A quantitative study of antenatal care, access barriers and maternal health vulnerability in rural Sindh, Pakistan

AGHA, Nadia <http://orcid.org/0000-0002-3208-0952>, ANSAR, Fizza <http://orcid.org/0009-0002-2151-1670>, RIND, Rahim Dad, CHANNA, Moomal Mandhri and BHANBHRO, Sadiq <http://orcid.org/0000-0003-0771-8130>

A Quantitative Study of Antenatal care, access barriers, and Maternal Health Vulnerability in Rural Sindh, Pakistan

Abstract

Purpose

This study investigates a complex interplay of socio-ecological aspects that increases Maternal Health Vulnerability (MHV) in rural Sindh, Pakistan.

Design/methodology/approach

This study used a cross-sectional design involving 352 women aged 18 to 49 years from rural Sindh, Pakistan. The analysis included descriptive statistics and parametric and nonparametric tests, including t-test, ANOVA with Tukey's correction, and Spearman's correlation test. A four-step multiple linear regression was used to identify SEM-level factors associated with MHV. Data analysis was done in STATA version 17.0.

Results

MHV was higher among women with post-natal health issues (β=2.67, 95%CI: 1.11–4.23), no hospital nearby (β=5.17, 95%CI: 4.06–6.28), irregular LHW visits with those receiving only one visit (β=5.11, 95%CI: 2.63–7.59), significant gender inequality (β=0.98, 95%CI: 0.74–1.23) and poverty (β=0.42, 95%CI: 0.29–0.56) while lower vulnerability was linked to ANC at public facilities (β=-0.72, 95%CI: -2.20-0.74) and exposure to health information through lady heath workers (β=-4.12, 95%CI: -7.16 – -1.08).

Originality/value

This study identifies several interconnected barriers to accessing maternal health services. Many women lack the education necessary to make timely decisions, which leads to delays in attending antenatal care (ANC) visits. Additionally, the combination of educational gaps and structural factors, including poverty, often drives women to rely on traditional birth attendants for assistance. The study underscores the importance of using a variety of approaches to tackle gender inequalities, improve health knowledge, and invest in women's social connections. This

means building support networks, trust, and sharing information, which can significantly impact women's health habits and pregnancy results.

Key words: Maternal health vulnerability; Socioecological model; Gender inequality; Poverty; antenatal care, sociocultural barriers, Rural Pakistan

Introduction

Maternal health during pregnancy, childbirth and the postpartum period includes healthcare dimensions of preconception, prenatal and postnatal care, and family planning to reduce maternal morbidity and mortality (Shrivastava et al., 2023). When women face adverse outcomes during any of these stages, the impact can extend beyond the perinatal period, often leading to maternal mortality or further morbidities or disabilities in life (Koblinsky et al., 2012). Globally, 260,000 maternal deaths occur, equivalent to 712 deaths each day, 70% of which are reported by Sub-Saharan Africa, and 17% by Central and Southern Asia (World Health Organization, 2025a). Recognizing the urgent need to address this issue, Sustainable Development Goal (SDG) 3.1 aims to reduce the global maternal mortality ratio to below 70 per 100,000 live births by 2030. The achievement of SDG 3.1 has become a challenge, particularly in Low- and Middle-Income Countries (LMICs). The situation of maternal and child health in South Asia is appalling. It requires immediate interventions because the region, along with sub-Saharan Africa, accounts for about 87% of global mortality (World Health Organization, 2025b).

Pakistan, unlike its neighboring countries, lags in achieving SDGs targets of maternal health, with the second-highest MMR, 186 maternal deaths per 100,000 live births, in the period 2017–2019 (Midhet et al., 2025). This persistent gap is particularly acute in rural regions, where access to essential maternal health services is limited by deeply rooted demographic, socio-cultural, economic and infrastructural barriers (Omer et al., 2021).

Several factors make it challenging to improve maternal health in rural areas of Pakistan. These include low household income, low education levels, poor healthcare services, cultural beliefs, long distances to health facilities, malnutrition, unfair resource distribution, and a political environment that creates challenges for pregnancy-related health issues (Habib et al., 2021). Furthermore, poverty is another significant factor which limits women in seeking healthcare and

accessing facilities before, during and after birth (Khan et al., 2009). Additionally, unmet nutritional needs, heavy physical labour, infections, and other primary chronic conditions like being overweight and diabetes further deteriorate pregnancy outcomes (Roos et al., 2021).

Maternal mortality can be prevented if women regularly visit for antenatal care (ANC) during pregnancy, deliver in a health facility and receive postnatal care (PNC) after delivery (Paul and Chouhan, 2020). However, antenatal care compliance remains low in rural regions due to these systemic barriers. Additionally, in rural areas, where there are low levels of education, community health workers often work as an extension of the healthcare system and have been found to improve uptake of maternal health services and reduce maternal mortality by providing antenatal and postnatal health visits (Lavasani, 2012).

The non-availability of essential healthcare facilities for rural women, as these are far off from their village, can be fatal due to delays or complications during travel. As a result, homebirths are extremely common in these regions (Shaeen et al., 2022). Further compounding these challenges is the country's entrenched gender inequality, exacerbated in rural communities where women face limited education, minimal decision-making autonomy (particularly concerning health and finances) and restricted mobility (Habib et al., 2021). This is supported by Pakistan's ranking of 151st in the World Economic Forum’s Global Gender Gap Report, third from the bottom. It is proposed by Hakim et al. (2003) that a more substantial gender equity, by enhancing women's autonomy and decision-making power, may contribute to improved maternal health outcomes, including increased adoption of contraceptive practices.

The concerning upward trend in the MMR rate of Pakistan emphasizes an urgent need for strengthened interventions in maternal health in the country. Pakistan is a signatory to the Sustainable Development Goals (SDGs) Agenda 2030, but it still needs to accelerate its efforts to reduce the MMR in rural areas. The quality of healthcare is a crucial concern for universal health coverage and equity, as well as for reducing maternal and newborn mortality (World Health Organization, 2021). National programs and interventions often fail due to distance and poor infrastructure, particularly for people living in rural areas (Jimenez Soto et al., 2013). Therefore, it is essential to understand existing antenatal care (ANC) practices to assess the quality and standard of care provided to women, particularly in less privileged areas.

Socioecological approach to understanding maternal health

This study used the socio-ecological model (SEM) to analyze the complex association among ANC practices, barriers to accessing health services, and MHV. The SEM is rooted in ecological theory, first proposed by American psychologist Urie Bronfenbrenner in the 1970s. It urges that individuals interact with four domains in their environment, and it is an interaction between these that affects human development (Max et al., 2015). Later, his work was modified by McLeroy, Bibeau, Steckler, and Glanz (1988), who developed a multilevel framework (SEM) which was then widely adopted by policymakers as a framework for health promotion programs. McLeroy et al. recommended incorporating behaviour into a dynamic, complex network. Public health problems can be identified using the socioecological model, showing that health is influenced by multilevel factors, including the individual, interpersonal, community, organizational, and policy levels (McLeroy et al., 1988).

We selected this model over traditional regression methods for various reasons. First, it allows simultaneous testing for all hypotheses within the model, which is key to understanding the multifaceted nature of maternal outcomes (Kline, 2023). Secondly, a fundamental advantage of SEM is its ability to incorporate latent variables to accurately represent unobservable core constructs, such as vulnerability and access barriers, through their measurable indicators (Bollen, 1989). This is particularly relevant to our study because constructions such as access barriers and MHV are theoretical concepts that indicate latent variables. Moreover, the SEM approach seems well-suited to social science and public health research for exploring a similar complex theoretical framework (Ullman & Bentler, 2013). Thus, this model enabled us to broadly understand the range of factors women encounter during pregnancy, childbirth, and the postpartum period, in relation to antenatal care practices, access barriers, and service delivery. To the best of our knowledge, there is no evidence of incorporating demographic and sociocultural factors to improve maternal health, and thus, limited studies have used the SEM model to assess these variables in relation to maternal health vulnerability.

Methodology

Study Design and Setting

This is a cross-sectional quantitative study guided by the Socio-Ecological Model (SEM), which allows for the examination of factors across multiple domains; individual, interpersonal, community, and organizational/policy in relation to maternal health vulnerabilities (MHV). The study was conducted in rural villages of Taluka Sukkur, Sindh, between January and February 2024. These villages were selected based on poor maternal health indicators, socio-cultural barriers to care, and limited access to health services.

Sampling Strategy, sample size and Eligibility

A cluster sampling technique was employed to recruit participants from rural areas of Sindh, Pakistan. The province, along with selected districts, was purposively chosen due to its poor maternal health indicators and limited access to healthcare services. Within each selected district, villages were randomly selected and treated as primary sampling units (PSUs). In each village, eligible households with at least one woman of reproductive age (18–49 years) who had given birth in the past 2 years were approached to participate. The final target sample comprised 352 women from the Sukkur district in Sindh.

This cross-sectional study was conducted in rural areas of Sindh, Pakistan. The cluster sampling method was used to recruit participants. We deliberately selected four important villages, keeping in view their literacy rates, poverty levels, and availability of health care services. To avoid over-representation of households with multiple eligible women, only one eligible woman aged 18-49 years from each household was selected for interview to ensure uniformity. The sample size was calculated using Cochran's single population proportion formula: $n_0 = (Z^2 \times p \times (1 - p)) / d^2$ (Cochran, 1977). With a 95% confidence level ($Z = 1.96$) and use of a conservative prevalence ($p = 0.50$) of 5% ($d = 0.05$), the sample size was calculated at 384. After a non-respondent rate of 8% was considered, the sample's requirement was 353, out of which 352 women completed the survey. Pregnant women and other women who were unable to participate were excluded from the survey. The remaining women in the survey sample met the accepted thresholds for the regression analyses, as defined by Green (1991). The sample size had sufficient statistical power for the multivariable regression. The data were collected using a structured questionnaire to examine a strong link between barriers to health services, service accessibility, ANC practices, and the vulnerability of women in rural Sindh.

Ethical Considerations

This study was reviewed and approved by the Research Ethics Committees of Aga Khan University, Karachi (2023-9128-27163) on 25 November 2023 and Sheffield Hallam University (ER59568368) on 9 January 2024. We followed all the ethical protocols outlined in the proposal during data collection. For example, prior informed and verbal consent was obtained from the participants, as most of the women (49%) were illiterate, and 19% had only primary-level education. All participants were briefed about the study before data collection. They were assured that their identity would remain confidential and that all identifiable information would be anonymized.

Data Collection Procedure

Women who had delivered within the two years preceding data collection were invited to participate by trained female interviewers. Data were collected through face-to-face interviews using a structured questionnaire, administered in Urdu or Sindhi, as preferred by the participants. Prior to the interview, participants were informed about the purpose, duration, and ethical considerations of the study, including voluntary participation, anonymity, the potential risks and benefits, and data confidentiality. Informed consent was obtained before the interview began. All interviews were conducted in private settings to ensure participants' comfort and confidentiality. Each interview lasted approximately 20–30 minutes, and no incentives were provided. Responses were recorded manually and subsequently digitized for analysis.

Data Collection Tool

A structured questionnaire was developed by researchers, guided by the Socio-Ecological Model (SEM) and informed by an extensive review of relevant literature. It was designed to capture various determinants of maternal health vulnerability across four SEM domains: intrapersonal, interpersonal, community, and organizational/policy. Internal consistency reliability was assessed using Cronbach's alpha. The overall scale demonstrated good reliability, with Cronbach's alpha of nearly 0.80 across all constructs (Supplementary table S4), indicating that the questions are valid and reliable.

Dependent variable: Maternal Health Vulnerability (MHV). Given the often ambiguous use of the term "vulnerability," in this study, MHV is defined as *"State or condition of women in pregnancy, childbirth, or puerperium, who lack health or are susceptible to poor outcomes related to the presence of at least one adverse determinant or lack of access to basic rights and resources." (Makinde et al., 2022)* MHV was measured through 10 items on a 5-point Likert scale (1 = Strongly Agree to 5 = Strongly Disagree). The scale included both positive- and negative-worded statements. Negative items (e.g., "I cannot visit a health facility due to distance", "High-quality health services are not present in public hospitals") were reverse-coded, with strong agreement indicating greater vulnerability or adverse health outcomes. The total scale score ranges from 10 to 50.

Socioecological Factors:

The socioecological factors were selected based on the prior research on maternal health outcomes (Muhammad et al., 2025, Koren and Mawn, 2010, Al-Mamun et al., 2025, Asif et al., 2014). Moreover, they were mapped across SEM levels (Figure 1). These included women's sociodemographic and socioeconomic characteristics, as well as behavioral and contextual variables that influence maternal health outcomes across intrapersonal, interpersonal, community, organizational and policy domains.

- Individual/Intrapersonal variables: This included women's age, education, occupation, working status, reproductive health behaviors such as pregnancy status, contraceptive use, and antenatal check-ups. We assessed women about their contraceptive use by asking if they used contraceptives frequently, irregularly or never used/do not know. Other reproductive indicators, such as current pregnancy status, whether the respondent received a checkup during the last pregnancy, experience of any health complications following delivery, and whether a scan was done during pregnancy, were recorded as dichotomous variables (yes/no).
- Interpersonal level variables: The factors in this domain were based on marital status (married, divorced/widowed), husband's education (no education, primary, secondary, higher), occupation (unskilled, skilled, professional), household income, and gender inequality. Income was categorized as: poorest (below PKR 15,000), poor (PKR 15,000–25,000), and less poor (PKR 26,000–31,000 or more). Further questions assessing gender inequality were measured using 4 items on a 5-point Likert scale (1 = Strongly Agree to 5 = Strongly Disagree). Items included statements such as "I get permission from my husband to visit the hospital," "My husband decides about family planning," and "I do not seek healthcare when not accompanied by a male." Responses were recorded, and

since all questions reflected negatively worded items, they were reverse-coded to ensure that higher scores reflected greater gender inequality. The total scale ranges from 4 to 20.

- Community level variables: Community domain variables included poverty, availability of a hospital in the village (Yes/No), place of delivery (home, public hospital, private hospital), type of delivery assistance (facility-trained provider or midwife), and place of antenatal care (ANC) checkup (midwife, public hospital, private hospital). Poverty was measured using 10 Likert-scale items (1 = Strongly Agree to 5 = Strongly Disagree) that addressed financial constraints, such as food intake during pregnancy and access to maternal services. Negatively worded statements were reverse-coded for questions such as, "I had less milk consumption during pregnancy," "I preferred home births due to lack of money," "I did not take proper meals regularly". The total scale scores range from 10 to 50, with higher scores indicating greater poverty.
- Organizational/Policy variables: This level assessed access to health information and outreach services. Participants were asked whether a Lady Health Worker (LHW) visited their home during pregnancy (Yes/No), and the number of LHW visits before and after delivery (none, 1, 2, or more). Additionally, respondents were asked to identify their primary source of maternal healthcare information, including older women, doctors, midwives, Lady Health Workers, and health-related TV programs.

Figure 1: Socioecological framework of Maternal Health Vulnerabilities

Data Analysis

Descriptive statistics, including frequencies, percentages, mean, median, and standard deviation, were calculated to summarize the demographic and socioeconomic characteristics of women aged 18-49 years who had delivered in the past 2 years. Before employing multivariate analysis, bivariate analyses were conducted using the Spearman correlation coefficient, independent t-tests, and ANOVA to identify relationships among variables representing different levels of the socioecological model. Spearman's rank correlation coefficient with p-value < 0.05 was considered statistically significant. ANOVA with post-hoc analysis using Tukey's correction was conducted, with significance set at $p < 0.05$. Each SEM component was treated as a distinct analytical domain, and four separate regression models were developed to examine the contributions of factors in the intrapersonal, interpersonal, community, and organizational/policy domains to maternal health vulnerability. Multivariate analysis was conducted using multiple linear regression to assess the association between Maternal Health Vulnerability (MHV) scores and predictors structured across the four SEM components. Variables were entered in a stepwise

manner, with each model representing the contribution of a set of factors at a specific SEM domain to the overall variance in MHV. Further multicollinearity and Cronbach's alpha values were also calculated. All analyses were conducted using Stata version 17.0.

Evaluation criteria: We used AIC (Akaike Information Criterion) and BIC (Bayesian Information Criterion) to compare our models, which assess the trade-off between a model's goodness-of-fit and its complexity, particularly when comparing models with varying numbers of predictors. Lower AIC and BIC scores indicate better model fit.

Results

Table 1: Demographic characteristics of all variables in the analysis (N=352)

Table 1 presents the descriptive characteristics of all variables in the analysis, based on data from 352 women aged 18-49 years. The mean maternal health vulnerability (MHV) score was 32.83 (SD = 6.22), ranging from 16 to 45. The majority of participants were aged 28-32 (24%), and almost half (49%) had no formal education. Almost 75% reported being employed, primarily in skilled occupations (63%). Contraceptive uptake was low, with 71% having never used any method. One in four women was currently pregnant (25%), and 75% reported experiencing post-natal health issues. While 76% of women received antenatal checkups, only 60% reported having a scan during pregnancy. The mean gender inequality score was 15.91 (SD = 2.44), ranging from 7 to 20. Around one-third of husbands had no formal education (31%), while around 29% received higher education. Husband's employment was around 39% for both skilled and unskilled labor. The mean household poverty score was 35.53 (SD = 4.19), ranging from 23 to 45, with 47% of households classified as "less poor". 49% reported having a hospital in the village, with the majority (75%) delivering at a public hospital, and around 81% of deliveries were assisted by facility-trained staff. ANC was primarily sought in a public hospital (72%). 55% of respondents reported receiving at least one visit from a lady health worker before and after delivery. In comparison, exclusively 50.85% reported no visits before delivery, and around 54% received no visits after delivery. Only 23% of respondents showed two or more LHW visits at pre- and post-delivery. Older women (54%) were the most reported source of maternal healthcare awareness, followed by doctors (22%), midwives (12%) and LHWs (6%).

Table 2: Bivariate association using an independent t-test showing significant variables with

Table 2 presents the independent t-test results for the two groups on MHV mean scores. The parametric t-test results indicate significant differences between groups of women for scans during pregnancy, postnatal health issues, and hospital availability. The results show the MHV scores were significantly high among women who did not receive a scan during pregnancy, while MHV scores were lower among women who did not report having any post-natal health issues. The results also show that the mean MHV scores were much higher in areas with no hospital availability. MHV scores did not significantly differ by employment status, pregnancy status, marital status or whether women received LHW visits.

Table 3: Bivariate association using one-way ANOVA with post-hoc Tukey's correction showing significant variables with MHV

Table 3 presents one-way ANOVA tests to assess significant differences in the meanings of the categories. Post-hoc analyses using the Tukey HSD method indicated that women who delivered at home had significantly higher MHV scores than those who delivered at a public hospital (mean difference = 2.99, 95% CI: -5.094 – -0.883). Lower MHV scores were observed for two or more LHW visits before and after delivery compared with one or no visits. Tukey post hoc tests further showed that women informed by TV programs or lady health workers had significantly lower vulnerability scores compared to those informed by doctors, midwives, or older women. Similarly, midwives had significantly higher scores than LHWs (mean difference = 4.62, 95% CI: 0.258–8.996) and TV (mean difference = 4.78, 95% CI: 0.348–9.222). No significant differences were observed between midwives, doctors, and older women.

Table 4- Bivariate Spearman Correlation Matrix for study variables

**Indicate Significance level at $p < 0.05$ (based on two-tailed hypothesis)*

For continuous outcomes, Spearman correlation was used to assess the strength and direction of associations, providing correlation coefficients (ρ) ranging from -1 to +1, as shown in Table 4. A statistically significant level is assumed if the p-value is ≤0.05, indicating that the variables are monotonically correlated in the sample. Most variables were significantly correlated with MHV (p-value < 0.05), except for women's age and contraceptive use. Two variables showed moderate positive correlations with MHV: gender inequality ($\rho=0.42$, $p<0.01$) and poverty ($\rho=0.34$, $p<0.01$), indicating that as these variables increase, MHV scores also increase. Four variables

showed significant negative correlations: women's and husbands' education, husbands' occupation, and monthly income, indicating that higher educational attainment, more stable employment, and improved economic status are associated with lower levels of maternal vulnerability.

Crude beta Coefficients with 95% Confidence Interval of Linear regression models showing association between SEM variables and MHV are shown in table S1 (Supplementary Material)

Multicollinearity was assessed, and both VIF and tolerance showed no multicollinearity is present (Supplementary table S3).

Multivariate results:

Table 5- Adjusted Beta Coefficients with 95% Confidence Interval of Linear regression models showing association between SEM variables and MHV (N=352)

1. *Model 1- Intrapersonal:*
   The Model 1 factors (Table 5) influencing maternal health vulnerability showed that women with primary education had lower MHV scores than women with no education (β = -2.54; 95% CI: -4.30 -0.77). MHV scores were lowest among women with primary education, and the association was not statistically significant (β = -2.53; 95% CI: -4.29 to -0.77). Women who experienced post-natal health issues had higher MHV scores (β = 2.67; 95% CI: 1.11– 4.23), whereas those who underwent a pregnancy scan had significantly lower MHV scores (β = 2.51; 95% CI: -3.89 -1.12).

2. *Mode2 - Interpersonal:*
   Model 2 included social and household-level predictors (Table 5). For every one-unit increase in the Gender Inequality Score, MHV scores increased by 0.99 units (β = 0.99; 95% CI: 0.75 – 1.23). There was an inverse relationship between the husband's education and maternal vulnerability, with the lowest score observed among those in the higher education category (β = -2.78; 95% CI: -4.64 -0.92). Overall, this model explained 22.06% of the variance in MHV scores, ranking second-highest in explanatory power after the community model.

3. *Mode 3 -Community:*
   The highest level of variability on MHV is explained by community-level predictors (Table 5), accounting for 32.64% of the variance in scores. Women living in villages without a hospital had significantly higher MHV scores (β = 5.17; 95% CI: 4.06 – 6.28). For every one-unit increase in the poverty score, MHV increased by 0.42 units (β = 0.43; 95% CI: 0.29 – 0.56). Women who received ANC in private facilities had higher MHV

scores (β = 2.60; 95% CI: 0.41 – 4.79), while a negative association, though statistically insignificant, was observed for those using public facilities (β = -0.72; 95% CI: -2.20 – 0.74).

4. *Mode 4 -Organizational/Policy:*
   Table 5 shows, MHV scores were lower by 1.67 units among women who received at least one LHW visit pre- or post-delivery, although this association was not statistically significant (β = -1.67; 95% CI: -4.09 – 0.75). For the number of LHW visits before delivery, women who received 1 visit had significantly higher MHV scores by 5.11 units (β = 5.11; 95% CI: 2.63 – 7.59), whereas women with 2 or more visits showed a non-significant change (β = 0.16; 95% CI: -2.44 – 2.78). Maternal healthcare information sources were significantly associated with MHV. Compared to women relying on midwives, those who received information from Lady Health Workers had lower MHV scores (β = -4.12; 95% CI: -7.16 – -1.08), and exposure to maternal health TV programs also corresponded with lower MHV (β = -4.22; 95% CI: -7.35 – -1.10). Women who relied primarily on older women for maternal health information were more vulnerable, although this was not statistically significant (β = 1.40; 95% CI: -0.59 – 3.40).

5. Model *5* –
   The final model as shown in Table 5 combined all significant predictors from the four SEM domains to assess their association with maternal health vulnerability (MHV), with community factors and gender inequality showing the strongest associations, suggesting that community determinants are strong contributors even after adjustment for other domains.

Figure 2. Model Fit Comparison Across Socio-Ecological Domains

Model 1=Intrapersonal, Model 2=Interpersonal, Model 3=Community, Model 4= Organizational / Policy
Note: Adjusted R^2 values - Intrapersonal: 0.10; Interpersonal: 0.22; Community: 0.33; Organizational/Policy: 0.14

Figure 2; supplementary table S2 shows the comparison of model fit indices, AIC (Akaike Information Criterion) and BIC (Bayesian Information Criterion), across the four SEM domains. Both AIC and BIC decreased from Model 1 to Model 3, indicating improved model fit with the inclusion of community-level factors. Model 3 had the lowest AIC and BIC values, suggesting that community domain predictors contributed most to explaining maternal health vulnerability. The values increased in Model 4, indicating that adding organizational/policy factors did not improve overall model fit as much as the community domain.

Discussion

This study fills an important gap in demonstrating how multiple domains of the Socioecological Model (SEM) influence maternal health vulnerability (MHV) among women living in less privileged areas. The findings of this study indicate that intersecting social and demographic factors, including limited literacy, cultural barriers to mobility, economic hardships, and limited access to healthcare, shape women's health outcomes (See figure 1). This aligns with the findings of previous studies, which found that income, cultural norms and beliefs, household power dynamics, and health literacy are determining factors of maternal health behaviors and outcomes (See Sarikhani et al., 2024; Mustafa et al., 2020). These influencing factors reduce adequate and timely ANC uptake, perpetuating a cycle of poor health and unmet needs. To address these barriers, there is a need for community-based interventions, more specifically through basic health literacy, LHWs and improving women's access to maternal health services in remote settings to ensure equitable and timely care during pregnancy.

Poor maternal health outcomes among rural women often stem from the household and community level, where poverty, gender inequality, and cultural practices limit women's choices and access to health services. These factors are closely tied to low levels of education, restricting women's autonomy and awareness about their own health needs. Education remains an important factor in improving maternal health by enabling women to access services, understand the importance of antenatal care and make better decisions for themselves and their children (Kumar et al., 2019). However, in our study, almost half of the women (49%) were illiterate. In comparison, only a small proportion had education beyond primary level: 19% had primary education, 6% had completed matriculation, and 4% had studied up to intermediate level. Resultantly, most of the women lacked reading and comprehending information about ANC and the use of contraceptives, as well as the importance of follow-ups, and knowledge about modern healthcare facilities. This suggests that inequalities – both in formal schooling and health knowledge – are likely to shape maternal health outcomes and contribute to MHV in marginalized settings.

This study suggests that spouse education, employment and gender power relations strongly influence MHV in rural areas of Sindh. Limited education of men and their involvement in daily wage labor affect household income and lead to irregular and poor maternal health care access. Women's socioeconomic dependency on men further curtails their reproductive autonomy and

ANC utilization and results in obstetric risks. A similar barrier has been associated with women's health-seeking behaviour in previous literature, in which low literacy and continued reliance on traditional birth attendants delay women's skilled care-seeking behaviour (Sumankuuro et al., 2019; Naz et al., 2023). Husbands' role, household income, and women's health literacy are likely to positively influence women's maternal health, ANC access, and approach to skilled birth attendance.

This study further reveals that the prevalence of patriarchy and socio-cultural norms significantly increases MHV in rural Sindh, where these norms widely influence the uptake of ANC. Results of this study also show that women's regular visits to healthcare facilities and regular ANC visits require travelling long distances. However, their ability to access ANC care is restricted by gender norms that give priority to men in household decision-making and prevent women's independent mobility. The findings underscore the need for gender sensitization, transformative policies that promote male engagement, women's mobility, and their participation in household decision-making, and the availability of community-based ANC care services closer to rural households.

The structural inequalities and spatial disparity in health infrastructure, which perpetuate MHV in rural settings, are highlighted by this study. The unavailability of nearby, functional birth centers and overcrowded public birth centers delays timely ANC and pushes rural women towards home deliveries or untrained midwives (Atukunda et al., 2020). The results of this study also reveal that overcrowded public health facilities and the informal setup of midwifery further worsen health issues for women. These patterns are shaped by poverty, cultural norms, and limited health literacy, which collectively reinforce women's reproductive preferences (Alam et al., 2025). To address these issues, it requires well-integrated rural health infrastructure, skilled birth attendants (SBAs) at the village level, and the introduction of mobile ANC services to reduce distance-related barriers and promote safe deliveries. The dissemination of critical maternal health knowledge is severely impeded by the irregular visits of lady health workers (LHWs). For example, research conducted in Northern Ghana aligns with our study. It reveals that women, who are unable to receive structured engagement of LHWs during their pregnancy, are less likely to access timely ANC or identify danger signs during gestation and delivery (Kotoh & Boah, 2019). The strong institutionalization of outreach programs, adequate policy

prioritization, and logistical support initiatives require promoting MH of women living in rural areas.

The association between MHV and ANC practice reflects health inequalities and raises broader social, political, and economic questions. Our study redirects a multidimensional policy to address poor management, system defects and inefficient organization of available resources, the key determinants of health access and outcomes. Findings of this study suggest a multidimensional approach to maintain gender equity, strengthen education, empower women, and ensure accountability to improve maternal health. To enhance maternal health outcomes, it is essential to invest in women's social capital, ensure access to quality and timely reproductive health services, and uproot systemic disparities that perpetuate women's marginalization.

Conclusion

This quantitative study assessed maternal health vulnerability embedded within the four levels of the socioecological model and identified that low literacy among women and their husbands, combined with poor awareness of ANC, reduced health-seeking behaviour and increased MHV. Education, along with other factors, emerged as a significant determinant influencing women's ability to access health information and make informed decisions regarding their reproductive health. This study concludes that gender inequality and poverty are well entrenched in rural areas, resulting in poor ANC practices and barriers to access and healthcare services. The SEM framework provided a comprehensive lens for understanding how factors at the personal, community, and societal levels influence individuals' health-seeking behaviour and increase vulnerabilities.

This study contributes to the existing knowledge on maternal health by identifying several underlying factors that exacerbate the situation of maternal health outcomes in rural areas of Pakistan, including poverty, constrained access to maternal health facilities, availability of quality care, and inadequate reproductive and maternal health knowledge. Most notably, among the four SEM levels analyzed, the community-level model provided the best fit, accounting for the most significant variance in MHV. This suggests that interventions targeted at improving individual behaviors or household dynamics may be insufficient unless the broader structural and

contextual challenges at the community level are addressed. Future qualitative research should focus on cultural norms, gender power relations, and religious beliefs to explore how these factors influence behaviour related to maternal health.

The study calls for greater investment in women's health education and in building social capital, such as community support and trust networks, to address these persistent challenges. It highlights the need for educational interventions that aim to inform and empower, positioning health literacy as a foundational element for improving maternal health outcomes and dismantling systemic inequalities that contribute to women's marginalization. Policies and interventions must consider these factors while targeting improvements in maternal health outcomes, with multilayered, region-specific interventions, with a particular focus on community-level improvements. We suggest addressing the needs and priorities of the women residing in less privileged areas. This is only possible if socioeconomic and geographical factors are taken into account and women are given improved access to financial and physical resources. The challenge of maternal health in rural areas of Pakistan can be reduced by increasing outreach through Lady Health Workers (LHWs), including regular home visits, timely follow-up, and specialized ANC care and education. LHWs should be trained to monitor high-risk pregnancies through capacity-building workshops on ANC care, refresher courses on health literacy methods, and supervision and mentorship to maintain quality service delivery. Additionally, they must be provided with mobile health tools and educational materials to enhance their ability to track MHV indicators and help women access essential health services. The knowledge and skills of LHWs may influence access to health care, utilization of antenatal care, and overall availability of maternal health care among rural women.

Limitations

This study is limited to some villages in northern Sindh, which may affect the generalizability of findings to other rural regions of Pakistan. Due to security and accessibility concerns, some remote villages were excluded, leading to selection bias. Further research on MHV is required in similarly underserved areas where patriarchy and poverty are well entrenched, and women's access to public spheres is restricted.

References

Alam, C.E., Abou-Abbas, L., Ramadan, M.S. and Asmar, M.K. (2025), "Exploring the barriers to accessing antenatal care at the primary health care center level of a tertiary hospital in Lebanon: a qualitative study", *BMC Health Services Research*, Vol. 25 No. 1, pp. 1–14, doi: 10.1186/s12913-025-12444-y.

Al-Mamun, M., Kalam, A. and Uzzal, N.I. (2025), "Factors affecting maternal health and antenatal care services of working mothers in southwestern coastal Bangladesh: a cross-sectional study", *Annals of Medicine and Surgery (Lond)*, Vol. 87, pp. 487–496, doi: 10.1097/MS9.0000000000002895.

Asif, M., Baig, M.F. and Yousfani, G.M. (2014), "Factors affecting the utilization of antenatal care services among pregnant women at District Headquarter Hospital, Mirpurkhas", *JMMC*, Vol. 5, pp. 12–16.

Atukunda, E.C., Mugyenyi, G.R., Obua, C., Musiimenta, A., Agaba, E., Najjuma, J.N., … and Matthews, L.T. (2020), "Women's choice to deliver at home: understanding the psychosocial and cultural factors influencing birthing choices for unskilled home delivery among women in Southwestern Uganda", *Journal of Pregnancy*, Vol. 2020 No.1, 6596394, doi: 10.1155/2020/6596394.

Bollen, K.A. (1989), *"Structural equations with latent variables",* Vol. 25. John Wiley & Sons.

Cochran, W.G. (1977)*, "Sampling techniques",* (3rd ed.). John Wiley & Sons.

Farmer, P. (2004), *Pathologies of power: Health, human rights, and the new war on the poor.* Vol. 4, *University of California Press.*

Habib, S.S., Jamal, W.Z., Zaidi, S.M.A., Siddiqui, J.U., Khan, H.M., Creswell, J., Batra, S. and Versfeld, A. (2021), "Barriers to access of healthcare services for rural women applying gender lens on TB in a rural district of Sindh, Pakistan", *International Journal of Environmental Research and Public Health*, Vol. 18, doi: 10.3390/ijerph181910102.

Jimenez Soto, E., La Vincente, S., Clark, A., Firth, S., Morgan, A., Dettrick, Z. and Widiati, Y. (2013), "Investment case for improving maternal and child health: results from four countries", *BMC Public Health*, Vol. 13 No. 1, pp. 1–14, doi: 10.1186/1471-2458-13-601.

Khan, Y.P., Bhutta, S.Z., Munim, S. and Bhutta, Z.A. (2009), "Maternal health and survival in Pakistan: issues and options", *Journal of Obstetrics and Gynaecology Canada*, Vol. 31, pp. 920–929, doi: 10.1016/S1701-2163(16)34321-3.

Kline, R.B. (2023), "*Principles and practice of structural equation modeling". Guilford Publications.*

Koblinsky, M., Chowdhury, M.E., Moran, A. and Ronsmans, C. (2012), "Maternal morbidity and disability and their consequences: neglected agenda in maternal health", *Journal of Health, Population and Nutrition*, Vol. 30 No. 2, 124–130, doi: 10.3329/jhpn.v30i2.11294.

Koren, A. and Mawn, B. (2010), "The context of unintended pregnancy among married women in the USA", *Journal of Family Planning and Reproductive Health Care*, Vol. 36 No. 3, 150–158, doi: 10.1783/147118910791749380.

Kotoh, A.M. and Boah, M. (2019), "No visible signs of pregnancy, no sickness, no antenatal care: initiation of antenatal care in a rural district in Northern Ghana", *BMC Public Health*, Vol. 19 No. 1094, doi: 10.1186/s12889-019-7400-2.

Kumar, G., Choudhary, T.S., Srivastava, A., Upadhyay, R.P., Taneja, S., Bahl, R. and Mazumder, S. (2019), "Utilisation, equity and determinants of full antenatal care in India: analysis from NFHS-4", *BMC Pregnancy and Childbirth*, Vol. 19 No. 327, doi: 10.1186/s12884-019-2473-6.

Lavasani, L. (2012), "*The effect of the Lady Health Worker Program on maternal health and family planning services in rural Pakistan"*, doi.org/10.17615/7d4t-c093.

Makinde, O.A., Uthman, O.A., Mgbachi, I.C., Ichegbo, N.K., Sule, F.A., Olamijuwon, E.O. and Okusanya, B.O. (2022), "Vulnerability in maternal, newborn, and child health in LMICs: scoping review", *PLOS ONE*, Vol. 17, e0276747, doi: 10.1371/journal.pone.0276747.

Max, J., Sedivy, V. and Garrido, M. (2015), "Increasing our impact by using a social-ecological approach", *Administration on Children, Youth and Families*.

McLeroy, K.R., Bibeau, D., Steckler, A. and Glanz, K. (1988), "An ecological perspective on health promotion programs", *Health Education Quarterly*, Vol. 15 No. 4, 351–377.

Midhet, F., Khalid, S.N., Baqai, S. and Khan, S.A. (2025), "Trends in maternal mortality in Pakistan: analysis of national surveys", *PLOS ONE*, Vol. 20, e0311730, doi: 10.1371/journal.pone.0311730.

Muhammad, S., Memon, Z.A., Mian, A., Wasan, Y., Rizvi, A., Ahmed, I., … and Bhutta, Z.A. (2025), "A cross-sectional analysis of the impact of lady health worker visits in the prenatal and postnatal period on the uptake of continuum of care interventions and childhood mortality in Pakistan", *Journal of Global Health*, Vol. 15, 04158, doi: 10.7189/jogh.15.04158.

Mustafa, M., Batool, A., Fatima, B., Nawaz, F., Toyama, K. and Raza, A.A. (2020), "Patriarchy, maternal health and spiritual healing: designing maternal health interventions in Pakistan", *CHI Conference on Human Factors in Computing Systems*, pp. 1–13, doi: 10.1145/3313831.3376294.

Naz, S., Khan, O. and Azam, M. (2023), "Determinants of rural women's healthcare behavior in Khyber Pakhtunkhwa, Pakistan", *Journal of Development and Social Sciences*, Vol. 4 No. 1, 140–148, doi: 10.47205/jdss.2023(4-I)13.

Omer, S., Zakar, R., Zakar, M.Z. and Fischer, F. (2021), "The influence of social and cultural practices on maternal mortality: a qualitative study from South Punjab, Pakistan", *Reproductive Health*, Vol. 18 No. 1, 97, doi: 10.1186/s12978-021-01151-6.

Paul, P. and Chouhan, P. (2020), "Socio-demographic factors influencing maternal health service utilization in India", *Clinical Epidemiology and Global Health*, Vol. 8, pp 666–670, doi: 10.1016/j.cegh.2019.12.023.

Shaeen, S. K., Tharwani, Z. H., Bilal, W., Islam, Z. and Essar, M. Y. (2022), "Maternal mortality in Pakistan: challenges, efforts, and recommendations", *Annals of Medicine and Surgery*, Vol. 81, 104380, doi: 10.1016/j.amsu.2022.104380.

Shrivastava, R., Singhal, M., Joshi, A., Mishra, N., Agrawal, A. and Kumar, B. (2023), "Barriers to antenatal maternal healthcare in urban slums: systematic review", *Clinical Epidemiology and Global Health*, Vol. 20, 101233, doi: 10.1016/j.cegh.2023.101233.

Sarikhani, Y., Najibi, S.M. and Razavi, Z. (2024), "Key barriers to maternal health services in low-income settings: a scoping review", *BMC Women's Health*, Vol. 24 No. 1, 325, doi: 10.1186/s12905-024-03177-x.

Sumankuuro, J., Mahama, M.Y., Crockett, J., Wang, S. and Young, J. (2019), "Narratives on why pregnant women delay seeking maternal health care during delivery and obstetric complications in rural Ghana", *BMC Pregnancy and Childbirth*, Vol. 19 No. 1, 260, doi: 10.1186/s12884-019-2414-4.

Ullman, J. B. and Bentler, P. M. (2013), "Structural equation modeling", in Schinka, J. A., Velicer, W. F. and Weiner, I. B. (Eds.), *Handbook of psychology: Research methods in psychology* (2nd ed., pp. 661–690). John Wiley & Sons, Inc.

World Health Organization (2025a), "Trends in maternal mortality 2000 to 2023: estimates by WHO, UNICEF, UNFPA, World Bank Group and UNDESA/Population Division". Available at: https://www.who.int/publications/i/item/9789240108462.

World Health Organization (2025b), "WHO recommendations on maternal health: guidelines approved by the WHO Guidelines Review Committee, 2nd ed". Available at: https://www.who.int/publications/i/item/9789240080591.

World Health Organization (2021), "Why we need to focus on quality care for women and newborns". Geneva: WHO. Available at: https://www.who.int/news/item/04-05-2021-why-we-need-to-focus-on-quality-care-for-women-and-newborns.