ONLINE ISSN :3007-309X
PRINT ISSN :3007-3081

Journal of Medical & Health Sciences Review

DETERMINANTS OF KNOWLEDGE ABOUT NEONATAL DANGER SIGNS AMONG FIRST-TIME MOTHERS IN PAKISTAN: A CROSS-SECTIONAL STUDY

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ARTICLE INFO

Keywords: Neonatal danger signs; primiparous mothers; Pakistan; neonatal mortality; antenatal determinants.

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ABSTRACT

Introduction: The neonatal period, the first 28 days of life, is a critical window of vulnerability. Pakistan's neonatal mortality rate was approximately 37.6 per 1,000 live births in 2024, among the highest in South Asia . Most neonatal deaths occur at home, often because of delayed recognition of neonatal danger signs (NDSs). First-time mothers are particularly at risk due to limited experience. Identifying socio-demographic and obstetric determinants of maternal knowledge is essential for early recognition and timely care-seeking.

Objective: To examine socio-demographic and obstetric factors influencing knowledge of neonatal danger signs among first-time mothers in Pakistan.

Methods: A hospital-based cross-sectional study was conducted from September 1, 2022, to February 28, 2023, in the maternity wards of Liaquat University Hospitals, Jamshoro and Hyderabad, Sindh. Using purposive sampling, 300 primiparous women were recruited. A structured, pre-validated questionnaire assessed knowledge of 12 WHO-recommended danger signs (e.g., poor feeding, convulsions, lethargy, thermal extremes). Knowledge scores were categorized as low (0–4), average (5–8), or high (9–12). Associations with socio-demographic and obstetric variables were analyzed using chi-square and multivariate logistic regression (SPSS-26; $p \leq 0.05$).

Results: Among participants, 84% were aged 18–28 years, 65.3% had no formal education, and 86.7% were unemployed. Knowledge levels were: low 35.7%, average 53.7%, high 10.7%. Fever was recognized by all, followed by poor feeding and rapid breathing. Significant predictors of higher knowledge included maternal education

(AOR 2.15; 95% CI 1.28–3.61), ≥4 antenatal visits (AOR 1.89; 95% CI 1.12–3.19), and receiving neonatal care education (AOR 3.02; 95% CI 1.74–5.24).
Conclusion: Maternal knowledge of neonatal danger signs at hospital discharge in Pakistan is low. Strengthening antenatal and postnatal education—especially targeting less-educated and socioeconomically disadvantaged mothers—with culturally tailored counseling is essential to promote early recognition of neonatal illnesses and improve outcomes.

Introduction

The neonatal period, the first 28 days, is the most vulnerable time for a newborn's survival. Globally, an estimated 2.3 million neonatal deaths occurred in 2023, with nearly 6,300 newborns dying each day, predominantly in low- and middle-income countries (LMICs) like Pakistan[1–2]. While under-five mortality has declined globally, neonatal deaths comprise an increasing share, underscoring the need for targeted interventions[3].

Pakistan continues to struggle with one of the highest neonatal mortality rates in South Asia, reported at 37.6 per 1,000 live births in 2024, down from approximately 52 per 1,000 in 2006. Most neonatal deaths are due to preventable or treatable conditions—neonatal sepsis, birth asphyxia, pneumonia, prematurity—and frequently follow early warning signs[4]. The WHO identifies core danger signs including poor feeding, convulsions, lethargy, fever, hypothermia, jaundice, rapid breathing, chest in drawing, and signs of infection such as umbilical redness and eye discharge .

Early maternal recognition of NDSs and prompt care-seeking are critical for reducing neonatal morbidity and mortality. However, multiple studies have shown that mothers—particularly in LMICs, often lack sufficient knowledge about these warning signs, contributing to delays in care-seeking and preventable deaths[5, 6]. In Pakistan, such knowledge gaps are compounded by social and structural barriers including limited education, poverty, restrictive gender norms, and poor access to healthcare services, especially in rural areas [7, 8].

First-time (primiparous) mothers represent a particularly vulnerable group, as they generally lack prior experience with neonatal care and may be highly dependent on family members or untrained caregivers for guidance[9,10]. Their lack of confidence, decision-making autonomy, and limited access to structured health education, especially during the critical period around childbirth—place their newborns at increased risk[11,12]. Unfortunately, despite being a crucial point of contact between mothers and healthcare providers, the hospital discharge period is often overlooked as an opportunity for targeted counseling on newborn care[13,14]. Discharge instructions, when given, are frequently rushed or superficial due to high patient loads and inadequate staffing in public-sector hospitals.

While maternal and child health programs in Pakistan have emphasized antenatal care, immunization, and safe delivery practices, structured postnatal education, particularly tailored for first-time mothers, remains largely underdeveloped[15]. Research exploring maternal knowledge of NDSs at the time of hospital discharge is limited, despite this being a pivotal moment when mothers assume full responsibility for neonatal care.

This study seeks to fill this critical knowledge gap by assessing the level of understanding of neonatal danger signs among first-time mothers at the time of hospital discharge in Pakistan. Additionally, it investigates key socio-demographic and obstetric determinants, such as maternal age, education, employment status, family structure, residence, antenatal care utilization,

exposure to neonatal health education, and mode of delivery—that may influence maternal knowledge. By identifying these determinants, the study aims to inform hospital-based and community-level strategies to enhance postnatal education. Evidence-based recommendations can support health policy reforms that institutionalize comprehensive postnatal counseling, ultimately empowering mothers, promoting timely care-seeking, and improving neonatal survival outcomes in Pakistan.

Objective: To explore the socio-demographic and obstetric determinants influencing knowledge of Neonatal Danger Signs (NDSs) among first-time mothers in Pakistan.

Methodology

Study design and setting:

This cross-sectional study assessed the determinants of maternal knowledge about WHO-defined neonatal danger signs among 300 first-time mothers at the time of discharge from maternity units. Conducted over six months following ethical approval, data were collected in the maternity wards of Liaquat University Hospitals in Jamshoro and Hyderabad, Sindh, which serve urban, semi- urban, and rural populations across southern Pakistan.

Sample size:

Sample size was calculated from prevalence based formula. The 78.2% of the expectant mothers were reported to have a knowledge gap regarding danger signs in neonates[1.]

$$n= Z^2*p*q/e^2$$

n=required sample size.

p = proportion of expectant mothers having knowledge gap regarding neonatal danger signs=78.2

q=100-p=22.8

Z =critical value at 95% confidence as 1.96.

e=margin of error at 95%confidence interval= 5%.

Keeping all values together n=78.2×22.8×1.96×1.96÷5×5=273

Keeping in view, non-respondents/ incompletely filled questionnaire we take 10% more of the calculated sample size. n=273+27.3= 300.3= 300

Sampling technique:

Purposive sampling was used to recruit eligible participants who fulfilled the inclusion criteria.

Study subjects and sampling selection:

The newly delivered primiparous women of age >18 who are planned to discharge from maternity wards, fulfilling the following criteria

Inclusion Criteria: Primiparous mothers aged 18 years or older who delivered term, preterm, or IUGR newborns via vaginal or cesarean birth at Liaquat University Hospitals, Jamshoro or Hyderabad, with neonates lacking any apparent comorbidity at discharge.

Exclusion Criteria: Mothers who declined participation, had infants with severe illness requiring NICU care, were multiparous, or experienced intrauterine or stillbirth outcomes.

Data collection procedures:

Data were collected using pre-validated tools through face-to-face interviews conducted by the principal investigator. A structured questionnaire comprising four major sections was employed, ensuring comprehensive coverage of relevant determinants and maternal knowledge.

Section 1: Socio-demographic Information

This section captured maternal and household characteristics, including:

- Maternal age, education, and employment status

- Husband's education and employment
- Family type (nuclear, joint, extended)
- Monthly household income
- Place of residence (urban, semi-urban, rural)

Section 2: Obstetric Determinants

This section explored maternal health and obstetric history relevant to newborn care:

- Mode of delivery (normal vaginal delivery or caesarean section)
- Gestational age (term, preterm, or IUGR)
- Number of antenatal care (ANC) visits
- Receipt of neonatal care education during pregnancy or postnatal stay

Section 3: Knowledge of Neonatal Care

- Participants were asked about their knowledge and practices concerning essential newborn care:
- Exclusive breastfeeding
- Personal hygiene
- Thermal care (keeping the baby warm)
- Vaccination
- Skin, eye, and umbilical cord care

Section 4: Knowledge of Neonatal Danger Signs

Maternal knowledge of 12 WHO-listed neonatal danger signs (NDSs) was assessed using a pre-validated Likert scale-based tool. Participants were asked whether they recognized each danger sign, and their responses were scored accordingly. Based on cumulative scores, knowledge was categorized as:

Knowledge Level	Score Range	Description
Low	0–4	Minimal recognition
Average	5–8	Moderate recognition
High	9–12	Good recognition of NDSs

NDSs included: poor feeding, convulsions, lethargy, fever, hypothermia, jaundice, rapid breathing, severe chest indrawing, local infections (e.g., umbilical redness, eye discharge), and others based on WHO (2013) guidelines. Danger signs were explained in local languages (Urdu and Sindhi) using culturally sensitive descriptions to ensure accurate understanding.

Data Management and Quality Control

- Data collectors were trained by the principal investigator.
- Although the tool was self-administered, interviews were conducted to ensure clarity and completeness.
- Initial data collection was supervised for quality assurance.
- Daily field editing and weekly office editing were conducted to check for errors and missing data.
- Data were double-entered into SPSS version 25.0.
- Hard copies were stored securely, and digital data were password-protected with access limited to the principal investigator

Data analysis procedures:

Data were analyzed in SPSS v26. Descriptive statistics included frequencies and percentages for categorical variables (e.g., education, employment, residence, ANC visits, delivery mode), and means ± SD for continuous variables (maternal age, income, NDS knowledge score). Knowledge scores (0–12) were categorized: Low (0–4), Medium (5–8), High (9–12).
For inferential analysis, one-way ANOVA compared mean knowledge scores across groups, while chi-square tested associations between categorical predictors and knowledge levels (significance at $p \leq 0.05$, 95% CI). Multivariable modeling included linear regression for continuous scores and multinomial logistic regression for categorical knowledge outcomes. A stepwise approach identified significant predictors, with checks for multicollinearity, and results reported as crude and adjusted ORs with 95% CIs.

Ethical considerations:

Ethical approval was granted by the Liaquat University of Medical and Health Sciences Ethical Review Committee, Jamshoro; all relevant hospital leadership provided permission. Written informed consent was obtained in Urdu, Sindhi, or English, and interviews were conducted in the participants' preferred language. Participation was fully voluntary and confidential, with the option to withdraw at any time. No personal identifiers were recorded, and all data were securely stored and used solely for research purposes.

Results

The **Results** first present descriptive statistics summarizing participants' socio-demographic and obstetric characteristics, followed by distributions of composite neonatal danger sign knowledge scores. We evaluated normality of continuous variables using the Kolmogorov–Smirnov test (supported by SPSS-generated histograms), confirming approximate normal distributions. Inferential analyses then examined associations between key variables and maternal knowledge: one-way ANOVA compared mean scores across groups, while chi-square tested relationships between categorical predictors and knowledge levels (with $p \leq 0.05$ significance). Finally, variables significant in univariate analyses were included in a multivariate logistic regression model to identify independent determinants of adequate neonatal danger sign knowledge.

Description of sample

A total of 300 primiparous mothers were enrolled (Table 1). Participants had a mean age of 22.9 years (SD 4.4); 84% were aged 18–28. Most were Muslim (73%), uneducated (65.3%), and housewives (86.7%), with 10.7% part-time and 2.7% full-time employed. In terms of family structure, 43.7% lived in extended households, 37.7% in joint, and 24.7% in nuclear families. Residents were primarily rural (51.7%), followed by urban (29.3%) and semi-urban (19.0%). Descriptive summaries like this provide clear demographic insights and complement detailed tables.

Table. 1. Socio demographic characteristics of the study participants (n=300)

Characteristic	Categories	Frequency (%)
Age Group	18–28 years	252 (84.00%)
	29–39 years	48 (16.00%)
	Mean ± SD	22.88 ± 4.40
Literacy Status	Uneducated	196 (65.30%)

	Primary	61 (20.30%)
	Matriculate	34 (11.30%)
	Intermediate	9 (3.00%)
Spouse Literacy Status	Uneducated	57 (19.00%)
	Primary	69 (23.00%)
	Matriculate	73 (24.30%)
	Intermediate	92 (30.00%)
	Graduation	9 (3.00%)
Monthly Income	< Rs. 5000	53 (17.70%)
	Rs. 5000–15,000	126 (42.00%)
	Rs. 15,000–25,000	112 (37.30%)
	> Rs. 25,000	9 (3.00%)
Employment Status	Housewife	260 (86.70%)
	Part-time	32 (10.70%)
	Full-time	8 (2.70%)
Religion	Muslim	219 (73.00%)
	Non-Muslim	81 (27.00%)
Family Type	Nuclear	74 (24.70%)
	Joint	95 (31.70%)
	Extended	131 (43.70%)
Residence	Urban	88 (29.30%)
	Rural	155 (51.70%)
	Semi-Urban	57 (19.00%)

Descriptive statistics of obstetric characteristics

Table 2 describes the obstetric profile of 300 primiparous mothers: 65.7% were booked, but only 10% attended the recommended ≥ 4 ANC visits; 27.7% had no ANC, 30.7% had two visits, 20% had three, and 11.7% had one. A mere 31.3% underwent normal vaginal delivery, while 68.7% had cesarean or instrumental deliveries. Only 21.3% received neonatal care education during their antenatal or postnatal visits.

Table 2. Obstetric Characteristics of the Study Participants (n = 300)

Characteristic	Categories	Frequency (%)

Booking Status	Booked	197 (65.67%)
	Un-booked	103 (34.33%)
Antenatal Visits	None	83 (27.70%)
	One	35 (11.70%)
	Two	92 (30.70%)
	Three	60 (20.00%)
	Four or more	30 (10.00%)
Mode of Delivery	Normal Vaginal Delivery (NVD)	94 (31.34%)
	Other than NVD	206 (68.66%)
Received Neonatal Teaching	Yes	64 (21.34%)
	No	236 (78.66%)

Mother's knowledge scores on neonatal danger signs (out of 12)

Table 3 shows the distribution of total knowledge scores. A majority of mothers scored between 3 and 7, with 24.3% scoring 7.

Approximately 35.7% scored 4 or below, indicating low knowledge, while only 5.3% scored a perfect 12.

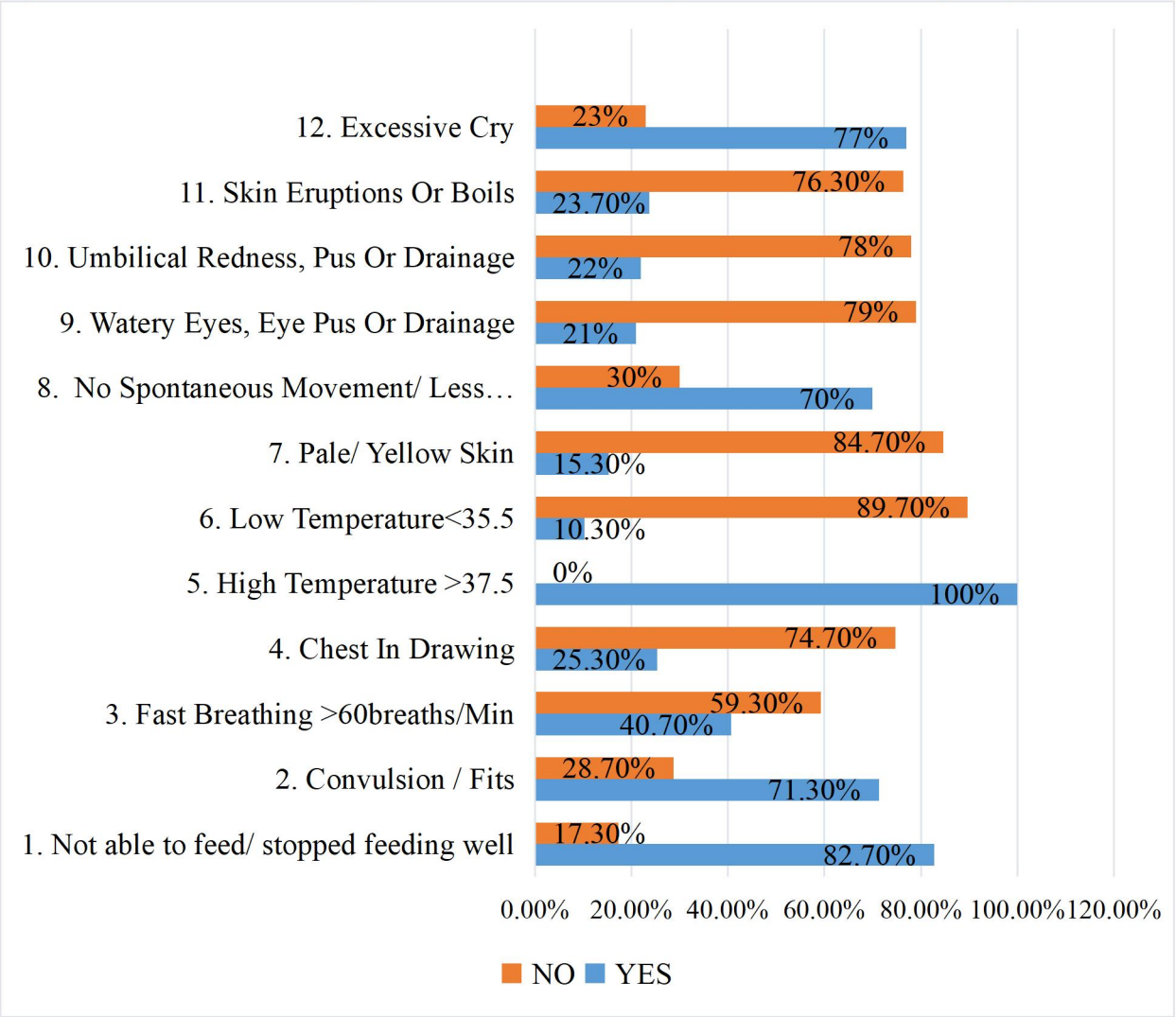
Table 3. Distribution of Mothers' Scores on Neonatal Danger Signs (out of 12)

Knowledge Score	Frequency (n)	Percentage (%)	Cumulative Percentage (%)
1	11	3.7%	3.7%
2	11	3.7%	7.4%
3	32	10.7%	18.1%
4	57	19.0%	37.1%
5	39	13.0%	50.1%
6	29	9.7%	59.8%
7	73	24.3%	84.1%
8	28	9.3%	93.4%
9	4	1.3%	94.7%
12	16	5.3%	100.0%
Total	300	100.0%	

Mother's knowledge about the WHO recognized Neonatal Danger Signs

Participants knew fever (>37.5 °C) as a neonatal danger sign universally (100%). High awareness followed for poor feeding (82.7%), excessive crying (77.0%), convulsions (71.3%), and reduced movement (70.0%). However, recognition dropped sharply for fast breathing (40.7%), chest indrawing (25.3%), skin eruptions (23.7%), umbilical infection signs (22.0%), eye discharge (21.0%), jaundice (15.3%), and hypothermia (<35.5 °C) (10.3%) (Figure 1). These results show that while mothers recognize some prominent warning signs, awareness of subtler but equally critical signs is much lower.

Figure.1. Mother's knowledge about the WHO recognized Neonatal Danger Signs



Mother's Level of Knowledge About Neonatal Danger Signs (Categorical):
Knowledge Categories (Table 4, n = 300): Mothers were categorized based on their total scores (out of 12) for neonatal danger sign knowledge: Low (≤ 4), Average (5–8), and High (≥ 9). The majority (53.5%) fell into the average category, 35.8% were in the low category, and only 10.7% achieved high knowledge—indicating that well-informed mothers constituted a small minority.

Table. 4. Mother's Level of Knowledge About Neonatal Danger Signs (Categorical):

Knowledge Level	Score Range	Frequency	Percentage (%)
Low Knowledge	≤ 4	107	35.8%

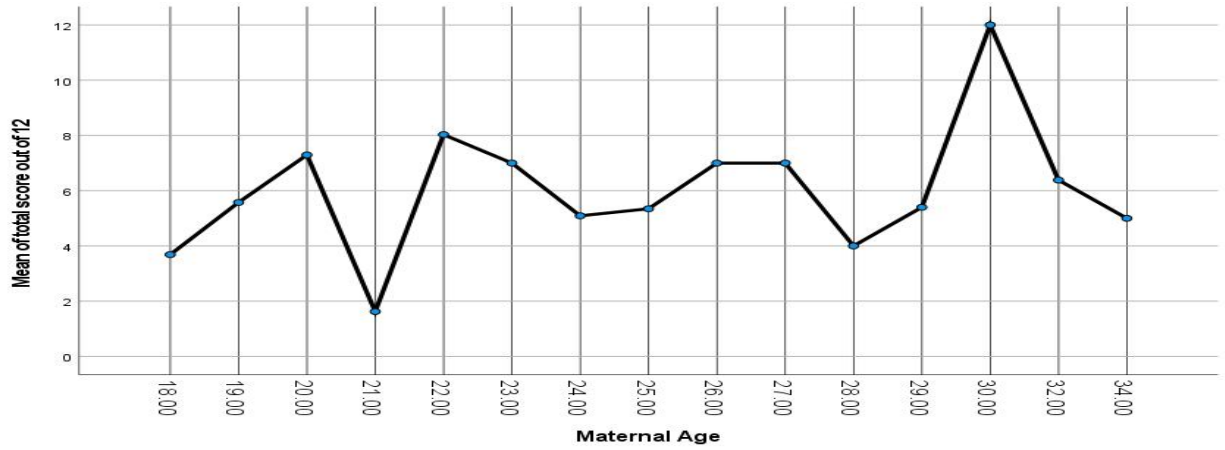
Average Knowledge	5–8	161	53.5%
High Knowledge	≥ 9	32	10.7%
Total	12	300	100.0%

Note. Knowledge level categories were based on total scores out of 12 on a neonatal danger sign knowledge assessment.

Inferential Statistics

A one-way ANOVA assessed differences in mean knowledge scores across age groups and revealed a significant effect of maternal age on neonatal danger sign knowledge ($F(14, 284) = 31.03, p < .001$). The highest scores were seen around age 30, while noticeably lower scores were observed among mothers aged 21 and 28. These results underscore maternal age as a key determinant of knowledge, with younger (early twenties) and late-twenties mothers showing lower awareness levels (Figure 2)

Figure 2. The effect of maternal age on knowledge scores about neonatal danger signs



Statistical association between Knowledge level with socio-demographic characteristics by applying chi- square (n = 300).

The Table 5 presents a summary of chi-square analyses conducted to assess the association between various socio-demographic factors and the level of maternal knowledge regarding neonatal danger signs (NDSs). Statistically significant associations ($p < 0.05$) were observed between knowledge levels and the following variables: maternal age ($\chi^2 = 5.951$, $p = 0.05$), religion ($\chi^2 = 6.061$, $p = 0.048$), participants' education ($\chi^2 = 160.430$, $p = 0.001$), spouse's education ($\chi^2 = 103.301$, $p = 0.001$), participants' occupation ($\chi^2 = 90.239$, $p = 0.001$), family type ($\chi^2 = 13.146$, $p = 0.01$), and residence ($\chi^2 = 63.438$, $p = 0.001$). The results indicate that mothers with higher educational attainment (both their own and their spouse's), those engaged in part-time jobs, living in urban settings, or from joint or extended families were more likely to have better knowledge of neonatal danger signs. These findings highlight the influence of socio-demographic determinants on maternal awareness and suggest the need for targeted health education interventions.

Table 5: Statistical association between Knowledge level and socio-demographic characteristics by applying chi- square (n = 300).

Socio-Demographic Variable	Low Knowledge n (%)	Average Knowledge n (%)	High Knowledge n (%)	Total n (%)	χ^2 (df)	p-value	Significance
Maternal Age					5.951 (2)	0.05	Significant
18–28 years	97 (32.33%)	128 (42.66%)	27 (9.00%)	252 (84%)			
29–39 years	10 (3.33%)	33 (11.00%)	5 (1.66%)	48 (16%)			
Religion					6.061 (2)	0.048	Significant
Muslim	87 (29.00%)	109 (36.33%)	23 (7.66%)	219 (73.1%)			
Non-Muslim	20 (6.66%)	52 (17.33%)	9 (3.00%)	81 (26.9%)			
Maternal Education					160.43 (6)	0.001	Highly significant
Uneducated	107 (36.60%)	75 (25.00%)	14 (4.60%)	196 (65.33%)			
Primary	0 (0%)	61 (20.00%)	0 (0%)	61 (20.0%)			
Matriculate	0 (0%)	16 (5.33%)	18 (6.00%)	34 (11.33%)			
Intermediate	0 (0%)	9 (3.00%)	0 (0%)	9 (3.00%)			
Spouse's Education					103.30 (8)	0.001	Highly significant
Uneducated	39 (13.00%)	18 (6.00%)	0 (0%)	57 (19%)			
Primary	41 (13.66%)	28 (9.33%)	0 (0%)	69 (23%)			
Matriculate	22 (7.00%)	42 (14.00%)	9 (3.00%)	73 (24.33%)			
Intermediate	5 (2.00%)	64 (21.00%)	23 (8.00%)	92 (30.66%)			
Graduation	0 (0%)	9 (3.00%)	0 (0%)	9 (3%)			
Occupational Status					90.24 (4)	0.001	Highly significant

Housewife	107 (35.60%)	139 (46.33%)	14 (4.66%)	260 (86.66%)			
Part-time	0 (0%)	14 (4.66%)	18 (6.00%)	32 (10.66%)			
Full-time	0 (0%)	8 (2.66%)	0 (0%)	8 (2.66%)			
Family Type					13.15 (4)	0.01	Significant
Nuclear	39 (13.00%)	30 (10.00%)	5 (1.66%)	74 (24.66%)			
Joint	27 (9.00%)	55 (18.50%)	13 (4.33%)	95 (31.66%)			
Extended	41 (13.50%)	76 (25.33%)	14 (4.66%)	131 (43.66%)			
Residence Status					63.44 (4)	0.001	Highly significant
Urban	5 (1.66%)	65 (21.66%)	18 (6.00%)	88 (29.33%)			
Rural	83 (27.66%)	67 (22.33%)	5 (1.66%)	155 (51.66%)			
Semi-urban	19 (6.30%)	29 (9.66%)	9 (3.00%)	57 (19%)			

Association of Level of Knowledge about Neonatal and Obstetric Factors: Table 6 reveals strong links (all p = .001) between maternal knowledge and obstetric factors: being booked for ANC, attending at least 4 antenatal visits, receiving neonatal-care education, having a cesarean/instrumental delivery, attending postnatal care, and staying ≥ 3 days in the hospital were each associated with significantly higher knowledge levels. No un-booked mothers reached "high" knowledge, while 10.7% of booked mothers did.

Table 6: Association of Level of Knowledge about Neonatal and Obstetric Factors

Variable	High Knowledge %	Key Finding
Booking Status	Booked: 10.7%; Un-booked: 0%	Booked mothers significantly more knowledgeable
ANC Visits (≥4 visits)	16.7%	"Dose-response" seen—more visits = higher awareness
Neonatal Care Education	With education: 36%; Without: 3%	Education greatly improves knowledge
Delivery Mode (C/S)	C/S: 13%; NVD: 5%	Caesarean deliveries tied to better

		awareness
PNC Attendance	Attended: 44%; Missed: 2%	Follow- up boosts knowledge significantly
Hospital Stay (≥3 days)	24%	More time in hospital corresponds with higher awareness

Multinomial Logistic Regression Analysis

The multinomial logistic regression showed that higher maternal education**,** urban residence**,** part-time employment**,** and factors reflecting health service engagement (booking, ≥4 ANC visits, neonatal education, postnatal visits, cesarean delivery, and ≥2-day hospital stay) were independently associated with significantly greater odds of average or high knowledge of neonatal danger signs compared to low knowledge (all $p < 0.05$). Notably, matriculate-educated mothers were over **8-fold**, and urban mothers nearly 8-fold, more likely to have high knowledge (Table 7). Reception of neonatal-care education and being employed part-time also substantially increased the likelihood of elevated awareness.

Table 7. Multinomial Logistic Regression Predictors of Maternal Knowledge (n = 300)

Predictor	Comparison Group	OR (95% CI)	p- value
Participant's education	Matriculate vs. Uneducated	8.20 (3.54–19.0)	<0.001
	Intermediate vs. Uneducated	4.56 (1.40–14.8)	0.012
Spouse's education	Intermediate vs. Uneducated	5.25 (2.48–11.1)	<0.001
Occupation	Part-time vs. Housewife	6.70 (3.20–14.0)	<0.001
Family type	Joint vs. Nuclear	2.33 (1.01–5.36)	0.048
Residence	Urban vs. Rural	7.92 (3.12–20.1)	<0.001
ANC booking status	Booked vs. Unbooked	3.90 (1.85–8.21)	<0.001
ANC visits	≥4 vs. <4	5.40 (2.60–11.2)	<0.001
Neonatal education received	Yes vs. No	6.75 (3.01–15.1)	<0.001
Postnatal visit	Yes vs. No	2.85 (1.38–5.87)	0.004
Mode of delivery	Cesarean vs. NVD	2.60 (1.12–6.03)	0.027
Hospital stay ≥2 days	vs. 1 day	2.95 (1.41–6.17)	0.004

Discussion

This study found that only 10.7% of first-time mothers had high awareness of WHO neonatal danger signs (NDSs), while 53.7% had average and 35.8% had low knowledge—mirroring low awareness reported in other LMICs[14], [15]. Maternal and paternal education were strong predictors: matriculate-educated mothers were ~8-fold and those with intermediate education ~4.6-fold more likely to have high knowledge; similarly, spouses with intermediate education increased odds ~5.3-fold—findings consistent with research from Ethiopia and Nepal[16], [17]. Urban residence conferred nearly eightfold higher knowledge compared to rural settings, reflecting urban–rural disparities reported in similar populations[16], [18]. Age also played a role: mothers in their early or late twenties showed lower awareness than those around age 30, aligning with trends seen in sub-Saharan Africa and Asia[17], [19].

Regarding engagement with maternal health services, mothers who were booked for ANC, had ≥ 4 antenatal visits, received neonatal-care education, delivered via cesarean, attended PNC, or stayed ≥ 3 days in hospital exhibited significantly higher knowledge. This is consistent with Ethiopian findings that ≥ 4 ANC visits greatly improve awareness[16], and that structured neonatal education further boosts maternal knowledge[20], [21]. Extended hospital stays allow more time for counseling[22]. Additionally, timely and context-specific education during both antenatal and postnatal periods emerged as a critical enabler of maternal NDS knowledge. Studies from Coimbatore and Tanzania demonstrated that structured education—either before delivery or immediately postpartum—significantly boosted maternal awareness. In Coimbatore, mothers with moderate knowledge increased to adequate awareness after tailored educational sessions[23]. A Tanzanian study similarly found that mothers who received ENC counselling before delivery were 1.7 times less likely to have poor knowledge, and those counseled afterward were over 4 times less likely[24]. These findings underscore the amplified impact of educational counselling when integrated at multiple touch points in the maternal care pathway—an approach that could be scaled across Pakistani public hospitals, especially given the suboptimal ANC engagement and low discharge education reported in our cohort. Moreover**,** hospital discharge presents a vital yet underused opportunity for reinforcing neonatal care messages. A scoping review of discharge-education interventions across LMICs found that multifaceted, visual-based programs delivered just-in-time to mothers during hospital stay improved retention of neonatal care principles better than generic prenatal messages[25]. Our results—showing significantly higher knowledge among cesarean-delivered mothers and those with longer hospital stays—suggest that longer maternity stays may naturally facilitate this window. To leverage this, standardized discharge protocols could incorporate brief, culturally adapted educational sessions (e.g., using flipcharts or mobile videos) led by trained nurses or community health workers. Such scalable interventions have the potential to narrow knowledge gaps between urban and rural, educated and less-educated mothers.

Conclusion

This study highlights a significant gap in neonatal health knowledge among first-time mothers in Pakistan, with only 10.7% demonstrating high awareness of WHO-defined neonatal danger signs. Critical socio-demographic predictors included maternal and paternal education, urban residence, and maternal employment; stronger health service factors involved ANC booking, completing four or more visits, receiving structured neonatal education, cesarean delivery, postnatal care follow-up, and extended hospital stays. Tackling these disparities requires integrating standardized neonatal danger-sign education into routine ANC and discharge protocols, especially targeting younger, rural, and less-educated mothers, while actively involving male partners and leveraging hospital time to reinforce learning. Such evidence-based, contextual interventions can meaningfully improve timely recognition of neonatal illness and ultimately enhance newborn survival outcomes.

Strengths

This study's major strengths lie in its targeted focus on primiparous women at hospital discharge—a critical yet underrepresented population in neonatal health research—and its integration of both socio-demographic and health-service variables (e.g., parental education, ANC attendance, delivery type, and hospital stay duration) into a comprehensive multivariate analysis, enhancing contextual applicability across LMIC settings[14,16].

Limitations

Limitations include its cross-sectional design, which restricts causal inferences; a single tertiary hospital setting that may limit wider generalizability; reliance on self-reported data prone to recall and social desirability bias; and absence of qualitative components, which constrained insights into cultural beliefs and household decision-making dynamics surrounding care-seeking[12].

Future Directions

Future research should evaluate structured neonatal danger-sign education interventions integrated into ANC, hospital discharge, and postnatal care using experimental or longitudinal designs; employ mixed-methods and qualitative approaches to explore knowledge retention, cultural factors, and behavior change mechanisms; broaden study settings to include rural and district-level health facilities for improved representativeness; and investigate the roles of male partners, elder family members, and community health workers in reinforcing maternal knowledge and improving neonatal care outcomes.

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