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The Role of Socio-Economic Factors in Influencing Antenatal Care Quality and Stillbirth Rate in Rural Districts: A Case of Lejweleputswa (Using Structural Equation Modeling)

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ABSTRACT
Stillbirth and maternal mortality remain significant public health concerns in low- and middle-income countries, with rural areas disproportionately affected due to inadequate healthcare access and poor infrastructure. This study investigates the role of socio-economic factors in influencing the quality of antenatal care and their subsequent impact on stillbirth rates in rural South African settings, with a specific focus on the Lejweleputswa District. Despite national policy commitments, rural communities continue to experience disproportionately high rates of stillbirth. Using Structural Equation Modeling (SEM), this study analyzed how variables such as maternal education, household income, access to healthcare services, and employment status affect antenatal care quality and stillbirth outcomes. The study employed a cross-sectional survey design with 263 respondents sampled from public healthcare facilities across the district. Findings revealed that socio-economic conditions significantly influence antenatal care quality, which in turn is strongly associated with stillbirth reduction. The results highlight the need for targeted policy interventions that address both economic and health system barriers to improve maternal and neonatal outcomes.

Keywords: *Augmented Reality, Midwifery Education, Knowledge Enhancement, Skill Development, Digital Learning*

1. INTRODUCTION

Maternal healthcare quality, infrastructure, and knowledge play a fundamental role in reducing maternal mortality and stillbirth rates, particularly in rural areas where healthcare access remains a challenge (Vallely *et al.* 2023). Globally, stillbirth remains a significant public health concern, with approximately 2 million stillbirths occurring annually (Hug *et al.* 2020; Comfort *et al.* 2024). According to Ekwuazi, Chigbu and Ngene (2023), low- and middle-income countries (LMICs) bear the highest burden, accounting for over 90% of these cases. The provision of quality maternal healthcare, supported by well-equipped infrastructure and adequate knowledge, is essential in preventing adverse pregnancy outcomes, including stillbirths (Ekwuazi, Chigbu and Ngene 2023; Key 2024). However, disparities in healthcare access, particularly in rural and underserved regions, contribute to high stillbirth rates due to inadequate prenatal care, poor obstetric services, and a lack of timely interventions (Grand-Guillaume-Perrenoud, Origlia and Cignacco 2022).

In sub-Saharan Africa, stillbirth rates remain disproportionately high due to systemic barriers such as inadequate healthcare facilities, shortages of skilled professionals, and poor maternal health education (Mukherjee *et al.* 2024). Socioeconomic factors, including poverty and limited transportation, further hinder access to quality care (Dahab and Sakellariou 2020). According to (Esther *et al.* 2024), many pregnant women in rural regions delay seeking antenatal care or give birth in under-resourced facilities, increasing the risk of complications leading to stillbirth. Despite global and national efforts to improve maternal healthcare, stillbirth remains a persistent issue, necessitating further investigation into the underlying causes and potential solutions (Atkins *et al.* 2023; Familia 2025).

In South Africa, maternal and perinatal mortality remain critical public health concerns, with rural areas facing a disproportionately high burden (Mlambo, Mvuyana and Ntshangase 2023; Pillay and Moodley 2024). According to Pillay and Moodley (2024), the country has made progress in improving maternal health services, yet challenges persist, particularly in rural districts. The lack of adequately equipped healthcare facilities, limited skilled personnel, and socio-cultural barriers to healthcare utilization contribute to the high rates of adverse maternal outcomes (Mlambo, Mvuyana and Ntshangase 2023).

The National Perinatal Mortality and Morbidity Committee (NaPeMMCo) has identified stillbirths as a key issue requiring urgent intervention, with many cases attributed to preventable causes such as inadequate fetal monitoring and delayed referrals (Dramowski *et al.* 2020).

Lejweleputswa District, located in the Free State province, reflects many of the challenges faced by rural South African communities (Lejweleputswa DM 2022). According to Lejweleputswa DM (2022), the district has a high burden of stillbirths, with many cases linked to inadequate maternal healthcare services, infrastructural limitations, and low maternal health literacy. Many healthcare facilities in the district like any other rural districts are under-resourced, leading to delays in emergency obstetric care (Eshetu *et al.* 2024). Additionally, socio-economic challenges, including unemployment and poor health-seeking behavior, exacerbate the problem (Mbunge and Sibiya 2024). Given these challenges, there is a need for targeted interventions to improve healthcare infrastructure, enhance healthcare providers' capacity, and promote maternal health education (Yuningsih, Yohandoko and Pirdaus 2024).

This study aims to explore how socio-economic factors impact the quality of ANC and how, in turn, ANC quality influences stillbirth rates in Lejweleputswa. Employing Structural Equation Modeling allows for a more nuanced understanding of the direct and indirect relationships between socio-economic determinants and health outcomes.

2. THEORETICAL FRAMEWORK

The Behavioral Model of Health Services Utilization (BMHSU) was first developed in the late 1960s by Ronald M. Andersen, a medical sociologist, as part of a national study on access to medical care in the United States (Lederle, Tempes and Bitzer 2021; Alkhawaldeh *et al.* 2023). The model was designed to understand the various factors influencing why and how individuals access healthcare services and was revised in 1973, 1995, 2000, and 2001 (Alkhawaldeh *et al.* 2023). Andersen's model was grounded in the need to explain health service usage patterns beyond illness alone, emphasizing the role of societal and individual characteristics (Von Lengerke, Gohl and Babitsch 2013).

The original framework identified three primary categories that shape healthcare utilization: predisposing characteristics (such as age, gender, education), enabling factors (like income, access to health facilities, and health insurance), and need factors (perceived and evaluated health status) (Zhang, Chen and Zhang 2019). Over the decades, the model has evolved to include components like personal health behaviors, consumer satisfaction, external environmental factors, and feedback loops, reflecting a more comprehensive and dynamic understanding of healthcare utilization (Alkhawaldeh *et al.* 2023).

Numerous studies across various contexts have applied BMHSU. A study in Nigeria used the model to identify factors influencing the usage of intermittent preventive treatment of malaria in pregnancy, including maternal education, health insurance enrollment, and community perception of malaria (Solanke *et al.* 2023). In China, the model was used to explore the impact of factors such as age, GDP per capita, and health resources on health service utilization at the provincial level (Xin and Ren 2023). Additionally, a study in the US found that factors such as age, education level, and sleep duration were associated with emergency department visits and hospitalizations (Xin and Ren 2023). In Jordan, (Alhalaseh *et al.* 2023) found that knowledge, stigma, and life satisfaction were predictive of seeking formal mental health services among primary care patients with depression. Health Behavior includes personal health beliefs and practices and the use of health services (Doshi *et al.* 2013). Figure 4.2 shows the healthcare utilization and determinants of health utilization behavior.

When addressing the complex issue of maternal care and stillbirth management in the Lejweleputswa District Municipality, it is imperative to employ a comprehensive and systematic approach. Andersen and Newman's Health Care Seeking Behavior Model provides a robust framework to understand and analyze the multifaceted factors that influence healthcare-seeking behaviors among expectant mothers (Kabir 2021). By utilizing this model, the study aims to identify and scrutinize the predisposing, enabling, and need-based factors that affect access to and utilization of maternal healthcare service (Mustapha and Muhibat 2030). This analytical approach ensures a thorough understanding of the barriers and facilitators within the healthcare system, ultimately guiding the development of effective interventions and policy recommendations tailored to the unique needs of this community (Tesfaye *et al.* 2018)

3. HYPOTHESIS DEVELOPMENT

H1: Socio-economic factors significantly influence antenatal care (ANC) quality in rural districts.

Women from lower socio-economic backgrounds often face challenges such as limited education, low income, and unemployment, which impact their ability to access and utilize quality antenatal care (Esther *et al.* 2024). Financial constraints may prevent them from attending ANC visits, while low educational attainment may reduce their awareness of the importance of maternal healthcare (Mwenebanda *et al.* 2024). Additionally, women in rural areas often experience limited healthcare accessibility, with long distances to facilities and inadequate transportation options acting as barriers to ANC utilization (Gamberini, Angeli and Ambrosino 2022). This study hypothesizes that these socio-economic disparities directly affect the quality of ANC services received by pregnant women in the Lejweleputswa District.

H2: Socio-economic factors significantly influence stillbirth rates in rural districts.

Poor socio-economic conditions are associated with higher stillbirth rates due to inadequate maternal healthcare utilization

and limited access to skilled birth attendants (Esther *et al.* 2024). According to Simoncic *et al.* (2022), women with low income or unstable employment may delay or forgo antenatal visits, leading to undiagnosed pregnancy complications. Additionally, nutritional deficiencies, high stress levels, and poor living conditions common in lower-income households may contribute to adverse pregnancy outcomes, including stillbirth (Janaki and Prabakar 2025). This study hypothesizes that women from disadvantaged socio-economic backgrounds are at a higher risk of experiencing stillbirth due to both direct health-related factors and systemic barriers to quality healthcare.

H3: Perceived susceptibility and severity of pregnancy complications influence ANC utilization.

Women who perceive themselves as being at risk of pregnancy complications and stillbirth are more likely to seek ANC services (Arsenault *et al.* 2024). However, in low-resource settings, women may have low perceived susceptibility to pregnancy-related risks due to cultural beliefs, misinformation, or a lack of health education (Warri and George 2020). This study hypothesizes that higher perceived susceptibility and severity of complications will lead to increased ANC utilization, whereas low perceived risk may result in fewer ANC visits, increasing the likelihood of adverse birth outcomes.

H4: Perceived barriers negatively impact antenatal care utilization.

Common barriers to ANC utilization in rural districts include financial constraints, long travel distances, inadequate transportation, cultural stigma, and lack of healthcare provider trust (Penman *et al.* 2023; Abdiwali *et al.* 2024). Women who face these barriers are less likely to attend ANC visits, leading to delayed detection of complications (Alam *et al.* 2025). This study hypothesizes that higher perceived barriers to maternal healthcare significantly reduce ANC utilization, ultimately increasing the risk of stillbirth due to inadequate pregnancy monitoring and care.

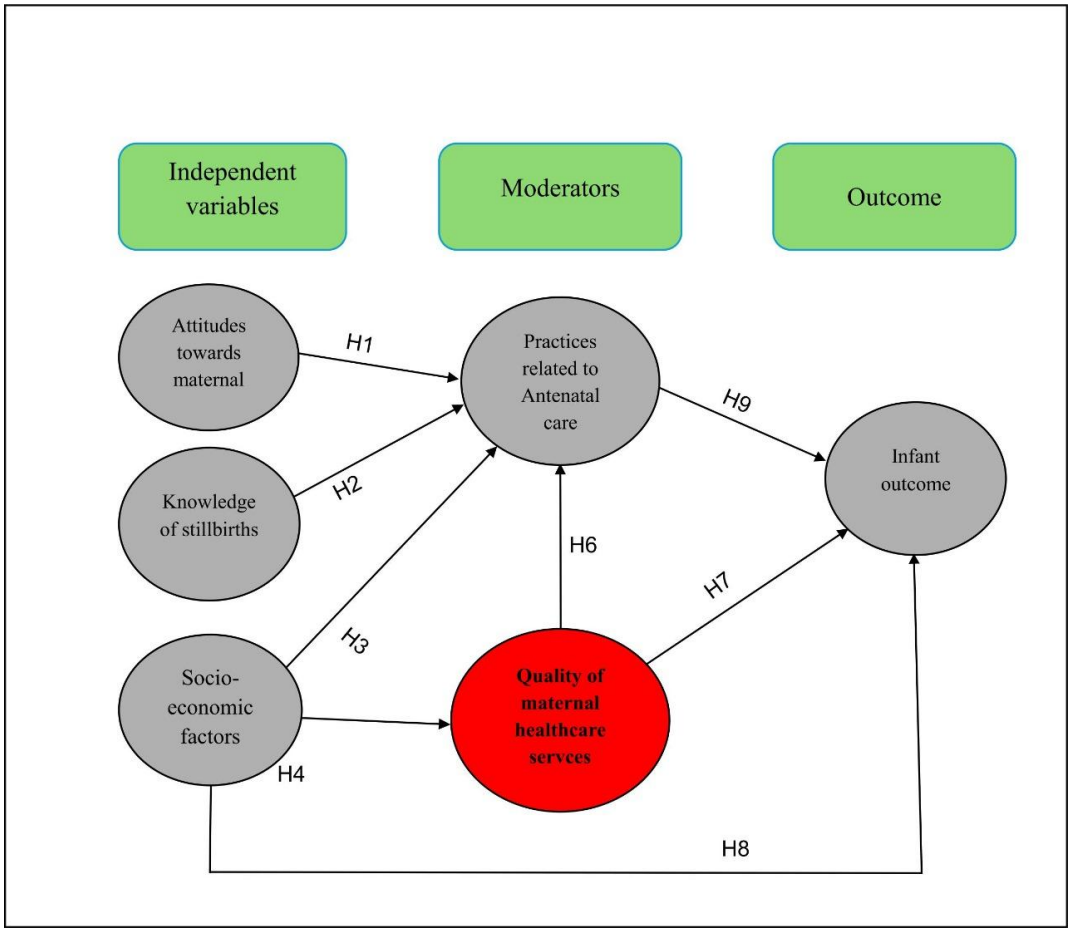
H5: Cues to action, such as awareness campaigns and healthcare interventions, positively influence ANC uptake.

Public health interventions, such as community-based education programs, maternal health campaigns, and healthcare provider engagement, can serve as cues to action that encourage women to seek ANC services (Kassim *et al.* 2023). Women who receive targeted messaging on the importance of maternal healthcare may overcome socio-economic barriers and increase ANC attendance (Gamberini, Angeli and Ambrosino 2022). This study hypothesizes that the presence of strong cues to action positively influences ANC uptake and maternal healthcare utilization in rural districts like Lejweleputswa.

H6: The quality of antenatal care services mediates the relationship between socio-economic factors and stillbirth rates.

While socio-economic disadvantages may increase the risk of stillbirth, the availability and quality of ANC services can mitigate these effects (Penman *et al.* 2023). Women who receive timely and comprehensive ANC, even in low-income settings, may experience better pregnancy outcomes despite financial and social challenges (Chatata and Chirwa 2025). This study hypothesizes that ANC quality serves as a mediating factor, meaning that when maternal healthcare services are improved, the negative effects of poor socio-economic conditions on stillbirth rates can be reduced.

Fig. 1. Proposed conceptual framework



4. METHODOLOGY

4.1 Research setting and design

This study used a quantitative research approach to examine the influence of healthcare quality and infrastructure on healthcare outcomes in Lejweleputswa District Municipality, Free State, South Africa. The study applied a cross-sectional design to collect data from healthcare facilities within the district.

Lejweleputswa District Municipality is a Category C municipality located in the north-western part of the Free State. The district accounts for almost a third of the province and comprises five local municipalities: Masilonyana, Tokologo, Tswelopele, Matjhabeng, and Nala. It includes approximately 18 towns, such as Welkom, Virginia, Odendaalsrus, Bothaville, and Theunissen (Lejweleputswa DM, 2022). As a district with diverse healthcare infrastructure and varying healthcare quality, understanding its healthcare challenges is essential for improving maternal and infant health outcomes. This study provides insights into the role of healthcare quality and infrastructure in shaping healthcare outcomes, contributing to evidence-based policy and healthcare improvements in the region.,

4.2 Population and Sampling

Data on stillbirth rates and infant mortality will be collected from health records in the district's hospitals and clinics. Questionnaires were administered to mothers to gather information on their healthcare experiences, including antenatal care visits, delivery circumstances, and perceived quality of care. The sample size was calculated using the Raosoft sample size calculator with a 5% margin of error, 95% confidence level, a total population of 5225, and a response distribution of 50%. Thus, a total of 358 responses was sufficient to produce robust results whose inferences would be reliable.

The target population included healthcare professionals (e.g., nurses, doctors, facility managers, community health workers, and accounting officers) within public healthcare facilities in the Lejweleputswa District Municipality.

4.3 Data Collection Instruments

A structured questionnaire was used as the primary data collection instrument. The questionnaire consisted of three sections:

- **Section A:** Demographic information (age, gender, role, years of experience, facility type).

- **Section B:** General Knowledge on stillbirth and maternal healthcare
- **Section C:** Knowledge of Stillbirth (This category assesses healthcare providers' understanding of stillbirth causes, prevention strategies, and their role in reducing stillbirth rates.
- **Section D:** Attitude Towards Maternal Healthcare (This category evaluates the attitudes of healthcare workers towards maternal healthcare services and their impact on stillbirth prevention.)
- **Section E:** Socioeconomic Factors: These questions assess the impact of socioeconomic conditions (income, education, etc.) on the ability to access maternal care services and reduce stillbirth.)
- **Section F:** Practices Related to Antenatal Care: (These questions evaluate healthcare workers, practices during antenatal care visits, and how they affect stillbirth outcomes.)
- **Section G:** Quality of Maternal Health Services: This section assesses the quality of maternal healthcare services available, focusing on service provision, staff competence, and overall healthcare infrastructure.)
- **Section H:** Infant Outcome

All items were measured using a **5-point Likert scale** ranging from "Strongly Disagree" (1) to "Strongly Agree" (5).

4.4 Variables and Constructs

- Socioeconomic Factors (SF)**:** Income level, education, employment, transport cost.
- Quality of Maternal Health Services (Q)**:** Timeliness of visits, service availability, provider interaction, diagnostic procedures.
- Infant Outcome (IF)**:** Whether the pregnancy resulted in stillbirth or not.

4.5 Validity and Reliability

The questionnaire was reviewed by public health experts to ensure content validity. A pilot test was conducted on 20 respondents, and the results were used to refine the instrument. Cronbach's alpha was calculated to assess internal consistency, with a threshold of 0.70 accepted for reliability.

2.6 Data Collection Procedure

Data were collected through self-administered questionnaires distributed in person and via email. Participation was voluntary, and informed consent was obtained. Anonymity and confidentiality were maintained throughout the study.

5. DATA ANALYSIS

The collected quantitative data were analysed using the Statistical Package for the Social Sciences (SPSS), Version 29. Before analysis, all completed questionnaires were checked for accuracy, completeness, and consistency. The data were then coded and entered into SPSS for statistical analysis. Descriptive statistics were used to summarize the demographic characteristics of the respondents and the distribution of responses across key variables. Measures such as means, and standard deviations were computed to describe the overall trends in perceptions of healthcare quality, infrastructure adequacy, and healthcare outcomes. Structural Equation Modelling (SEM) was conducted using AMOS to examine the relationships test the study hypotheses. Reliability and validity of constructs were tested through Confirmatory Factor Analysis (CFA), Cronbach's alpha, AVE, and Composite Reliability.

6. ETHICAL CONSIDERATIONS

The study received formal authorization from the Free State Provincial Department of Health, ensuring compliance with provincial regulations and ethical standards for conducting research within healthcare facilities. All participants gave written consent to take part in the study. Their participation was entirely voluntary, and they were informed of their right to withdraw from the study at any time.

Approval of the study was obtained from the Durban University of Technology-Institutional Research Ethics Committee (ref. no. IREC 056/24). Participants' autonomy was prioritized by obtaining their written informed consent before they joined the study, and they were informed of their right to withdraw at any point. Interviews took place in a secure, private location, ensuring a safe environment.

7. RESULTS

7.1 Response rate analysis

The study assesses ways of enhancing South African maternal care within the public health system by exploring a case of stillbirths in the Lejweleputswa District Municipality. The researcher successfully retrieved 263 administered questionnaires, resulting in a response rate of approximately 73.5% (Table 4.1). In survey research, the response rate, also

known as the completion or return rate, is calculated by dividing the number of completed questionnaires by the total distributed, usually expressed as a percentage. A response rate of at least 50% is considered adequate for analysis and reporting, while 60% is regarded as good and 70% or higher is considered excellent (Holtom *et al.* 2022). Thus, the response rate in this study significantly surpasses these benchmarks, providing a strong foundation for credible analysis and ensuring that the findings accurately reflect the views of the respondents.

Table 1: Response Rate Analysis

Total number of questionnaires distributed	Numbers of questionnaires returned/responded n (%)	Number of questionnaire non-responded n (%)
358	263(73.5%)	95 (26.5%)

Demographic Characteristics (Summary)

Table 2 presents a summary of the respondents' demographic and professional profiles. The majority were female (82.9%, n=218), with males comprising 15.2% (n=40), and 1.9% (n=5) not disclosing their gender. Most participants were middle-aged, with 46.0% aged 35–44 and 40.3% aged 55–64. Only 13.7% were in the 25–34 age group. Educational qualifications varied, with 39.2% holding diplomas, 32.7% PhDs, and the remainder having master's (12.5%), bachelor's (11.0%), or honours degrees (4.6%). Nearly half were married (47.1%), while 43.7% were single. Smaller percentages were widowed, divorced, or separated. Professionally, 55.5% belonged to "Other" roles, 25.5% were midwives, and 14.4% nurses, with a few being general doctors (4.2%) or gynaecologists (0.4%). The racial composition was predominantly Black (93.9%), with small percentages of Coloured and White respondents (3.0% each). Over half (57.0%) reported having no children, and most had either one or two children. Regarding experience, 46.8% had more than 10 years, followed by 17.9% with 5–8 years, 17.5% with 0–2 years, 11.4% with 8–10 years, and 6.5% with 2–5 years. This indicates a largely experienced workforce.

Table 2: Demographic Characteristics of respondents

Variables	Frequency=263	Percent=100
Gender		
Male	40	15,2
Female	218	82,9
Prefer not to say	5	1,9
Age group		
25- 34 years	36	13,7
35-44 years	121	46,0
55-64 years	106	40,3
Education level		
Diploma	103	39,2
Bachelors	29	11,0
Honours	12	4,6
Masters	33	12,5
PhD	86	32,7
Marital status		

	Single	115	43,7
7.2	Married	124	47,1
	Separated	4	1,5
	Divorced	9	3,4
	Widowed	11	4,2
	Profession		
	Nurse	38	14,4
	Midwife	67	25,5
	Gynaecologist	1	,4
	General Doctor	11	4,2
	Other	146	55,5
	Race		
	Black	247	93,9
	Coloured	8	3,0
	White	8	3,0
	Number of children		
	None	150	57,0
	1	65	24,7
	2	36	13,7
	More than 3	12	4,6
	Work experience		
	0 to 2 years	46	17,5
	2 to 5 years	17	6,5
	5- 8 Years	47	17,9
	8 -10 yes	30	11,4
	10 years and above	123	46,8

Empirical findings

Table 3 presents the results of a factor analysis conducted on measured variables related to maternal healthcare. Exploratory Factor Analysis (EFA) was performed to assess the dimensionality, reliability, and validity of the constructs. The measured variables were grouped into six constructs: Attitude Towards Maternal Healthcare, Practices Related to Antenatal Care, Quality of Maternal Health Services, Infant Outcomes, Socioeconomic Factors, and Knowledge of Stillbirth. The total variance explained by the model is 68.1%, indicating that the measured variables are strongly correlated and effectively explained by the six constructs.

The Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy is 0.803, confirming that the data is suitable for factor analysis (Hadi et al., 2016). Bartlett's Test of Sphericity is statistically significant ($p < 0.001$, $X^2 = 3796.226$, $df = 300$), indicating that the correlation matrix is not an identity matrix and that the measured variables are related (Shrestha, 2021).

For each construct, Table 3 provides the factor loadings, representing the strength of the relationship between each measured variable and its respective construct. Factor loadings range from 0 to 1, with higher values indicating stronger relationships. The Attitude Towards Maternal Healthcare construct has factor loadings ranging from 0.815 to 0.849, suggesting that all items effectively measure the underlying attitude construct. The Practices Related to Antenatal Care

construct demonstrates high factor loadings between 0.518 and 0.873, indicating strong internal consistency among the measured variables. Similarly, the Quality of Maternal Health Services construct shows moderate to strong factor loadings (0.632 – 0.796), supporting its validity.

For the Infant Outcome construct, factor loadings range from 0.532 to 0.759, indicating a moderate correlation with the measured variables. The Socioeconomic Factors construct exhibits factor loadings between 0.618 and 0.783, highlighting its relevance in explaining disparities in maternal healthcare access. The Knowledge of Stillbirth construct has strong factor loadings ranging from 0.718 to 0.795, confirming its ability to capture respondents' awareness of risk factors associated with stillbirth.

The Cronbach's alpha values for the six constructs range from 0.735 (Attitude Towards Maternal Healthcare and Knowledge of Stillbirth) to 0.885 (Practices Related to Antenatal Care). These values meet the criteria for internal consistency and scale reliability (Hair et al., 2010), indicating that the measured variables are reliable indicators of the underlying constructs.

The mean values for each construct indicate respondents' general agreement with the measured variables. The mean scores for Attitude Towards Maternal Healthcare range from 4.22 to 4.33, suggesting that respondents hold positive attitudes towards maternal care. The Practices Related to Antenatal Care construct has high mean values between 4.29 and 4.52, reflecting strong engagement in ANC-related practices. The Quality of Maternal Health Services construct has mean values ranging from 3.93 to 4.21, indicating a generally positive perception of maternal healthcare services, though communication effectiveness (Q9) received a slightly lower mean score.

The Infant Outcome construct has mean values between 3.90 and 4.28, suggesting agreement on the need to improve maternal care practices. The Socioeconomic Factors construct has lower mean values (3.21 – 3.87) with higher standard deviations, indicating that financial and logistical barriers to healthcare access remain significant challenges. The Knowledge of Stillbirth construct has mean values ranging from 3.51 to 3.87, showing moderate awareness of stillbirth risk factors.

Overall, the findings suggest that the six constructs provide a useful framework for understanding maternal healthcare challenges. The high factor loadings, strong reliability coefficients, and statistically significant validity tests confirm that the measured variables are reliable indicators of maternal healthcare attitudes, practices, and outcomes.

Table 3: Factor Loading Coefficient, Mean and Standard Deviation of the Constructs and Cronbach's Alpha

CONSTRUCT	Measured variables		Factor Loadings	Mean (SD)	Cronbach's Alpha
Attitude Towards Maternal Healthcare	AT4	Addressing stillbirth concerns during ANC visits	,825	4.22 (0.802)	.735
	AT5	Healthcare workers' attitudes influence antenatal care.	,849	4.23 (0.793)	
	AT6	Improved healthcare attitudes improve pregnancy outcomes.	,834	4.33 (0.693)	
	AT7	Efforts to change negative attitudes towards antenatal care	,815	4.30 (0.662)	
Practices Related to Antenatal Care	P2	I always inform pregnant women about the importance of attending all their scheduled ANC visits.	,765	4.49 (0.670)	.885
	P3	Early detection of warning signs during antenatal care helps prevent stillbirths.	,873	4.51 (0.665)	
	P4	Regular ANC visits are promoted and encouraged at this health facility.	,855	4.52 (0.610)	
	P5	I provide information on the symptoms and warning signs that	,678	4.35	

		require urgent medical attention.		(0.757)	
	P6	There is a structured system in place for referring high-risk pregnancies to specialized care.	,518	4.29 (0.766)	
Quality of Maternal Health Services	Q7	The antenatal care provided at this facility includes comprehensive screening for risk factors associated with stillbirth	,636	4.15 (0.868)	.770
	Q8	In case of maternal complications, timely interventions are always carried out to prevent adverse outcomes, including stillbirths.	,796	4.08 (0.807)	
	Q9	Communication between healthcare providers (doctors, nurses, midwives) in this facility ensures that maternal cases are handled effectively and on time.	,731	3.93 (0.862)	
	Q10	Women who experience high-risk pregnancies receive adequate support and counseling from healthcare professionals at this facility to minimize risks to maternal and fetal health.	,632	4.21 (0.699)	
Infant Outcome	IF2	Is there a need to improve current maternal practices to improve maternal outcomes	,664	4.21 (0.764)	.767
	IF4	The current Guidelines for Maternity Care in South Africa need improvement to increase positive maternal outcomes	,709	3.90 (0.956)	
	IF6	Current healthcare infrastructure needs improvements to support safe and effective delivery and maternal care	,626	4.08 (0.825)	
	IF8	Healthcare providers need more confidence in handling complicated pregnancies and reducing adverse outcomes such as stillbirths	,532	4.28 (0.679)	
	IF10	Current interventions need improvements to reduce the occurrence of stillbirth	,759	4.11 (0.746)	
Socioeconomic Factors	SF1	Women with higher education levels are more likely to attend regular antenatal care visits	,618	3.87 (1.102)	.774
	SF2	Low-income women face more barriers to accessing quality antenatal care services	,763	3.31 (1.221)	
	SF3	Lack of transportation is a major factor preventing women from attending antenatal check-ups in this	,783	3.21 (1.233)	

		area.			
	SF4	Women from poorer households are less likely to seek maternal health care compared to women from higher-income households.	,663	3.34 (1.218)	
Knowledge of Stillbirth	KS1	Maternal age play a role in the causes of stillbirth	,718	3.78 (0.875)	.735
	KS2	Obesity cause stillbirth	,795	3.51 (0.945)	
	KS3	Diabetes cause stillbirth	,751	3.87 (0.886)	
Variance=68.1% Kaiser-Meyer-Olkin Measure of Sampling Adequacy=0.803 Bartlett's Test of Sphericity= ($p<0.001$; $X^2=3796,226$; df=300)					

7.3 Theoretical findings

Measurement model: scale reliability and construct validity

The data in Table 4 show that all the measured constructs have AVE values in the range of 0.538–0.684, which is above the recommended threshold of 0.5 (Fornell & Larcker, 1981). This indicates that the measured constructs have an acceptable level of convergent validity, meaning that the indicators effectively explain the variance of their respective constructs. By contrast, Maximum Shared Variance (MSV) is a measure of discriminant validity, representing the highest correlation between a construct and any other construct in the model. Values of MSV below AVE are desirable as they indicate that each construct shares more variance with its own indicators than with other constructs. In Table 3, the AVE for each construct is greater than the MSV values, which suggests adequate discriminant validity across all constructs. Similarly, MaxR(H) (Maximum Reliability with Heterotrait) is another measure of discriminant validity that represents the maximum correlation between a construct and any other construct in the model that is different from the target construct. Values above 0.7 indicate strong construct reliability. All constructs in Table 3 have MaxR(H) values above 0.7, further supporting discriminant validity and ensuring that the constructs effectively capture distinct aspects of maternal healthcare. These results confirm that the measurement model has strong reliability, convergent validity, and discriminant validity, making it a robust framework for assessing attitudes, practices, service quality, and infant outcomes in maternal healthcare.

Table 4 Composite reliability, average variance extracted, and maximum shared square values

	CR	AVE	MSV	MaxR(H)	ATT	Quality	Practice	IF
ATT	0,896	0,684	0,301	0,919	**0,827**			
Quality	0,793	0,562	0,389	0,799	0,391	**0,749**		
Practice	0,891	0,672	0,389	0,895	0,549	0,624	**0,820**	
IF	0,816	0,538	0,284	0,962	0,309	0,533	0,478	**0,733**

Note: ATT= Attitude towards Maternal Healthcare; Quality= Quality of Maternal Health Services; IF= Infant Outcome; Practice= Practices Related to Antenatal Care

7.4 Model fit evaluation

The overall fit of the model was assessed using multiple fit criteria, as shown in Table 5. The first criterion, χ^2/df (p-value), represents the ratio of the chi-square statistic to the degrees of freedom. The value of 3.381 is less than the threshold of 5, indicating an acceptable model fit (Byrne, 2010). The next criterion, the Incremental Fit Index (IFI), measures the proportional improvement in model fit compared to a null model. The IFI value of 0.913 is greater than 0.9, which is the acceptable threshold, indicating that the model fits the data well. Similarly, the Comparative Fit Index (CFI) compares the model fit against a null model. The CFI value of 0.912 exceeds 0.9, confirming that the model provides a good fit (Bentler, 1990). The Root Mean Square Error of Approximation (RMSEA) measures how well the model fits the covariance matrix

of the observed data, with smaller values indicating better fit. The RMSEA value of 0.095 is slightly above the recommended threshold of 0.08, suggesting a moderate fit (Browne & Cudeck, 1993). Finally, the Root Mean Square Residual (RMR), which assesses the residual differences between observed and predicted values, has a value of 0.042, which is below the 0.06 threshold, indicating a good model fit (Hu & Bentler, 1999).

The model fit indices measured in Table 4 suggest that the measurement model has an acceptable to good fit. While RMSEA is slightly above the ideal cutoff, the strong IFI, CFI, and RMR values confirm that the model adequately represents the data.

Table 5: Model fitness indices for the MM

Fit indices	Fit values	Criteria
χ^2 / df (p-value)	3.381(<.001)	<5
IFI	0.913	>.9
CFI	0.912	>.9
RMSEA	0.095	<0.08
RMR	0.042	<0.06

7.5 Path analysis and hypothesis testing

The measurement model was subsequently converted into a path model to depict the relationships among the latent variables. Structural Equation Modelling (SEM) was employed to assess the proposed interactions between these variables. Figure 2 displays the SEM with estimated standardized relationships. The fit indices for the model are as follows: chi-square = χ2 = 267,536 degrees of freedom (df) = 81, p < .001, χ2/df = 3.344, CFI = 0.912, IFI = 0.913, RMSEA=0.095, and RMR=0.041 indicating that the measurement model is acceptable. Consequently, it was determined that the model aligns well with the actual data.

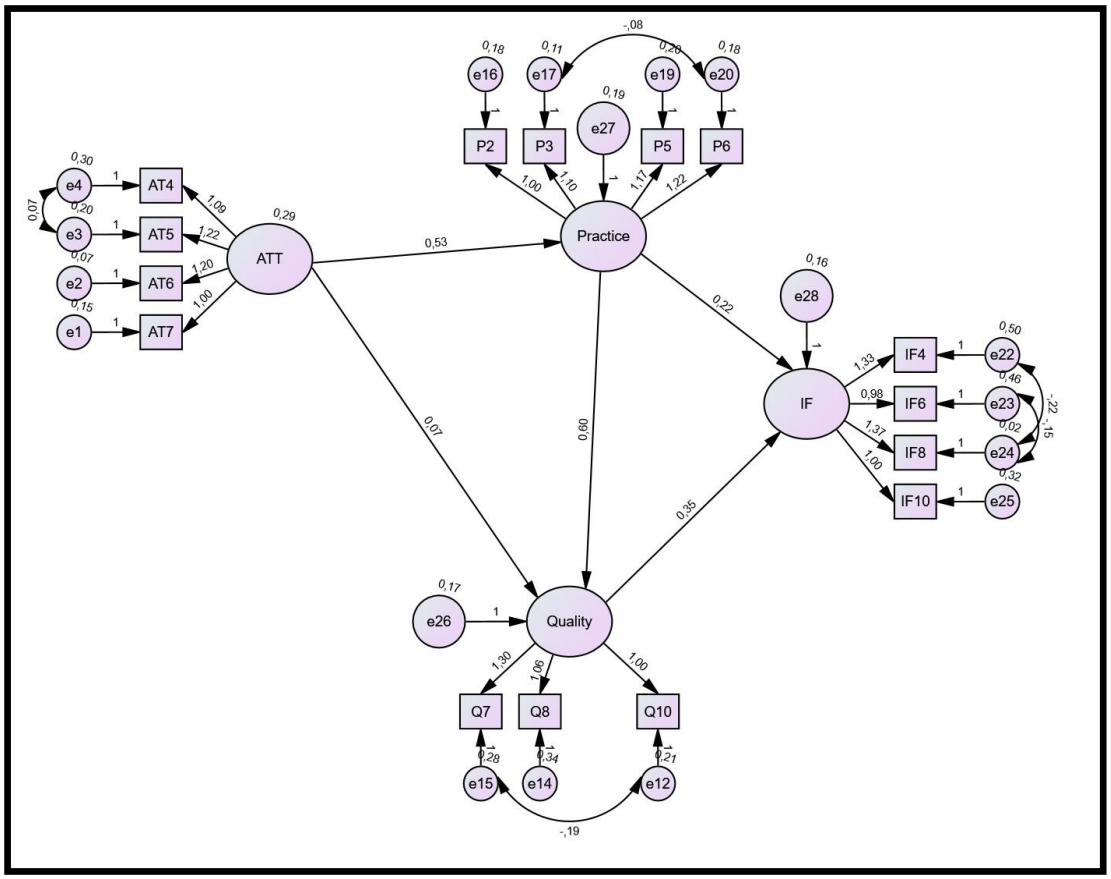


Figure 2: Revised path analysis of MM

Note: $\chi 2 = 267{,}536$, df = 81, $p < .001$, $\chi 2 / df = 3.344$, CFI = 0.912, IFI = 0.913, RMSEA=0.095, RMR=0.041

Table 6 details the path estimate in the MM. The result suggests that the path from Attitude towards Maternal Healthcare (ATT) to Practice was positive and significant (β= 0.551, p<0.001), implying that ATT strongly influences Practice. Thus, the hypothesis (H1) is accepted. Likewise, the path from Practice related to antenatal care to Quality of Maternal Health Services (Quality) was positive and significant (β= 0.587, p<0.001), demonstrating that improved Practice positively impacts Quality. This supports the acceptance of this hypothesis (H2).

On the contrary, the relationship between ATT and Quality was not significant (β = 0.070, S.E. = 0.066, C.R. = 1.045, p=0.296). As the p-value exceeds the threshold for significance, this hypothesis (H3) is rejected, indicating that ATT does not directly influence Quality in this model. A significant positive relationship was observed between Practice and Infant Outcome (IF) with a β of 0.240, S.E. of 0.070, and C.R. of 3.185. The p-value (0.001) confirms the hypothesis (H4), suggesting that improved Practice has a positive effect on IF. Similarly, the path from Quality and IF was positive and significant (β=0.386, p<0.001), highlighting the strong influence of Quality on IF. This supports the acceptance of hypothesis (H5).

The results indicate that ATT significantly influences Practice (H1), and Practice significantly impacts both Quality (H2) and IF (H4). Additionally, Quality plays a crucial role in determining IF (H5). However, ATT does not have a direct effect on Quality (H3). These findings provide insights into the interrelationships among the variables and emphasize the importance of Practice and Quality in influencing maternal healthcare outcomes.

Table 6: Path analysis and estimate of reworked hypotheses

Hypotheses	Independent		Dependent	Standardized coefficient B	S.E.	Critical ratio (C.R)	P	Decision
H1	Practice	<---	ATT	,551	,067	8,014	***	Accepted
H2	Quality	<---	Practice	,587	,082	7,256	***	Accepted
H3	Quality	<---	ATT	,070	,066	1,045	,296	Rejected
H4	IF	<---	Practice	,240	,070	3,185	,001	Accepted
H5	IF	<---	Quality	,386	,084	4,164	***	Accepted

Note: ATT= Attitude towards Maternal Healthcare; Quality= Quality of Maternal Health Services; IF= Infant Outcome; Practice= Practices Related to Antenatal Care

8. DISCUSSION

In this study, we applied a structural equation model (SEM) to investigate the influence of maternal healthcare quality, infrastructure, and socio-economic conditions on stillbirth outcomes in the Lejweleputswa District, Free State Province, South Africa. The model explained a significant proportion of the variance in maternal healthcare outcomes and stillbirth rates, highlighting the interrelated impact of socio-economic factors, access to antenatal care (ANC), and maternal knowledge. The findings revealed that socio-economic conditions had a significant negative influence on access to and quality of maternal healthcare, which in turn affected stillbirth outcomes. These results are consistent with previous research, which indicates that socio-economic disadvantages such as low income, unemployment, and limited education often lead to delayed or reduced access to maternal health services (Penman et al., 2023; Alamgir et al., 2024). For example, rural women in Limpopo and KwaZulu-Natal provinces have reported transportation costs, long distances, and lack of resources as key barriers to timely ANC (Esther et al., 2024). The plausible explanation for these findings lies in the infrastructural and systemic challenges faced by rural areas such as Lejweleputswa, including poor road networks, insufficient health facilities, and healthcare worker shortages. This aligns with Mlambo et al. (2023), who found that despite policy improvements, rural communities in South Africa continue to experience high perinatal mortality due to weak health systems and late presentation for delivery. The implication of this is that interventions aimed at reducing stillbirths should not only target maternal behavior or knowledge but also address broader structural issues within the healthcare system.

The analysis also found that attitudes toward maternal healthcare services influenced health-seeking practices, which in turn had a strong positive effect on ANC quality and outcomes. This is in line with the Theory of Planned Behavior (Ajzen, 2020), which suggests that behavior is driven by attitudes, subjective norms, and perceived behavioral control. Similarly, studies by Kassim et al. (2023) and Arsenault et al. (2024) have demonstrated that positive maternal attitudes and trust in health services can lead to better ANC attendance and improved pregnancy outcomes. However, it is important to note that while women generally demonstrated positive attitudes and intentions toward using maternal health services, this did not

always translate into high-quality care or favorable outcomes—particularly in the presence of socio-economic and infrastructural constraints. This highlights a gap between intention and actual behavior, echoing findings from Roder-DeWan et al. (2020), who argue that good intentions alone are insufficient without an enabling environment that supports safe deliveries.

In terms of maternal knowledge and awareness, the findings showed that while women were aware of the importance of ANC and proper nutrition during pregnancy, knowledge related to stillbirth causes and prevention was low. This is concerning, as poor understanding of stillbirth risk factors can delay care-seeking and reduce adherence to ANC guidelines (Comfort et al., 2024). The implication here is that health education campaigns must go beyond general maternal care and specifically address stillbirth risk and prevention strategies. This may include community workshops, educational pamphlets in local languages, and radio broadcasts in rural communities, as recommended by Hug et al. (2020) and NaPeMMCo (2022). Additionally, the SEM results suggested that ANC quality mediated the relationship between socio-economic status and stillbirth outcomes. This means that improving ANC quality may help mitigate the negative effects of poverty on maternal and infant health outcomes. Similar conclusions were drawn by Obse and Ataguba (2021), who found that ANC service improvements can bridge health inequities in rural settings.

The factor analysis confirmed high internal reliability across constructs such as attitudes, practices, healthcare quality, socio-economic factors, and stillbirth knowledge. The relatively lower mean scores for infrastructure and socio-economic conditions suggest that these remain key barriers to safe pregnancy outcomes in the district. The implication is that interventions should not only empower women through knowledge and behavior change but also advocate for systemic investments in rural healthcare infrastructure, particularly transportation, skilled staffing, and emergency obstetric care. Moreover, disruptions in data collection due to service delivery protests and clinic staff shortages point to the fragile nature of rural health systems. This has also been observed by Kalaris et al. (2022), who recommend strengthening healthcare governance and community-based health worker programs to improve service continuity during times of crisis.

Overall, the findings of this study support the view that reducing stillbirths in South Africa requires a multifaceted approach. This includes addressing socio-economic inequalities, improving health infrastructure, training and retaining skilled healthcare professionals, and enhancing maternal health education. The findings contribute to the broader literature on maternal and child health in rural African contexts and provide evidence for more targeted and context-sensitive policy interventions. The insights from this study can inform national and provincial health strategies aiming to achieve the Sustainable Development Goals (SDGs), particularly SDG 3 on maternal and child health, and the African Union's Agenda 2063 goal of improved health outcomes. Specifically, these findings can guide the Department of Health in designing integrated maternal health programs that combine clinical care with social support and community engagement in the Lejweleputswa District and similar rural areas across South Africa.

9. CONCLUSION

This study provides empirical evidence that socio-economic conditions play a crucial role in shaping the quality of antenatal care (ANC), which in turn influences stillbirth outcomes in rural South Africa. Women from lower-income households and those with limited education often experience delays in seeking ANC services, leading to missed opportunities for early detection and management of pregnancy complications. Additionally, structural barriers such as long travel distances, transportation costs, and inadequate healthcare staffing further hinder access to quality maternal care, disproportionately affecting vulnerable populations.

The findings emphasize the need for policymakers and public health practitioners to adopt integrated approaches that address both economic barriers and health system deficiencies. Improving ANC accessibility through subsidized maternal healthcare programs, community-based outreach initiatives, and telemedicine interventions could help bridge the service gap in rural areas. Moreover, strengthening the healthcare infrastructure by increasing the number of skilled healthcare providers, ensuring the availability of essential medical supplies, and enhancing referral systems can significantly reduce adverse maternal and neonatal outcomes.

Despite the valuable insights provided by this study, several limitations must be acknowledged. First, the cross-sectional design limits the ability to establish causal relationships between socio-economic factors, healthcare quality, and stillbirth outcomes. While structural equation modeling (SEM) allows for the examination of complex interrelationships among variables, the temporal sequence of cause and effect cannot be fully confirmed. Future research should consider expanding to longitudinal study designs to track maternal health outcomes over time and identify long-term patterns in ANC utilization and stillbirth risk factors. Additionally, incorporating healthcare provider perspectives will provide valuable insights into systemic challenges, service delivery gaps, and potential areas for intervention. A comprehensive approach that integrates economic, social, and healthcare system reforms is essential to reducing stillbirth rates and improving maternal and infant health outcomes in South Africa's rural communities.

Declaration of Competing Interest

The author declares that they have no known competing financial interests or personal relationships that could have

appeared to influence the work reported in this paper.

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