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RESEARCH PAPER

Assessing Healthcare Access Disparities and Mother–Child Health Outcomes in Pakistan: Evidence from PDHS (2017-18)

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ABSTRACT

This research examines the impact of inequities in contact with professional and non-professional health care providers through the utilisation of mother and child health services. Disparities in provider availability continue to hinder improvements in mother and child health, stunting progress on Sustainable Development Goal. Our study used Pakistan Demographic and Health Survey (2017-18) data of 8,287 females (15-49 years). Bivariate and multivariate regression models were applied to assess the correlation between the health care provider. The results of regression analysis show that exposure to professional providers has a positive association with uptake of adequate ANC, service delivery and mother and child post-natal care. On the other hand, non-professional providers have a statistically significant but relatively weak association with ANC utilization and PNC visits. These results highlight the need to increase the presence of professional health providers and access to services to promote mother and child health care quality in Pakistan.

Keywords: Mother Health Services, Antenatal Care Utilization, Post-natal Care, Healthcare Provider Distribution, Generalized Structural Equation Modeling GSEM

Introduction

Improving mother and child health is a key priority of the global Sustainable Development Goals (SDG) and inequalities in access to basic health care services continue to hinder progress, especially in low and middle-income countries like Pakistan. While the provision of antenatal care (ANC), skilled birth attendance and post-natal care (PNC) are well-known interventions to prevent avoidable maternal and newborn diseases and death, their uptake is still inequitable across different sections of the population. In this regard, the availability and effectiveness of Human Resources for Health (HRH) have a critical impact on the accessibility and quality of the services (Suhail & Azhar, 2016; Witter et al., 2020).

There are global disparities in the distribution of the health workforce. Nations burdened with illness often lack available skilled health professionals, affecting their capacity to provide basic mother and child health services (Anyangwe & Mtonga, 2007). With global efforts to strengthen health systems, there are issues of inequities in access and distribution of HRH, particularly in low-income countries where there are low numbers of trained health care providers, impacting health service delivery and quality (Lassi et al., 2016; World Health Organization, 2024; Azzopardi-Muscat et al., 2023). This demonstrates the need for evidence-based policies for improved access and quality of HRH. This is not limited to Pakistan, where there is inequity in access and distribution of HRH across provinces and urban and rural areas. The health sector faces a shortage of skilled health care providers (nurses and midwives in rural areas) and uneven distribution of services (urban-

rural) and hence limited access to health services in rural areas (Nawaz et al., 2021; Hafeez et al., 2010; Khan & Hussain, 2020). This is compounded by "brain drain" with a large number of doctors emigrating from Pakistan and limiting health services (Nadir et al., 2023). These contribute to the mother and child health inequities in Pakistan.

Thus, this study explores health care provider's influence on the utilisation of infants alongwith mother's health care with the PDHS (2017-18). Firstly, it looks at mother's health care use and secondly the influence of these providers on child health care through a generalised structural equation modelling (GSEM). The findings will provide insight into the health workforce distribution and mother and child health care access in Pakistan.

Literature Review

Maternal deaths have fallen in Pakistan, but are still high, with 186 mothers per 100,000 live births dying as a result of pregnancy complications, and significantly higher in rural and poorer regions. Likewise, child mortality is also strongly linked to socio-economic factors, including being higher among the poor than the rich (Patel et al., 2021). Globally, mother deaths have declined over the past few decades, but they are not on track to meet global targets, particularly in regions with weak health care systems and limited health and midwifery staff (Souza et al., 2024; World Health Organization, 2021).

There are also disparities in mothers' health service use. Whilst antenatal care (ANC) and institutional birth are almost universal in high-income countries, this is not the case in low- and middle-income countries and particularly for timely post-natal care (Lawson & Keirse, 2013; Ferreira et al., 2020). Many countries still have a large number of women who do not deliver in health facilities and who do not have timely post-natal visits, which increases the risk of adverse health outcomes for mother and child (Waiswa et al., 2021; Shaw et al., 2016). This is also impacted by geographical, socioeconomic and health system inequalities (Bolan et al., 2021; Tadesse, 2020).

A recent study, using data from Pakistan, shows that these inequities still exist and are also clustered. This study of the PDHS (2017-18) demonstrates that mother health care not being utilised is concentrated in particular locations (less progressive provinces) and related to poverty, mother education and women's empowerment (Kamal et al., 2025). Similarly, although antenatal care and skilled birth attendant have improved, there remain inequalities as a result of structural and socio-economic factors that impact women's access to health care (Afridi et al., 2025). Similarly, with regards to child health, there are inequalities in accessing health care, with mother schooling and family wealth a determinant of health care (Haque et al., 2024). We know that from other countries there is a lot of evidence that there are inequalities in socio-economic and geographical inequality for antenatal care, making our problem more generalisable (Youmbi et al., 2024; Afridi & Jan, 2024).

In Pakistan, public health investments are in tertiary health care, rather than primary health care which is important to deliver preventable mother and child health care services (World Health Organization, 2023).Although some studies have examined the socio-economic implications of health care utilisation, fewer have looked at how health care provider availability influences health care seeking (Banke-Thomas et al., 2017; Bain et al., 2022). This is because professional and non-professional providers can affect health care seeking and utilisation.

Methodology

We analysed data from the PDHS (2017-18), a nationally representative survey that is repeated every 5 years in several countries. The PDHS used a two-stage stratified sampling technique in all four provinces and other administrative divisions. Strata were

defined by urban and rural areas for representation. The target population was females between 15-49 years of age selected for interview using pre-tested, structured questionnaires. The survey is structured into three major modules: household, female and male. For this analysis, we extracted mother and child healthcare (MCH) variables from the female's dataset. PDHS adopts rigorous data collection procedures to ensure data quality, such as the selection of trained data collectors, and the use of standardised tools and validation checks. Main indicators, such as antenatal care (ANC) visits, post-natal care (PNC) and place of delivery were reported with a 5-year recall. A total of 8260 observations were included in the data for ANC visits and 8,287 for last-born children.

Our population of interest was limited to births within five years before the survey. There were 12,708 births identified, but to avoid inconsistency of mothers' health care indicators, only the last-born child was considered. This left a total of 8,287 observations. ANC care was considered in two ways: as a continuous variable (number of visits n = 8,260) and as a Dummy variable, namely, less than four visits versus four or more visits. The place of delivery variable was defined as whether the child was born in a health service or not (n = 8,273). The post-natal care for mothers was measured in three categories: none, non-professional provider and professional provider within two months of delivery. For children, post-natal check for children within 2 days of birth was examined. A composite index was created based on five key services: examining the cord, measuring temperature, advising on danger signs, advising on breastfeeding and observing breastfeeding. Two types of health-care providers were considered: firstly, by professionals (such as medical specialists, physicians, midwives and nurses) as well as secondly by the non-professionals like pharmacologists, the chemists and practitioners of traditional medicine). The sample size for different models changed due to observations with missing values in control variables. Since the missingness was random and small (1.5%), list-wise deletion was used in the data analysis.

Variables and Measurement

The study has four outcome measures (i) number of antenatal care (ANC) visits, (ii) delivery place, (iii) post-natal checks for mothers (PNC) and (iv) post-natal checks for children. The total of antenatal care visits (ANC) is used in two ways. Importantly, it is used as a quantitative variable measuring the number of visits. Secondly, it is converted to a Dummy variable that refers to less than 3 or 3 or more visits. Place of birth is the place where the most recent birth took place. It is a binary variable: 0 = non-medical and 1 = medical service. Post-natal checks for mothers (PNC) are considered a qualitative variable, based on whether and from whom the mother received care in the two months after the delivery. Likewise, the post-natal checks for children are also treated as a quantitative outcome variable, based on care received within 2 days of birth. This variable is based on five essential components of care received: checking the cord, taking temperature, advising on danger signs, advising on breastfeeding and checking breastfeeding practice.

Health-care providers (as defined by the type of care received for antenatal services) is the key independent variable. A total of three categories are considered. Those (women) who seek no care by professional for antenatal care (ANC) are considered as no care (coded with 1). Those who consulted chemists, pharmacists, compounders, and traditional practitioners are classified as non-professional care providers (coded with 2). On the other hand, those who accessed care from professionals (doctors, nurses and midwives) are grouped as professional health care providers (coded with 3). The "no care received" category is used as a reference category in the analysis, to compare across types of care providers. The conceptual model is shown in Figure 1.

To control for confounding factors, we considered a series of socio-demographic factors at different levels (child, mother, household and community) as control variables. These variables have been shown to be significant predictors of mother and child health. At

the child level, these include gender, age and place of birth (medical service or not). Maternal factors include age, number of living children and employment. Household characteristics represent access to and economic status. Health care access is represented by perceived access to health care, which is problematic or not problematic. Household economic conditions are measured by an index of household wealth generated with the Principal Component Analysis (PCA). It is calculated from the ownership of a range of assets, including a television, bicycle or car, and is extracted from the PDHS. Community factors include region and rural/urban status

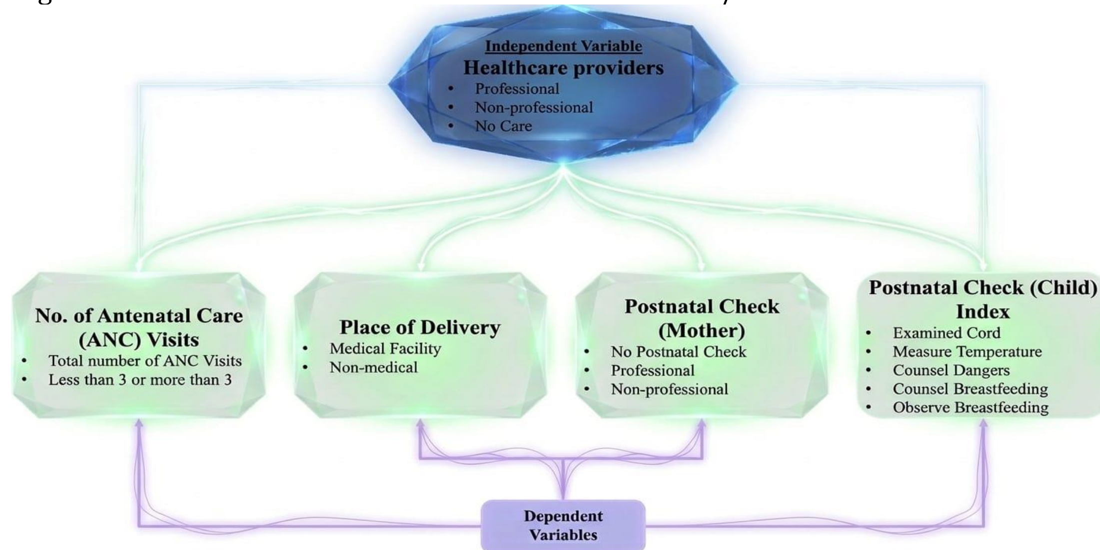

Figure 1 Schematic representation of the linkage amongst healthcare provider, mother and child healthcare indicators.

We began by using descriptive methods to describe the study sample. This entailed weighted percentages (to account for the sampling scheme) and mean with standard deviation. In the initial (dummy) stage, percentages and graphics were used to assess the association of the explanatory variable and each outcome variable: visiting ANC, loction of servuces delivered, mother's post-natal checks and children's post-natal checks. We calculated the Variance Inflation Factor (VIF) to test the multicollinearity of the predictors, which was 1.5, and we found no serious collinearity. In the multiple stage, variables were retained based on statistical significance (i.e. those with t-statistics outside of the range of (−2) to (+2) and or having a probability of 0.1 to draw the GSEM model. This is because t-statistics greater than (±2) are typically used to determine statistically significant relationships.

GSEM was chosen because it allows for the simultaneous estimation of multiple equations with different outcomes (quantitative, dummy and qualitative). It also accounts for intricate interdependencies among variables and non-normality of data. This makes the GSEM an ideal choice for modeling Mother and Child Healthcare (MCH) service utilisation with a large number of control variables. We estimated four models depending on the type of the dependent variables. The Models I, II, III and IV reveals similar link amid the healthcare service providers and visiting the ANC where quotient p is less than 0.001 ($p < 0.001$) for all.

Appropriate link functions were used for results depending variable. Continuous (total ANC visits and child's post-natal care index) variables were modelled with a Gaussian (identity) link. The Dummy outcome (Location of delivery) was specified with a binomial link - the results are presented as odds ratios for interpretation. For post-natal checks for mothers, a multinomial link was used, and odds ratios were used for comparisons. For post-natal services for babies, a 0-5 index was created out of five services: examination of the cord, temperature, danger signs counselling, breastfeeding counselling and observation of

breastfeeding. This index was used as a continuous variable with the coefficient estimates detailing the magnitude and direction of the association with the predictors. The empirical study is based on several assumptions. First, the relationship between the explanatory variables and quantitative response variables is assumed to be linear. Second, the error terms are assumed to be exogenous to all equations and there are no correlation between the error terms. Third, the error terms have a constant variance (homoscedasticity).The model was validated by assessing and reducing the multicollinearity among the explanatory variables. Finally, we took care to specify the appropriate model based on the link function (Gaussian, binomial, and multinomial) of each dependent variable. These assumptions contribute to the validity of the estimated parameters.

Results and Discussion

Socio-demographic Characteristics

A summary of the descriptive characteristics and mother and child health indicators of the sample is shown in Table 1. The total of pre-birth ANC check up calls was measured quantitatively and qualitatively. Average visiting of ANC was 4.0 (standard deviation, 3.1). As a categorical variable, 4200 females (50.7%) reported less than 3 ANC visits while 4100 females (51.0%) reported 4 or more visits. In terms of delivery practices, 2740 deliveries (34.0%) took place outside health institutions and 5640 (67.0%) in health institutions. The coverage of post-natal care (PNC) among females was low; 5800 females (71.0%) reported no post-natal check, 500 (6.1%) received care from non-professional providers (26.1%) accessed services from professional healthcare providers. For children, a total of 8230 observations were analysed. The summary index of post-natal checks for children was low with a mean of 2.1 (SD 2.3), suggesting limited coverage of critical post-natal services. In terms of the use of health-care providers during antenatal care, 1360 females (16.0%) did not use any health-care services, while very few (120, 1.4%) used non-professional providers. The rest (7005, 84%) sought care from professional providers. With the respect to socio-demographic profile, the average age of mothers was 30.3 years (S.D 6.4). Females had an average of 4.7 years of Schooling (S.D 5.9) and a family size of 3.3 children (S.D 2.1). Many females (7287, 87.1%) did not work in the last year, while 1200 (13.3%) did. The household wealth index was (S.D 0.1). As for residence, 4675 (55.6%) were from rural and 3879 (46.3%) from urban areas.

Table 1
Weighted distribution and percentage of mother and child healthcare indicators and selected socio-demographic characteristics

Variables	N	Percentage	Mean	S.D
Outcome Variables				
Mother and Childcare				
ANC visits				
Total	8260		4.0	3.5
> than 3	4200	50.7		
≥ 4	4100	51.0		
DeliveryLocation				
Non-medical	2740	34.0		
Medical Service	5640	67.0		
Post-natal check (Mother)				
None	5800	71.0		
Non-professional	500	6.1		
Skilled professional	2118	26.1		
Post-natal check (Child)				
Index score	8230		2.1	2.3
Explanatory Variables				
Health Facilitators (professionals and non-professionals)				
No treatment (care)	1360	16.0		

Traditional Experts	120	1.7		
Medical Specialists	7005	84		
Socio-demographic factors				
Child gender				
Male	4291	51.0		
Female	4006	50.1		
Age	8376		30.3	7.1
Schooling (years)	8377		4.7	5.9
Equality	8370		3.9	3.2
Employment status				
Not working	7287	87.1		
Working	1200	15.1		
FEM per week				
Not at all	3300	39.2		
< once a week	1100	13.1		
At least once a week	4101	49.2		
Spouse's Schooling (years)	8201		8.3	6.1
Resources index	8401		-0.3	0.6
Remoteness from centre of healthcare				
Problematic	4290	51.7		
Non Problematic	4201	50.6		
Residence Area				
City	3879	46.3		
Village	4675	55.6		
Provinces				
Islamabad	550	7.1		
Punjab	1753	22.5		
Sindh	1500	18.4		
Khyber Pakhtunkhwa	1445	17.8		
Baluchistan	1130	14.2		
Gilgit-Baltistan	620	8.1		
Azad Jammu & Kashmir	881	11.8		
FATA	662	8.2		

Source:PDHS(2017-18)

Impact for providing health facilities compared with total visits to ANC

Figure 2 shows a proportion related to the antenatal care (ANC) in various types of health providers. The sum of ANC visits is categorised into two categories: less than 3 visits (0) and 3 or more visits (1). In our study, 100% of the female population who did not seek antenatal care had fewer than 3 visits. However, among females who consult non-professional health care providers, 68.06% reported fewer than 3 ANC visits whereas, 31.94% had 4 or more visits. The picture is better among females who consulted professional health care providers. Among this population, 40.63% had fewer than 3 ANC visits and 59.7% had 4 or more visits. These statistics suggest a gradient: those who receive care from professional health care providers use more recommended antenatal and perinatal services.

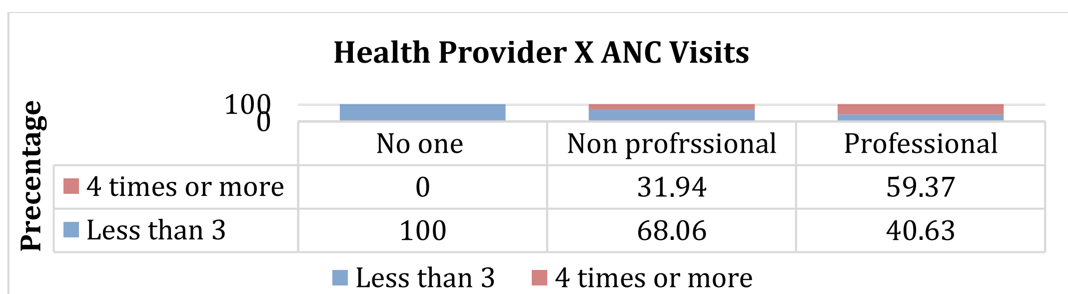

Figure 2 The connotation between healthcare provider type and the total of antenatal care visits

Healthcare providers' level compared to the location of delivery

Fig 3 shows the association of status of health care providers with location of clinic. Among mothers almost (100%) who took part in survey did not get any pre-natal treatment. It was found that 74.43% mothers give birth to children from out of hospitals, where there was no service provided to them; 25.57% mothers gave birth to babies in hospitals, where they were provided health facilities. Likewise, 68.04% received service by non professionals and 31.96% by professionals. Comaparatively, 24.47% gave birth from out of hospital, while 75.53% in hospitals.

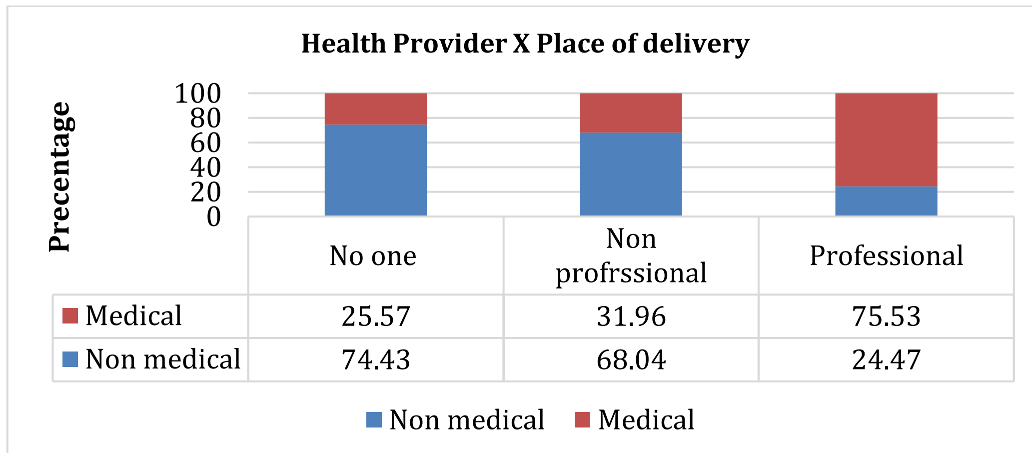

Figure 3: The connotation between types of healthcare providers and delivery location

Healthcare providers' level compared to the post-natal (mother) check up

Figure 4 shows division of women who received their post-natal check-ups according to the type of provider who provided their pre-natal care. 4% reported post-natal check-ups from professional healthcare provider among the mothers in the group, which constituted 100% of mothers who did not have access to pre-natal check ups. By contrast, a large number (85.02%) did not receive post-natal check-ups and 11.01 per cent by the non-professionals. 71.31% were given pre-natal treatment by non professional health workers, while (100%) did not attend any post-natal check-ups. 25.29% availed post-natal treatment by the non-professional health visitors, whereas 3.4% by professional health workers.. Similarly, those mothers who were given pre-natal medial aid by the professional staff were (100%), yet 60.92% did not receive check-ups, 6.2% accessed post-natal services from non-professional and nearly 32.99% mothers got post-natal treatment by the professional doctors.

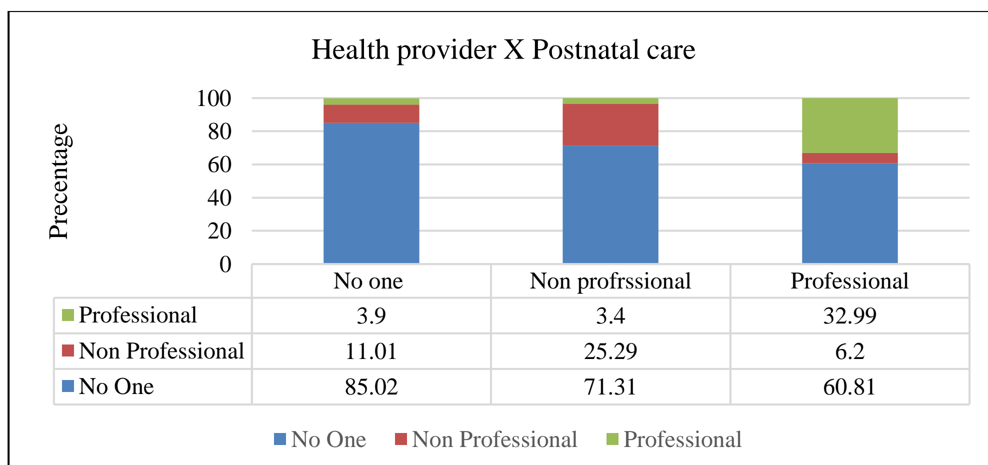

Figure 4: The connotation among healthcare providers and post-natal care of mothers

Healthcare providers' level compared to the post-natal check (child)

Figure 5 shows a percentage of babies who received five essential services of post-natal care from different types of provider. The figure is based only on respondents who reported they received all five post-natal services for their newborn. Of all the children (100%) in this analysis, 68.79% had the cord examined by professional health care providers within 2 days of delivery, and 40.97% examined by non-professionals. The umbilical cord was examined by a professional 2 days after birth for 38.55% of children. For the measurement of body temperature, 52.64% of children had their temperature monitored by professionals, 22.9% monitored by non-professionals, and no monitoring was done in 17.59% of children.

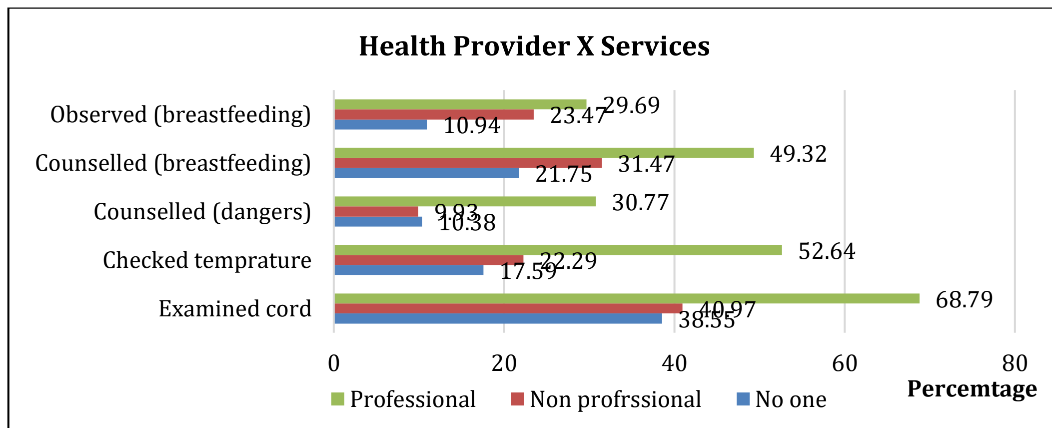

Figure 5: The connotation between healthcare providers and post-natal care for children

Concerning mother counseling, 31.51% of mothers received counseling on danger signs from professional healthcare providers, 10.01% from non-professionals, and 10.38% of mothers stated there was no counseling. Finally, for breastfeeding counseling, 51.02% of mothers reported they had received counseling from professional health-care providers, 32.01% received counseling from non-professional providers, and 22.49% of mothers did not receive any breastfeeding advice. Finally, with regard to observation advice on breastfeeding practices, 30.39% of mothers were observed by professional health-care providers, 24.32% were observed by non-professionals, and 11.53% of mothers were not observed while breastfeeding.

The Multivariate Study (analysis)

Connotation amongst Health Service Providing Centres, ANC Visits, Location of Delivery, and Post-natal Care

The multivariate link concerning the category of health facility supplier (professional, non-professional & no antenatal care [ANC] as a base category) and mother and child health outcomes, such as visiting the ANC service providers, the delivery point of services, post-natal care for new born babies and their mother is shown in Table 2.

Table 2
Relationship amongst healthcare providers and mothers' health service utilization: ANC visits, delivery location, and post-natal care

VARIABLES	Total ANC visi		Location of deliv		Post-natal by No professional		Post-natal care b professional		Post-natal check (Child	
	Model I		Model II		Model III				Model IV	
	Gaussian		Dummy		Multinomial				Gaussian	
	Coe (S.I	95%	(S.E)	95% C	(S.E)	95% C	(S.E)	95% C	Coeff. (S	95% CI

Healthcare Provide										
benchmark category (No ANC)										
Non-professional	2.45	(2.5-2	0.92	(-0.71-0.	4.0**	(0.96-1.9	0.99	(-1.23-1.	0.20	(-0.19-0.51)
	(0.3		(0.21		(0.87		(0.61		(0.15	
Professional	3.21	(3.1 3.40	4.91**	(1.51-1.8	0.96	(-0.31-0.2	6.11**	(1.50-2.2	0.61**	(0.50-0.71)
	(0.0		(0.51		(0.15		(1.20		(0.08	
Female (benchmark category male)	-0.0	(-0.5 0.71	0.97	(-0.17-0.	0.96	(-0.20-0.	1.00	(-0.15-0.	-0.05	(-0.11-0.04)
	(0.0		(0.04		(0.12		(0.05		(0.05	
Mothers' age (in year	0.04	(0.0 0.05	1.03**	(0.02-0.	0.99	(-0.04-0.	1.06**	(0.03-0.	0.04**	(0.02-0.03)
	(0.0		(0.03		(0.02		(0.02		(0.01	
Mothers' Schooling (i years)	0.14	(0.1 0.15	1.10**	(0.06-0.	0.89	(-0.10-0.	1.05**	(0.05-0.	0.06**	(0.04-0.07)
	(0.0		(0.03		(0.02		(0.03		(0.02	
Equality	-0.20	(-0.20 0.13	0.90**	(-0.19- 0.06)	1.10*	(0.03-0.1	0.90**	(-0.18- 0.11)	-0.09*	(-0.09- -0.04)
	(0.		(0.01		(0.02		(0.01		(0.02	
Employment status (benchmark category N	-0.2	(-0.30 0.05	0.95	(-0.21- 0.10)	0.99.1	(-0.16- -0.	1.09	(-0.10- 0.31)	0.20**	(0.09-0.40)
	(0.0		(0.07		(0.20		(0.10		(0.04	
FEM per week										
benchmark category (Not at all)										
< once a week	0.0	(-0.1 0.19	0.99	(-0.99-0.	0.10	(-0.64-0.	1.10	(-0.99-0.	-0.07	(-0.18-0.07)
	(0.1		(0.99		(0.99		(0.99		(0.10	
At least once a week	0.1	(0.0 0.20	0.99	(-0.10-0.	1.22	(-0.02-0.	1.10	(-0.10-0.	0.04	(-0.07-0.10)
	(0.1		(0.10		(0.99		(0.10		(0.04	
Spouse's Schooling (yea	0.0	(-0.0 0.09	0.99	(-0.02-0.	0.10	(-0.04-0.0	1.07	(0.001-0.	0.09	(0.00-0.09)
	(0.0		(0.09		(0.08		(0.09		(0.00	
Wealth index	0.71	(0.6 0.70	1.70**	(0.40-0.	0.10	(-0.30-0.	1.70**	(0.41-0.	0.30**	(0.18-0.22)
	(0.0		(0.07		(0.07		(0.07		(0.04	
Distance to a health service										
Not a problem (benchmark category problem)	0.1	(0.0 0.23	1.20*	(0.07-0.	0.90	(-0.35-0.	0.99	(-0.10-0.	0.04	(-0.05-0.08)
	(0.0		(0.06		(0.99		(0.06		(0.03	
Rural (benchmark category urban)	-0.0	(-0.1 0.03	1.12*	(-0.41- 0.09)	0.99	(-0.20-0.	1.00	(-0.20-0.	-0.07	(-0.20-0.00)
	(0.0		(0.04		(0.99		(0.06		(0.03	
Provinces										
Benchmark category (Islamabad)										
Punjab	-1.20	(-1.3 0.88	1.01	(-0.41- 0.41)	2.18*	(0.22-1.3	1.26	(0.10-0.	-0.48*	(-0.64- -0.32)
	(0.1		(0.14		(0.61		(0.14		(0.08	
Sindh	-0.43	(-0.67 0.18	2.20**	(0.49-1.	2.52*	(0.49-1.4	2.81**	(0.79-1.	0.60**	(0.43-0.77)
	(0.1		(0.33		(0.73		(0.34		(0.09	
Khyber Pakhtunkhw	-1.38	(-1.61 1.13	1.08	(-0.20-0.	0.92	(-0.79-0.	0.37**	(-1.25- 0.74)	-1.30*	(-1.46- -1.13)
	(0.1		(0.16		(0.24		(0.05		(0.08	
Baluchistan	-1.55	(-1.80	0.51**	(-0.95-	1.96	(0.10-1.2	0.58**	(-0.84-	-1.13*	(-1.31- -0.95)

		1.28		0.36)				0.23)		
	(0.1		(0.08		(0.57		(0.09		(0.09	
Gilgit-Baltistan	-1.13	(-1.42 0.84	1.80**	(0.25-0.	0.50	(-1.42-0.	0.54**	(-0.93- 0.29)	-0.76*	(-0.96- -0.56)
	(0.1		(0.31		(0.19		(0.09		(0.10	
Azad Jammu & Kashm	-1.50	(-1.96 1.19	0.86	(-0.45-0.	1.42	(-0.26-0.	0.91	(-0.34-0.	-0.57*	(-0.74- -0.39)
	(0.1		(0.13		(0.44		(0.12		(0.09	
FATA	-1.35	(-1.63 1.06	1.50	(0.08-0.	0.15**	(-2.86- -0.	0.31**	(-1.57- 0.75)	-1.04*	(-1.24- -0.84)
	(0.1		(0.24		(0.07		(0.07		(0.10	
Observations	8,1		8,14		8,15		8,15		8,09	

S.E are in parentheses ***p < 0.001, **p < 0.01, *p < 0.05, Marginal significant †p < 0.1

From Model I, which is focused on antenatal care (ANC) visits, females who attended non-professional providers posted a coefficient of 2.33 (CI: 2.3-2.78, p < 0.001), which is the equivalent of an average increase in 2.33 ANC visits relative to those who received no antenatal care. Similarly, females receiving service from professionals had a greater connotation with a coefficient of 3.21 (CI: 3.01-3.33, p < 0.001) with an average increase of 3.21 ANC visits compared with the benchmark group. Both meanings were statistically significant, suggesting women with any type of interaction with a health care provider have higher ANC utilization than those who received no care. In Model II the delivery location was examined. The findings show that mothers who were given pre-natal medical aid by the professional health experts were more likely to receive medical care (Odds ratio 4.91, CI: 1.42-1.74, p < 0.001) as compared to those who did not have any ANC. This supports a significant association between professional pre-natal care and institutional births. In Model III, which was conducted to examine the post-natal care status of mothers, females receiving care from non-professional providers had 4 times higher odds (CI: 0.88-1.86, p < 0.001) of receiving post-natal checks by non-professional providers. However, the odds in those receiving professional care of getting post-natal care was even higher (odds ratio 6.11; CI is equivalent to the value from 1.50-2.21; and p is less than the value 0.001). Clearly, pre-natal treatment provider has a significant impact on post-natal care. Model IV looked at post-natal care for children. Results indicated that children who received professional pre-natal care were 0.61 times most probably (CI is equivalent to the value from 0.44-0.66, and p is less than the value 0.001) to be given timely post-natal treatment (within two days) which involved examination of cord, monitoring temperature, giving counselling on danger signs, counselling on breastfeeding, observing breastfeeding for those who delivered within 24-hours, when compared to children who did not receive antenatal care provided by a professional.

The impact of social and financial indicators were also highly linked to the mother and child health service utilisation. Education of mother was positively related with outcomes such as an increase (CI is equivalent to the value from 0.09-0.12, and p is less than the value 0.001) for visiting ANC to get antenatal care, nearly 1.07 times more likely (CI: 0.06-0.09, p < 0.001) to give birth in health institutions, and 1.03 times more probable (CI is equivalent to the value from 0.01-0.04, and p is less than the value 0.001) to get post-natal cure from professional providers. Also, mothers with education were 4 times (CI is equivalent to the value from 0.03-0.05, and p is less than the value 0.001) most probably for receiving after birth necessary medication by the professionals, in comparison with the women who had no visits to ANC. Both, household wealth index also had a gradient effect. Comparing with the lowest wealth index category of no ANC, increases in household wealth status associated with being 60 times more likely to receive ANC (CI is equivalent to the value from 0.51-0.69, and p is less than the value 0.001), likely 1.7 times in hopital (CI is equivalent to the value from 0.40-0.60, and p is less than the value 0.001), nearly 1.7 instances for getting post-natal services from a professional provider (CI: 0.30-0.50, p <

0.001), a 0.30 increase in the likelihood of children receiving post-natal check-ups from professional healthcare providers (CI: 0.20-0.33, p < 0.001).

In Figure 6, we present the goodness-of-fit results of 4 models. The LL, AIC and BIC models are used to assess the model fit. In general, LL suggests that all models are an acceptable representation of the data; but Model II fits the best with a good fit for explanatory power and model parsimony. In contrast, Model I and Model IV have relatively poorer performance (as indicated by upper BIC & AIC values) which suggests that they may not to be used for analysis in this model. The log-likelihood (LL) is used to assess the fit of a model, with smaller values preferred. Model II has the highest LL (-3943.876) value, which indicates the best fit to the data.

By contrast, Models I (-16557.50) and IV (-16303.78) have much lower LL values, suggesting that they don't explain the data as well. AIC values are calculated for model comparisons, and lower scores represent better fits for the model. Again, model II has the best fit (lowest AIC 7830.692). Again, Model III (10340.89) is the next best model, with much higher AIC values of Model I (37847.99) and Model IV (30530.6), further reinforcing that their model efficiency is relatively low. Again, BIC (which places heavier penalties on model complexity) confirms the same. This time Model II offers the lowest BIC (7969.950). This is followed by Model III (10694.18), while Model I (38089.89) and Model IV (29691.70) again display the highest scores and could be over-fitted or inefficient. Overall, based on the three measures (LL, AIC and BIC), Model II finds itself superior to all other models and is a preferred model for the data. The next best model is Model III (10694.18), while Model I (38089.89) and Model IV (29691.70) are less appropriate and may need to be re-specified or further explored with different modelling approaches.

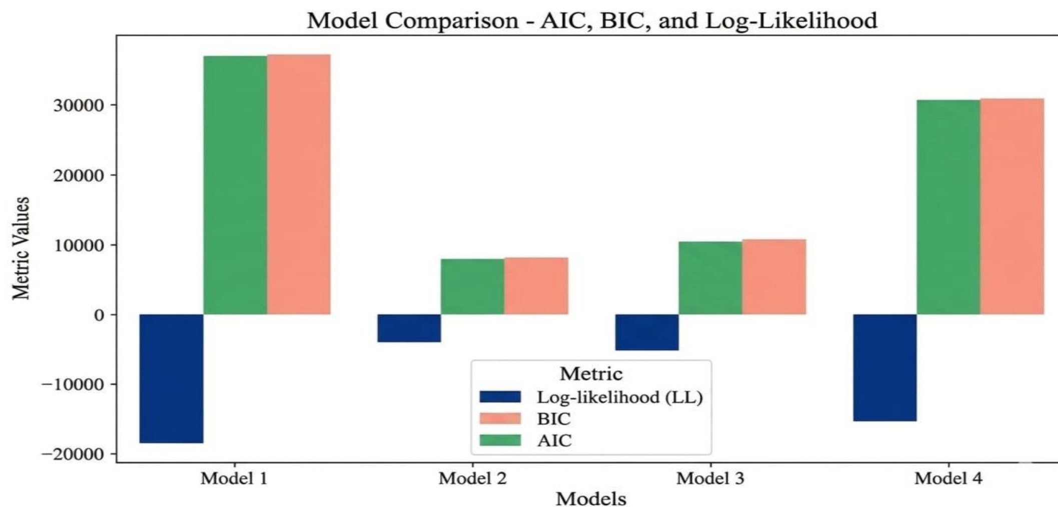

Figure 6: Goodness-of-fit evaluation across models based on AIC, BIC, and log-likelihood criteria

The current report examined the associations between types of care providers such as, the professionals (doctors), the non professional (health workers) and providing no care and a range of mother and child health outcomes such as visiting the ANC, birth -place of new borns as well as mothers' PNC care. It also examined the trends in five key newborn post-natal care (PNC) services (cord and temperature check, danger sign counselling, breastfeeding support and breastfeeding monitoring) in Pakistan. In general, the study findings suggest that there are good attitudes from mothers towards the use of ANC and PNC services; however, mothers' use of institutional delivery care and post-natal care remains relatively low despite the benefits.

The GSEM approach was used to explore factors associated with the selected outcomes. The association between type of health care provider and utilization of ANC revealed that all mothers who did not use pre-natal care had less than 3 ANCs. Of those who received care were 68.06% by professional health experts for three times and 31.94% for four times. On the other hand, among females who had taken treatment were about 40.63% for the three times, and nearly 59.37% for four time visits.. This is also consistent with these studies (Arefaynie et al., 2022; Ali et al., 2021; Ayalew et al., 2022; Rosser et al., 2022). Our study showed variations in delivery place by types of providers. Women who did not attend ANC (No-ANC) had a higher percentage of NRB (74.43%) compared to females who delivered in health facilities (25. 57%). Similarly, 68.04% of females who used non-professional care had non-medical delivery and 31.96% had health institutional delivery. In contrast, females who had pre-natal care with professionals, 75.53% had health institutional birth and 24.47% had non-medical institutional birth (Hulsbergen et al., 2020; Hirai et al., 2020).

Post-natal care service access by mothers was also examined. These showed that for mothers with no pre-natal care, 85.02% had no post-natal care, 11.01% received non-professional care and 3.9% received professional pre-natal care. Among the mothers receiving ANC from non-professionals, 71.31% did not have post-natal visits, 25.29% of the mothers used non-professional services and 3.4% used professional services. Of those receiving professional ANC, 60.92% did not receive post-natal treatment, 6.2% given by the non professional health facilitators, in addition to 32.99% from professionals. These results are in line with previous reports (Ameyaw et al., 2020). The survey showed mixed results for the child post-natal services. Evaluation of the cord within 2 days following delivery was done by 68.79% for professionals, 40.97% for non-professionals and 38.55% for new-borns. For temperature checking 52.64% were checked by professionals, 22.9% by non-professionals and 17.59% were unchecked. Concerning danger sign counselling, 30.77% of mothers received counselling from professional providers, 9.93% from non-professional providers, and 10.38% received no counselling. Regarding breastfeeding, 51.02% were counseled by professionals, 31.47% by non-professionals while 21.75% did not receive any. Lastly, 30.39% had breastfeeding observed by professionals, 23.47% observed by non-professionals, and 10.94% did not have breastfeeding observed. Our findings are in line with earlier studies (Mohan et al., 2015).

In conclusion, the findings show exposure to professional providers during pregnancy is strongly related to higher ANC service use, likelihood of institutional birth and post-natal care for the mother and the child, compared with not having ANC exposure. Exposure to non-professional providers also demonstrate a positive association with service use, albeit to a lesser extent. Our results are aligned with results of those countries having low incomeslike Brazil that demonstrate the strong positive associations between health workforce availability and ANC coverage (Bexson et al., 2021). Selected studies from Burkina Faso also found a correlation among the availability of the health workers and child births (Campbell et al., 2016).

In terms of policy, these findings highlight the need to improve access to professional health care to improve mother and child health in Pakistan. Scaling up professional health services, particularly in rural regions, is vital to enhance ANC rates, institutional births and post-natal services. Maintaining free mother and child health services in disadvantaged areas can also improve access. Also, capacity strengthening through training non-professional providers in the community may contribute to enhancing quality of care in settings where skilled providers are scarce. A multifaceted approach that optimises the allocation and training of health care professionals, provides health care services for mothers or training to informal providers can play an important role in the attainment of the SDGs related to mother and child health.

While these represent contributions, the study has limitations. While the chosen model specifications are justified in theory, potential model misspecification is possible, especially in the presence of nonlinear effects. Omitted-variable biases could potentially be present if other confounders are left out of the analysis, and have implications for the interpretability of the estimated connotations. Collinearity between the predictors may also affect the precision of the connotations. Finally, results may not be generalisable if the sample is not reflective of other populations. The cross-sectional nature of PDHS limits the ability to infer causation. Otherwise, underreporting in mortality indicators may also occur because of cultural sensitivities or emotional challenges of reporting children lost. Moreover, there is likely measurement error when mothers report fathers' Schooling, particularly as Schooling was reported in years completed.

Finally, the results highlight the importance prevalence of after birth facilities for mothers and new born infants in Pakistan. It highlights that by appointing skilled health providers, improving health infrastructure and basic health determinants such as Schooling, nutrition, sanitation and hygiene are key to improving health outcomes. Government policy should ensure appropriate resource allocation to disadvantaged regions to enhance mother and child health service delivery.

Conclusions

In our current research, we shed light on the role of categories of health care providers to enhance baby and mother health in Pakistan. Our findings show a positive association between availability of health care providers and utilization of antenatal care, institutional birth and uptake of post-natal care services (for mothers and infants). These findings point out that ensuring equitable allocation of human resources for health across regions is significant for improving mother and child health services in Pakistan.

Further research would assess the effects of mother and child health, including in rural areas. Consultation with the Copenhagen consutant may be worthwhile to explore the use of other advanced methods of econometric analysis, which may better examine the complex inter-relationships between health outcomes. To conclude, addressing the equity of health provider distribution, improving maternal education and making basic and responsive quality maternal and child health services readily accessible, particularly in rural areas, are crucial for positive health outcomes. They are crucial for improving equity and maternal and child health care standards in Pakistan.

Recommendations

Engaging non-professional health care providers in the formal health system through streamlined training, mother level awareness programs, and informing mothers on the use of ANC services, safe delivery and post-natal care can improve access to services. Incentives may also attract health personnel to disadvantaged communities. Improving public-private partnerships, as well as partnerships between the public sector and non-government organizations (NGOs), can also support outreach efforts in the form of counseling, media campaigns and community mobilisation.

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