

# Socioeconomic Disparities in Accessing Early Newborn Care in Pakistan: Secondary Data Analysis of Nationally Representative Sample

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## What is already known on this topic?

- Poor standards, staff, and infrastructure hinder newborn care practices in Pakistan, particularly in rural and low-income areas.
- Socioeconomic disparities significantly influence newborn care outcomes, with higher mortality rates observed in rural and poorer populations compared to urban and wealthier families.
- Previous studies assessed maternal knowledge and practices regarding newborn care lacked a comprehensive focus on all 6 World Health Organization-recommended signal functions (cord examination, temperature measurement, danger sign counseling, breastfeeding observation, and weight measurement) during the first 48 hours.

## ABSTRACT

**Objective:** Pakistan ranks third in newborn mortality. The study aims to examine any socioeconomic disparities in 48-hour newborn care practices in Pakistan using 6 signal functions.

**Materials and Methods:** Using R (version 4.3.1), a secondary analysis of 3936 mothers' Pakistan Demographic and Health Survey 2017–2018 data was performed. Newborn care practices in 48 hours of life were measured using 6 indicators: cord examination, temperature measurement, danger sign counseling, breastfeeding counseling, breastfeeding observation, and weight measurement. The outcome variable was defined as completing at least 2 signal functions. The frequencies of explanatory variables were estimated using descriptive analysis. Multivariate logistic regression was performed between independent variables and at least 2 signal functions.

**Results:** Among mothers practicing the most newborn care, 71.8% were from urban areas, 81.9% were among the richest, 68.9% had institutional deliveries, 71.3% had 4 or more antenatal care (ANC) visits, 81.5% had cesarean sections (C-sections), and 68.1% were attended by skilled birth attendants. After adjusting for covariates, the likelihood of having at least 2 signal functions was 2.46 times greater for C-sections and 1.58 times greater for institutional deliveries, 2.41 times more probable for mothers with over 4 ANC visits, 1.75 times more likely for those with skilled birth attendants, and 1.64 times more common for the richest mothers.

**Conclusion:** Wealth, C-sections, institutional births, skilled birth attendants, and frequent ANC visits were related to higher care levels, indicating the need for targeted measures in vulnerable populations.

**Keywords:** Newborn care, Pakistan, postnatal, socioeconomic disparities

## INTRODUCTION

Globally, an estimated 7.7 million children under the age of 5 years die annually, with around 3.1 million neonatal mortalities during the newborn phase. Remarkably, a significant proportion of these fatalities occur in poor countries.<sup>1</sup> Based on data from the World Health Organization (WHO), it has been observed that the neonatal phase, encompassing the initial 28 days after birth, has a considerable mortality rate, contributing to around 45% of total deaths among children under the age of 5.<sup>2</sup> Within the early 24 hours following delivery, approximately 50% of neonatal deaths occur, while a higher proportion of 75% occur during the neonatal phase, spanning from 0 to 6 days after delivery.<sup>3</sup> The WHO has recommended a range of essential newborn care (ENC) procedures that must be adhered to. These measures encompass thermal care, counseling on danger signs and breastfeeding, and evaluation of the umbilical cord.<sup>4</sup> Implementing ENC practices, encompassing immediate primary care during birth, and ongoing care during the neonatal period in both home and hospital

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## What this study add to this topic?

- Using nationally representative data, this study is one of the first to comprehensively analyze all 6 signal functions of postnatal care within the first 48 hours.
- This study highlights the uneven implementation of all 6 essential newborn care (ENC) signal functions, with cord examination being the most performed and weight measurement the least.
- Wealth, institutional deliveries, skilled birth attendants, frequent antenatal care visits, and cesarean sections significantly improve the likelihood of achieving ENC practices.

environments can potentially decrease the occurrence of morbidity and mortality among newborns.<sup>5</sup>

Pakistan is positioned as the third-highest country globally in terms of neonatal mortality. The promotion of newborn health has been underscored by the Sustainable Development Goals (SDGs), which aim to reduce the neonatal mortality rate to 70 per 100,000 and the neonatal mortality rate to 12 per 1,000 live births by the year 2030.<sup>6</sup> The 2012–2013 Pakistan Demographic and Health Survey (PDHS) found 55 neonatal deaths per 1,000 live births.<sup>7</sup> Due to significant advances in newborn care integration into national policy over the past decade, neonatal mortality rates have decreased by 0.9% annually.<sup>8</sup> This estimation suggests that the present decline in death rates would not be sufficient for Pakistan to attain its SDGs successfully.<sup>7</sup> Besides, Pakistan continues to struggle with the problem of inequalities in postnatal care (PNC).<sup>9</sup> Based on an analysis of data from the 2017–18 PDHS, significant discrepancies in newborn mortality rates were evident across several socioeconomic and demographic factors, indicating inadequate provision of social and healthcare services in the public sector.<sup>10</sup> More than twice as many newborns in Pakistan's poorest families die on their first day. Rural areas have a greater mortality rate than urban ones.<sup>11</sup> A study, in addition, revealed several traditional neonatal care practices in Pakistan, including the use of pre-lacteals, the initiation of breastfeeding at a later age, and the practice of cutting the umbilical cord without using a sterile technique.<sup>12</sup> The above practices are affected by the culture and religion of the caregivers and often do not correspond with the WHO's recommended ENC practices.<sup>13</sup> In the past literature, mothers' knowledge, attitude, and practices regarding newborn care were assessed, and identified factors that influence newborn care practices; however, there is a lack of studies that cover all 6 signal functions of PNC performed. Evaluating ENC practices on newborn care may help lower-middle-income countries (LMIC), notably Pakistan, develop and execute initiatives to enhance neonatal care.<sup>5</sup> Therefore, the present research aims to examine any socioeconomic discrepancies in providing ENC practices using signal functions during the first 48 hours in Pakistan.

## MATERIALS AND METHODS

### Data Source

The Demographic and Health Survey (DHS) program conducted over 300 door-to-door cross-sectional surveys on nutrition, fertility, family planning, and maternal and newborn health in over 90 developing nations.<sup>14</sup> This study used data from the PDHS 2017–18, a national survey managed by the Ministry of National Health Services, Regulations, and Coordination supported by the Pakistan Bureau of Statistics and ICF International. Based on the most recent census, the PDHS 2017–18 sampled 168,943 enumeration blocks (EBs), 55,365 in urban regions and 113,578 in rural areas.<sup>14</sup>

### Study Population

The PDHS 2017–18 used a 2-stage stratified sampling method to recruit ever-married women of reproductive age (15–49 years).<sup>14</sup> The stratification was achieved by dividing 8 regions of Pakistan (Punjab, Sindh, Khyber Pakhtunkhwa [KPK], Balochistan, Islamabad Capital Territory [ICT], Gilgit Baltistan [GB], Azad Jammu and Kashmir [AJK], and Federally Administered Tribal Areas [FATA]) into urban and rural areas, creating 16 sampling strata. Within each EB, 28 households were randomly selected. Based on the recommendation by DHS, AJK, and GB were excluded from the national estimates.<sup>14</sup> The survey interviewed 12,364 of the 13,118 eligible women, resulting in a response rate of 94.3%. Within the 2 years preceding the survey, 3,936 recorded live births were among these interviewed women. The unit of analysis for this study was the children born to mothers who had a live birth during this period.

### Data Collection

The DHS program developed a standard and model questionnaire tailored with input from specialists in target countries such as Pakistan.<sup>14</sup> Section 4 of the questionnaire was used to gather data on prenatal and PNC in this study. The DHS survey collects this information retrospectively from mothers of the most recent live births within the 2 years preceding the survey. The ICF Institutional Review Board and the National Bioethics Committee (NBC) Pakistan Research Ethics Committee reviewed and approved the survey. The 2017–18 Pakistan DHS complies with all the requirements of 45 CFR 46, "Protection of Human Subjects." Each participant provided informed consent. The ICF Institutional Review Board approval number is

FWA00000845 on October 19, 2017. The NBC Pakistan Research Ethics Committee reference number is 4-87/NBC-285//17/1438 on November 17, 2017.

### Study Variables

This study used 6 indicators of newborn care practices in the first 2 days of life from the PDHS 2017-18: cord examination, temperature measurement, danger sign counseling, breastfeeding counseling, breastfeeding observation, and weight measurement.<sup>14</sup> The outcome variable is defined as the presence (1) or absence (0) of at least 2 signal functions (out of 6) performed during the first 2 days after birth, as this threshold reflects standard practice levels reported in the PDHS 2017-18.<sup>14</sup> Mothers asked whether any medical practitioner had performed the above procedures within 2 days of their child's birth. Demographic and socioeconomic status was measured by the mother's age at birth, education, wealth index, residence, and region. Based on the mother's and baby's birth dates and age at delivery, the mother's age at birth was categorized into 3 groups: less than 20 years, 20–34 years, and 35 years or older. The mother's education level was determined by asking the participant if she had ever attended school and her highest class. Furthermore, the divisions were no education, primary (up to grade 5), secondary (up to grade 10), and higher (grades 11 and above).

The wealth index was calculated using the household's assets and amenities and was divided into 5 quintiles: poorest, poorer, middle, richer, and richest. The DHS surveys used a standard asset and service set to construct the wealth index. These include the type of flooring, water supply, sanitation facilities, electricity, and ownership of items such as a radio, television, telephone, refrigerator, and type of vehicle. Additional indicators, such as the number of persons per sleeping room, ownership of agricultural land, domestic servants, and other country-specific items, were also included in the calculation. The methodology for constructing wealth quintiles has been well-documented in prior literature.<sup>15</sup>

In addition, residential status was urban or rural in the Punjab, Sindh, KPK, Balochistan, ICT, and FATA regions. Access to information and healthcare resources was measured through questions on media exposure, mobile phone ownership, perceived difficulty in accessing healthcare facilities, and involvement in health-related decision-making. To assess maternal utilization

of healthcare services, the following components were added: the presence of skilled birth attendants (birth assisted by doctors, nurses, midwives, lady health visitors, and community midwives), place of delivery, whether a cesarean section (C-section) was performed, and the number and quality of antenatal care (ANC) visits.

The quality of antenatal care visits was assessed by creating a composite variable based on the following key indicators extracted from the DHS dataset: blood pressure measurement, urine sample taken, blood sample taken, iron tablets or syrup intake, and intestinal parasite drugs taken. These components were assessed as "yes" or "no" during the ANC visits. The overall quality of care was classified as "Good" if at least 4 essential components were provided and "Poor" if fewer than 4 were provided. This classification was coded as a binary variable (1 = good, 0 = poor). For newborn-related variables, the child's sex and birth order were also included.

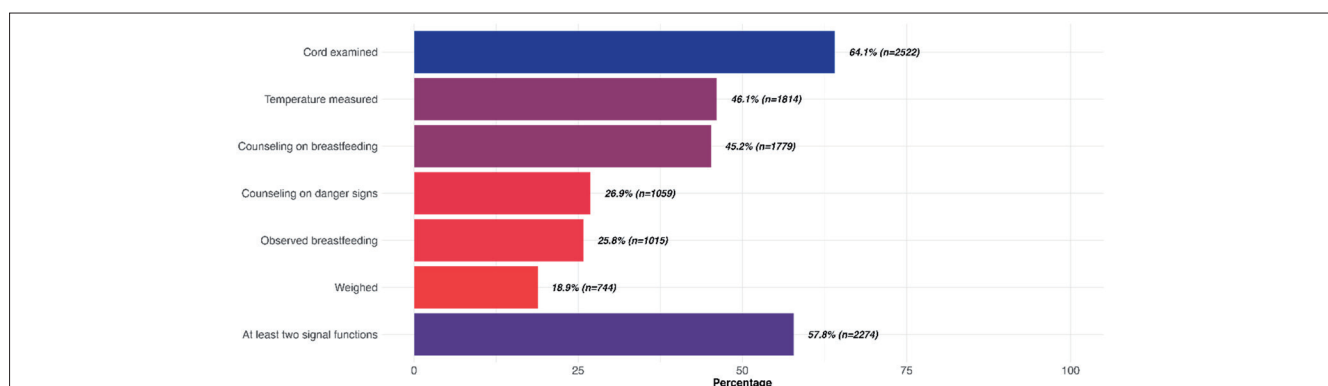
### Data Analysis

The data preparation and analyses were done using RStudio in the R programming language (version 4.3.1) (R Foundation for Statistical Computing, Vienna, Austria). Maternal factors and newborn practices were presented in frequencies and percentages and examined using survey-weighted binary logistic regressions to calculate crude odds ratios (OR) with 95% CIs and *P*-values. A significance level of 5% ( $\alpha = 0.05$ ) was considered the threshold for statistical significance when examining the association between each independent variable and the outcome variable. Stepwise multiple logistic regression was performed to adjust for the confounding effect of the participant's background and health characteristics. This method selected significant variables by iteratively including or excluding them based on their statistical significance while minimizing multicollinearity among predictors.

## RESULTS

### Prevalence of Newborn Care Practices

Figure 1 presents the percentage of newborns receiving each of the 6 signal functions of PNC within the first 2 days after birth, along with the percentage of newborns who received at least 2 signal functions ( $n = 2274$ , 57.8%). Cord examination was the most commonly performed signal function ( $n = 2522$ , 64.1%), followed by temperature measurement ( $n = 1814$ , 46.1%), and



**Figure 1.** Percentage of newborns receiving 6 signal functions of postnatal care.

**Table 1.** Background Characteristics of Study Participants by Signal Function Performed During the First 2 Days After the Birth

	Number of Births with Less Than 2 Signal Functions Performed	Number of Births with At Least 2 Signal Functions Performed	Total
Mother's age (years)			
<20	192 (53.61)	166 (46.39)	358 (9.1%)
20–34	1265 (40.12)	1888 (59.88)	3154 (80.1%)
35 and above	202 (47.76)	221 (52.24)	424 (10.8%)
Mother's education			
No education	1026 (54.94)	841 (45.06)	1867 (47.4%)
Primary	268 (43.31)	350 (56.69)	618 (15.7%)
Secondary	252 (28.17)	643 (71.83)	895 (22.7%)
Higher	114 (20.58)	442 (79.42)	556 (14.1%)
Place of residence			
Urban	366 (28.24)	930 (71.76)	1296 (32.9%)
Rural	1294 (49.01)	1346 (50.99)	2639 (67.1%)
Region			
Punjab	741 (35.68)	1336 (64.32)	2077 (52.8%)
Sindh	247 (27.22)	661 (72.78)	909 (23.1%)
KPK	444 (70.48)	186 (29.52)	630 (16.0%)
Balochistan	151 (76.28)	47 (23.72)	197 (5.0%)
ICT	9 (26.82)	23 (73.18)	32 (0.8%)
FATA	68 (75.39)	22 (24.61)	90 (2.3%)
Wealth index			
Poorest	442 (52.52)	399 (47.48)	841 (21.4%)
Poorer	444 (59.16)	306 (40.84)	751 (19.1%)
Middle	401 (47.15)	450 (52.85)	851 (21.6%)
Richer	236 (32.12)	499 (67.88)	734 (18.7%)
Richest	136 (18.01)	621 (81.99)	758 (19.3%)
Media exposure			
No	1018 (54.06)	865 (45.94)	1883 (47.9%)
Yes	642 (31.27)	1411 (68.73)	2052 (52.2%)
Owns a mobile phone			
No	1239 (48.88)	1296 (51.12)	2535 (64.4%)
Yes	421 (30.03)	980 (69.97)	1401 (35.6%)

breastfeeding counseling ( $n = 1779$ , 45.2%). However, birth weight measurement was the least common newborn care practice ( $n = 744$ , 18.9%). This distribution shows variability in the uptake of signal functions.

### Background Characteristics

Table 1 demonstrates the distribution of participants' socio-demographics, access to information, healthcare utilization, and child characteristics in relation to the number of signal functions performed during the first 2 days after birth, categorized as less than 2 or at least 2 functions performed. Most of the 3936 mothers were 20–34 years old at birth ( $n = 3154$ , 80.1%), with nearly half having no formal education ( $n = 1867$ , 47.4%). Most participants lived in rural areas ( $n = 2639$ , 67.1%), predominantly in the Punjab region ( $n = 2077$ , 52.8%). There is a gradient across the categories of wealth index, where births among wealthier mothers were more likely to receive at least 2 signal functions ( $n = 621$ , 81.9%) compared to mothers from the poorest category ( $n = 399$ , 47.5%).

### Health Characteristics

Table 2 presents the distribution of health characteristics of study participants. Mothers who reported having problems accessing healthcare facilities were less likely to receive

at least 2 signal functions. Differences can also be observed in the proportion of signal functions across mothers participating in health-related decision-making: 69.1% ( $n = 1179$ ) vs. 48.7% ( $n = 1068$ ). Mothers who had 4 or more ANC visits and received good-quality ANC had higher proportions of at least 2 signal functions performed: 71.3% ( $n = 1492$ ) and 73.3% ( $n = 1196$ ), respectively. Similarly, mothers who delivered with a skilled birth attendant, had institutional deliveries, or underwent a C-section showed higher proportions of at least 2 signal functions.

### Association of At Least 2 Signal Functions Performed with Background Characteristics

Table 3 shows regression results with crude and adjusted OR for background characteristics. Newborns with mothers aged between 20 and 34 years were 1.39 (95% CI 1.13–1.72) times more likely to receive at least 2 signal functions when compared to newborns with younger mothers. This effect was not statistically significant to be included in the multivariate analysis. In unadjusted analysis, we observed mothers with higher educational attainment were more likely to have their children get at least 2 signal functions when compared to mothers with no education. After accounting for confounding variables in the final model, the odds of the newborns in rural areas having at

**Table 2.** Health Characteristics of Study Participants by Signal Function Performed During the First 2 Days After the Birth

	Number of Births with Less Than 2 Signal Functions Performed	Number of Births with At Least 2 Signal Functions Performed	Total
Problem in accessing healthcare facility			
No	385 (35.09)	713 (64.91)	1098 (27.9%)
Yes	1274 (44.91)	1563 (55.09)	2837 (72.1%)
Health decision-making			
Does not decide	1124 (51.30)	1068 (48.70)	2192 (56.2%)
Decides	528 (30.92)	1179 (69.08)	1707 (43.8%)
Number of ANC visits			
None	321 (71.57)	128 (28.43)	449 (11.4%)
1–3	738 (52.96)	656 (47.04)	1394 (35.4%)
4 and more	600 (28.68)	1492 (71.32)	2093 (53.2%)
ANC quality			
Poor	1224 (53.14)	1079 (46.86)	2303 (58.5%)
Good	436 (26.69)	1196 (73.31)	1632 (41.5%)
Skilled birth attendant			
Unskilled	727 (71.31)	292 (28.69)	1019 (25.9%)
Skilled	930 (31.91)	1983 (68.09)	2913 (74.1%)
Place of delivery			
Elsewhere	787 (69.99)	338 (30.01)	1125 (28.6%)
Institutional delivery	872 (31.04)	1938 (68.96)	2810 (71.4%)
CS performed			
No	1511 (51.75)	1409 (48.25)	2920 (74.2%)
Yes	147 (14.49)	867 (85.51)	1014 (25.8%)
Sex of the child			
Male	829 (41.76)	1155 (58.24)	1984 (50.4%)
Female	1952 (42.59)	1120 (57.41)	1952 (49.6%)
Birth order			
1	341 (36.38)	596 (63.62)	937 (23.8%)
2–3	599 (38.72)	949 (61.28)	1548 (39.3%)
4–5	418 (45.83)	494 (54.17)	913 (23.2%)
>6	301 (56.00)	237 (44.00)	538 (13.7%)

least 2 signal functions performed were 3% less than those of newborns from urban settings.

In the unadjusted model, the odds for newborns from Sindh & ICT were higher than those from Punjab for having at least 2 signal functions performed. In contrast, newborns from KPK, Balochistan, and FATA regions had lower odds (cORs: 0.29, 0.21, and 0.23, respectively). However, the effect of ICT became statistically equivalent to Punjab after controlling for the effects of confounding variables. Regarding wealth, we observed a stepwise increase in the odds of newborns from poorer to richest households for the outcome variable compared to those from the poorest families. Nevertheless, after controlling for the effect of confounders, the effect diminished, with the odds for richer households becoming statistically similar to the poorest (aOR: 0.99, 95% CI: 0.94–1.05). Newborns from the richest households were statistically more likely to have higher odds (aOR: 1.08, 95% CI: 1.01–1.14) than those of the poorest families.

#### Association of At Least 2 Signal Functions Performed with Health Characteristics

Women who reported perceiving problems in accessing health-care facilities had significantly higher odds of having at least 2 signal functions performed on their newborns (aOR: 1.04, 95% CI: 1.01–1.07) than those who did not report such problems. The

odds of having at least 2 signal functions performed among women having access to media (aOR: 1.03, 95% CI: 0.99–1.07), participating in health-related decision-making (aOR: 1.06, 95% CI: 1.03–1.10), received good quality of ANC (aOR: 1.07, 95% CI: 1.04–1.11), had delivered with skilled birth attended (aOR: 1.11, 95% CI: 1.03–1.19), delivered at a healthcare facility (aOR: 1.09, 95% CI: 1.02–1.18) or underwent C-section (aOR: 1.16, 95% CI: 1.12–1.21) had higher odds when compared to those without these characteristics. Characteristics such as mother's age at the time of birth, maternal education, ownership of a mobile phone, child's sex, and birth order were excluded from the stepwise regression model.

## DISCUSSION

The findings showed that, regarding the PNC practices of 3936 mothers, mothers who were wealthier, better educated, lived in urban areas, gave birth in hospitals, and had three or more ANC visits were more likely to care for their newborns.

#### Variability in Uptake of Signal Functions

In this study, cord examination (64.1%) was the most common PNC signal function. In contrast, birth weight measurement (18.9%) was the least, consistent with previous research showing the uneven distribution of PNC signal functions.<sup>16</sup> The low

**Table 3.** Crude and Adjusted Odds Ratios for Background and Health Characteristics Associated with the Signal Function Performed During the First 2 Days After the Birth

	Crude Odds Ratio			Adjusted Odds Ratio		
	OR	95% CI	P	aOR	95% CI	P
Mother's age (years)						
<20		Ref			–	
20–34	1.39	1.13–1.72	.002		–	
35 and above	0.96	0.73–1.25	.763		–	
Mother's education						
No education		Ref				
Primary	2.00	1.65–2.45	<.001		–	
Secondary	3.17	2.67–3.78	<.001		–	
Higher	4.33	3.52–5.36	<.001		–	
Place of residence						
Urban		Ref			Ref	
Rural	0.50	0.44–0.57	<.001	0.97	0.94–0.99	<.05
Region						
Punjab		Ref			Ref	
Sindh	1.51	1.24–1.84	<.001	1.11	1.07–1.16	<.001
KPK	0.29	0.24–0.35	<.001	0.80	0.77–0.84	<.001
Balochistan	0.21	0.17–0.26	<.001	0.84	0.80–0.88	<.001
ICT	1.75	1.32–2.34	<.001	1.03	0.97–1.09	.348
FATA	0.23	0.18–0.30	<.001	0.85	0.80–0.89	<.001
Wealth index						
Poorest		Ref			Ref	
Poorer	0.90	0.73–1.09	0.283	0.96	0.92–0.99	.045
Middle	1.42	1.16–1.73	0.001	0.95	0.91–0.99	.043
Richer	2.45	2.00–3.01	<0.001	0.99	0.94–1.05	.888
Richest	5.42	4.37–6.75	<0.001	1.08	1.01–1.14	.015
Media exposure						
No		Ref			Ref	
Yes	2.77	2.44–3.16	<0.001	1.03	0.99–1.07	.050
Owns a mobile phone						
No		Ref				
Yes	2.37	2.07–2.72	<0.001		–	
Problem in Accessing Healthcare Facility						
No		Ref			Ref	
Yes	0.53	0.46–0.61	<0.001	1.04	1.01–1.07	.030
Health decision-making						
Does not decide	Ref	Ref				
Decides	2.51	2.20–2.87	<0.001	1.06	1.03–1.10	<.001
Number of ANC visits						
None	Ref					
1–3	2.89	2.31–3.63	<0.001	1.06	1.02–1.11	.007
4 and more	7.94	6.40–9.93	<0.001	1.14	1.08–1.19	<.001
ANC quality						
Poor		Ref			Ref	
Good	3.14	2.75–3.59	<0.001	1.07	1.04–1.11	<.001
Skilled birth attendant						
Unskilled		Ref			Ref	
Skilled	5.68	4.84–6.69	<0.001	1.11	1.03–1.19	.005
Place of delivery						
Elsewhere		Ref			Ref	
Institutional delivery	5.46	4.69–6.37	<0.001	1.09	1.02–1.18	.010

(Continued)



**Table 3.** Crude and Adjusted Odds Ratios for Background and Health Characteristics Associated with the Signal Function Performed During the First 2 Days After the Birth (Continued)

	Crude Odds Ratio			Adjusted Odds Ratio		
	OR	95% CI	P	aOR	95% CI	P
CS performed						
No		Ref			Ref	
Yes	6.80	5.57–8.37	<0.001	1.16	1.12–1.21	<.001
Sex of the child						
Male		Ref				
Female	0.96	0.85–1.09	0.564		–	
Birth order						
1		Ref				
2–3	0.89	0.75–1.06	0.184		–	
4–5	0.65	0.54–0.79	<0.001		–	
>6	0.41	0.33–0.51	<0.001		–	

prevalence of birth weight measurement in the present study raises concerns. Birth weight is an essential indicator of neonatal health since it reflects intrauterine growth and potential problems in early life.<sup>17</sup> Its decreased prevalence may be due to a lack of weighing scales, awareness, and training of healthcare providers as contributing factors.<sup>18</sup> Evidence from studies conducted in LMICs pointed to comparable difficulties in establishing comprehensive newborn care programs.<sup>5,19</sup> Thus, this practice's low frequency emphasizes the need for necessary equipment, robust training, and increased awareness among healthcare professionals.<sup>20</sup>

### Demographic Disparities

Global evidence supports the findings that maternal age, education, and urban residency are important factors in determining whether newborns receive adequate PNC.<sup>21,22</sup> The correlation between advanced maternal age and newborn care practices was consistent with previous research. It highlighted that women of advanced maternal age (35 years and older) tend to have more expertise and maturity, resulting in improved care practices.<sup>23</sup> However, this correlation decreased after adjusting for other variables, suggesting that age alone may not predict newborn practices.<sup>24</sup> The current study found that women more commonly used comprehensive care with greater levels of education. This finding aligned with past evidence that adults with higher education were more likely to adopt evidence-based care practices due to their increased health literacy and decision-making ability.<sup>19</sup> Education empowers mothers to make informed health decisions for themselves and their newborns.<sup>22</sup> However, half of the mothers in the research were uneducated, highlighting gaps in healthcare knowledge and practices related to education. Thus, the community should start educational programs to improve maternal health and newborn practices, considering the influence of maternal education on healthcare use and health-promoting behaviors.<sup>25</sup> Moreover, evidence from previous research suggested that rural populations may be less likely to implement recommended newborn care practices due to barriers to healthcare access,<sup>26</sup> corroborated by the present study's results of a significant urban-rural gap in performing signal functions.

In this study, mothers from Sindh showed higher odds of completing at least 2 newborn signal functions than those from

Punjab, despite literature suggesting Sindh's healthcare system has deteriorated more than Punjab's.<sup>27</sup> The quality of ANC may explain this contrast.<sup>28</sup> Past evidence showed that Sindh had better ANC quality than other provinces.<sup>29</sup> This supports the current study's finding that more ANC visits improved newborn signal function completion. This highlights the key role of ANC quality in improving PNC outcomes, even in regions with otherwise limited healthcare infrastructure.

### Economic Determinants

The present study's wealth gradient, where wealthier households had better likelihoods of at least 2 signal functions, is consistent with the well-established correlation between economic position and variations in healthcare access, health literacy, and health-promoting behaviors.<sup>30,31</sup> However, the reduced effect of wealth after adjusting for confounders indicates the intricacy of structural obstacles, such as systemic healthcare access inequalities<sup>32</sup> that remain even for the richest families in underprivileged areas. Compared to Pakistan, Misu and Alam<sup>9</sup> reported that PNC for mothers and newborns was more impacted by the disparity in wealth, media exposure, and delivery methods in Bangladesh.

### Role of Healthcare Utilization

Frequent ANC visits, institutional births, and skilled birth delivery were associated with better signal function. The current study findings aligned with the WHO's emphasis on the importance of ANC visits in improving neonatal outcomes, as they provide opportunities for health education, risk assessment, and early detection of complications.<sup>33</sup> Likewise, newborns delivered in hospitals or other healthcare facilities often receive more advanced care because of the availability of healthcare providers and specialized technology.<sup>34</sup> This study also found that cesarean births were more likely to have at least 2 signal functions performed, which might be because these cases received more medical attention. This finding, however, calls for further research to ensure that all newborns, regardless of delivery method, receive fair treatment. At least 2 signal functions were performed by mothers' participation in health-related decision-making and their access to media, which were identified as key drivers in this study. The interaction of maternal empowerment and media access underlines the need for policies that promote women's participation in household health decisions and media-based health education.<sup>35</sup> Particularly

in areas with limited resources, these initiatives can potentially increase access to quality neonatal care services while decreasing associated costs.<sup>36</sup> In this study, the association of wealth, institutional deliveries, skilled birth attendants, and frequent ANC visits with improved PNC outcomes reinforces the importance of improving healthcare infrastructure and services to decrease newborn mortality by 2030.

### Limitations

The study employed a cross-sectional design, which presents limitations in establishing causal relationships in newborn care. Although PDHS 2017–18 helped gather nationally represented data, it should be noted that it excluded marginalized populations, such as those in conflict-affected areas. Furthermore, the DHS program modified a standard questionnaire for Pakistan and used it in the study. However, accuracy relies on the respondents' ability to report information accurately. Moreover, the mothers who participated in the survey provided self-reported data. This introduces the possibility of recall and social desirability bias. The study focused on specific newborn care practices within the first two days of life. Even though these measures are crucial, they only comprise a portion of newborn care. This study did not consider other important facets of newborn care, such as immunization and PNC beyond two days. Addressing these gaps in future research could offer a more thorough understanding of newborn care.

### CONCLUSION

Despite the study's limitations, it highlighted that all 6 ENC signal functions were not consistently implemented, with cord examination being the most common and weight measurement being the least. Postnatal care was associated with factors such as wealth, C-sections, institutional deliveries, skilled birth attendants, and frequent ANC visits, suggesting that underprivileged populations require advanced interventions. Strengthening the continuum of care requires incentivizing healthcare professionals and mothers to carry out institutional births and all necessary ANC visits.

Community-based ANC initiatives can improve adherence to ENC by improving the quality and frequency of ANC visits. Maternal education and community-based healthcare awareness programs can also help bridge knowledge and practice gaps. Policymakers should prioritize providing necessary resources, such as weighing scales and healthcare practitioner training, to standardize care across regions. Empowering women to make health decisions and increasing media-based health education initiatives can improve neonatal outcomes. Pakistan may achieve its SDGs and improve newborn survival by taking these steps.

**Availability of Data and Materials:** The data that support the findings of this study are available on request from the corresponding author.

**Ethics Committee Approval:** This study was approved by the ICF Institutional Review Board (approval number: FWA00000845; date: October 19, 2017). This study was also approved by the NBC Pakistan Research Ethics Committee (approval number: 4-87/NBC-285//17/1438; date: November 17, 2017).

**Informed Consent:** Verbal and written informed consent was obtained from the mothers who agreed to take part in the study.

**Peer-review:** Externally peer-reviewed.

**Author Contributions:** Concept – M.A.; Design – M.A., O.R.; Supervision – M.A.; Resources – O.R.; Materials – O.R., R.A.K. Data Collection and/or Processing – S.Z.; Analysis and/or Interpretation – O.R.; Literature Search – R.A.K.; Writing – R.A.K.; Critical Review – R.A.K.

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