely interventions.[5]

Oligohydramnios is a reduction of normal amniotic fluid volume that almost always tends to coincide with adverse neonatal outcomes.[6] The conditions commonly associated include placental insufficiency, intrauterine growth restriction (IUGR), and fetal distress.[7] Ultrasound is used to estimate AFI for measurement of the deepest vertical pocket.[8] It is helpful for the baby to protect from the increased risk of preterm birth, umbilical cord compression, and low Apgar scores, and early detection is thus important.[9] Oligohydramnios can be used as a predictor that enables the health care provider to adopt close monitoring and timely delivery strategies.[10]

While polyhydramnios presenting as an excessive volume of amniotic fluid, is often associated with signs of fetal distress during pregnancy.[11] Mothers with polyhydramnios presenting with maternal diabetes or potential birth defects include fetal gastrointestinal malformations or structural anomalies related to neurological impairments.[12] Moreover, polyhydramnios can promote complications such as premature labor and placental abruption, leading to an increased likelihood of cesarean deliveries.[13]

Diagnostic ultrasound help determine fluid abnormalities, particularly concerning polyhydramnios, permitting more timely preparation at the time of onset.[14] This enables appropriate management of related newborn care to be provided early.

The role to predict neonatal outcomes based on amniotic fluid volume underscores its diagnostic significance in obstetrics.[15] By combining fluid volume assessments with other diagnostic parameters, such as Doppler studies and biophysical profiles, clinicians can better evaluate fetal well-being.[15] So, regular monitoring of amniotic fluid volume, particularly in high-risk pregnancies, aids in early detection of potential complications, reducing perinatal morbidity and mortality.[16] This predictive capability highlights the importance of standardized assessment protocols and, more importantly, the role that advanced imaging technologies play in the improvement of neonatal outcomes.

Bhagat and Chawla,[17] reported that women with low amniotic fluid index (AFI <5 cm) had significantly higher cesarean section rates for fetal distress (57.1% vs 38.7%, p = 0.048), low birth weights (56% vs 21.7%, p = 0.001), and lower Apgar scores (36% vs 10.9%, p = 0.001). The low AFI group also had higher non-reactive NST rates (32% vs 9.7%, p = 0.002) and more frequent NICU admissions (92% vs 71.4%, p = 0.028).[17]

Variations in amniotic fluid, such as oligohydramnios, have been linked to adverse perinatal outcomes, including low birth weight, cesarean deliveries, and neonatal complications such as respiratory distress and NICU admissions. Understanding how different volumes of amniotic fluid impact neonatal health can guide clinicians in identifying high-risk pregnancies early,[18] enabling timely interventions. This research could ultimately enhance the management of pregnancies, improve neonatal health outcomes, and reduce healthcare costs associated with preventable complications.

METHODOLOGY

This prospective cohort study was conducted from June 2023 to December 2023 at department of Obstetrics and Gynaecology, CMH Multan. The study comprised 60 pregnant women with term pregnancies. The sample size was determined with 80% power and a 95% confidence level, considering an anticipated proportion of low birth weight (56% vs 21.7%).[17]

Patients were selected using a non-probability consecutive sampling technique. Inclusion criteria consisted of women aged 18 to 40 years, with singleton, non-anomalous pregnancies at or beyond 37 weeks of gestation, who provided informed consent. Exclusion criteria included women with pre-existing medical conditions (e.g., hypertension, diabetes), multiple pregnancies, known fetal anomalies, premature rupture of membranes, or those with a history of cesarean delivery. After obtaining informed consent, demographic information was collected, including age, gestational age, parity, and medical history.

Amniotic fluid index (AFI) was measured using the four-quadrant technique. The participants were categorized into two groups of 30 patients each: Group A (AFI <5 cm) and Group B (AFI >5 cm). Neonatal outcomes, including Apgar scores at 1 and 5 minutes, birth weight, meconium aspiration, NICU admission, respiratory distress, and cord pH were recorded. Additionally, non-stress test (NST) results were categorized as reactive or non-reactive. Apgar score of <7 at 5 minutes was considered low. A non-reactive NST was defined as the failure to show two accelerations of at least 15 bpm for 15 seconds within 20 minutes. Admission to NICU for complications such as respiratory distress or low birth weight. Low Birth Weight was defined as birth weight less than 2.5 kg.

Data analysis was performed using IBM SPSS version 27. Continuous variables were expressed as mean ± standard deviation, and categorical variables were represented as frequencies and percentages. Chi-square tests were used for categorical data, with a p-value of <0.05 considered statistically significant.

RESULTS

The mean age was 30.80±3.50 years in Group A and 31.13±2.95 years in Group B. Gestational age was lower in Group A (38.30±1.17 weeks) compared to Group B (39.00±1.25 weeks), while parity and BMI were comparable between groups, with parity at 2.37±1.42 and 2.60±1.65 and BMI at 26.30±1.23 kg/m² and 26.33±1.18 kg/m², respectively. Non-reactive non-stress tests (NST) were significantly more frequent in Group A (33.3%) compared to Group B (6.7%) (as shown in Table-I). Cesarean delivery was notably higher in Group A (66.7%) than in Group B (20%), while vaginal deliveries predominated in Group B (80%) (p<0.05) (Table-1).

Table 1
Demographics of the patients.

Demographics		**Group A n=30 Mean±SD**	**Group B n=30 Mean±SD**
Age (years)		30.800±3.50	31.133±2.95
Gestational age (weeks)		38.300±1.17	39.000±1.25
Parity		2.366±1.42	2.600±1.65
BMI (kg/m^2)		26.300±1.23	26.333±1.18
Nonreactive NST	Yes n(%)	10 (33.3%)	2 (6.7%)
	No n(%)	20 (66.7%)	28 (93.3%)
Mode of Delivery	C-section n(%)	20 (66.7%)	6 (20%)
	Vaginal delivery n(%)	10 (33.3%)	24 (80%)

n=60

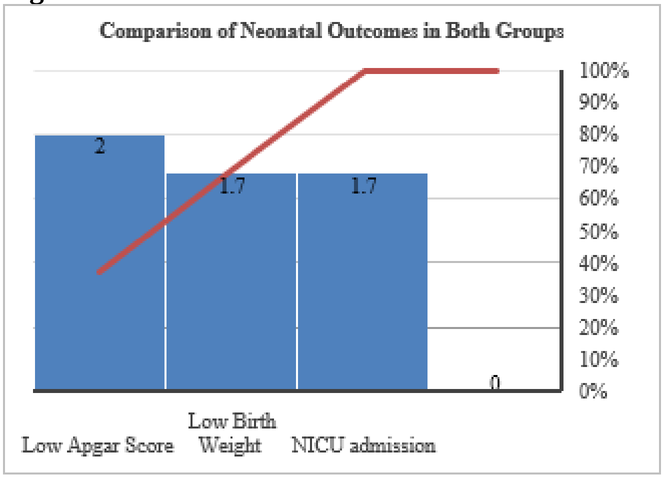
Neonatal outcomes demonstrated significant differences, with low Apgar scores occurring more frequently in Group A (73.3%) than Group B (36.7%) (p=0.004). NICU admissions were also significantly higher in Group A (80%) compared to Group B (46.7%) (p=0.007). While low birth weight was more common in Group A (50%) than Group B (30%), the difference was not statistically significant (p=0.114) (Table-2).

Table 2

Comparison of neonatal outcomes in both groups.

Neonatal outcomes	Groups	Yes (n, %)	No (n, %)	RR	P value
Low Birth Weight	A	15 (50%)	15 (50%)	1.7	0.114
	B	9 (30%)	21 (70%)		
Low Apgar Score	A	22 (73.3%)	8 (26.7%)	2	0.004
	B	11 (36.7%)	19 (63.3%)		
NICU admission	A	24 (80%)	6 (20%)	1.7	0.007
	B	14 (46.7%)	16 (53.3%)		

Figure 1



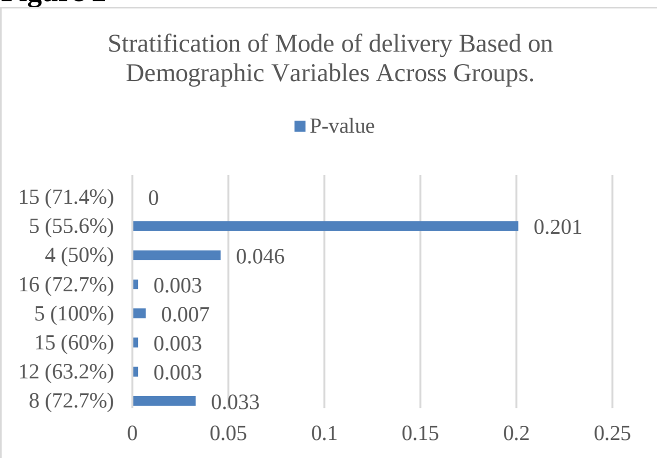
Stratification of delivery mode based on demographic variables in Table-III revealed significant associations between cesarean section rates and factors such as age, gestational age, parity, and BMI across Groups A (AFI <5 cm) and B (AFI >5 cm). Among patients aged 18–30 years, cesarean delivery was more frequent in Group A (72.7%) compared to Group B (27.3%) (p=0.033). Similarly, for patients aged 31–40 years, cesarean rates remained higher in Group A (63.2%) versus Group B (15.8%) (p=0.003). Regarding gestational age, cesarean delivery was significantly more common in Group A for both gestational age ranges. In patients with gestational age of 37–39 weeks, Group A had a cesarean rate of 60%, compared to 15.8% in Group B (p=0.003). For gestational age >39 weeks, cesarean delivery occurred in 100% of Group A patients versus 27.3% in Group B (p=0.007). Parity also showed a notable impact. In patients with parity 0–3, cesarean rates were significantly higher in Group A (72.7%) compared to Group B (26.3%) (p=0.003). Similarly, for parity >3, cesarean delivery occurred in 50% of Group A patients versus 9.1% in Group B (p=0.046). BMI further influenced the mode of delivery, with cesarean rates significantly higher in patients with BMI >25 kg/m² in Group A (71.4%) compared to Group B (18.2%) (p<0.001). Although differences in cesarean rates among patients with BMI ≤25 kg/m² were observed (55.6% in Group A versus 25% in Group B), the association was not statistically significant (p=0.201).

Table 3

Stratification of Mode of delivery Based on Demographic Variables Across Groups.

Demographics variables		Group	Mode of delivery		P-value
			C-section (n, %)	Vaginal delivery (n, %)	
Age (years)	18-30	A	8 (72.7%)	3 (27.3%)	0.033
		B	3 (27.3%)	8 (72.7%)	
	31-40	A	12 (63.2%)	7 (36.8%)	0.003
		B	3 (15.8%)	16 (84.2%)	
Gestational age (weeks)	37-39	A	15 (60%)	10 (40%)	0.003
		B	3 (15.8%)	16 (84.2%)	
	>39	A	5 (100%)	0 (0%)	0.007
		B	3 (27.3%)	8 (72.7%)	
Parity	0-3	A	16 (72.7%)	6 (27.3%)	0.003
		B	5 (26.3%)	14 (73.7%)	
	>3	A	4 (50%)	4 (50%)	0.046
		B	1 (9.1%)	10 (90.9%)	
BMI (Kg/m^2)	≤25	A	5 (55.6%)	4 (44.4%)	0.201
		B	2 (25%)	6 (75%)	
	>25	A	15 (71.4%)	6 (28.6%)	0.000
		B	4 (18.2%)	18 (81.8%)	

Figure 2



DISCUSSION

The findings of this study highlight the significant impact of low amniotic fluid index (AFI <5 cm) on neonatal outcomes and delivery modes, consistent with the study's objective of evaluating AFI as a predictor of perinatal outcomes. The higher cesarean section rates in

Group A can be attributed to increased fetal distress and non-reactive non-stress tests (NST), likely due to compromised placental perfusion in cases of oligohydramnios. The higher occurrence of low Apgar score and NICU admissions in the same group simply highlights the role of impaired AFI value in fetal hypoxia—a condition wherein adequate amniotic fluid is expected to provide major cushioning and thermoprotection mechanisms, especially during labor. The association of high BMI and C-section delivery in conjunction with advanced gestational age can be explained primarily by the compounded obstetric risks represented by maternal obesity and prolonged gestation in their oligohydramnios condition. These findings emphasize the potential clinical significance of AFI regarding delivery planning in an effort to achieve improved neonatal outcomes.

In our study, Group A (AFI < 5 cm) had a significantly higher incidence of cesarean sections, low Apgar scores, NICU admissions, and poor neonatal outcomes as compared to Group B (AFI > 5 cm). These findings are consistent with those presented by Moin et al. [19] Ülker et al. [20] and Lajber et al. [21] all of whom also showed a strong correlation between low AFI and higher incidences of cesarean deliveries, meconium-stained amniotic fluid, and NICU admissions. It has also been established that AFI ≤5 cm was significantly associated with induction of labor and low Apgar scores, all falling under the category of adverse perinatal outcomes, thus further validating our findings by Gunasingha et al.[22]

This finding of increased cesarean rates in women with low AFI, as seen across many studies including ours, stands to further strengthen the hypothesis that oligohydramnios predisposes the fetus to distress during labor because of inadequate cushioning and compromised placental function.[19-22] This is further supported by the findings of Megha et al.[23] who reported that an AFI < 5 cm significantly increased the cesarean rates for fetal distress. Similarly, Lajber et al. [21] and Ülker et al. [20] also detected a significant relation between severe oligohydramnios with operative deliveries that underscores the clinical relevance once more in labor monitoring of the AFI.

This corresponds to most incidences reported in the study by Dwivedi et al. [24] and Megha et al.[23] with lower birth weight or NICU admissions from this series, which show a consistent trend due to factors like underlying conditions leading to low AFI resulting from chronic intrauterine insult and placental insufficiency. The study surprisingly identified a new parameter—brightness of the amniotic fluid assessed by ultrasound—proving that it has strong predictive value for neonatal respiratory distress, which is a new direction in assessing fetal well-being.

The variations in 5-minute Apgar scores from the studies showed insignificant differences reported by Sultana et al. [26] and Dwivedi et al. [24] while our current study and some recent comparable literature, like Gunasingha et al. [22] and Moin et al. [19] found the association statistically significant. This discordance may well represent differences in neonatal intervention or cutoff values taken for normal versus low Apgar scores.

Our findings are also in agreement with those obtained by Lajber et al. [21] and Ülker et al. [20] who demonstrated that gestational age is one of the factors influencing AFI, with the lowest AFI in post-dated pregnancies. Such a relation would, therefore, imply that prolonged pregnancies need frequent monitoring of AFI to avoid adverse outcomes. Moreover, the statistical significance of some of the studied outcomes, such as NICU admissions and birth weights, may vary due to the sample size, selection, and characteristics of the population studied. The fact that our findings are in agreement with the literature further supports the clinical relevance of routine AFI monitoring in term pregnancies, especially in the identification of cases at risk for neonatal morbidity. However, the variability among some outcomes of different studies calls for further research to standardize AFI thresholds and to enhance the predictive accuracy of the test in diverse populations. New methodologies that have been developed—for instance, assessment of amniotic fluid brightness by ultrasound—provide supplementary value to AFI measurements in the assessment of fetal well-being.

This study is not free of limitations, and most of them should be mentioned. First, this is a single-center study, and generalizability to broader populations and health care settings is limited. The relatively small sample size may limit the statistical power to detect differences in certain outcomes. Variations in clinical management practices and measurement techniques may further introduce biases. Larger cohort multicenter studies in the future will be needed to confirm our findings and provide a standardized protocol in the management of pregnancies complicated by low AFI.

CONCLUSION

Our study has concluded that low amniotic fluid index is a significant predictor of adverse perinatal outcomes, including increased rates of cesarean deliveries, neonatal morbidity, and poor Apgar scores. The findings underscore the importance of routine AFI monitoring in term pregnancies to identify and manage high-risk cases effectively. The study highlights the critical role of AFI in guiding clinical decisions and improving neonatal outcomes, reinforcing its utility as a valuable tool in obstetric care.

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