Social determinants of women's health in low and middle income countries

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Social determinants of women's health in low and middle income countries

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Editorial: Social determinants of women's health in low and middle income countries

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Editorial on the Research Topic
Social determinants of women's health in low and middle income countries

The recognition of women's improved health and addressing health inequities is critical to achieving the Sustainable Development Goals. The Social Determinants of Health (SDOH) provide a vital framework to comprehend and interpret health disparities, particularly among women in low- and middle-income countries (LMICs). The social determinants of women's health are multidimensional, encompassing political, socio-cultural, economic, and environmental factors that extend beyond bio-medical causes (1, 2).

A holistic approach to SDOH emphasizes the influence of political ecology (3) and various social structures impact women's health in LMICs. It calls for an integrated analysis of the social and environmental systems and policies, which restrict women from opting for healthier opportunities leading to increased maternal mortality and morbidity (3). Socio-economic inequities—such as poverty, limited resources, and lack of education disproportionately affect maternal and children's health outcomes (4, 5). Deeply entrenched patriarchal structures, cultural practices, gender norms further exacerbate these disparities by restricting women's decision-making power (3, 6, 7). The intersection of gender with race, ethnicity, and socioeconomic status further widens these gaps leading to poorer health indicators of marginalized women (4). Further, systemic biases, unfamiliarity with health care systems, and social injustices also contribute to poor maternal health outcomes (8).

The SDOH framework highlights the need for an equity-focused approach, shifting beyond a biomedical model of healthcare to address women's health disparities and create an enabling environment for their well-being (9). This collection of 13 original research articles from LMICs highlights how various social determinants influence maternal health. These comprised of eight manuscripts from Ethiopia, such as two secondary analyses of the Demographic and Health Survey (DHS) (Belay et al., Mebratie), three cross- sectional research studies (Deresa Dinagde et al., Tolesa et al., Desta et al.), two community-based case-control studies (Teressa et al., Aleye et al.), and mixed- method research (Dibaba Degefa et al.). Further, there is a qualitative research from India (Ahuja et al.), an empirical analysis of Papua New Guinea (Shen et al.), a prospective study from Ghana (Tettegah et al.), and a cohort study from Tanzania (Mbwele et al.). Furthermore, there is a historical cohort study from 6

countries, i.e., Democratic Republic of Congo, Guatemala, India, Kenya, Pakistan, and Zambia (Nyongesa et al.). In sum, these thirteen original research articles shed light on three major intersecting themes shaping the social determinants of women's health in LMICs: socio-economic dynamics, socio-cultural norms, and structural and environmental conditions.

Socio-economic dynamics

Predominately, this collection indicated the crucial role of socio-economic dynamics influencing women' health during the prepartum, intrapartum, and postpartum periods. These factors included lower literacy rates, geographies and residential disparities (rural vs. urban), poor economic conditions, occupational status, and lack of decision-making autonomy. For instance, the collection included two secondary analyses of the 2016 Ethiopian DHS (Belay et al., Mebratie), underscored socio-economic disparities. In a study by Mebratie on antenatal care (ANC) and its associated factors, it was found that mothers from rural areas, with lower educational levels, and belonging to the lowest wealth quintile were significantly more marginalized in receiving essential ANC compared to their counterparts in the highest wealth quintiles in Ethiopia. Similarly, Belay et al. found that women's education, geographical location, wealth index, mass media exposure, unintended pregnancy, and multi-parity were strong predictors of the first ANC visit in Ethiopia.

Women from disadvantaged socio-economic backgrounds are more vulnerable to health risks. A prospective study by Tettegah et al. in Ghana demonstrated that exposure to risk factors, including lower education and occupational status of pregnant women, increased their susceptibility to anemia, even when they attended ANC.

Socioeconomic contexts generally shape women's social status in a society's hierarchy. Recognizing the link between women's social status, empowerment, and maternal and child health services, Shen et al. evaluated the causal relationship between these factors and skilled birth attendance using Papua New Guinea DHS (2016–18). This study revealed that women's education substantially improved their decision-making autonomy, positively contributing to maternal healthcare utilization in low-resource settings.

These studies underscore the importance of educating and empowering women by improving their socioeconomic status and addressing disparities to enhance maternal healthcare utilization in LMICs.

Socio-cultural norms

Prevailing socio-cultural norms surrounding pregnancy and childbirth outline maternal health behaviors and healthcare-seeking practices in LMICs, including maternal age and autonomy to start a family, and women's choices regarding nutrition and childbirth practices. Aleye et al. conducted a community-based case-control study in Eastern Ethiopia and found that maternal age influenced peripartum care utilization, leading to shorter birth intervals. Similarly, Nyongesa et al., using a historical cohort (2010–2020), analyzed maternal and perinatal outcomes based on maternal age across six low-resource settings, including the Democratic Republic of Congo, Guatemala, India, Kenya, Pakistan, and Zambia. The increased prevalence of adolescent pregnancies in these settings reflected early marriages and pregnancies in, consistent with local cultural practices. These early pregnancies often occur in environments where girls face cultural restrictions, limited opportunities, gender inequality, and poverty, which not only heighten the risk of adverse perinatal outcomes but also perpetuate cycle of disadvantage.

Conversely, while advanced maternal age pregnancies were less common, they were associated with a higher risk of maternal and perinatal adverse outcomes. This finding suggests that women in deprived circumstances may delay childbirth due to economic instability and a lack of resources for child-rearing.

Additionally, Tettegah et al. assessed the hemoglobin levels of pregnant women in Ghana and identified associated risk factors. Despite greater awareness of anemia, cultural norms limited access to nutritious diets and medical care during pregnancy. These findings suggest that a lack of women's health education about nutritious food during pregnancy, coupled with cultural customs, increases the risk of anemia. Similarly, Ahuja et al. observed dietary restrictions in India due to strong cultural beliefs and practices during pregnancy and the postnatal period. Their study highlighted how these practices negatively impacted maternal and infant health, leading to postpartum depression and isolation, which requires urgent attention.

Gender roles, societal expectations and cultural norms generally affect women' health education, their informed decision making capacity and adoption of healthier practices in LMICs. This is evident from a community-based unmatched case-control study by Teressa et al. in Southern Ethiopia. The results highlighted that inadequate health education and poor maternal healthcare utilization often lead to home deliveries, increasing the risk of maternal mortality or morbidity, especially for marginalized women. Health education can be a catalyst, empowering women during the peripartum period to recognize the benefits of institution-based deliveries for the well-being of both mothers and newborns.

Socio-cultural beliefs arising from SDOH highly influence factors affecting women by exacerbating pre-existing conditions, with serious implications on maternal health outcomes. The vulnerability of socio-economic status coupled with traditional practices often result in poor nutritional intake and unhealthy dietary practices, increasing the risk for anemia and other maternal complications. Any deficiency or health risk during pregnancy or childbirth can have detrimental effects on both fetus and the mother.

Structural and environmental conditions

Structural and environmental inequities often lead to adverse maternal outcomes when disparities in access, resource distribution and power dynamics are reinforced through

structural mechanisms (10). Marginalized women in LMICs experience multiple layers of inequalities in healthcare system, influencing both their access to and utilization of quality maternal healthcare services. Beyond the health system, other structural factors, such as governance, social and public policies, and social values (11), contribute to variations in social determinants of health (SDOH) and shape women's healthcare opportunities. This collection primarily focused on maternal healthcare access and utilization during the perinatal period, particularly ANC and PNC services, highlighting barriers and inadequacies in healthcare infrastructure. However, it lacked an appraisal of the enforcement of existing policies and programs designed to enhance these services.

Deresa Dinagde et al. conducted an institution-based cross-sectional study that assessed optimal ANC utilization among pregnant women. It revealed that only less than half of the pregnant women achieved optimal ANC in Southern Ethiopia. Similarly, Mebratie found lower levels of awareness and utilization of core ANC components, particularly among women from rural areas. Subsequently, a mixed-method research by Dibaba Degefa et al. estimated more than 55% PNC utilization among women in Southern Ethiopia. Overall, a significant proportion of women in LMICs demonstrated a relatively unsatisfactory maternal healthcare utilization, with obstacle such as distant health facilities, long travel times, and extended waiting hours. There is a need to address these barriers related to access to maternal health service and promote health education on importance of regular check-ups for ANC and PNC service utilization, and awareness of pregnancy danger signs to prevent adverse maternal outcomes.

Maternal satisfaction with labor and delivery is an essential indicator of healthcare access and quality of care. Tolesa et al. assessed maternal satisfaction with intrapartum care in public hospitals in Ethiopia, finding that more than 50% of mothers were satisfied with the care they received, indicating healthcare access and quality. Another community-based cross-sectional survey by Desta et al. assessed maternal healthcare utilization was associated with women's perception of respectful treatment by service providers, with satisfaction towards health facility infrastructure being a key contributors to healthcare utilization. Additionally, Aleye et al. found that peripartum care utilization affected short birth intervals, suggesting that improving maternal healthcare utilization is indispensable to reducing the burden of short birth intervals.

Institutional deliveries reduce the likelihood of adverse maternal outcomes. Teressa et al. reported that inadequate health education, poor maternal healthcare utilization, and resistance to institutional deliveries result in home births, thus may increase the risk of maternal complications, maternal mortality and morbidity.

Lastly, Mbwele et al. highlighted the role of healthcare providers and measured the impact of blended training on obstetric hemorrhage management in Tanzania. The training was found to significantly improve healthcare providers' knowledge and skills, emphasizing the potential of blended training in reducing maternal deaths.

This research agenda on social determinants of women's health largely contributes to the existing literature, providing valuable insights for academics, researchers, program managers/implementers, and policymakers. It encapsulates a broader spectrum of SDOH influencing maternal and children's health and addressing health disparities in systemic and meaningful ways to promote a more equitable society.

Key lessons include the need for addressing systemic barriers such as inadequate healthcare infrastructure, unequal resource distribution, and restrictive cultural practices that limit women's access to and utilization of maternal healthcare services. Health education, particularly regarding antenatal and postnatal care, can empower women and improve health-seeking behaviors, while enhancing governance and enforcing policies are critical to improving healthcare access. Future research should focus on the intersectionality of social determinants, specifically how socio-economic status, cultural practices, and gender inequalities impact maternal health outcomes. Additionally, there is a need to evaluate and implement targeted interventions, such as blended training for healthcare providers and community-based health education programs, to mitigate these challenges and ensure equitable healthcare access for women in LMICs. By focusing on these areas, research can contribute to developing sustainable strategies that promote women's empowerment and improve maternal and child health in resource-constrained settings.

Author contributions

RZ: Conceptualization, Methodology, Supervision, Writing – review & editing. SI: Conceptualization, Methodology, Resources, Supervision, Writing – original draft, Writing – review & editing.

Conflict of interest

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Maternal satisfaction with intrapartum care and associated factors among mothers who gave birth in public hospitals of the South West Shewa Zone, Ethiopia, 2022

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Background: Maternal satisfaction with intrapartum care is a multidimensional assumption of satisfaction with self and with the physical environment of the delivery ward and quality of care. Maternal satisfaction with intrapartum care affects the selection of birthplace and helps to identify gaps between actual and intended healthcare outcomes. This study aims to assess factors that affect maternal satisfaction with intrapartum care.

Objectives: To assess maternal satisfaction with intrapartum care and associated factors among mothers who gave birth in public hospitals in the South-west Shewa Zone, Ethiopia, 2022.

Methods: A cross-sectional study approach among 420 mothers was conducted between April 14 and June 14, 2022. Systematic random sampling was used to select mothers for face-to-face interviews every two intervals. Bivariate and multivariable logistic regression analyses were carried out. P-values of <0.25 in association with study variables were transferred to multivariable logistic regression models. An adjusted odds ratio with a 95% confidence interval was computed, and p-values of <0.05 were considered statistically significant in the multivariable model. The results of this study are presented using text, tables, and charts.

Results: Data were collected from 420 participants, and 413 mothers completed the interview, giving a response rate of 98.33%. The overall maternal satisfaction with intrapartum care was 245 (59.32%) [95% CI: 55−64]. Mothers who were considered normal during labor and delivery (AOR = 2.57 (95% CI: 1.30−5.07), had a labor duration of 12 h or less (AOR = 1.59 (95% CI: 1.03−2.44), and experienced a waiting time of <15 min (AOR = 2.06 (95% CI: 1.21−3.52) were significantly associated with maternal satisfaction with intrapartum care.

Abbreviations

ANC, Antenatal Care; AOR, Adjusted Odd Ratio; CI, Confidence Interval; COR, Crude Odd Ratio; C/S, Cesarean Section; FHB, Fetal Heart Beat; SPSS, Statistical Package for the Social Sciences; SVD, spontaneous vaginal delivery; WHO, World Health Organization.

Conclusion and Recommendations: More than half of mothers were satisfied with the overall intrapartum care they received. Health facility managers and healthcare providers work together to improve maternal satisfaction with intrapartum care.

1. Introduction

Satisfaction is difficult to define conceptually because it is affected by a variety of factors. Expectations of mothers, which might vary across women due to different contexts, such as their socioeconomic background, education level, and individual preferences, are among the various elements that determine this level of satisfaction (1). Maternal satisfaction refers to a mother's feelings of joy as a result of comparing a service provided in a health facility to her expectations and the ability of the services provided to meet her expectations, which is a crucial factor when choosing a health facility, compliance with services and follow-ups, and continuation of healthcare (2).

Users' satisfaction with intrapartum care is a comprehensive concept that involves one's contentment, the physical environment of the delivery ward, and the degree of care delivered. Women's satisfaction during childbirth is the most widely reported criterion for evaluating the quality of childbearing services (3).

The World Health Organization (WHO) defines intrapartum care as a platform for providing pregnant women with respectful, individualized, woman-centered, and effective clinical and non-clinical practices to improve birth outcomes for mother and baby by having skilled healthcare providers provide intrapartum care in a well-functioning healthcare system. Women seek a "good childbirth experience" that meets or exceeds their past personal and societal beliefs and expectations according to the evidence used to establish the 2018 WHO recommendations on intrapartum care (4).

Physical environment and infrastructure, continuity of service provided to mothers, access, information, cost, and attention to psychological issues are all factors that can influence maternal satisfaction (3, 5). Mothers' satisfaction is an outcome indicator of the quality and efficiency of care services in the healthcare system, professional healthcare being an important indicator of overall client satisfaction (6).

Maternal satisfaction with intrapartum care is closely tied to service utilization and the perception of care outcomes that fulfill mothers' expectations (3). Globally in 2017, more than 830 women died within 24 h from cases related to pregnancy and childbirth process problems, and 94% of all maternal mortality occurs in low and middle-income countries (7). As part of Sustainable Development Goal 3, countries have committed to decreasing the maternal mortality ratio to less than 70 per 100,000 live births between 2015 and 2030. Therefore, addressing current levels of maternal and neonatal mortality in low- and middle-income countries by 2030 is a global priority (8). The burden of maternal and neonatal mortality is highest in Sub-Saharan Africa, where estimates of severe maternal morbidity range up to 108 per 1,000 live births (9). Maternal mortality is high at-home deliveries (10). Utilization of healthcare services and the belief that the care provided meets clients' expectations are directly related to women's satisfaction (11).

Studies carried out in Malaysia and Nepal revealed that 79.2% and 89.88% of women were satisfied with the services received during childbirth respectively (11, 12). Maternal satisfaction among women who gave birth in African nations was 78.54%, 94%, and 92.54% in Egypt, Ghana, and Mozambique, respectively (13–15). However, in Ethiopia, the proportion of women who were satisfied with child bearing care ranged from 19% to 87.2% (16–21).

Long waiting times, improper availability of drugs and supplies, disrespect, lack of privacy, poor cleanliness in health facilities, poor communication, unprofessional healthcare behavior, unplanned pregnancy, and complicated feto-maternal birth outcomes were factors that had negative impacts on maternal satisfaction with intrapartum care (2, 15, 22–25).

Mothers who denied the friendly approaching behavior of the healthcare provider during childbirth preferred traditional birth attendance (26, 27). Women who were dissatisfied with the quality of care during labor and delivery preferred to give birth at home in the future (28). The dissatisfaction of mothers with childbirth services was an important barrier to women seeking institutional delivery (29, 30). Maternal satisfaction with childbirth provides crucial and cost-effective feedback for further improving institutional childbearing services (11). Satisfaction with intrapartum care has long-term and immediate benefits for the health of the mother and the subsequent uptake and recommendation of the institution's care among their neighbors and relatives (6).

Ethiopia has made remarkable progress in expanding healthcare services through the rapid expansion of infrastructure, increased availability of healthcare providers, increased budget allocation, and enhanced financial management. However, only half of all women give birth in a hospital. Until now, maintaining and improving the quality of service has been a major challenge. As a result, providing high-quality healthcare has become a major transformation priority (31). An Ethiopian mini demographic survey showed that only 48% of live births took place at a health facility (32).

Small studies on maternal intrapartum care satisfaction have been conducted in Ethiopia, and the levels of maternal satisfaction with intrapartum care vary from region to region. Furthermore, there was no study conducted on maternal satisfaction with intrapartum care in the South West Shewa zone. The results of this study will help healthcare providers, hospital

managers, local planners and decision-makers, and other stakeholders better understand how well services are provided, how well providers have met clients' expectations, and what changes may be required to meet clients' expectations and increase service utilization, which has a significant positive impact on mothers' and newborns' lives. Therefore, this study aims to assess factors associated with maternal satisfaction with intrapartum care in public hospitals in the South West Shewa Zone, Ethiopia.

2. Methods and materials

2.1. Study area and study period

The study was carried out in public hospitals in the South West Shewa Zone, Oromia region, Ethiopia. Based on the 2007 census conducted by the Central Statistical Agency of Ethiopia, this zone has a total population of 1,101,129, of whom, 556,194 are men and 544,935 are women (33). Southwest Shewa Zone consists of six hospitals (five government hospitals and one non-government hospital), 54 health centers, 264 health posts, 72 private clinics, eight private pharmacies, and 28 drug stores. The study was conducted from April 14–June 14, 2022.

2.2. Study design

A facility-based, cross-sectional study was conducted.

2.3. Study population

All selected mothers who gave birth in public hospitals in the South West Shewa Zone from April 14–June 14, 2022.

2.4. Inclusion criteria and exclusion criteria

Mothers who gave birth and were discharged from hospital by healthcare providers were included in the study. However, mothers who gave birth to stillborn babies or who suffered serious health issues and were unable to communicate during face-to-face interviews were not included.

2.5. Sample size and sampling procedure

The sample size was calculated using a single proportion population formula for the first objective, with the assumption of 95% confidence interval, 5% margin of error, 45% maternal intrapartum satisfaction), based on a previous study conducted in Public Health Facilities, Jimma Zone (34) and 10% of non-response rate. The final sample size for the study was found to be 420. The sample size for the second objective was also calculated using a double population proportion formula in Epi Info version 7.2.5; however, this is less than the first objective sample size.

The study participants were selected using a systematic random sampling technique, and the sampling interval was determined by dividing the number of average monthly delivered mothers by their allocated sample size at each hospital, which is $K = N/n \sim 2$. Therefore, every other two postpartum women was included in the study until the required allocated sample at each hospital was achieved at the time the healthcare provider decided to discharge, but before leaving the hospital (See **Figure 1**).

2.6. Data collection tools and quality control

Data were collected by pretested structured face-to-face interviewer-administered questionnaire adapted from related literature (2, 12, 19, 20, 24, 37, 38). To ensure the consistency of the questionnaires, the English version was translated into Afaan Oromo for data collection and retranslated into English by a professional translator. The questionnaires contained three parts and 45 items composed of 7 items relating to socio-demographic characteristics, 10 items relating to obstetrics-related factors, and 28 items relating to satisfaction assessment questions.

Pretesting was conducted on 50 study participants (50 mothers) who gave birth in Inchini Primary Hospital. The collected data were entered into EpiData version 4.62 and then exported to SPSS version 25. Cronbach's alpha of the tools was assessed, which was 0.85. One day of training was provided for the data collectors and supervisors regarding the data collection procedure, tools, the purpose of the study, and ethical considerations. Data collectors were strictly supervised. At the end of each day, the questionnaire was reviewed and checked for completeness by the supervisors, and corrections were made.

2.7. Variables

The dependent variable was maternal satisfaction with intrapartum care and the independent variables were socio-demographic characteristics (age, place of residence, educational status, occupational status) and obstetric history of mothers (parity, duration of labor, status of current pregnancy, mode of delivery, maternal outcome, fetal outcome, ANC follow-up, waiting time).

2.8. Operational definitions

Maternal satisfaction with intrapartum care was measured using 28 items, composed of three dimensions: interpersonal care aspect (14 items), information aspect (7 items), and physical birth environment (structural) (7 items). Participants were asked to rate their satisfaction level using a 5-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree). The 5-point Likert scale was merged into two categories of outcome variables for analysis purposes. Strongly
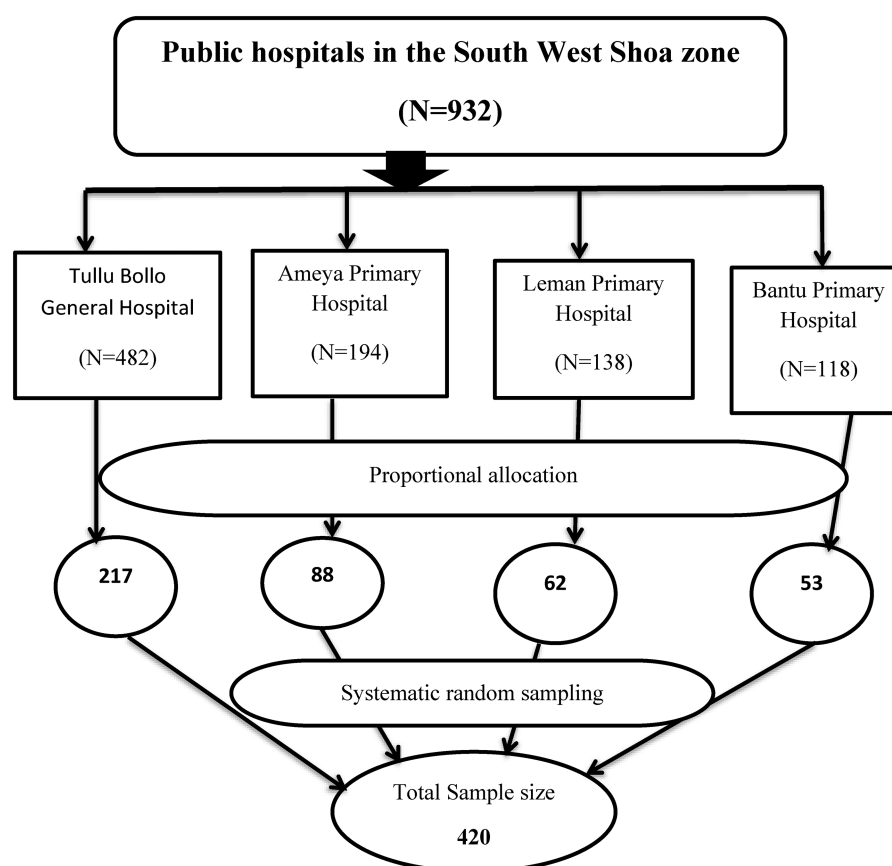
FIGURE 1
Schematic presentation of sampling procedure on maternal satisfaction with intrapartum care and associated factors among mothers who gave birth in public hospitals in the South West Shewa Zone, Oromia region, Ethiopia, 2022.

disagree, disagree, and neutral responses were coded as "0", whereas agree and strongly agree were coded as "1". Then, responses to 28 measuring items were added and converted to give an overall score for the women's levels of satisfaction.

Satisfied: Mothers who scored 75% or more in the 28 items of the mothers' satisfaction questionnaires were categorized as satisfied with the overall care received.

Unsatisfied: Mothers who scored below 75% in the 28 items of the mothers' satisfaction questionnaires were categorized as unsatisfied for overall satisfaction (17, 34, 37, 39, 40).

Waiting time: The time between admissions to the time seen by the healthcare providers (41).

Maternal outcome: Mothers were considered to have had complications if they developed at least one of the following: postpartum hemorrhage, puerperal sepsis, perineal and cervical lacerations, and retained placenta. Mothers who had none of the complications listed above and were clinically assessed as good were considered normal.

2.9. Data processing and analysis

The collected data were checked for completeness, entered into the EpiData manager version 4.62, and exported to SPSS version 25

for data analysis. Descriptive analysis (frequencies, percentages, means, and standard deviation) and inferential analysis were conducted. Variance inflation factors (VIF) were utilized to screen for multicollinearity and a VIF of less than 10 was employed as a cutoff point to diagnose multicollinearity.

Model goodness of fit was checked by the Hosmer–Lermeshow test and was found to be 0.78. Bivariate and multivariable logistic regression analyses were conducted. Variables with a p-values 0.25 in bivariate analysis were transferred to multivariable analysis. AOR (adjusted odds ratio) with a 95% confidence interval was computed, and the p-value < 0.05 was considered statistically significant in the multivariable. The results are presented using text, tables, and charts.

2.10. Ethical consideration

Ethical clearance to conduct the study was obtained from the Salale University College of Health Science Ethical Review committee (Ref number HSC/878/2022). Informed written consent was also obtained from each study participant after the objectives of the study were explained. Participation in the study was based on their volunteer status. The information obtained from the participants was kept confidential. All

methods were carried out in accordance with relevant guidelines and regulations.

3. Results

A total of 420 women were interviewed, making the response rate 98.33%. The seven questionnaires that were not completed were excluded from the analysis (**Table 1**).

3.1. Socio-demographic characteristics of the respondents

The minimum age of respondents was 18 years, while the maximum was 45 years, with a mean age of 28.04 (SD± 6.63). Among the 413 study participants, more than half, (236, 57.1%) of women were living in rural areas. More than three-quarters of the study participants were married (314, 76%), and 141 (34.1%) women had completed secondary education (see **Table 2**).

3.2. Maternal obstetrics characteristics

In this study, among the 413 respondents, more than half (237, 57.4%) of mothers were multiparous. More than three-quarters (323, 78.2%) of women had planned their current pregnancy. The majority of the respondents (354, 85.7%) had ANC follow-ups. However, only 171 (48.3%) women completed the fourth visit (see **Table 3**).

3.3. Maternal satisfaction with intrapartum care

The findings of this study reveal that the overall maternal satisfaction with intrapartum care was 245 (59.32%) [95% CI: 55–64] (see **Figure 2**).

3.4. Maternal satisfaction with intrapartum care related to interpersonal care

The findings of this study show that 268 (64.9%) of the respondents were satisfied with the privacy they were provided

TABLE 2 Socio-demographic characteristics of mothers who gave birth in public hospitals, South West Shewa, Ethiopia, 2022 (*n* = 413).

Variables	Variables categories	Frequency	Percentage
Age	≤24	145	35.1
	25–29	101	24.5
	30–34	89	21.5
	≥35	78	18.9
Residency	Urban	177	42.9
	Rural	236	57.1
Marital status	Married	314	76
	Unmarried	99	24
Educational status	No formal education	83	20.1
	Primary Education	128	31
	Secondary Education	141	34.1
	Diploma and above	61	14.8
Occupational status	Housewife	101	24.5
	Farmer	93	22.5
	Merchant	91	22
	Government employee	57	13.8
	Non-government employee	71	17.2
Reason for going to the hospital	By referral	175	42.4
	By friends and relatives	77	18.6
	By self	161	39
Type of visit	New	263	63.7
	Repeat	150	36.3

during childbearing. Among 413 mothers, more than one-third (295, 71.4%) received a warm welcome. Regarding healthcare providers' stay with mothers, 315 (76.3%) of the mothers were satisfied. More than three-quarters (332, 80.4%) of women were satisfied with the monitoring of their labor progress by caregivers. Concerning assistance in early ambulation, 318 (77%) mothers were satisfied with the intrapartum care they received (see **Table 4**).

3.5. Maternal satisfaction with intrapartum care related to information

According to the result of the current study, 252 (61%) mothers were satisfied with the information given about the result of their examination. A total of 323 (78.2%) and 267 (64.6%) of the respondents were satisfied with the information given by healthcare providers about the progress of their labor and personal hygiene, respectively (see **Table 5**).

TABLE 1 Sample size determination for the second objective of intrapartum care maternal satisfaction among mothers who gave birth in the South West Shewa Zone, Oromia region, Ethiopia, 2022.

Variables	CI	Power	P1	P2	AOR	Ratio	Sample size	10% Non-response rate	Final sample size	Reference
	95%	80%								
Duration of labor	95%	80%	69.6	10.1	3.03	1:1	220	22	242	(35)
Residency	95%	80%	49.5	10.4	2.63	1:1	290	29	319	(36)
Maternal outcome	95%	80%	67.2	16.7	3.597	1:1	116	12	128	(37)
Parity	95%	80%	42.7	47.2	2.352	1:1	198	20	218	(12)

P1, Proportion of outcome among population with the exposure of interest. P2, Proportion of outcome among population without the exposure of interest.

TABLE 3 Obstetrics characteristics of mothers who gave birth in public hospitals, South West Shewa, Ethiopia, 2022 (n = 413).

Variables	Variables categories	Frequency	Percentage
Parity	Primiparous	176	42.6
	Multiparous	237	57.4
Status of current pregnancy	Planned	323	78.2
	Unplanned	90	21.8
ANC follow-up	Yes	354	85.7
	No	59	14.3
Number of ANC visit (n = 354)	First visit	12	3.4
	Second visit	48	13.6
	Third visit	123	34.7
	Fourth visit	171	48.3
Labor duration	Less than or equal to 12 h	209	50.6
	Greater than 12 h	204	49.4
Mode of delivery	Spontaneous vaginal delivery	218	52.8
	Instrumental delivery	81	19.6
	Cesarean section	114	27.6
Maternal outcome	Normal	365	88.4
	With complications	48	11.6
Mothers with complications (n = 48)	Postpartum hemorrhage	20	41.7
	Puerperal sepsis	9	18.8
	Perineal and cervical laceration	14	29.1
	Retained placenta	5	10.4
Fetal outcome	Normal	305	73.8
	With complication	108	26.2
Waiting time	<15 min	216	52.3
	15–30 min	93	22.5
	>30 min	104	25.2

TABLE 4 Interpersonal-related maternal satisfaction with intrapartum care among mothers who gave birth in public hospitals in the South West Shewa Zone, Ethiopia, 2022 (n = 413).

Variables	Variables category	Frequency	Percentage
Available doctors and midwives	Satisfied	341	82.6
	Dissatisfied	72	17.4
Respecting mother while giving care	Satisfied	283	68.5
	Dissatisfied	130	31.5
Examination with mother's permission	Satisfied	332	80.4
	Dissatisfied	81	19.6
Assured privacy	Satisfied	268	64.9
	Dissatisfied	145	35.1
Received by welcoming	Satisfied	295	71.4
	Dissatisfied	118	28.6
Listening and answering all the mother's questions	Satisfied	318	77
	Dissatisfied	95	23
Labor pain management	Satisfied	314	76
	Dissatisfied	99	24
Allowing families to stay with laboring mothers	Satisfied	317	76.8
	Dissatisfied	96	23.2
Monitoring FHB	Satisfied	332	80.4
	Dissatisfied	81	19.6
Monitoring progress of labor	Satisfied	332	80.4
	Dissatisfied	81	19.6
Healthcare providers stay with mothers	Satisfied	315	76.3
	Dissatisfied	98	23.7
Keeping mother in a comfortable position	Satisfied	278	67.3
	Dissatisfied	135	32.7
Assisting in perineal care	Satisfied	290	70.2
	Dissatisfied	123	29.8
Assisting in early ambulation	Satisfied	318	77
	Dissatisfied	95	23

Overall maternal satisfaction with intrapartum care

- Satisfied 59.32%
- Dissatisfied 40.68%
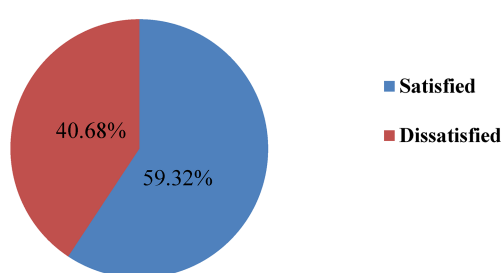
FIGURE 2
Pie chart shows the overall maternal satisfaction with intrapartum care among mothers who gave birth in public hospitals in the South West Shewa Zone, Ethiopia, 2022.

TABLE 5 Information-related maternal satisfaction with intrapartum care among those who gave birth in public hospitals in the South West Shewa Zone, Ethiopia, 2022(n = 413).

Variables	Variables category	Frequency	Percentage
Information about the results of an examination	Satisfied	252	61.0
	Dissatisfied	161	39.0
Information about the progress of labor	Satisfied	323	78.2
	Dissatisfied	90	21.8
Information about the outcome of newborn	Satisfied	317	76.8
	Dissatisfied	96	23.2
Information about breastfeeding	Satisfied	318	77
	Dissatisfied	95	23
Information about personal hygiene	Satisfied	267	64.6
	Dissatisfied	146	35.4
Information about newborn care and immunization	Satisfied	267	64.6
	Dissatisfied	146	35.4
Consent requested before the procedure	Satisfied	335	81.1
	Dissatisfied	78	18.9

3.6. Maternal satisfaction with intrapartum care related to health facility structure

The results of this study showed that 321 (77.7%) of the respondents were satisfied with the cleanliness of the delivery room. Among the 413 mothers, 331 (80.1%) and 330 (79.9%) were satisfied with getting prescribed drugs and laboratory tests in the health facilities, respectively. Concerning the availability and cleanliness of toilets, less than half (203, 49.2%) of the mothers were satisfied (see Table 6).

3.7. Factors associated with maternal satisfaction with intrapartum care

According to this study, the age of mothers, marital status, educational status, labor duration, maternal complications during labor and delivery, fetal outcome, and waiting time were identified as candidate variables for multivariable logistic regression analysis. After controlling for possible confounding variables by multivariable logistic analysis, labor duration, maternal complications during labor and delivery, and waiting time were significantly associated with maternal satisfaction with intrapartum care at a p-value of <0.05.

This study's findings show that the mothers whose labors lasted 12 h or less were [AOR = 1.59 (95% CI:1.03–2.44)] more likely to be satisfied with their intrapartum care than those whose labors lasted longer than 12 h. In this study, women who did not develop obstetric complications during labor and delivery were [AOR = 2.57(95% CI: 1.30–5.07)] more likely to be satisfied compared to those who developed obstetric complications. In addition, women who waited 15 min or less to be seen by the healthcare providers were [AOR = 2.06 (95% CI: 1.21–3.52)] two times more likely to be satisfied compared to women who waited more than 30 min (see Table 7).

4. Discussion

Maternal satisfaction with labor and delivery service is an important outcome measure for the quality of care and provision of services. This study aims to assess maternal satisfaction with intrapartum care at public hospitals in South West Shewa. Accordingly, the overall percentage of mothers who were satisfied with intrapartum care in this study was 59.32% [95% CI: 55–64]. This study is in line with the study conducted in the West Shewa zone (60.8%) (40) and the Bench-Maji Zone, Ethiopia (63.25%) (36). The probable justification for the observed inline findings could be due to the study design and study setting because both studies were conducted using a facility-based cross-sectional study design at the zonal level.

However, the findings of this study are higher than the studies conducted in West Shewa, Central Ethiopia (36.6%) (42), at St Paul's Hospital Millennium Medical College, Addis Ababa Ethiopia (19%) (16), in Gondar Teaching Hospital, Northwest

TABLE 6 Structure-related maternal satisfaction with intrapartum care among mothers who gave birth in public hospitals in the South West Shewa Zone, Ethiopia, 2022 (n = 413).

Variables	Variable category	Frequency	Percentage
Cleanliness of delivery room	Satisfied	321	77.7
	Dissatisfied	92	22.3
Comfort of the waiting area	Satisfied	315	76.3
	Dissatisfied	98	23.7
Getting prescribed drugs and supplies	Satisfied	331	80.1
	Dissatisfied	82	19.9
Getting laboratory tests	Satisfied	330	79.9
	Dissatisfied	83	20.1
Cleanliness of bed	Satisfied	325	78.7
	Dissatisfied	88	21.3
Availability and cleanliness of bathroom	Satisfied	217	52.5
	Dissatisfied	196	47.5
Availability and cleanliness of toilet	Satisfied	203	49.2
	Dissatisfied	210	50.8

TABLE 7 Bivariate and multivariable logistics regression analysis for maternal satisfaction with intrapartum care among mothers who gave birth in public hospitals in South West Shewa, Ethiopia, 2022 (n = 413).

Variables	Variables category	Satisfaction		P-value	COR 95% CI	P-value	AOR 95% CI
		Satisfied, N (%)	Dissatisfied, N (%)				
Age	≤24	95 (65.5%)	50 (34.5%)	0.015	2.00 (1.14–3.50)	0.343	1.38 (0.71–2.71)
	25–29	58 (57.4%)	43 (42.6%)	0.247	1.42 (0.78–2.57)	0.814	1.09 (0.55–2.16)
	30–34	54 (60.7%)	35 (39.3%)	0.122	1.62 (0.88–3.00)	0.448	1.30 (0.66–2.58)
	≥35	38 (48.7%)	40 (51.3%)		1		
Marital status	Unmarried	50 (50.5%)	49 (49.5%)		1	0.065	0.62 (0.37–1.03)
	Married	195 (62.1%)	119 (37.9%)	0.041	1.61 (1.02–2.53)		
Educational status	No formal education	49 (59.0%)	34 (41.0%)	0.080	1.81 (0.93–3.54)	0.247	1.55 (0.74–3.27)
	Primary Education	82 (64.1%)	46 (35.9%)	0.011	2.24 (1.22–4.17)	0.129	1.72 (0.85–3.46)
	Secondary Education	87 (61.7%)	54 (38.3%)	0.023	2.03 (1.10–3.73)	0.147	1.66 (0.84–3.27)
	Diploma and above	27 (44.3%)	34 (55.7%)		1		1
Labor duration	≤12 h	135 (64.6%)	74 (35.4%)	0.028	1.56 (1.05–2.31)	**0.036***	**1.59 (1.03–2.44)**
	>12 h	110 (53.9%)	94 (46.1%)		1		
Maternal outcome	Normal	229 (62.7%)	136 (37.3%)	0.001	3.37 (1.78–6.36)	**0.006***	**2.57 (1.30–5.07)**
	With complications	16 (33.3%)	32 (66.7%)		1		1
Fetal outcome	Normal	199 (65.2%)	106 (4.8%)	0.001	2.53 (1.62–3.96)	0.067	1.60 (0.97–2.65)
	With complications	46 (42.6%)	62 (57.4%)		1		1
Waiting time	<15 min	145 (67.1%)	71 (32.9%)	0.001	2.78 (1.72–4.51)	**0.008***	**2.06 (1.21–3.52)**
	15–30 min	56 (60.2%)	37 (39.8%)	0.013	2.06 (1.17–3.65)	0.097	1.67(0.91–3.06)
	>30 min	44(42.3%)	60(57.7%)		1		1

* = statistically significant, 1 = Reference. COR, Crude odd ratio; AOR, Adjusted odd ratio; CI, confidence interval; N, frequency.

Ethiopia (31.3%) (43). The difference in the study area, the standard of the healthcare facility providing intrapartum care, and the variation in the quality of the care provided could all be contributing factors to this variance.

On the contrary, the findings of this study are lower than the studies conducted in Ethiopia, such as in West Gojjam (88%) (24), Hawassa City (87.7%) (17), Wolaita Sodo University Teaching and Referral Hospital (67.3%) (38), Harar hospitals, Eastern Ethiopia (84.7%) (44), Egypt (78.5%) (13). Variations in the research environment, health facility infrastructures, and socio-demographic characteristics of the study populations might be the cause of these disparities.

This study found that a mother who was considered normal after delivery was more likely to be satisfied with intrapartum care. This finding is similar to that of a study conducted in Nekemte Specialized Hospital in Western Ethiopia (2). This is due to the possibility that women without difficulties may be satisfied with the care they received, which could result in satisfaction. The other probable justification might be that mothers with complications blame the service of the health facility and give a negative response. Another reason could be mothers who experience complications during intrapartum may believe it to be the fault of the healthcare givers who attended her or the hospital in general, resulting in reduced trust in delivering at a health facility.

According to the current study, women whose labor lasts 12 h or less are more likely to be satisfied with their intrapartum care than mothers whose labor lasts more than 12 h. This was similar to the previous study conducted in Eastern Ethiopia (45) and Nekemte Specialized Hospital in Western Ethiopia (2). This could be a result of the fact that prolonged labor can exhaust a woman and subject her to repeated obstetric procedures like vaginal examinations (46), and as time goes on, anxiety about the birth's outcome may also rise, decreasing maternal satisfaction (47).

Furthermore, the findings of this study show that immediate care without delay as soon as women arrived at health facilities had a positive association with maternal satisfaction with intrapartum care. Women who waited less than 15 min to be seen by healthcare providers were more satisfied with their intrapartum care. This study was supported by a study conducted in the Harari regional state, Ethiopia (45) and Nekemte Specialized Hospital in Western Ethiopia (2). This might be a result of providing immediate care to women in labor, which could meet their expectations and lessen complications during labor and delivery, leading to maternal satisfaction.

5. Conclusion and recommendations

The results of the current study conclude that more than half of mothers were satisfied with their intrapartum care. Mothers' labor and delivery outcomes, labor duration, and waiting time were significantly associated with maternal satisfaction with intrapartum care.

Hospital managers and healthcare providers should focus their efforts on labor and delivery services in order to increase maternal

satisfaction with intrapartum care. Additionally, in order to increase maternal satisfaction with intrapartum care, waiting times should be decreased, extended labor should be managed immediately, and problems during labor and delivery should be identified and treated early.

6. Limitations of the study

Limitations of this study include its cross-sectional design, which is unable to show a cause-and-effect relationship; its restriction to public hospitals; and potential response biases due to social desirability. However, by interviewing the women as they prepared to leave hospital, the authors aimed to reduce prejudices.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary Material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving human participants were reviewed and approved by Salale University college of health sciences research ethics committee. The patients/participants provided their written informed consent to participate in this study.

Author contributions

All the authors made substantial contributions to the conception, design, acquisition of data, or analysis and interpretation of the data. They all took part in drafting the article or revising it critically for important intellectual content and decided to submit it to the current journal. All authors gave final approval of the version to be published and agreed to be accountable for all aspects of the work.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Time to initiation of antenatal care visit and its predictors among reproductive age women in Ethiopia: Gompertz inverse Gaussian shared frailty model

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Background: Early initiation of antenatal care (ANC) is essential for the early detection of pregnancy-related problems and unfavorable pregnancy outcomes. However, a significant number of mothers do not initiate ANC at the recommended time. Therefore, this study aimed to determine the median time of ANC initiation and its predictors among reproductive-age women in Ethiopia.
Methods: We used the Ethiopian Demographic and Health Survey (EDHS) 2016 data set. The proportional hazard assumption was assessed using Schoenfeld residual test and log−log plot. A life table was used to determine the median survival time (time of ANC initiation). The Gompertz inverse Gaussian shared frailty model was the best-fitting model for identifying the predictors for the early initiation of ANC booking. Finally, the adjusted hazard ratio (AHR) with a 95% confidence interval (CI) was used to determine the significance of predictors.
Results: A total of 7,501 reproductive-aged women gave recent birth in the last 5 years preceding the survey. Nearly three in five women [61.95% (95% CI: 60.85−63.04%)] booked their first ANC visit with a median time of 4.4 months. Women who attended primary education (AHR = 1.10, 95% CI: 1.01−1.20), secondary and above (AHR = 1.26, 95% CI: 1.11−1.44), media exposure (AHR = 1.07, 95% CI: 1.00−1.16), rich wealthy (AHR = 1.17, 95% CI: 1.06−1.30), grand multiparous (AHR = 0.82, 95% CI: 0.72−0.93), unwanted pregnancy (AHR = 0.88, 95% CI: 0.81−0.96), small periphery region (AHR = 0.58, 95% CI: 0.51−0.67), and rural residence (AHR = 0.86, 95% CI: 0.75−0.99) were significantly associated with first ANC visit.

Conclusion: According to this study, a significant number of women missed their first ANC visit. The education status of women, place of residence, region, wealth index, media exposure, unintended pregnancy, and multi-parity were significantly associated with the time of initiation of the first ANC visit. Therefore, policymakers should focus on improving the socioeconomic status (education, media coverage, and wealth) of reproductive-aged women by prioritizing women who live in small periphery regions and rural residences to improve the early initiation of ANC.

Background

Maternal and child health issues are major public health concerns globally. Maternal and neonatal mortality is unacceptably high with more than one woman dying every 2 min in 2017. Disproportionately, more than 95% of maternal and neonatal deaths occur in low and lower-middle-income countries (1–3). Sub-Saharan Africa takes the lion's share of mortality accounting for more than half of the global burdens, where the maternity continuum of care was scarcely used (1, 4). Ethiopian women have a 21 per 1,000 women lifetime risk for death related to pregnancy with a maternal mortality ratio of 412 per 100,000 live births (5).

The United Nations (UN) Sustainable Development Goal (SDG) sets an objective to reduce maternal mortality to 70 per 100,000 by the year, 2030 with no country falling short more than double this target (1). Providing sustainable and quality maternal care services during pregnancy, childbirth, and the postnatal period can reduce more than two-thirds of maternal and newborn deaths (6, 7). Women who received professional care had a 16% and 24% lower likelihood of losing their baby and experiencing preterm birth, respectively (8). Globally, providing maternity and neonatal continuum of care could prevent approximately half a million neonatal and 3–4 million maternal mortalities (2, 9). The Ministry of Health-Ethiopia (MoH-E) is developing a strategy envisioned to end preventable maternal deaths by 2035 (10) although it looks impossible as evidence points out that maternal mortality is high in the 2016 Ethiopian Demographic and Health Survey (EDHS) (5, 11).

Antenatal care (ANC) services were started across the globe to reduce maternal and neonatal mortality by increasing skilled birth attendance and institutional delivery rate (12–15). Early ANC is defined as the booking of all WHO-recommended services before 16 weeks of gestation, which is vital for the health of both the mother and the neonate (16). The timing of the first ANC visit is very important for subsequent maternal and neonatal care service utilization, which reduces maternal and neonatal mortalities significantly (17–20).

Sociodemographic factors such as parity, education, and wealth status are significantly associated with the time of ANC booking in Pakistan (16). Being a rural residence, married, employed occupation, unplanned pregnancy, and first pregnancy all had a significant impact on the late first ANC initiation (18). However, there is no evidence of the median time of ANC booking among pregnant women in Ethiopia. Therefore, this study aimed to assess the survival time to book the first ANC visit and to identify its possible predictors among pregnant women in Ethiopia. Based on the findings reported from the study, policymakers and stakeholders may be able to develop policies and strategies and design intervention programs to improve maternal care.

Methodology

Study design and data source and populations

The study used population-based cross-sectional survey data from EDHS 2016. Ethiopia is an East African country with the second largest population in Africa. Administratively, Ethiopia is federally decentralized into nine regions [Afar, Amhara, Benishangul-Gumuz, Gambela, Harari, Oromia, Somali, Southern Nations, Nationalities, and People's Region (SNNPR), and Tigray] and two administrative cities (Addis Ababa and Dire-Dawa). The EDHS employed a stratified two-stage cluster sampling technique selected in two stages using the 2007 Population and Housing Census (PHC) as a sampling frame. Stratification was achieved by separating each region into urban and rural areas. In the first stage, enumeration areas (EAs) were selected with probability selection proportional to the EA size, and in the second stage, households were systematically selected. The study design and setting are described in detail elsewhere (21).

The study population consisted of women who gave recent birth in the last 5 years preceding the survey. A total of 46 women who responded that they did not know the timing and number of their first ANC visit were excluded from the analysis. Finally, a total weighted sample of 7,501 reproductive-age women was included in the analysis.

Study variables

The outcome variable of the study is the time between the date of pregnancy of the women and their first ANC visit, which is measured in months. A woman is considered as an event (had her first ANC visit) if she booked WHO-recommended services during her gestational time; otherwise, she is censored. The WHO-recommended services during pregnancies are (1) blood pressure measurements for detecting pre-eclampsia, (2) blood

tests for infection and anemia, (3) urine tests for detecting bacteriuria and proteinuria, (4) counseling about the danger signs of pregnancy, (5) provision of iron supplements, and (6) provision of nutritional counseling (22, 23).

Time is defined as the time in months from conception of pregnancy up to the first ANC visit.

Survival time is defined as the time duration of the mother surpassing without the first ANC contact in months.

Failure time is defined as the time in months when the mother gets her first ANC care.

The independent variables considered for this study were categorized as sociodemographic variables such as the age of the mother, marital status, maternal education, education status of the husband, place of residence, household head wealth index, media exposure, pregnancy-related factors such as parity, pregnancy desire, terminated pregnancy, and health facility–related factors such as distance from the health facility, and health insurance coverage.

Data processing and analysis

The data were accessed in Stata format after registering as an authorized user. We weighed the data as per the recommendation of the major Demographic and Health Survey (DHS). Stata 14 was used for data clearance and analysis. The data were weighted using sampling weight before any statistical analysis to restore the representativeness of the survey. The data clearance and descriptive and summary statistics were conducted using Stata version 14 software. Since the EDHS data have a hierarchical structure where pregnant women are nested within a cluster/EA, the assumption of independent observations and equal variance across the clusters is violated. The random effect of the survival model was checked to assess the clustering effect, and the theta parameter (variance) was used to assess whether there was any significant clustering (24). It showed whether or not there was unobserved heterogeneity or shared frailty that needed to be considered to get a reliable estimate.

Schoenfeld residual test, log–log plot, and Kaplan–Meier and predicted survival plots were applied to check the proportional hazard (PH) assumptions. The log-likelihood ratio test, deviance ($-$2LL), and Akaike information and criteria (AIC) were applied for model selection. A model with the highest values of log-likelihood and the lowest value of AIC was the best-fitting model. Deviance, AIC, and Cox–Snell residual graph showed that the Gompertz inverse Gaussian shared frailty model had the lowest value and the closest graph to the bisector, which was the best-fitting model for the data (25).

A variable with a p-value less than 0.20 in the univariable Gompertz inverse Gaussian shared frailty analysis was included in the multivariable analysis. In the multivariable analysis, the adjusted hazard ratio (AHR) with 95% confidence interval (CI) was used to declare significant predictors for time to first ANC booking. The AHR is the simultaneous inclusion of multiple variables while adjusting for their potential confounding effects. It represents the hazard ratio for the exposure of interest, adjusted for the effects of other variables in the model.

Result

Characteristics of the study population

A total of 7,501 reproductive-age women were included in this study, of whom more than half of the mothers were in the age group 25–34 years (55.70%). Most of the study participants [6,934 (92.45%)] were married, and nearly two-third [4,721 (62.94%)] had no formal education (Table 1).

The median time for initiation of the first ANC visit

Of the total studied women, 4,701 (61.95%) initiated ANC visits from skilled health personnel, whereas the remaining 2,800 (38.05%) had no ANC visits (they were censored) during the follow-up time. Of those who had ANC, only 62.67% (95% CI: 60.95%–64.35%) of the pregnant women initiated their first ANC visits timely (within 16 weeks of gestational age). Of the total

TABLE 1 Characteristics of the study population in Ethiopia, 2016 EDHS.

Variables	Categories	Weighted frequency	Percentage (%)
Maternal age (years)	15–24	1,780	23.73
	25–34	4,178	55.70
	35–49	1,544	20.57
Maternal education	No education	4,721	62.94
	Primary education	2,136	28.00
	Secondary and above	645	8.59
Husband education	No education	3,321	47.29
	Primary education	2,719	39.00
	Secondary and above	983	14.00
Head of household	Male	6,405	85.39
	Female	1,096	14.61
Media exposure	No	4,914	65.52
	Yes	2,586	34.48
Marital status	Not married	566	7.55
	Married	6,934	92.45
Wealth index	Poor	3,271	43.61
	Middle	1,563	20.84
	Rich	2,666	35.55
Insurance covered	No	7,189	95.85
	Yes	312	4.15
Parity	Primiparous	1,408	18.77
	Multiparous	3,161	42.14
	Grand multiparous	2,932	39.09
Terminated pregnancy	No	6,834	91.11
	Yes	667	8.89
Child wantedness	Wanted	6,639	93.57
	Unwanted	456	93.57
Residence	Urban	1,779	23.73
	Rural	4,178	55.70
Distance from HF	Big problem	1,543	20.57
	Not a big problem	3,135	41.79
Region	Metropolis	245	3.27
	Large central	6,821	90.94
	Small periphery	434.7	5.80

HF; Health facility.

pregnant women, only 35.12% (95% CI: 34.06%–36.20%) initiated their first ANC visits timely. The total follow-up time contributed by all study participants was 19,189 person-years. The overall median survival time (the time when half of the pregnant women were found without booking their first ANC) was 4.4 months. The median survival time varies according to the characteristics of the respondents. The median survival time, for example, in urban areas was 4.0 months, whereas in rural areas (**Figure 1**).

Predictors of first ANC visit among women in Ethiopia

Comparisons of the survival functions of the first ANC visit for different categorical variables

The log-rank test and the Kaplan–Meier survival function were used to determine the differences in key variables at the baseline among different categories. The Kaplan–Meier survival function was constructed for different categorical variables. In general, the pattern of the survivorship function lying above another indicated that the group defined by the upper curve (red color) had a longer survival (short time failure) than that of the group defined by the lower curve (blue color). Based on this, in our study, rural residents have longer survival than urban residents at a log-rank p-value of <0.001. The significance of the graphically observed difference was assessed by log-rank test, and it is indicated in the p-value of the respective figures (**Figure 2**).

Model diagnostics and comparison

The Schoenfeld residuals test was used to assess the PH assumption, with results showing that a p-value of <0.001 with a chi-square value of 76.06 is significant. This smallest p-value is

evidence to contradict the PH assumption. Therefore, a parametric type of model should be fitted. Based on deviance, AIC, and Cox–Snell residual test, the shared frailty model with Gompertz distribution and inverse Gaussian frailty was most efficient, because it had the lowest deviance and AIC value (**Table 2**).

In the Gompertz inverse Gaussian shared frailty model, the variables with a p-value of <0.2 in the bi-variable analysis were considered for multivariable analysis. Based on these, the variables such as place of residence, maternal education, partner education, wealth index, parity, wanted last pregnancy, and media exposure and residence were significant predictors of the initiation of the first ANC visit in the multivariable analysis.

Women living in rural residences have a 14% lower hazard of initiating their first ANC visits than those living in urban residences (AHR = 0.86, 95% CI: 0.75–0.99). The hazard of initiating the first ANC visit among women who have primary and secondary and higher education is 1.10 and 1.26 times higher than no formal education (AHR = 1.10, 95% CI: 1.01–1.20) and (AHR = 1.26, 95% CI: 1.11–1.44), respectively. The hazard of initiating the first ANC visit among women whose husbands have primary and secondary and higher education is 1.17 and 1.32 times higher than those who had no education (AHR = 1.17, 95% CI: 1.04–1.22) and (AHR = 1.32, 95% CI: 1.12–1.39), respectively. Women who have media exposure have a 1.07 times higher hazard of having their first ANC visits than that in women who have no media exposure (AHR = 1.07, 95% CI: 1.00–1.16). The hazard of initiating the first ANC visit among women who have a rich wealth index is 1.17 times higher than that in those having a poor wealth index (AHR = 1.17, 95% CI: 1.06–1.30). Women who are grand multiparous have an 18% lower hazard of initiating their first ANC visit than that in those primiparous (AHR = 0.82, 95% CI: 0.72–0.93). The hazard of having the first ANC visit among
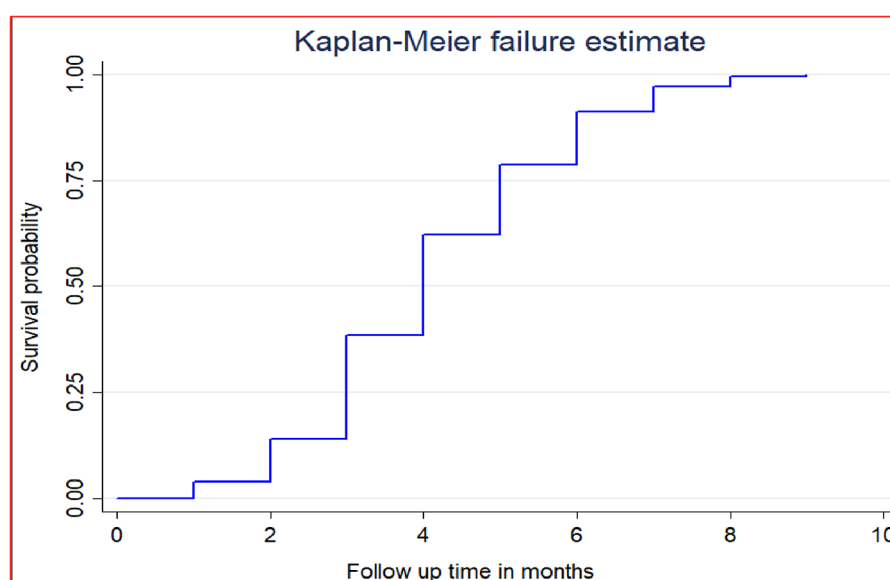
FIGURE 1
The overall Kaplan–Meier failure curve of initiation of first antenatal care visits in Ethiopia in 2016.
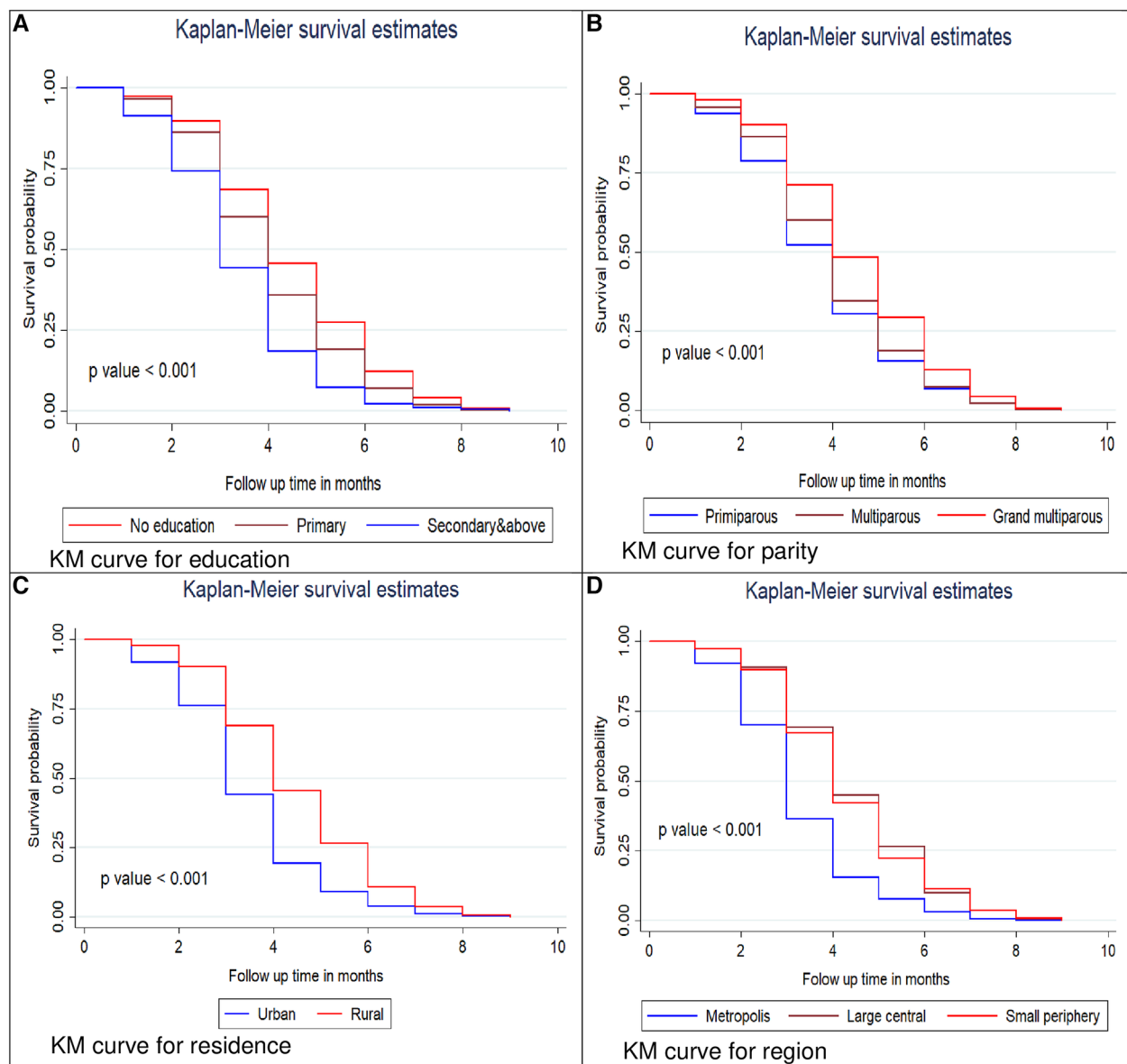
FIGURE 2
Kaplan–Meier survival curves and log rank tests of initiation of first ANC visits by women education status (A), parity (B), residence (C) and region (D) in Ethiopia, 2016.

women who had an unwanted last pregnancy was decreased by 18% as compared to that in those with wanted pregnancy (AHR = 0.88, 95% CI: 0.81–0.96). Women who are living in large central and small periphery regions have a 42% decrease in the hazard of initiating their first ANC visit as compared to that in those living in metropolis cities (AHR = 0.58, 95% CI: 0.51–0.67) (**Table 3**).

TABLE 2 Model diagnostics and comparison for time to initiation of first antenatal care visit and predictors among reproductive-age women in Ethiopia.

Models	Distribution	Frailty	Theta	AIC	BIC	Deviance (−2LL)	LR test of theta
Shared frailty	Gompertz	Gamma	0.33	9,452	9,608	9,776	120
Shared frailty	Gompertz	Inverse Gaussian	0.37	9,447	9,603	9,772	124
Shared frailty	Exponential	Gamma	0.30	9,997	10,140	9,952	106
Shared frailty	Exponential	Inverse Gaussian	0.34	9,992	10,140	9,948	110
Shared frailty	Weibull	Gamma	0.30	9,999	10,150	9,952	105
Shared frailty	Weibull	Inverse Gaussian	0.34	9,994	10,150	9,948	109
Shared frailty	Log-normal	Gamma	0.28	10,340	10,490	10,296	94
Shared frailty	Log-normal	Inverse Gaussian	0.30	10,330	10,490	10,292	98
Shared frailty	Log–log	Gamma	0.29	10,150	10,310	10,112	99
Shared frailty	Log–log	Inverse Gaussian	0.31	10,150	10,310	10,108	102

LR; Likelihood ratio.

TABLE 3 Shard frailty survival regression analysis of initiation of first antenatal care visit among reproductive-age women in Ethiopia, EDHS 2016 perspective.

Variables	Categories	Event (%) $n = 4,700$ (62%)	Failure (%) $n = 2,800$ (38%)	Crude hazard ratio (95% CI)	Adjusted hazard ratio (95% CI)
Age of women	15–24	1,215 (68.25)	565 (31.75)	1.00	1.00
	25–34	894 (21.38)	1,496 (35.82)	0.97 (0.91–1.05)	1.10 (0.99–1.20)
	35–49	804 (52.14)	738 (47.86)	0.84 (0.76–0.93)*	1.07 (0.93–1.23)
Residence	Urban	859 (90.16)	94 (9.84)	1.00	1.00
	Rural	3,842 (58.67)	2,706 (4,133)	0.48 (0.40–0.59)***	0.86 (0.75–0.99)***
Women education status	No education	2,527 (53.54)	2,193 (46.46)	1.00	1.00
	Primary	1,562 (73.19)	572 (26.81)	1.28 (1.19–1.38) ***	1.10 (1.01–1.20)*
	Secondary and above	610 (94.66)	35 (5.36)	1.88 (1.69–2.06) ***	1.26 (1.11–1.44)**
Partner education status	No education	1,767 (53.2)	1,554 (46.8)	1.00	1.00
	Primary	18,03 (66.34)	915 (33.66)	1.25 (1.16–1.36)***	1.17 (1.04–1.22)*
	Secondary and above	843 (85.76)	140 (14.24)	1.78 (1.62–1.96)***	1.32 (1.12–1.39)**
Marital status	Not married	338 (59.75)	228 (40.25)	1.00	1.00
	Married	4,362 (62.91)	2,572 (37.09)	0.96 (0.86–1.08)	1.19 (0.89–1.59)
Head of household	Male	4,024 (62.84)	2,380 (37.16)	1.00	1.00
	Female	676 (61.68)	420 (38.32)	1.12 (1.04–1.22)*	0.07 (0.98–1.17)
Media exposure	No	2,705 (55.03)	2,210 (44.97)	1.00	1.00
	Yes	1,996 (77.17)	590 (22.83)	1.40 (1.30–1.50)***	1.07 (1.00–1.16)*
Wealth index	Poor	1,706 (52.17)	1,564 (47.83)	1.00	1.00
	Middle	975 (62.41)	588 (37.59)	1.10 (0.99–1.21)	1.06 (0.95–1.17)
	Rich	2,018 (75.70)	648 (24.3)	1.58 (1.46–1.72)***	1.17 (1.06–1.30)***
Insurance covered	No	4,465 (62.11)	2,724 (37.89)	1.001.00	1.00
	Yes	236 (75.59)	76 (24.41)	1.21 (1.03–1.43)*	1.19 (1.01–1.41)*
Parity	Primiparous	10.98 (78.02)	309 (21.98)	1.00	1.00
	Multiparous	2,067 (65.42)	10.93 (34.58)	0.91 (0.84–0.98)*	0.92 (0.85–1.02)
	Grand multiparous	1,535 (52.34)	1,397 (47.66)	0.71 (0.65–0.78)***	0.82 (0.72–0.93)**
Child wantedness	Wanted	3,572 (64.79)	1,941 (35.21)	1.00	1.00
	Unwanted	1,127 (56.77)	859 (43.23)	0.86 (0.79–0.93)**	0.88 (0.81–0.96)**
Distance from HF	Big problem	2,372 (54.34)	1,993 (45.66)	1.00	1.00
	Not a big problem	2,338 (74.27)	806 25.73	1.16 (1.08–1.24)*	1.00 (0.94–1.08)
Region	Metropolis	230 (93.99)	15 (6.01)	1.00	1.00
	Large central	4,248 (62.29)	2,572 (37.71)	0.43 (0.38–0.48)**	0.58 (0.50–0.66)***
	Small periphery	221 (50.91)	213 (49.09)	0.43 (0.38–0.491)**	0.58 (0.51–0.67)***

HF; health facility.
Event = women who booked an ANC; failure = women who did not book an ANC.
*p-value < 0.05.
**p-value < 0.01.
***p-value < 0.001.

Discussion

This study was conducted to assess the predictors of initiating the first ANC booking in Ethiopia based on the EDHS 2016 data. According to this study, only 61.95% (95% CI: 60.85%–63.04%) of women had their ANC visits. Of those who had ANC, only 62.67% (95% CI: 60.95%–64.35%) of pregnant women initiated their first ANC visits timely (within 16 weeks of gestational age). Of the total pregnant women, only 35.12% (95% CI: 34.06%–36.20%) of women initiated their first ANC visits timely. Moreover, the overall median survival time (the time when half of the pregnant women were found without booking their first ANC) was 4.4 months. This finding was less than the finding from health centers of Addis Ababa, where 65.6% of women started their ANC visit within 16 weeks of gestation. The discrepancy might be because Addis Ababa is the capital of the country and the community there might have better health awareness than other parts of the country. It could also be due to EDHS covering more remote areas where health institutions could be a major predictor of ANC utilization.

In the Gompertz inverse Gaussian shared frailty model analysis, the education statuses of women and husbands, media exposure, wealth index, wanted child, parity, and place of residence were significantly associated with the time of the first ANC visit.

Women who had formal education had a higher chance of booking their first ANC visit as compared to that in women who had no formal education. This is supported by the findings of the studies conducted in Northern (26) and Northwest Ethiopia (27) and Nigeria (28). Better education status of husbands increases the risk of early ANC visits of women as compared to that of their counterparts. This is supported by evidence from a study conducted in Southern Ethiopia (29), where women with educated husbands had more chance of early ANC visits. This is due to being educated to understand the importance of ANC visits, which encourages them to have early ANC bookings.

Women living in rural residences and small periphery regions had less risk of having initiation of ANC visits compared to that of their counterparts. This finding is supported by findings from

Zambia (30) and might be explained by urban women who may have better access to health facilities to have an early booking. A better wealth index increases the chance of first ANC visits as compared to the poor. This is supported by evidence reported from Nigeria (28) and Zambia (30), where better household wealth improves the time for women to have their first ANC visit. This might be explained by women with better wealth may have better transport access and the ability to pay for transport to visit health facilities.

Women with media exposure had an increased risk of initiation of their first ANC visit. This is also in line with other findings from Nigeria (28). This could be justified by those women with better media exposure who had better knowledge about the importance of ANC visits, which encourages them to have early ANC bookings.

Being a grand multipara significantly decreases the risk of initiation of the first ANC visit as compared to primiparous women. This is supported by findings of studies conducted in the United Kingdom (31) where having high parity increases the risk of women having late ANC visits. This might be because those women with primigravida are more sensitive to complications and visit health facilities to have experiences with delivery and other services, whereas the multiparous women adapt the pregnancy and labor so they may not visit the health institution early. Women with unwanted pregnancies had a lower risk of initiation of the first ANC visit as compared to those with unwanted pregnancies in Ethiopia. This is in agreement with the reports of studies conducted in Northwest Ethiopia (32) and Zambia (30), where women with wanted pregnancies had a double risk of early initiation of ANC visits. This might be explained by the women with wanted pregnancies who might have a positive experience and more intention to have a healthy neonate with additional support from husbands or families which will encourage them to have an early ANC visit.

The main strength of this study was the use of weighted nationally representative data with a large sample that makes it representative at national and regional levels. Therefore, it can be generalized to all pregnant women during the study period in Ethiopia. Moreover, this study used a shared frailty model that considered the nested nature of the EDHS data and the variability within the community to get a reliable estimate and standard errors. But it is not free of limitations mainly resulting from the use of secondary data. Since the study includes women who delivered in the last 5 years before the data collection and asked about the essential service she provided, there might be a recall bias for relatively older delivery. Moreover, some important confounders like the health service quality and behavioral factors are missed. In addition, the outcome variable is measured in an integer even though the continuous time survival model is fitted.

Conclusion

According to this study, only three-fifth of pregnant women booked their first ANC visit. The median survival time for initiation of the first ANC visit is higher than what the WHO recommends. The place of residence, education of women and husbands, wealth index, media exposure, pregnancy wantedness, and multi-parity were significantly associated with the time of the first ANC visit.

Therefore, empowering women through improving education level, access to media, and improvements in wealth status can lead to the early booking of ANC by raising awareness and promoting positive healthcare-seeking behaviors. A priority should be given to women in the periphery regions and rural residences, with targeted interventions designed to overcome barriers and ensure equitable access to ANC services for all women.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary Material, further inquiries can be directed to the corresponding author.

Ethics statement

Ethical approval was not required for the study involving humans in accordance with the local legislation and institutional requirements. Written informed consent to participate in this study was not required from the participants or the legal guardians/next of kin of the participants in accordance with the national legislation and the institutional requirements.

Author contributions

Acknowledgments

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Post-natal care: a vital chance to save mothers and infants! Exploring barriers and factors associated with it: a mixed study

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Introduction: The most effective maternal health intervention for enhancing mother and baby survival is postnatal care, yet it is also the most neglected service in Ethiopia. Less is known about postnatal care despite earlier studies concentrating on pregnancy and delivery service utilization. Postnatal care is the subject of few national and local area studies. Therefore this research aims to evaluate postnatal care utilization and barriers and associated characteristics among women in Ilubabor Zone and Buno Bedele Zone.

Methods: A mixed-methods study involving women who visited immunization clinics was conducted in Southwest Ethiopia. For the quantitative part, a cross-sectional survey was conducted between June 12 and July 12, 2022. The data collected through interviews was analyzed using SPSS version 26. An adjusted odds ratio (AOR) with a 95% confidence interval (CI) and p-value was constructed to evaluate the associations between postnatal care service utilization and explanatory variables. The usage of postnatal care services was determined to be significantly correlated with explanatory variables in multivariable logistic regression with a p-value less than 0.05. This qualitative study used two focused group discussions and two in-depth interviews to gather data from purposely selected mothers, and thematic analysis was used to analyze the data.

Results and discussion: A total of 422 participants with a 100% response rate were included in the analysis. 234 (55.5%) of these underwent postnatal checks. In the quantitative section, postnatal care counseling and appointment setting, counseling on danger signs, and prior postnatal care utilization all demonstrated a statistically significant association with the use of postnatal care services (AOR = 3.6, 95% CI (1.47−7.23)), [AOR = 2, 95% CI (1.05−3.64)], and [AOR = 3, 95% CI (1.36−58), respectively). At the qualitative level, it was determined that the themes of knowledge and access were obstacles to the use of postpartum care services. Generally this study revealed that the Ilubabor Zone and Buno Bedele Zone have a poor total PNC service utilization rate. Furthermore, ignorance, conventional wisdom, religious activity, distance from facilities, environmental exposure, and waiting time were identified as barriers to postnatal care service utilization. To optimize this service, all parties involved should address these factors.

KEYWORDS

postnatal care, factors, utilization, services, barriers

Abbreviations

ANC, antenatal care; APH, antepartum care; HDP, hypertension disorder during pregnancy; MDG, millennium development goal; Para, parity.

1. Introduction

Globally, approximately 1.5 million mothers die after childbirth each year. In developing countries, 1 in 7 mothers die from pregnancy and childbirth particularly during the postnatal period. The global community has addressed women's health in the past few years. Reduced maternal mortality and universal access to reproductive health care were two objectives of the fifth Millennium Development Goal (MDG) for maternal health. However, it is believed that the MDG had a low success rate (1–4).

Ethiopia still has a high rate of maternal and newborn mortality, similar to other third-world nations. In Ethiopia, direct reasons such as hemorrhage, infection, obstructed labor, unsafe abortions, and high blood pressure, which typically happen during the postpartum period, account for over 80% of maternal mortality. In Ethiopia, severe obstetric hemorrhage is a leading cause of death. The fastest maternal killer is postpartum hemorrhage, which can kill even a healthy woman within 2 h if left untreated. To prevent this postpartum issue, the postnatal period, which is defined as the first six weeks following birth, is essential for the health and survival of both a woman and her infant. For monitoring delivery-related difficulties, the first two days following delivery are particularly important. Due to this, a postnatal visit is the ideal time to inform the mother of danger signs, and all women should have at least three to four postnatal visits, as advised by the WHO. If care is not given during this period, missed opportunities to promote healthy behaviors in mothers and newborns may end in death or impairment. The figures on postnatal service utilization are deficient for countries like Ethiopia, where 75% of women do not receive any postpartum care, followed by Bangladesh (73%), Nepal (72%), and Rwanda (71%). Other countries with sizable proportions of women who did not obtain any postpartum medical care include Burkina Faso (44%), Cambodia (46%), Haiti (55%), Kenya (46%), and Malawi (41%). Mali (49%), Nigeria (46.5%), Uganda (57%) and Zambia (41%) also showed comparable results. On average, nearly 40% of women did not receive a postpartum care checkup in the 30 countries studied (5–11).

Postnatal care obstacles and other factors have been found in prior work. Findings from studies conducted in Jabitena district, Amhara regional state, Northwest Ethiopia, Northern Ethiopia, and Wolkite, Ethiopia, as well as rural areas of Northern Ethiopia, Tigray, Ethiopia, Debre Tabor town, Northern Ethiopia, Hawassa Zuria, Northern Ethiopia at Adigirat town, Addis Ababa, in Sodo Zuria and Shebe Sombo Woreda, Jimma, revealed that the prevalence of postnatal service utilization ranges from 20.2% to 77.7% (12–30).

Some studies conducted in parts of Ethiopia assessed a number of barriers and factors associated with postnatal care service utilization. For instance, a community-based study in Northern Ethiopia found that women who delivered at health institutions were three times more likely to attend postnatal care services than those who delivered at home. Similarly, women who knew about the complications related to pregnancy/labor were more likely to use postnatal care services than those who did not. In addition, women were 4.6 times more likely to use postnatal care services if they were aware of them than if they were unaware. The number of children ever delivered, the mother's level of literacy, and radio listening frequencies were determined to be the drivers of PNC use in a study conducted in parts of Ethiopia. Other factors such as more than four pregnancies, wanted pregnancy, spontaneous vertex delivery, husband with secondary education, delivery with cesarean section, secondary education or above for the mother, a monthly household income of more than 1,500 ETB, planned and supported prior pregnancy, institutional delivery of last pregnancy, accessing health care, having a positive attitude towards the use of postnatal services, and having a living child born from the previous pregnancy show significant associations with postnatal service utilization (13, 14, 20–29).

The most effective maternal health intervention for enhancing mother and baby survival is postnatal care, yet it is also the most neglected service in Ethiopia. Less is known about postnatal care, despite earlier studies concentrating on pregnancy and delivery service consumption. Postnatal care is the subject of few national and local area studies. Therefore this study aims to evaluate postnatal care utilization, barriers and associated characteristics among women in Southwest Ethiopia who gave birth 10 weeks before the survey and who visited selected health centers for child immunizations up to 14 weeks following delivery in the of Ilubabor Zone and Buno Beadle Zone.

2. Methods and materials

2.1. Study area, design and period

A mixed methods study was carried out at health centers in Southwest Ethiopia, between June 12 and July 12, 2022. For the quantitative study cross-sectional study design was used whereas the qualitative study was carried out to triangulate the quantitative study. Ilubabor Zone has one referral hospital, one district hospital, and forty health centers that serve its residents whereas Buno Bedele has thirty two health facilities, 246 health posts, three operational hospitals, and one hospital that is currently being built.

2.2. Populations

For the quantitative part, the study population consisted of all women in the Ilubabor and Buno Bedele zones who gave birth 10 weeks before the survey and who visited health facilities for child immunizations up to 14 weeks following delivery and who met the inclusion criteria throughout the chosen time. For the qualitative part we selected mothers purposely from similar populations.

2.3. Inclusion and exclusion criteria

Women who visited the specified medical institutions between 10 and 14 weeks following delivery to have their child immunized and gave their informed consent were included.

2.4. Sample size determination, sampling technique, and procedures

With the following assumptions: $p = 48\%$, coverage of postnatal care service utilization in urban areas (EDHS 2019), a 95% confidence level, a 5% precision, and a 10% non-response rate, the sample size was calculated using a single population proportion formula, and the final sample size was 422 for the quantitative part. Based on each health center's 6-month infant immunization rate, the total sample sizes were distributed among the health centers in a proportional manner. Throughout the study period, all eligible women in each health center were invited to participate in turn until the necessary sample size was reached. Ten women were chosen for the qualitative level using the purposive sampling method. From 72 health centers in the two zones 21 health centers were selected by systematic random sampling technique and the total sample size was distributed for each health center based on 6 months of client flow in the immunization clinic.

2.5. Data collection tool, procedure, and quality control

After reading the pertinent literature, the questionnaire for the quantitative portion was modified to address the study objectives. Then, 5% of the sample participants underwent pretesting outside the research location. Accordingly, the questionnaire was modified. Quantitative information was gathered via Open Data Kit (ODK) using standardized questionnaires that were pretested and administered by interviewers. During and after data collection, the lead investigators and supervisors evaluated and verified the questionnaire to ensure its accuracy and applicability. The quantitative level gathered information from new mothers who visited health clinics to have their children immunized and receive family planning. Data collectors received a half-day orientation from the supervisors overseeing the entire data collection process. The survey was written in English, translated into Afan Oromo, then back into English to ensure uniformity. Two weeks before the real data collection period, a pretest was conducted. Every day before entering the data, data collectors, supervisors, and the lead investigator verified all the information that had been obtained. In addition, non-respondents were counted for any incomplete surveys that missed >10% of the total response.

Data were gathered at the qualitative level using a semi-structured guide. To assure the quality of the data, the guide was first pretested on four women before the real data collection. The guide included major theme areas of knowledge about postnatal care service utilization, accessibility, financial constraints and traditional and religious barriers. Afan Oromo was used to translate the conceptual guide from English. The idea behind the guide was to move from general principles to precise specifics. In-depth interviews and focused group discussions were used for 48 and 50 min respectively to gather information from the participants. The modulator served as the principal investigator for the duration of the entire data collection process.

2.6. Study variables

2.6.1. Dependent variable

Postnatal care service utilization.

2.6.2. Independent variable

Socio-demographic characteristics: age, ethnicity, and religion, current state of marriage, monthly income, and occupation of the partner.

Obstetric and reproductive factors affecting mothers include gravidity, parity, abortion, number of living children, type of pregnancy (planned vs. unplanned, supported vs. unsupported), distance to health facility, mode of delivery, location of delivery, use of antenatal care, use of postpartum care in the past, and length of stay in the facility following delivery.

2.7. Operational definition

Utilization of postnatal care services: postnatal care (PNC) is the care given to the mother and their newborn baby immediately after the birth and for the first six weeks of life.

2.8. Data processing and analysis

After data collection, each questionnaire was examined for completeness and coding on a quantitative level. Epidata version 4.6 was used to enter the data, which was subsequently exported to SPSS (Statistical Package for Social Sciences, version 26) for analysis. Using variable logistic regression analysis, descriptive summaries, frequency, and percentages were employed to summarize the study variables. First, it was verified that the premises of dichotomy, multi-co-linearity, the Chi-square test, and mutual exclusivity held. To find potential variables for multivariable analysis, bi-variable analysis was used. In bi-variable logistic regression, a variable with a significant association was transferred to multivariable logistic regression. To assess the relationships between the outcome and explanatory factors, an adjusted odd ratio (AOR) with a 95% Confidence Interval (CI) and p-value was calculated. When it came to determining if an explanatory factor was substantially correlated with the outcome variable, a p-value of 0.05 was used. The multi-collinearity was examined using variance inflation factors (VIF), which should be less than 10. Hosmer and Lemeshow tests were performed to evaluate the goodness of fit, which was sig = 0.989. A histogram and Q–Q plot test were used to determine the normality of the data.

In the qualitative study, in-depth interviews and focused group discussions were used for data collection, while thematizing was used for analysis. From the collected data codes, categories and themes were extracted using atlas.ti.7.1. We (the primary

investigators) transcribed verbatim from the recorded audio. Then we translated the transcribed data into English. Finally we presented the result by quotations derived from the data.

3. Results

3.1. Socio-demographic characteristics of the respondents

A sum of 422 women took part in the study, with a response rate of 100%. In total, 292 (69.2%) participants were between 20 and 30 years. A sum of 228 (54.0%) were Protestants, and 412 (97.6%) were married. For the level of education, only 78 (18.5%) had a college degree. The typical monthly household income in Ethiopian birr was between 2,000 and 4,000. Nearly half (259 (61.5%)) of the participants used taxis as their primary form of transportation to the medical facilities (**Table 1**).

3.2. Reproductive characteristics of the participants

About 357 (84.6%) participants had no history of abortion. Approximately 262 (62.1%) participants were Para 2–4, and 312 (73.9%) currently had planned pregnancies. Furthermore, 317 (75%) participants undertook ANC follow-up once (**Table 2**).

3.3. Obstetrics characteristics of the respondents

There were 287 (68%) institutional deliveries among the study's participants. The mode is 6 h, however the mean hospital stay before release after delivery was 26.7 h (+SD = 41 h). Approximately 304 (72%) of women stayed at a health institution for 6–11 h before discharge. About 252 (59.7%) of them were given appointments by health professionals for postnatal care before discharge. About 62 of them were not informed by health professionals about the accessibility of postnatal care. Out of those who knew about the availability of postnatal care, nearly 36% were not given appointments before discharge. Out of mothers who delivered in a health institution, 271 (67.2%) were counseled about danger signs that can happen during the postpartum period before discharge (**Figure 1**, **Table 3**).

3.4. Prevalence and characteristics of postnatal care utilization

The health center was the location most often used for postnatal care (177 (75.6%)), followed by government hospitals (38 (16.2%)). The proportion of postnatal care visits within 72 h of discharge, one week, two weeks, and six weeks after delivery was 70 (29.9%), 92 (39.3%), 30 (12.8%), and 25 (10.6%), respectively. Concerning the frequency of postnatal care visits, 79

TABLE 1 Socio-demographic characteristics of the respondents interviewed at Southwest Ethiopia Health Centers in 2022, (*n* = 422).

Variable	Characteristic	Respondents	
		Frequency (no.)	Percentage (%)
Age of the participant	</=19	8	1.9%
	20–30	292	69.2%
	31–40	103	24.4%
	41–50	19	4.5%
	Total	422	100%
Marital status of the participant	Married	412	97.6
	Divorced	–	0
	Widowed	10	2.4
	Total	422	100%
Educational status of the participant	No formal education	30	7.1
	Primary education	168	39.8
	High school and preparatory education	146	34.6
	Higher education	78	18.5
	Total	422	100
Educational status of the father	No formal education	8	1.9
	Primary education	108	25.6
	High school and preparatory education	76	18
	Higher education	230	54.5
Religion of the participant	Orthodox	116	27.5
	Protestant	228	54
	Others	22	5.2
	Muslim	56	13.3
Occupation of the participant	Employed	118	28
	Housewife (unemployed)	202	47.9
	Merchant	92	21.8
	Others	10	2.4
	Total	422	100
Family's monthly income	<2,000	150	35.5
	2,000–4,000	203	48.3
	>4,000	102	24.2
	Total	422	100
Means of transport to health facility	Public transport	259	61.4
	By foot	163	38.6
	Total	422	100

(33.7%) participants had visited once, 60 (25.6%) twice, 66 (28.2%) thrice, and the remaining 26 (211.1%) had visited four times (**Table 4**).

3.5. Factors related to the use of postnatal care services

3.5.1. Quantitative analysis

After conducting a bi-variable logistic regression analysis, *p*-values 0.25 were used to determine which variables should be included in a multivariable logistic regression. Out of 25 independent variables grouped under socio-demographic, reproductive and obstetrics, labor and postpartum characteristics, eight variables—educational status, pregnancy type, prior ANC use, delivery place, PNC appointment provided or not, healthcare

TABLE 2 Reproductive characteristics of the participants at Southwest Ethiopia Health Centers in 2022, (n = 422).

Variable	Characteristic	Respondents	
		Frequency (no.)	Percent (%)
History of abortion	Yes	65	15.4
	No	357	84.6
	Total	422	100
Parity	Para 1	112	26.5
	Para 2–4	262	62.1
	≥5	48	11.4
	Total	422	100
Pregnancy status	Intended and supported	312	73.9
	Unintended but supported	100	23.7
	Unintended and unsupported	10	2.4
	Total	422	100
History of ANC	Yes	317	75
	No	105	25
	Total	422	100
Number of ANC visits (n = 317)	<4	149	47
	≥4	149	47
Gestational age of index pregnancy (n = 298)	<37 weeks	86	29
	≥37 weeks	212	71
Number of current pregnancy	Single	405	96
	Twins	17	4
Neonatal sex	Male	223	47.2
	Female	199	52.8
Neonatal feeding	Exclusive breastfeeding	327	77.5
	Formula feeding	95	22.5
APH during pregnancy	Yes	44	10.5
	No	378	89.5
HDP	Yes	25	5.9
	No	397	94.1
Premature rupture of membrane and choriamnioties	Present	11	2.5
	Absent	411	97.5

practitioner counseling on danger signs given or not, prior history of PNC, and length of hospital stay before discharge—had shown association.

Three variables—counseling on PNC and appointment provision, health care practitioner counseling on danger signs, and prior history of PNC—showed a statistically significant association with PNC service use in multivariable logistic regression. As a result, women who received postnatal care counseling and appointments were roughly 3.6 [(AOR = 3.6, 95% CI (1.47–7.23)] times more likely to use PNC services than their counterparts. Women who received counseling from the healthcare professional on danger signs were twice as likely to receive a postnatal care visit than their counterparts [(AOR = 2, 95% CI (1.05–3.64)]. Similar to this, multiparous women who had previously used PNC services were three times more likely to do so for the current delivery than those who had not [AOR = 3, 95% CI (1.36–5.8)] (Table 5).

3.5.2. Qualitative analysis

Qualitative data was obtained from the participants through in-depth interviews and focused group discussions to identify the barriers to PNC services utilization. The investigation revealed knowledge about postnatal care service utilization and access to health facilities were identified as barriers to postnatal care service utilization. The theme of knowledge included the sub-themes of ignorance, conventional wisdom, and religious activities. There were three sub-themes under access: waiting time, environmental exposure, and distance (Table 6).

Lack of knowledge about postnatal care service utilization

1. Ignorance

Mothers, husbands, and other members of families discussed that they ignore education and advice on the importance of postnatal care service utilization from the health extension worker at the community level. They stated that even though health
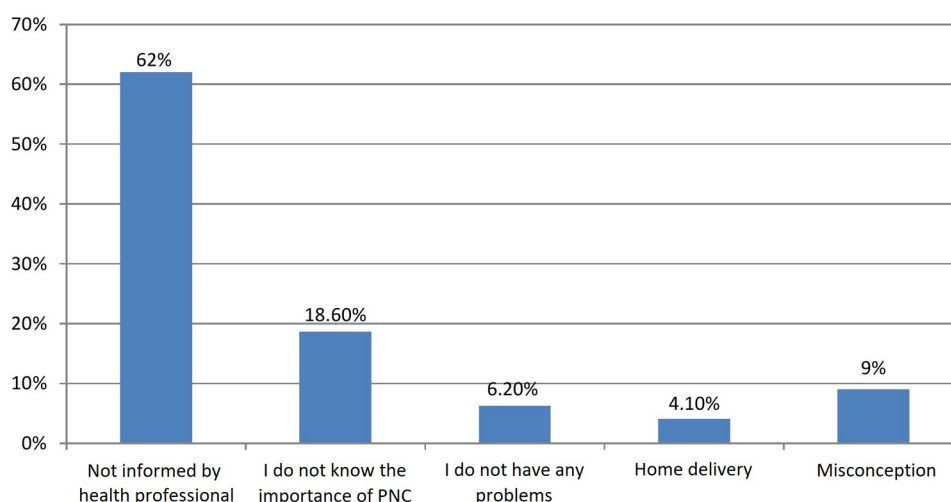
FIGURE 1
Reasons why the participants did not visit a health facility for postnatal care in Southwest Ethiopia Health Centers, 2022 (n = 422).

TABLE 3 Obstetrics characteristics of the respondents interviewed at Southwest Ethiopia Health Centers in 2022, (*n* = 422).

Variable	Characteristic	Respondents	
		Frequency (no.)	Percent (%)
Delivery setting	Home	135	32
	Health center	185	43
	Private clinic	32	7.5
	Governmental hospital	70	17.5
Delivery attended by	Midwife (nurse)	202	48
	Physician	85	20
	Traditional birth attendant/family	135	32
Mode of delivery	Vaginal delivery	359	86.7
	Instrumental delivery	9	2.1
	Cesarean section	54	3.8
Minor inscision during vaginal delivery (N = 368)	Yes	97	26.4
	No	271	73.6
	Total	368	100
Cesarean delivery (N = 54)	Emergency	14	25.9
	Elective	40	74.1
	Total	54	100
Length of hospital stay following delivery	<6 h	304	72
	6–11 h	45	10.7
	12–23 h	54	12.8
	≥24 h	2	5
	Total	405	96
An appointment given for postnatal care	Yes	252	59.7
	No	152	36
	Total	404	95.7
Appointment within 72 h of discharge (N = 252)	Yes	11	4.2
	No	241	95.6
Appointment within 1 week	Yes	26	10
	No	233	89.9
Appointment after 1 week	Yes	58	22.4
	No	201	77.6
Appointment after two weeks	Yes	27	10.4
	No	232	89.5
Appointment at 6 weeks	Yes	97	37.4
	No	162	62.5
Others	Yes	40	15.4
	No	219	84.5
Counsel for any danger signs before discharge	Yes	271	67.2
	No	132	32.7
	Total	403	95.5

TABLE 4 Characteristics of postnatal care utilization of interviewed respondents at Southwest Ethiopia Health Centers in 2022, (*n* = 422).

Variable	Characteristic	Respondents	
		Frequency (no.)	Percent (%)
Received postnatal care for current delivery	Yes	234	55.5
	No	188	44.5
Received postnatal care for the previous delivery	Yes	188	54.3
	No	158	45.7
Place where postpartum care was received	Health center	177	75.6
	Governmental hospital	38	16.2
	Private hospital	14	6
	Private clinic	5	2.1
Received postnatal care services within 72 h of discharge	Yes	70	29.9
	No	164	70.1
Received postnatal care within 1 week	Yes	92	39.3
	No	142	60.7
Received postnatal care within 2 weeks	Yes	30	12.8
	No	204	87.2
Received postnatal care at 6 weeks	Yes	25	10.6
	No	209	89.3
No. of postnatal care visits	Once	79	33.7
	Twice	60	25.6
	Thrice	66	28.2
	Fourth	26	11.1
Being with baby during postnatal care	Yes	220	94.
	No	14	6
Contraceptive use	Yes	273	64.7
	No	149	35.3
Contraceptive initiation period (N = 273)	After 6 weeks (42 days)	162	59.3
	After 2 months	50	18.3
	After 4 months	34	12.4
	After 6 months	27	9.8

extension workers call them for meetings, they are busy with their farm work:

> "*I do not believe that education on postnatal care service utilization by health extension workers is important to me because before I gave birth I had no time to spend with them. Sometimes I had time, but I forgot the call from the health extension worker and wasn't available at the kebele's clinic. After I gave birth, [the health worker] visited us and told me that I had to visit the health center, but I was fine and didn't accept her counseling*" (30-year-old delivered mother).

Traditional belief and religious activities

1. Conventional wisdom

Conventional wisdom is another barrier mentioned by the study participants. They stated that going out of the house before forty days of delivery exposed the newborn and mother to evil spirits:

> "*Even though those health professionals tell us to visit a health center after we give birth, we can't go out of our home because the evil spirit will attack us and our newborn may be exposed to individuals with an evil eye. We can walk around our compound with a member of our family holding a knife because the evil spirit will not approach us while we hold a knife*" (34-year-old delivered mother).

2. Religious activities

Concerning a religious conviction, the study participants learned that among the community members who practiced Ethiopian orthodox Christianity, it was forbidden for the mothers and neonates to leave the house prior to the date of baptism, out of

TABLE 5 Logistic regression analysis of factors associated with postnatal care utilization in the interviewed women.

Variable	Utilization of postnatal care		COR (CI)	AOR (CI)
Educational status	Yes	No		
No formal education	38	27	1.56 (0.57–4.4)	0.77 (0.39–1.52)
Primary education	99	59	1.88 (0.8–4.45)	0.92 (0.53–1.62)
High school and preparatory education	89	31	1.56 (0.85–2.9)	0.67 (0.92–5.36)
Higher education	51	28	1	1
Nature of pregnancy				
Intended and supported	213	98	2.61 (0.78–8.75)	1.0 (0.17–5.91)
Unintended but supported	59	41	1.73 (0.49–6.04)	0.6 (0.01–3.61)
Unintended and unsupported	5	6	1	1
Previous history of antenatal care				
Yes	273	139	5.93 (1.00–30.5)	3 (1.36–5.8)[a]
No	4	6	1	1
Delivery setting				
Home	2	14	0.07 (0.011–0.48)	0.31 (0.01–7.63)
Health center	168	139	1.62 (0.47–5.58)	1.01 (0.16–7.53)
Governmental hospital	66	57	0.58 (0.17–2.02)	0.59 (0.09–4.13)
Private hospital	33	18	0.92 (0.24–3.47)	0.74 (010–5.43)
Private clinic	8	4	1	1
Appointment provided for PNC and counseling				
Yes	266	55	3.95 (1.98–7.88)	3.6 (1.47–7.23)[a]
No	11	90	1	1
Counseling on danger signs				
Yes	202	56	4.28 (2.79–6.56)	2 (1.05–3.64)[a]
No	75	89	1	1
Length of stay at the health facility before discharge				
6–11 h	134	58	1.13 (0.69–1.83)	0.81 (0.36–1.83)
12–23 h	48	25	0.94 (0.51–1.72)	0.34 (0.13–0.88)
≥24 h	86	42	1	1

[a]Significantly associated variables.

TABLE 6 Barriers of postnatal care service utilization among women in Southwest Ethiopia Health facilities, 2022, (n = 422).

Major themes	Categories	Respondents
Lack of knowledge of postnatal care service utilization	Ignorance to health extension workers counseling about post natal care service utilization	Delivered mother
Traditional belief and religious activities	Conventional wisdom	Delivered mother
	Religious activity	Delivered mother
Lack of access to post natal care service utilization	Distances from delivered mother's home to health facilities	Delivered mother
	Waiting time at the health center	Delivered mother
	Environmental exposure such as sunlight, wind, and rain	Delivered mother

fear of an evil spirit. As a result, they claimed that they had not visited the health facilities for PNC services before the date of baptism:

> "On the 45th day after I gave birth, the health extension worker came to see us the day before yesterday. This is due to the cultural prohibition on leaving the house prior to the date of baptism" (28-year-old female IDI participant).

Another idea mentioned by research participants was "hamechisa" (a festival in which newborns are taken to be blessed by a traditional healer, i.e., a witch), which takes place within the first two months of life. It was alleged that community members who followed this tradition did not go to the health facilities to seek any medical care before infants were blessed by the witch. They thought that unless the new-borns were seized and blessed, the witch or traditional healers would curse the family—especially the recently delivered mother and infant—and seriously implore a supernatural force to hurt or kill them:

> "It is our ancestors' culture we inherited; I have to allow the witch or healer in our kebele because if I don't do that, it is dangerous for me and my infant" (25-year-old delivered woman).

Access to health care facilities for postnatal care

1. Distances

Some of the health professionals reported that most of the mothers are far from the health facilities and that the road to their homes is so dangerous that available means of transportation, even ambulances, face challenges serving them. Furthermore, they explained that even during childbirth, the families and neighbors of the women carry the woman to the health facilities, and this takes a long time. For example, one of the mothers said:

"My home is so far away from a health facility that I didn't visit a health facility. Even though I gave birth at the health facility, there was no means of transportation other than parts of my family and neighbors who carried me to health facilities. Therefore, I didn't visit a health facility because of the distance after I gave birth" (35-year-old delivered mother).

2. Environmental exposures

Most of the participants mentioned that environmental factors, including cold weather conditions, sunlight, and rain, are commonly known factors that prohibit mothers from visiting health facilities during PNC. One of the participants said:

"After we give birth, it is very difficult to resist sunlight, cold weather, and rain because our body is too weak and fragile. Therefore, immediately after we gave birth, we had to stay in a safe environment, and that is our home" (30-year-old delivered mother).

Other participants also reported that they could not afford to buy protective materials from sunlight and rain, such as an umbrella. For instance, other women said:

"In fact, an umbrella is preferred during rain and sunlight, but I can't afford to buy it. I had one, but it was broken, and I couldn't buy a new one. Therefore, it is better to stay home than walk in the sun, light, and rain without an umbrella" (29-year-old delivered mother).

3. Waiting time at the health center

Other participants complained that they had to wait a long time to receive care after they reached the health facilities during postnatal care. The following participant said:

"The last year before I got pregnant, we visited health facilities with my brother's wife after she gave birth. I remember we stayed for many hours to get our turn to receive the care. Therefore, I didn't visit the health facility after I gave birth because I remembered how long we waited to get our turn for receiving care last year" (31-year-old delivered mother).

4. Discussion

This study evaluated factors and barriers related to postnatal care service use among women who delivered a baby and received vaccinations. Despite nearly 287 (68%) of the participants in this study having given birth in a medical facility, it was found that just over half of them, or 234 (55.5%), had a checkup following delivery. This number, however, is greater than the 2019 EDHS postnatal care use rate of 48% (4). The time gap and various strategies for obtaining and utilizing maternal healthcare services may be responsible for this improvement.

The prevalence of postnatal care utilization found in this study was also higher than in studies similar to this one that were carried out in Enderta District, Tigray (49.7%), Jabitena District, Amhara Region (20.2%), Southern Ethiopia (37.2%), Hawassa Zuria District, Southern Ethiopia (37.2%), Adigirat Town, Northern Ethiopia (34.3%), Northern Ethiopia (37%), and East Gojam, Northwest Ethiopia (12, 14, 19, 21–23, 25, 29, 30). The demographic homogeneity variation in the research areas may be related to the inconsistencies. The results of this study were also slightly higher than those of research carried out in Burkina Faso (44%), Cambodia (46%), Haiti (55%), Kenya (46%), Malawi (41%), Mali (49%), Nigeria (46.5%), and Zambia (41%), respectively, across Africa and Asia (20). The results, however, fell short of those of studies carried out in the Ethiopian towns of Debre Tabor (57.5%), Addis Ababa (65.6%), and Sodo Zuria (77.7%). The study results from Ethiopia's Shebe Sombo Woreda, Jima Zone (58.5%), Brazil (77%), Bangladesh (73%), Uganda (57%), Nepal (72%), and Rwanda (71%) all showed comparable differences. This implies that the utilization of postnatal care in this study area is considerably lower compared with other lower and middle income countries. This might be due to poor maternal care quality of services in the country which include a lack of counseling services on postnatal care service utilization and danger signs after delivery. Therefore all concerned stakeholders should work in collaboration to increase postnatal care service utilization uptake (9, 10, 19, 27, 28).

In our study, the health provider's PNC counseling and appointments, the counseling of women on danger signs, and a history of prior PNC use were the most related factors for PNC use. In comparison to their counterparts, women who received counseling and appointments for postnatal care services were roughly 3.6 times more likely to use the PNC service [AOR = 3.6, 95% CI (1.47–7.23)]. An investigation carried out in Northern Ethiopia and Shebe Sombo Woreda, Jima Zone, Ethiopia, supports this conclusion (12, 29). This finding would suggest that women's knowledge of the advantages of postnatal care significantly affects their use of PNC services. This finding implies that postnatal care appointments should be incorporated to optimize postnatal care uptake.

Counseling women about danger signs during the postnatal period was the other factor linked to the use of postnatal care services. Women who received information about any postpartum warning symptoms were twice as likely to use postpartum care services than their counterparts [AOR = 2, 95% CI (1.05–3.64)]. This result is consistent with a study carried out in Southern Ethiopia's Amhara Region and Hawassa Zuria District, which found that mothers who were aware of at least one postpartum obstetric danger sign were more likely to use PNC services than those who were not (12, 30). This result is also supported by investigations carried out in Uganda and Nepal that produced comparable results (15, 16). This similarity can be explained by the fact that knowledge of obstetric danger signs is a significant motivator for encouraging women and their families to seek medical attention as soon as possible in order to prevent, identify, and manage their obstetric danger symptoms. The implication of this result shows that all mothers and their

families ought to be mindful of danger signs amid the postnatal period. Health professionals should audit the emergency plans made amid the postnatal period to see whether they are still suitable. Health professionals should also remind mothers to bring their maternal wellbeing record with them even for emergency visits, as it is important in the optimization of postnatal care service utilization.

Utilization of postnatal care services in the past was the other key factor associated with postnatal care service use. Women who had previously given birth and had PNC were three times more likely to now seek PNC services than those who had never used PNC services in the past [AOR = 3, 95% CI (1.36–5.78)]. This strong positive association between PNC service utilization and prior history can be attributed to the fact that women who had PNC in health institutions had a greater opportunity to be exposed to health education related to PNC services at the time of their visit. Past experiences regarding PNC are essential to improve the quality of essential, routine postnatal care for women and newborns by targeting a positive postnatal experience.

Last but not least, unlike earlier studies in Ethiopia (12–30) which discovered that the participants' socioeconomic status, ANC, and educational status were the drivers of PNC utilization, these characteristics and others were not. This might be the case since most women have similar access to information on PNC service utilization through the media or at their ANC follow-up visits, and the study was carried out in the most urban areas of the nation.

In the qualitative analysis, similar to the study done in East Gojam Zone in Ethiopia and Debre Libanos District in Ethiopia (17, 18), the knowledge theme, which includes the sub-themes of ignorance, conventional wisdom, and religious activities, was identified as a barrier to the use of postnatal care. This might be the result of the cultural and religious similarity of the study population. It also emphasizes the significance of social and behavioral change and communication to alter community members' or religion leaders' perceptions and foster the development of health-seeking behavior such as employing PNC services. Furthermore, sub-themes of access, which include waiting time, exposure to the environment, and distance, were determined to be barriers to the use of postnatal care. This finding is also supported by research done in the East Gojam Zone in Ethiopia and Debre Libanos District in Ethiopia (17, 18). This might be the result of the similarity of the weather conditions, health care facility service provision, and distribution. To reduce these barriers and optimize the uptake of postnatal care an innovative approach to increase the health literacy on postnatal care is required. Furthermore, increasing the number of health facilities is mandatory to alleviate these barriers.

5. Conclusion

According to this study, overall use of postnatal care was still low and there is much room for improvement. There are various factors and barriers associated with postnatal service utilization. Therefore, all stakeholders should consider these factors to optimize the use of postnatal care.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary Material, further inquiries can be directed to the corresponding author.

Author contributions

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Maternal age extremes and adverse pregnancy outcomes in low-resourced settings

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Introduction: Adolescent (<20 years) and advanced maternal age (>35 years) pregnancies carry adverse risks and warrant a critical review in low- and middle-income countries where the burden of adverse pregnancy outcomes is highest.

Objective: To describe the prevalence and adverse pregnancy (maternal, perinatal, and neonatal) outcomes associated with extremes of maternal age across six countries.

Patients and methods: We performed a historical cohort analysis on prospectively collected data from a population-based cohort study conducted in the Democratic Republic of Congo, Guatemala, India, Kenya, Pakistan, and Zambia between 2010 and 2020. We included pregnant women and their neonates. We describe the prevalence and adverse pregnancy outcomes associated with pregnancies in these maternal age groups (<20, 20–24, 25–29, 30–35, and >35 years). Relative risks and 95% confidence intervals of each adverse pregnancy outcome comparing each maternal age group to the reference group of 20–24 years were obtained by fitting a Poisson model adjusting for site, maternal age, parity, multiple gestations, maternal education, antenatal care, and delivery location. Analysis by region was also performed.

Abbreviation

AMA, advanced maternal age; aRR, adjusted risk ratio; LMIC, low- and middle-income countries; MMR, maternal mortality ratio.

Results: We analyzed 602,884 deliveries; 13% (78,584) were adolescents, and 5% (28,677) were advanced maternal age (AMA). The overall maternal mortality ratio (MMR) was 147 deaths per 100,000 live births and increased with advancing maternal age: 83 in the adolescent and 298 in the AMA group. The AMA groups had the highest MMR in all regions. Adolescent pregnancy was associated with an adjusted relative risk (aRR) of 1.07 (1.02−1.11) for perinatal mortality and 1.13 (1.06−1.19) for neonatal mortality. In contrast, AMA was associated with an aRR of 2.55 (1.81 to 3.59) for maternal mortality, 1.58 (1.49−1.67) for perinatal mortality, and 1.30 (1.20−1.41) for neonatal mortality, compared to pregnancy in women 20−24 years. This pattern was overall similar in all regions, even in the <18 and 18−19 age groups.

Conclusion: The maternal mortality ratio in the LMICs assessed is high and increased with advancing maternal age groups. While less prevalent, AMA was associated with a higher risk of adverse maternal mortality and, like adolescence, was associated with adverse perinatal mortality with little regional variation.

Introduction

Adverse pregnancy outcomes such as maternal, perinatal, and neonatal mortality are essential global, regional, and national health indicators (1–3). All pregnancies carry risks. However, women ≤19 (adolescents) and those ≥35 years of age [advanced maternal age (AMA)] have been associated with a higher risk of adverse pregnancy outcomes, including maternal mortality, stillbirth, perinatal, neonatal, infant, and under-five mortality (4–8). Complications during childbirth are a leading cause of adolescent deaths (9). Likewise, AMA pregnancies are associated with a higher prevalence of morbidities such as diabetes, hypertension, and obesity, known to exacerbate adverse pregnancy outcomes (10–12).

The low- and middle-income countries (LMICs) of Africa and South Asia account for 87% of global maternal deaths (3). These regions also account for 95% of the global adolescent pregnancy burden—translating into 21 million yearly pregnancies in girls aged 15–19 (8). Available evidence indicates a rising trend in AMA pregnancies (13–15). However, these reports mainly originate from high-income countries; similar data from LMICs are sparse, often single-centered (16–20), historical cohorts (21), cross-sectional facility-based or demographic health surveys (6).

To appraise the impact of existing and inform future health policies, current and generalizable data on outcomes of adolescents and AMA pregnancies from LMICs are needed. This knowledge is critical to understanding local, national, and global progress towards the 2030 sustainable development goals of improving pregnancy outcomes (2). Hence, this study aimed to describe adolescent and AMA pregnancy rates and their associated adverse pregnancy outcomes in six LMICs participating in a large prospective maternal and newborn birth registry.

Patients and methods

We performed a historical cohort study on prospectively collected data from the Global Network for Women's and Children's Health Research Maternal and Neonatal Health Registry (global network registry). The global network registry is a multicountry prospective, population-based observational study that monitors all pregnant women and their pregnancy outcomes in seven sites within six LMICs (22, 24). The countries include the Democratic Republic of Congo (North and South Ubangi Provinces); Guatemala (Western Highlands); India (Belagavi and Nagpur); Kenya (Western region); Pakistan (Thatta, a rural district of Sindh province, near the city of Karachi); and Zambia (south and east of the capital city of Lusaka). The study population includes both peri-urban and rural settings. A previous publication details the overall purpose, methods, and data collection techniques of the global network registry (23).

For this study, we included all women enrolled in the registry between January 2010 and December 2020. The Democratic Republic of Congo began participation in the registry in mid-2013. We excluded women lost to follow-up before delivery, those who had a spontaneous or medically induced abortion or other pregnancy loss <20 weeks, medically terminated pregnancy at any point, women who gave birth to infants weighing less than 500 g, and those with no maternal age recorded. For this study, we excluded deliveries that were <500 g (defined as lower cut-off for stillbirths) because the majority of women we enrolled were at 20 weeks or greater (i.e., > 500 g).

This study evaluated maternal, perinatal, and neonatal outcomes. The maternal outcomes included antepartum and postpartum hemorrhage, obstructed labor, hypertensive disorders, sepsis, and maternal mortality within 42 days postpartum. The perinatal and neonatal outcomes included preterm birth (live

birth at <37 completed weeks' gestation), low birthweight (live birth weighing <2,500 g at birth), stillbirth [deaths occurring in fetuses >500 g (or >22 completed weeks gestation) noted at delivery], early neonatal deaths (neonatal deaths that occur 0–7 days after birth), neonatal mortality (neonatal deaths 0–28 days after birth), perinatal deaths (early neonatal deaths and stillbirths combined). Most women enrolled after 20 weeks gestation; consequently, we did not have data on early miscarriage/ spontaneous abortions. Thus, we did not include these adverse pregnancy outcomes.

Statistical analysis

Maternal and infant demographic characteristics and clinical outcomes were compared using standard descriptive statistics stratified by maternal age categories (<20, 20–24, 25–29, 30–35, and >35 years). We chose this categorization because the South Asian regions did not enroll participants younger than 18. We also present maternal and infant demographic characteristics and clinical outcomes by WHO country region (Africa, Southeast Asia, and Central America). Given the large sample size, we do not report p-values for the demographic and clinical comparison because even minimal differences become statistically significant.

To estimate the association of maternal age with maternal and perinatal outcomes, we used a Poisson model for each outcome for the entire cohort and within each region. We obtained point and interval estimates of the relative risk associated with maternal age groups (<20, 25–29, 30–35, and >35 years) from Poisson models controlling for site, parity, multiple gestation, maternal education (any or none), antenatal care and delivery location compared to mothers aged 20–24 years, consistent with a prior global network

publication. Poisson models were used to evaluate if the effect of maternal age on maternal, perinatal, and neonatal mortality is modified by education, attendance to at least one antenatal visit, and delivery location. Relative risks, 95% confidence intervals, and interaction p-values are obtained from a Poisson model for each outcome, including the covariates above and two-way interactions between maternal age and education, antenatal care, and delivery location. We performed regional analysis with further age categorization to <18 and 18–19 for the subgroups of women from the African region and Guatemala. All data were analyzed using SAS version 9.4 (SAS Institute, Cary, NC, USA).

Results

Description of the study population

Over the 11-year study period, 644,709 women were screened. Of these, 602,884 delivered 608,918 babies who met the inclusion criteria and were analyzed (Table 1). Women aged 20–24 years accounted for 41% (245,289) of deliveries, while adolescent and AMA deliveries accounted for 13% (78,584) and 5% (28,677), respectively (Table 2). By geographic regions, the African region had the highest rates of adolescents (22%), Guatemala had the highest rates of AMA pregnancies (10%), and Asia had the lowest rates of adolescent (6%) and AMA (2%) pregnancies (Figure 1).

The demographic differences between age groups are presented in Table 2. The proportion without education was lowest in adolescents (10%) and highest in AMA's (39%) and increased with advancing maternal age groups. The proportion of pregnancies that resulted in multiple births and parity of ≥3 increased with increasing age groups. The mean body mass index was 22 kg/m² in adolescents, 21 kg/m² in the 20–24-year

TABLE 1 Distribution of the included and excluded women and neonates by study country.

Consort diagram information	Overall	DRC[c]	Zambia	Guatemala	Belagavi	Pakistan	Nagpur	Kenya
Screened, n	644,709	43,897	71,648	94,130	142,315	110,878	94,844	86,997
Ineligible, n (%)	2,543 (0.4)	0 (0.0)	2 (0.0)	72 (0.1)	1 (0.0)	2,443 (2.2)	1 (0.0)	24 (0.0)
Eligible, n (%)	642,166 (99.6)	43,897 (100.0)	71,646 (100.0)	94,058 (99.9)	142,314 (100.0)	108,435 (97.8)	94,843 (100.0)	86,973 (100.0)
Did not consent, n (%)	1,118 (0.2)	0 (0.0)	0 (0.0)	1,010 (1.1)	24 (0.0)	81 (0.1)	0 (0.0)	3 (0.0)
Consented, n (%)	641,048 (99.8)	43,897 (100.0)	71,646 (100.0)	93,048 (98.9)	142,290 (100.0)	108,354 (99.9)	94,843 (100.0)	86,970 (100.0)
Lost to follow-up prior to delivery, n (%)	7,279 (1.1)	616 (1.4)	410 (0.6)	950 (1.0)	67 (0.0)	2,218 (2.0)	386 (0.4)	2,632 (3.0)
Delivered, n (%)	633,769 (98.9)	43,281 (98.6)	71,236 (99.4)	92,098 (99.0)	142,223 (100.0)	106,136 (98.0)	94,457 (99.6)	84,338 (97.0)
Exclusions, n (%)	30,885 (4.9)	554 (1.3)	686 (1.0)	894 (1.0)	14,160 (10.0)	7,736 (7.3)	5,833 (6.2)	1,022 (1.2)
Gestational at delivery < 20 weeksks[a]	28,113	448	608	828	13,536	7,077	5,230	386
Medically terminated. pregnancy (MTP)	1,597	51	12	2	482	476	545	29
Birthweight < 500 g	189	24	11	48	64	8	29	5
Maternal age missing	986	31	55	16	78	175	29	602
Deliveries included n	602,884	42,727	70,550	91,204	128,063	98,400	88,624	83,316
Births included[b], n	608,918	43,479	71,258	91,846	129,023	99,553	89,340	84,419

[a]Includes miscarriages with gestational age missing.
[b]All MNH Registry 2010–2020 births excluding deliveries <20 weeks gestation, medically terminated pregnancies, infants with.
measured birthweight < 500 g and participants missing maternal age.
[c]DRC began participation in the MNH registry in mid-2013, so it does not have data for 2010–2013 births.

TABLE 2 Maternal demographics and health care utilization by age group.

Characteristic	Overall	Maternal age category				
		<20	20–24	25–29	30–35	>35
Mothers, n (%)	602,884	78,584 (13.0)	245,289 (40.7)	163,583 (27.1)	86,751 (14.4)	28,677 (4.8)
Maternal education, n (%)	601,925	78,486	244,802	163,309	86,681	28,647
No formal schooling	143,096 (23.8)	7,531 (9.6)	36,011 (14.7)	51,264 (31.4)	37,098 (42.8)	11,192 (39.1)
Primary or secondary	417,199 (69.3)	69,319 (88.3)	187,679 (76.7)	98,311 (60.2)	45,211 (52.2)	16,679 (58.2)
University +	41,630 (6.9)	1,636 (2.1)	21,112 (8.6)	13,734 (8.4)	4,372 (5.0)	776 (2.7)
Parity, n (%)	600,128	78,023	243,837	162,953	86,646	28,669
0	193,940 (32.3)	63,268 (81.1)	104,902 (43.0)	21,623 (13.3)	3,687 (4.3)	460 (1.6)
1–2	251,347 (41.9)	14,361 (18.4)	125,094 (51.3)	88,733 (54.5)	20,568 (23.7)	2,591 (9.0)
3 +	154,841 (25.8)	394 (0.5)	13,841 (5.7)	52,597 (32.3)	62,391 (72.0)	25,618 (89.4)
Multiple births, n (%)	5,872 (1.0)	443 (0.6)	1,929 (0.8)	1,751 (1.1)	1,311 (1.5)	438 (1.5)
Body mass index (BMI) measured[a] (Kg/m^2), n (%)	495,160 (95.3)	56,376 (93.6)	206,116 (96.0)	139,086 (96.1)	70,857 (94.7)	22,725 (90.8)
Mean (std)	21.7 (4.0)	21.7 (3.3)	20.9 (3.5)	21.8 (4.0)	23.1 (4.6)	24.6 (4.9)
Median (min-max)	21.2 (12–65)	21.5 (12–63)	20.5 (12–64)	21.1 (12–60)	22.4 (12–60)	23.9 (13–65)
At least one antenatal care (ANC) visit, n (%)	585,029 (97.1)	77,418 (98.6)	241,290 (98.5)	157,370 (96.3)	81,838 (94.4)	27,113 (94.6)
At least four antenatal care visits, n/N (%)	283,745/482,920 (58.8)	37,887/64,492 (58.7)	123,189/189,331 (65.1)	75,968/132,124 (57.5)	35,264/72,595 (48.6)	11,437/24,378 (46.9)
Trimester of first ANC visit, n (%)	544,102	74,097	227,931	143,647	73,479	24,948
First (0–14 weeks)	241,148 (44.3)	25,897 (35.0)	122,945 (53.9)	65,239 (45.4)	21,817 (29.7)	5,250 (21.0)
Second (15–28 weeks)	240,743 (44.2)	40,479 (54.6)	85,358 (37.4)	60,734 (42.3)	39,138 (53.3)	15,034 (60.3)
Third (29–42 weeks)	62,211 (11.4)	7,721 (10.4)	19,628 (8.6)	17,674 (12.3)	12,524 (17.0)	4,664 (18.7)
Delivery attendant, n (%)	602,599	78,560	245,198	163,501	86,678	28,662
Physician	212,623 (35.3)	21,342 (27.2)	104,811 (42.7)	57,692 (35.3)	21,919 (25.3)	6,859 (23.9)
Nurse/nurse midwife/ Health worker	232,319 (38.6)	37,846 (48.2)	95,416 (38.9)	59,045 (36.1)	30,231 (34.9)	9,781 (34.1)
Traditional birth attendant	126,502 (21.0)	15,579 (19.8)	35,246 (14.4)	37,487 (22.9)	28,283 (32.6)	9,907 (34.6)
Family/self/other	31,155 (5.2)	3,793 (4.8)	9,725 (4.0)	9,277 (5.7)	6,245 (7.2)	2,115 (7.4)
Delivery location, n (%)	602,592	78,555	245,184	163,503	86,689	28,661
Hospital	261,466 (43.4)	30,316 (38.6)	125,046 (51.0)	68,594 (42.0)	28,394 (32.8)	9,116 (31.8)
Clinic/health center	193,592 (32.1)	29,269 (37.3)	76,266 (31.1)	52,432 (32.1)	27,428 (31.6)	8,197 (28.6)
Home/other	147,534 (24.5)	18,970 (24.1)	43,872 (17.9)	42,477 (26.0)	30,867 (35.6)	11,348 (39.6)
Placed on mother's chest after delivery or skin to skin, n (%)	313,126 (53.2)	48,742 (63.5)	136,994 (57.1)	76,541 (47.9)	37,186 (44.1)	13,663 (49.5)

[a]Kenya did not consistently obtain height measurements; therefore, Kenyan BMI data is excluded.

group, and 25 kg/m^2 in the AMA group. Any antenatal visit attendance declined with advancing age groups. The use of traditional birth attendants decreased between the <20 (20%) and 20–24 age group (14%) and increased with subsequent age groups 25–29 (23%), 30–35 (33%), and >35 years (35%). This pattern was similar for home births. Hospital or health care center deliveries were highest in the 20–24 age group (82%), followed by the adolescent group (76%), and declined with AMA to 60%.

Frequencies of adverse maternal outcomes by age group

The maternal, perinatal, and neonatal outcomes are presented in Table 3. The overall maternal mortality ratio (MMR) was 147 deaths per 100,000 live births. The MMR was 132 in the African region, 172 in the South Asian region, and 98 in Guatemala (Supplementary Tables S2, S4, S6). By maternal age group, MMR increased with advancing maternal age: 83 in adolescents, 111 in the 20–24 group, and 298 in the AMA group. In the

African region, MMR was 91 in the <18 years group, 65 in the 18–19 years group, and highest at 319 in the AMA group (Supplementary Table S2). In the South Asian region, MMR was lowest at 112 in adolescents and highest at 399 in the AMA group. In Guatemala, women <18 had the lowest MMR at 47, and the AMA groups had the highest at 206 deaths per 100,000 live births.

Frequencies of adverse perinatal and neonatal outcomes by age group

For the entire cohort, perinatal and neonatal mortality decreased slightly between adolescents (43 and 24 deaths per 1,000 live births) and mothers aged 20–24 (40 and 22 deaths per 1,000 live births). It increased in subsequent groups, with AMA having the highest rates (69 and 33 deaths per 1,000 live births). This pattern was similar by region, except in the African region, where women <18 years had the highest neonatal mortality rates (Supplementary Tables S2, S4, S6).
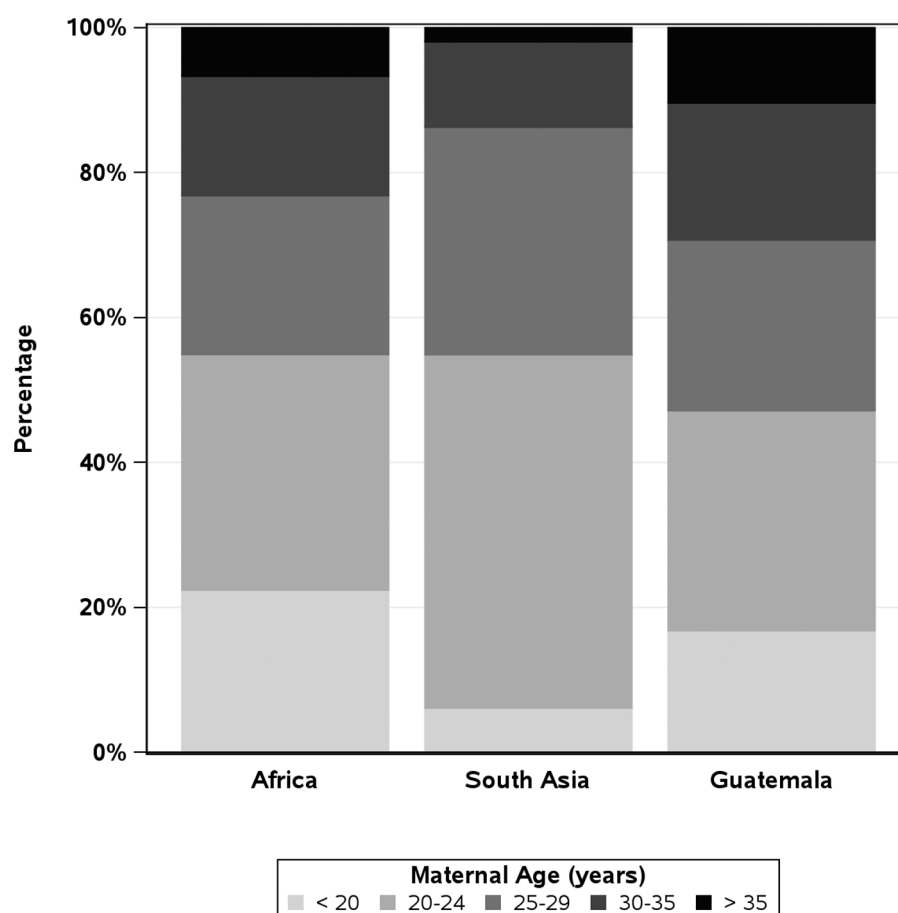
FIGURE 1
Maternal age distribution by global network region.

TABLE 3 Maternal and perinatal adverse outcomes by maternal age group.

Characteristic	Overall	Maternal age category				
		<20	<20	<20	<20	<20
Mothers, n	602,884	78,584	245,289	163,583	86,751	28,677
Obstructed/prolonged labor/failure to progress, *n* (%)	49,176 (8.2)	6,198 (7.9)	21,635 (8.8)	12,977 (7.9)	6,485 (7.5)	1,881 (6.6)
Antepartum hemorrhage, *n* (%)	7,418 (1.2)	799 (1.0)	2,077 (0.8)	2,247 (1.4)	1,701 (2.0)	594 (2.1)
Postpartum hemorrhage, *n* (%)	10,899 (1.8)	1,277 (1.6)	3,098 (1.3)	3,252 (2.0)	2,432 (2.8)	840 (2.9)
Evidence of hypertensive disease/severe pre-eclampsia/ eclampsia, *n* (%)	15,988 (2.7)	1,525 (1.9)	5,794 (2.4)	4,304 (2.6)	3,110 (3.6)	1,255 (4.4)
Abnormal lie: breech, transverse, or oblique, *n* (%)	12,294 (2.0)	1,272 (1.6)	4,534 (1.9)	3,409 (2.1)	2,205 (2.5)	874 (3.1)
Severe infection at follow-up, *n* (%)	2,614 (0.5)	294 (0.4)	780 (0.3)	762 (0.5)	563 (0.7)	215 (0.8)
Cesarean delivery, *n* (%)	83,680 (13.9)	7,966 (10.1)	38,052 (15.5)	24,224 (14.8)	10,325 (11.9)	3,113 (10.9)
Maternal death < 42 days,n (rate/100,000 live births)	872 (147)	64 (83)	269 (111)	250 (156)	206 (243)	83 (298)
Infants, N	608,918	79,038	247,250	165,375	88,115	29,140
Stillbirth, *n* (rate/1,000)	16,742 (27.5)	1,869 (23.7)	5,659 (22.9)	4,709 (28.5)	3,198 (36.3)	1,307 (44.9)
Stillbirth type, *n* (%)	15,589	1,792	5,315	4,297	2,942	1,243
Macerated	4,984 (32.0)	528 (29.5)	1,656 (31.2)	1,382 (32.2)	1,005 (34.2)	413 (33.2)
Fresh	10,605 (68.0)	1,264 (70.5)	3,659 (68.8)	2,915 (67.8)	1,937 (65.8)	830 (66.8)
Neonatal death < 7 days, *n* (rate/1,000)	11,556 (19.6)	1,496 (19.5)	4,283 (17.8)	3,093 (19.3)	1,995 (23.6)	689 (24.9)
Neonatal death < 28 days, *n* (rate/1,000)	14,527 (24.6)	1,826 (23.7)	5,303 (22.0)	3,923 (24.5)	2,560 (30.3)	915 (33.0)
Perinatal mortality, *n* (rate/1,000)	28,298 (46.6)	3,365 (42.7)	9,942 (40.3)	7,802 (47.4)	5,193 (59.2)	1,996 (68.8)
Preterm birth, *n* (%)	81,105 (13.7)	11,970 (15.5)	29,504 (12.2)	22,042 (13.7)	13,208 (15.4)	4,381 (15.5)
Low birthweight (<2,500 g), *n* (%)	88,516 (14.6)	11,320 (14.3)	36,979 (15.0)	23,668 (14.4)	12,463 (14.2)	4,086 (14.1)
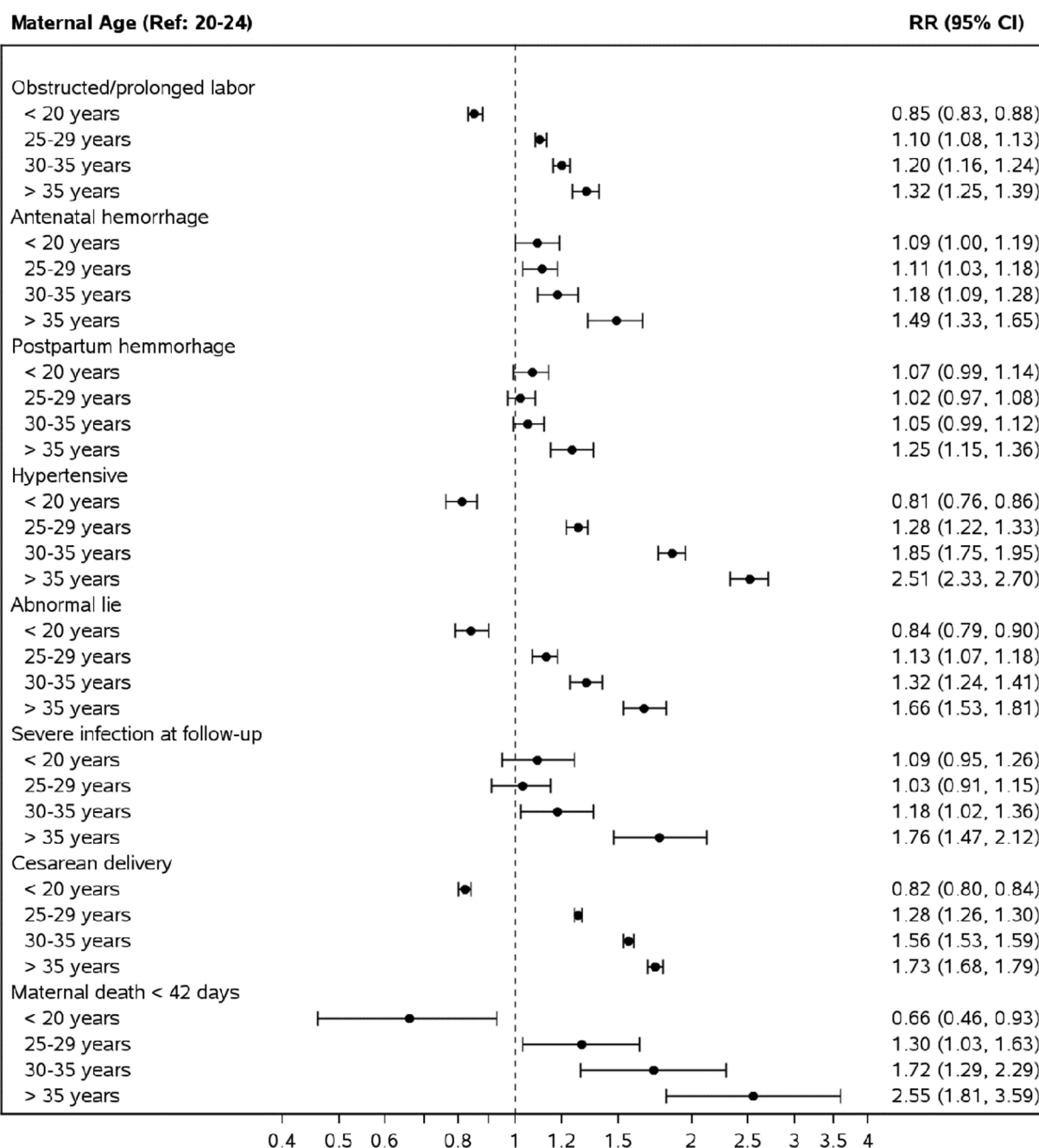
FIGURE 2
Risk of adverse maternal outcomes by maternal age groups compared to mothers aged 20−24. *Relative risks from a Poisson model adjusting for maternal age, site, parity, multiple gestation, maternal education (some or none), ANC care and delivery location.

Association of risk for maternal adverse outcomes

Estimated relative risks for maternal outcomes, controlling for site, parity, multiple gestation, maternal education (any or none), antenatal care, and delivery location, are presented in **Figure 2**. Overall, compared to women aged 20–24, pregnancy during adolescence had a lower or no associated risk of developing any maternal morbidity we assessed. However, AMA was associated with an adjusted risk ratio (aRR) of 2.55 [95% confidence interval (CI) 1.81–3.59] for maternal mortality, 1.32 (CI 1.25–

1.39) for obstructed or prolonged labor, 1.49 (CI 1.33–1.65) for antenatal hemorrhage, 1.25 (CI.15–1.36) for post-partum hemorrhage, and 1.73 (CI 1.68–1.79) for cesarean delivery. This pattern of a lower associated risk of maternal morbidity in adolescents and higher aRR in AMA compared to women aged 20–24 was observed in the South Asian region and Guatemala (**Supplementary Figures S3, S5**). In the African region, adolescence was associated with an increased aRR of obstructed labor, antepartum, post-partum hemorrhage, and severe infection but a lower risk of cesarean section and no difference in risk of maternal mortality compared to women aged 20–24. However,

FIGURE 3
Risk of perinatal and neonatal outcomes by maternal age groups compared to mothers aged 20–24. *Relative risks obtained from a Poisson model adjusting for maternal age, site, parity, multiple gestation, maternal education (some or none), ANC care and delivery location.
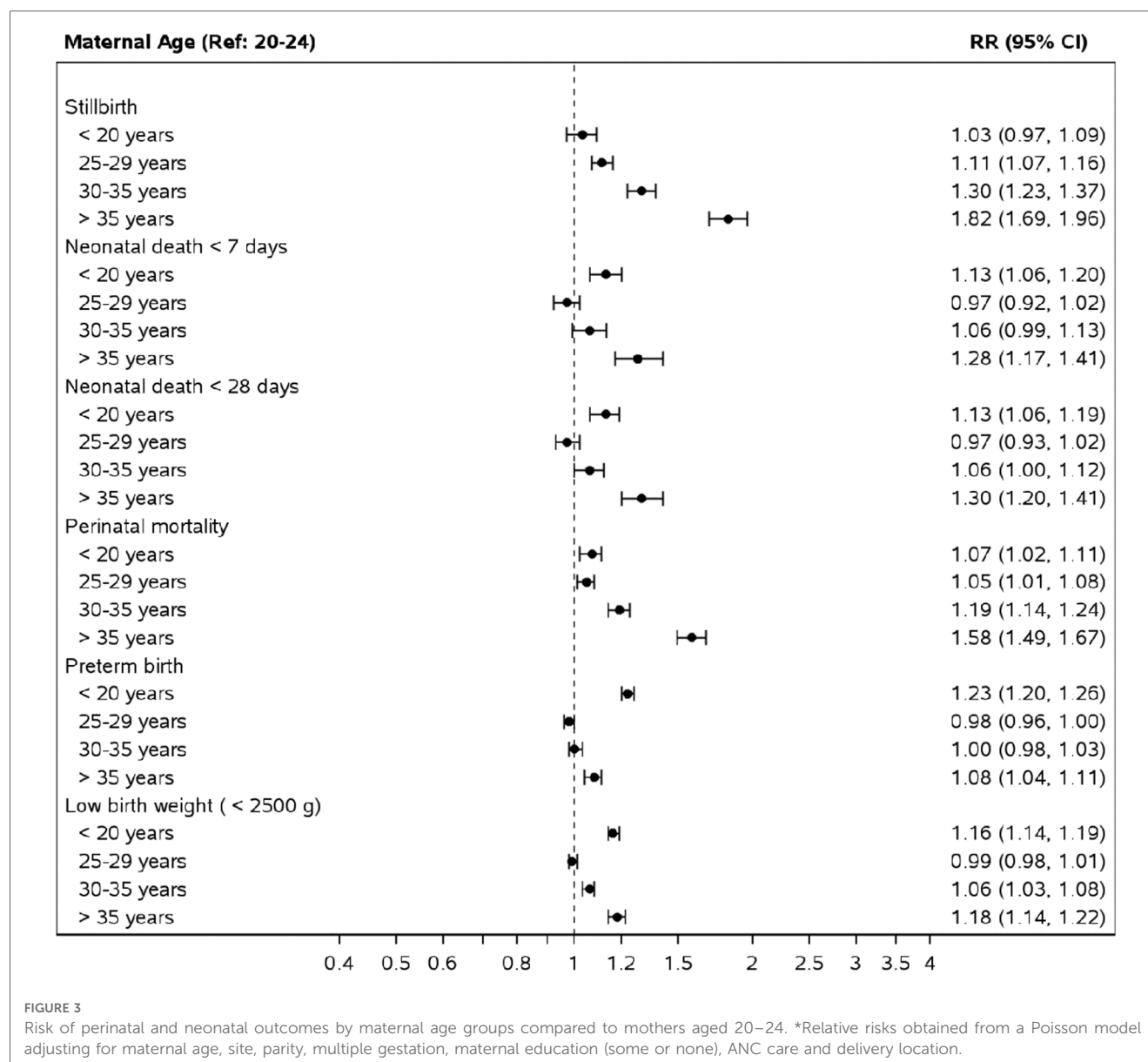
AMA showed increased aRR of all evaluated maternal morbidities except post-partum hemorrhage (**Supplementary Figure S1**).

Association of risk for perinatal and neonatal adverse outcomes

For the adverse perinatal and neonatal outcomes, compared to women 20–24 years, adolescence was associated with an aRR of 1.07 (CI 1.07–1.11) for perinatal mortality, 1.13 (CI 1.06–1.19) for neonatal deaths, and 1.16, (CI 1.14–1.19) for low birth weight (**Figure 3**). AMA was associated with an aRR of 1.58 (CI: 1.49–1.67) for perinatal mortality, 1.30 (1.20–1.14) for neonatal mortality, and 1.18 (CI 1.14–1.22) for low birth weight status.

In the African region, the pattern of associated risk took a C-shaped pattern on the forest plot, with adolescent and AMA groups both carrying an increased associated risk of perinatal, neonatal mortality and low birth weight status compared to women aged 20–24 years (**Supplementary Figure S1**). In the Asian region and Guatemala, adolescents were only associated with an increased aRR of low birth weight status. In contrast, AMA was associated with perinatal, neonatal, and low birth weight status (**Supplementary Figures S3**, **S5**).

Interaction between key variables and adverse perinatal and neonatal outcomes

In the *post-hoc* analysis, we added interaction terms to the Poisson models to evaluate if the effect of maternal age on maternal, perinatal, and neonatal mortality is modified by education (any vs. none), attendance to at least one antenatal visit or delivery location. The model for maternal mortality did not have any significant interaction terms, so it is omitted. The effect of

age on perinatal mortality is modified by education ($p < 0.001$), antenatal care ($p < 0.001$) and delivery location ($p < 0.001$) (**Supplementary Figure S7**). The risk of perinatal mortality is higher for adolescent and AMA women compared to women aged 20–24 for women with no schooling compared to those with schooling. AMA women have an increased risk of perinatal mortality for women with and without antenatal care, while adolescent women have increased risk without antenatal care but no difference compared to women with antenatal care aged 20–24.

Discussion

Using a robust population-based cohort spanning 11 years, we evaluated the prevalence and adverse outcomes associated with extremes of maternal age. Adolescent and AMA pregnancies represented 13% and 5% of all births, respectively. The African region had the highest proportion of adolescent pregnancies (22%), and Guatemala had the highest number of AMA pregnancies (10%). The MMR for the entire cohort was 147 deaths per 100,000 live births, increasing with advancing maternal age groupings. Adolescent pregnancy was shown to have a protective association with many maternal adverse outcomes but not perinatal or neonatal adverse outcomes. However, AMA was associated with an increased risk of adverse pregnancy outcomes. With a few exceptions, this pattern was similar in the African, Asian, and Central American regions.

In the past two decades, global MMR declined by 34% (743 to 223 deaths per 100,000 live births) (3). However, as with our findings, variations in MMR within and between global and regional geographies exist. In a large maternal cohort study involving eight countries (five from the current study) that evaluated 269,630 pregnant women, the MMR was 317 (24)—almost twice our findings. Socioeconomic differences do not explain these differences, as both studies recruited patients from rural and peri-urban communities in the African and South Asian regions. Differences in population sampling may explain the observed differences, as even within the referenced study, considerable variations existed within individual participating countries.

While we did not specifically study changes in MMR over time —as it was not the objective of this study—our finding closely mirrors data from the 2010 to 2018 global network cohort with an MMR of 157 per 100,000 live births (25). The slight difference in MMR is unlikely explained by improved health-seeking behaviors or socioeconomic status, as they were comparable between the 2010–2018 and 2020 cohorts.

We observed that overall and within regions, adolescents had the lowest maternal mortality compared to the older age groups and a lower associated risk of the adverse maternal pregnancy outcomes we evaluated. Our findings are similar to prior publications from the global network and a US-based cohort study (25, 26). Better health-seeking behaviors in adolescents may explain these findings. In our cohort, adolescents had the highest proportion of ≥1ANC visit, the second-highest proportion of first-trimester antenatal visits, ≥4 antenatal visits, and the use of skilled health personnel during delivery. These

proportions consistently declined with each advancing age group higher than the 20–24 age group.

Conversely, adolescent pregnancy was associated with increased perinatal and neonatal mortality risk and low birth weight status. However, the morbidities and risk sizes we observed vary from those reported in published studies. In a study that utilized demographic and health surveys from 2004 to 2018 for Sub-Saharan and South Asian countries, the authors segregated adolescents into age groups <16, 16–7, and 18–19 and compared them with women 23–25 years (5). The authors found that all adolescent groups had increased odds of stillbirth and neonatal death in both regions (5). In our cohort, however, overall adolescent pregnancy (<20 years) was not associated with an increased risk of stillbirth. In the current study, in the African region and Guatemala, only adolescents <18 years had an increased associated risk of stillbirths. There was no increased risk of neonatal mortality in women <18 or between 18 and 19 years in Guatemala or the <20 age group in the Asian region. However, both adolescent groups in the African region had an increased associated risk of neonatal mortality. This pattern of lower maternal but higher perinatal adverse outcomes is also reported elsewhere in the literature (26, 27).

Compared to pregnancies in women aged 20–24, AMA was associated with all the adverse maternal and perinatal outcomes assessed (**Figures 1**, **2**). Our study also indicates a direct association between adverse maternal outcomes and advancing maternal age categories. The MMR in the AMA group (291 deaths per 100,000 live births) was almost twice that of the entire cohort (145 deaths per 100,000 live births), four times that of adolescents, and three times that of pregnancies in women aged 20–24. This pattern is in keeping with the J-shaped age maternal age-related mortality curve, where mortality is acutely and persistently higher after age 30 (4, 28). These findings were consistent across the global network regions in our cohort (Africa 314, Southeast Asia 381, and Guatemala 201).

The current study has several limitations. Not all relevant confounders are collected in the global network registry, specifically medical conditions that could increase the risk of adverse pregnancy and maternal and perinatal outcomes. These morbidities are common in AMA, where we find the greatest association with these adverse outcomes in this study. Variables such as household income and marital status are important sociodemographic factors critical to assessing the risk of maternal and perinatal adverse outcomes. However, maternal education, which can serve as a proxy, was used in this study (29, 30). Data on the quality of hospital care is also unavailable and could provide insights into the divergence between our cohort's maternal and perinatal outcomes. Another study limitation is the exclusion of women who had a spontaneous abortion or other pregnancy loss that occurred <20 weeks, those with a medically terminated pregnancy at any point, and women who gave birth to infants with a birthweight of less than 500 g. These are all important adverse pregnancy outcomes that can affect maternal, perinatal, and neonatal outcomes. We did not include BMI in the regression model as it was unavailable for the Kenya cohort before 2017. We also do not have pre-pregnancy or early BMI for most women.

BMI is a known predictor of adverse maternal outcomes and may explain some of our study findings. The global network registry collaborates closely with delivery units within the catchment areas to obtain accurate data. Given that about 75% of the deliveries were either in a hospital or health center, the documentation of crucial quality metrics (presence of a skilled health worker and use of skin-to-skin Kangaroo mother care) is robust. Another limitation of this study is that the generated data originates from a limited geographical area and may not represent the country, other LMICs, or facility-based settings. However, the population-based nature of the registry makes the findings more generalizable than facility-based studies (26). Another strength of the study is that it is one of the largest prospective population-based studies of maternal and perinatal data in LMICs. The global network registry follow-up rates (93%) were high for the proportion of subjects enrolled in the registry.

In conclusion, the MMR in this large cohort involving six LMICs is high compared to the 2030 sustainable development MMR target goal and varied by region and maternal age group. Adolescent pregnancy was associated with a lower adjusted risk of adverse maternal outcomes but an increased adjusted risk of adverse perinatal outcomes. The prevalence of AMA pregnancy is low but associated with a higher adjusted risk of maternal and perinatal adverse outcomes.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The institutional review boards and ethics committees at the participating study sites and their affiliated United States collaborating institutions approved the study. 1. Kinshasa School of Public Health: ESP/CE/04208/2017; 2. University of North Carolina at Chapel Hill - School of Medicine: 13-2099; 3. University of Zambia: 008-01-08; 4. University of Alabama-Birmingham: IRB-080521010; 5. Institute of Nutrition of Central American and Panama (INCAP): 19-13; 6. University of Colorado at Denver Anschutz Medical Campus: 08-0511; 7. International Center for Diarrheal Disease Research (ICDDR, B): PR-18098; 8. University of Virginia: 21330; 9. KLE University JN Medical College: 181219008; 10. Thomas Jefferson University: 16F.349; 11. The Aga Khan University: 0581; 12. Colombia University: IRB-AAAJ7651; 13: Lata Medical Research Foundation: RPC # 22E; 14: Boston University School of Medicine: H-35430; 15: Moi University School of Medicine: 00305; 16: Indiana University School of Medicine: 1011003646. All women enrolled provided informed consent regarding data use related to their pregnancy.

Author contributions

PN, IM, CB, SB, AP, PH, FN, SS, RG, SG, RD, NK, AG, EC, WC, MM, AL, AT, MB, MK-T, JM, EM, ED, FE were responsible for the planning and conduct of this study including the design and sourcing of funding. They serve as either local or US-based principal or co-principal investigators. CT, RB, PN, OE, IM, CB, SB, AP, PH, FN, SS, RG, SG, RD, NK, AG, EC, WC, MM, AL, AT, MB, MK-T, JM, EM, ED, FE were responsible for the conduct of the study by supervising or directly involved with data collection. JM, OE, EL, EM, and FE were involved in data analysis. PN, OE wrote the first draft, ED, FE, JM, and RG provided a critical review of the article. All authors reviewed and approved the final manuscript. All authors contributed to the article and approved the submitted version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fgwh.2023. 1201037/full#supplementary-material

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A qualitative study to understand sociocultural beliefs around perinatal and neonatal health in rural areas of Mohali, Punjab, India

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Introduction: Globally, 600,000 mothers (15-49 years) die every year due to pregnancy and childbirth-related complications. Wide variations are seen in cultural practices and beliefs surrounding this period of a woman's life. The present study explores the cultural beliefs and practices of women and families during pregnancy and the postnatal period in order to understand what behavioral management strategies are required to improve maternal and infant outcomes during pregnancy and the postpartum period.

Methods: The study was conducted in a rural area of Punjab, from December 2019 to March 2021. A total of 20 women (up to 3 months postpartum, age >18 years, were interviewed.

Results: In general, women described eating varied and fairly healthy diets during pregnancy, especially nutritious warm food, following traditional practices. Other cultural practices included restrictions on movement and mobile phone use and the use of unsafe home remedies to promote infant safety and wellbeing, such as using gripe water, applying black pencil to the baby's eyes, and feeding the baby honey. A few were not inclined to engage with these and other cultural expectations, preferring instead to follow contemporary practices influenced by social media. These practices included being accompanied by a family member during delivery, celebrating the baby's birth regardless of sex, and early bathing post-delivery.

Discussion: It can be concluded that while many traditional practices are still followed in India, there are new beliefs and behaviors arising from an intersection between culture and technology. Developing strategies that acknowledge older beliefs and modern approaches is essential to promoting better antenatal and postpartum care.

KEYWORDS

sociocultural, beliefs, practices, pregnancy, postpartum, child health

1. Introduction

Globally, approximately nearly 600,000 mothers in the age group of 15–49 years die every year from pregnancy and childbirth-related complications (1). The major reasons behind this are complications arising from pregnancy and childbirth. The majority (99%) of these maternal deaths occur in developing countries (1). Almost 50% of postnatal deaths occur within the first 24 h of birth and 66% occur during the first week of the postnatal period. The major causes of maternal mortality include hemorrhage, pregnancy-induced hypertension (PIH), puerperal sepsis, ruptured uterus, anemia, and obstructed labor, all of which can be compounded by more distal factors such as malnutrition and poverty (2).

The infant mortality rate in India decreased from 57 per 1,000 live births in 2005–2006 (National Family Health Survey 3) to 41 in 2015–2016 (National Family Health Survey 4) and to 35 in 2019–2021 (National Family Health Survey 5) (3, 4). However, this figure is still high. The distribution of these gains is uneven across states and between urban and rural locations (5). The infant mortality rate in Punjab in NFHS-4 is estimated at 29 deaths before the age of one year per 1,000 live births, down from the NFHS-3 estimate of 42, and the NFHS-2 estimate of 57 (6). Only 30.7% of children under the age of 3 years were breastfed within 1 h of birth and 53.0% of children were exclusively breastfed up to 6 months, which contributed to poor infant outcomes (6).

As per a nationally representative survey (NFHS 4, 2015–2016) from India, Punjab state had only 30.7% of women receiving complete antenatal care (women aged 15–49 with a live birth in a given time period receiving antenatal care four or more times) (7). Although the percentage of women who had at least one postpartum health check in the 2 months after delivery increased from 53.1% (NFHS 3) to 87.2% (NFHS 4), only 40.7% of children received a health check from a doctor/nurse/LHV/ANM/ midwife/other health personnel within 2 days of birth (6).

Access-related factors can influence care-seeking practices and behaviors in pregnancy and postpartum, such as the logistical challenges of traveling to the health facility with a young baby or women living far from their health facility (rural or tribal area), particularly in India (8).

Besides these structural factors, cultural practices also influence women's behavior and outcomes during the pregnancy and postpartum period. There are wide variations in cultural practices and beliefs surrounding pregnancy and the postpartum period globally, which differ between countries.

While there has been some research on these cultural practices in pregnancy and postpartum in India (9, 10), much of the literature is from over a decade ago and it mostly focuses on influences on maternal diet pattern and breastfeeding practices. Much less research has looked at other sociocultural practices and how they are changing (or not) in an ever-modernizing world (9). Understanding these practices related to pregnancy and the postpartum period and planning for maternal health care education accordingly can help to improve morbidity and mortality indicators of both the mothers and their babies.

Traditional practices regarding dietary modification in pregnancy and the postpartum period in India are well documented, and pregnant women often follow the advice of their mothers-in-law (10–12). Studies have found that pregnancy diet is determined by beliefs that pregnancy contributes to body heat (13, 14) and eating "hot" food will add to this. As such, pregnant women are encouraged to avoid harmful "hot" foods (meat, eggs, and *ghee*) and eat "cold" foods (green leafy vegetables, milk) so as to avoid a miscarriage (10, 13). The opposite is recommended postpartum, where "hot" foods are encouraged and "cold" foods are avoided (11).

This is because after delivery, the woman's body has lost blood, fluids, and body heat, which is believed to put her in a "cold state". To balance this lower body temperature, it is believed that post-partum women should be eating "hot" foods. Reducing food consumption or "eating down" during pregnancy is also practiced due to a belief that excessive consumption will result in weight gain and hence cause difficulty in delivery and fear of delivering a large baby (10, 15). While some studies have found that women do not believe reducing consumption will harm the fetus, this practice is more prevalent in under-resourced areas (10).

While significant progress has been made to improve infant feeding practices in recent years, studies still show that deep-rooted beliefs persist in feeding practices (breastfeeding and complementary feeding) in rural areas. A study conducted by Bansal et al. (2021) reported a significant association between the delay in the time of initiation of breastfeeding and cough/cold episodes was reported by (*P* value 0.039). Poor nutrition in infancy and early childhood contribute to malnutrition and may also impair cognitive and social development, resulting in poor school performance and reduced productivity in later life (16, 17).

In India, delayed breastfeeding of up to 3 days is attributed to beliefs that colostrum (fluid produced before breast milk) contains indigestible substances and will harm the newborn (10, 17, 18). Several studies have found that pre-lacteal feeding (foods such as honey, *ghee, ghutti, (*digestive medicine given to infants*)* and *jaggery* (a type of solid dark sugar made in India from sugar cane) given before breastfeeding is initiated) still exists in some rural areas of India rural and where lower levels of education and industrial development are attained (10, 19, 20). Furthermore, a delay in complementary feeding after 6 months of birth (introducing other foods when breast milk alone is no longer sufficient) was common at 6 months, and most mothers fed their infants homemade complementary food rather than commercial food (18, 19).

Common postpartum practices that persist in Indian culture are based on the belief that they benefit the health of the mother and infant. Most of the current literature on this topic focuses on cultural practices around infant care, with less documentation of practices related to postpartum women, aside from those around eating practices. The fear of harm caused to the newborns by *nazar* (evil eye) results in various practices, including placing a black dot of *kajal* (black soot mixed in butter) on the newborn's forehead and discouraging admiration of the newborn to avoid causing envy (10, 12). After delivery, the mother, along with her infant, is placed in a 40-day confinement, restricting her movements and secluding her from the outside, since it is believed to be a highly vulnerable period for the mother and infant (10, 16, 21). This period of

isolation is believed to protect the new mother and infant from *nazar* and revert the "polluting" effects of giving birth (12, 16).

Understanding cultural practices in pregnancy and the postpartum period is important for designing interventions that address the full picture of the causes of certain behaviors. For example, simply providing information about the importance of early breastfeeding may not be enough without also addressing cultural beliefs around colostrum. An understanding of various traditional postnatal care practices is essential if effective behavior change strategies are to be developed and help the planners formulate effective intervention strategies and provide timely assistance to the mothers. Additionally, broadening our understanding of cultural practices in pregnancy and postpartum beyond those focused on maternal diet to really understand the wider range of influences on women's health, and how these may be shifting as India modernizes, is needed. Thus, the aim of this study was to explore the cultural beliefs and practices of women and families in one part of India (rural Punjab) during pregnancy and the postnatal period.

2. Materials and methods

2.1. Study area

The present study was conducted in Block Boothgarh, Mohali district of Punjab. Villages in Mohali are relatively densely populated and typically consist of 750–2,000 people living in approximately 150–400 households (22). According to the NFHS-4, the total fertility rate and crude birth rate in Punjab are 1.6 children per woman and 14.1 per 1,000 people per year, respectively. In total, 84.9% of women deliver in a health facility and 71.3% of women had at least four antenatal care visits during their last pregnancy (6). In rural areas of Mohali, 42.7% of women received full antenatal care [full antenatal care is at least four antenatal visits, at least one tetanus toxoid (TT) injection, and iron folic acid tablets or syrup taken for 100 or more days] (3). Only 35.8% of children under the age of 3 years were breastfed within 1 h of birth. Only 42% of children received a health check after birth from a doctor/nurse/LHV/ANM/midwife/other health personnel within 2 days of birth.

According to the "Household Survey on India's Citizen Environment & Consumer Economy" (ICE 360° survey) conducted in 2016, 88% of households in India have a mobile phone (23). Household mobile phone ownership is high in Punjab, with 90% of households and 50% of women in the Mohali district owning a mobile phone. In our target region, Punjab state, 57.2% of women own their own mobile phone.

2.2. Ethical consideration

This study received Ethics approval from the Institute Ethics Committee of the Postgraduate Institute of Medical Education and Research (PGIMER), Chandigarh, and the University of California, San Francisco. Permission was also received from the concerned authorities of Block Boothgarh. Potential participants were called on the telephone numbers provided by the health center and informed about the study, and if they were interested, verbal informed consent was obtained over the phone for enrolling them. Those who were interested were scheduled for an in-person interview. The Research staff (qualitative interviewer and a note-taker) visited the women at their homes, conducted the full informed consent process, obtained written confirmation of consent, and conducted the interview face-to-face.

2.3. CTRI registration

This research is part of the formative phase of a larger intervention trial. The trial was prospectively registered with the Clinical Trials Registry of India. (CTRI/2020/12/029800) [Registered on: 15/12/2020].

2.4. Recruitment

A total of 20 women were recruited through data collected from the 15 different health centers of Block Boothgarh.

2.5. Inclusion criteria

Women were eligible if they were primiparous, up to 3 months postpartum (post-delivery of their baby), and over the age of 18.

2.6. Exclusion criteria

Those not willing to participate and under 18 years of age were excluded.

2.7. Data collection tool

Data was collected via in-depth interviews addressing the following topics: cultural and traditional practices associated with conception, antenatal care, childbirth, postnatal care, and newborn care.

2.8. Data collection method

Data was collected by a qualitative researcher (a person who attempts to interpret human behavior based on the words of selected individuals). The interviews were conducted in a comfortable setting, at home (current residence with family). It was ensured that only the interviewer and the interviewee were present at the time of the interview. Interviews were audio recorded after receiving permission from the participants. The language used in the interview was either Hindi or Punjabi, based on the interviewee's preference.

2.9. Data collection period

The study was carried out from December 2020 to March 2021.

2.10. Data analysis

The average duration of the qualitative interviews was 45 min and all were audio recorded, transcribed, and translated to English for coding and analysis. A Research Team conducted a thematic analysis using the software Dedoose (24). Based on the interviews' preliminary analysis, a code guide was developed to analyze the rest of the transcribed interviews. It was updated continuously based on new areas found in the transcripts. Themes and sub-themes were cross-checked across the transcripts for consensus. Only major themes are reported in this paper. The topics of pregnancy, postpartum, and newborn care practices were further subdivided into various subthemes, e.g., under the theme of pregnancy, there was diet and rituals followed in pregnancy, phone usage, and support from family during pregnancy and delivery.

3. Results

All the 20 recruited women were found to be within the age range of 25–30 years. One participant was illiterate, three had education up to primary level, eleven had up to secondary school graduation, and five had higher than secondary education level. This shows that 95% of our study population was literate, compared to the overall Indian literacy rate of 74.37% and Punjab literacy rate of 75.85% in 2011 (23).

The key findings are presented within three main themes that permeated from a thematic analysis of the present research: (a) Pregnancy practices; (b) Postpartum period practices (c) Newborn care practices. The findings from the qualitative interviews are presented under these three themes.

3.1. Pregnancy practices

Different cultures have different values, beliefs, and practices. A woman's cultural background can affect her needs and expectations during pregnancy as well as the practices adopted by her. In our study, many women were influenced by the rituals described or advice given by elders or those close to them, whilst others were much less likely to follow traditional cultural practices. We could see in our study that women follow the dietary advice given by their elders. They were found to follow their family rituals regarding their stay place in pregnancy being their parents' or in-laws' house. They may stay there for a particular time in pregnancy or after delivery depending upon their cultural practice. In this time period, the husband stays at the residence (place of stay) where he was already living and does not move with the pregnant woman.

3.1.1. Diet during pregnancy

In general, women described eating varied and fairly healthy diets in pregnancy. Multiple women followed advice from older generations, such as their mothers or in-laws, on what foods to eat during pregnancy. One woman explains:

> *In pregnancy, my mother had told me not to eat anything hot in nature, especially in the beginning. In the initial months, she used to give me healthy things like milk and curd and fruits like pomegranate and apples.*

Women also listened to their elders regarding the food items to be avoided, which included hot foods (garam taseer) or "hard" foods. One woman describes:

> *I stopped my intake of hot food items as the elders used to say that hot food items could…harm the baby…I am told not to eat certain vegetables as hard food can cause indigestion…if I am eating apples, the elders will tell me to remove the skin of the apple and then eat. The skin is a bit hard and would not get digested in time.*

3.1.2. Support and mobility in the late pregnancy period

As a part of their ritual practices, whether the delivery location should be the mother's or the mother-in-law's home, the pregnant woman would be sent to her mother's home in the 7th month for a certain amount of time. One woman explains:

> *If delivery is to be done there (parent's house), then they (in-laws) send you in the 7th month…they send you with clothes and shagun (money given as a blessing to the child). But, I had to deliver here (in-laws house) that's why I came back after 4–5 days.*

During the last months leading to delivery, women reported generally being provided with extra care from their family members. They were told to eat well and rest more. However, this was not the case for all participants; other women were told that continuing to work and exercise would help them have a normal delivery:

> *Everyone used to suggest continuing working for normal delivery. I used to go for a walk in the evening also, as much as possible. This will help in normal delivery.*

One woman followed advice from the elders to engage in religious practices to promote positive effects on the baby.

> *I would recite Japji sahib (a prayer) in the morning or would recite Rehras sahib (another prayer) in the evening. I was in the habit of doing so. At times I would play Gurbani (Sikh hymn) whenever I felt like it. It means my whole day would pass on like this. It is said that when there is such a situation (stress, worry) then you should divert your thoughts to something else.*

Going outside of the home was not a common occurrence for the participants. Some women were restricted from going out by family members, while others chose to remain at home as a precaution."

> When my sister-in-law's baby was born, someone gave her something to eat before delivery, e.g. some sweets; her baby died after delivery. My mother-in-law was a little scared so now she wouldn't allow me to come in front of people; my room is upstairs. I would remain upstairs. I would not go outside; she restricted me from going out. I stayed at home and she or my sister-in-law always stayed with me, they never left me alone at home. It felt special, that was a good time. When mother-in-law is not allowing…. I cannot disobey her and even I was also not interested in going out.

3.1.3. Using phones during pregnancy

Pregnant women were also advised not to use their phones during pregnancy or after delivery in order to focus on caring for and protecting themselves and their babies.

> After delivery, they used to say to not use the phone for 1.5 months, not to hear anything too noisy… I started watching TV 1.25 months after delivery. It can be harmful to use phones a lot.

> They used to stop me from watching TV or advise me to use my mobile less because it has an impact on the eyes.

3.1.4. Support during delivery

Women described certain rules around who could and could not support them during their actual labor and delivery, but overwhelmingly, there was an awareness that women needed some form of social and emotional support at that time. One participant said that a pregnant woman's mother or husband should not be there beside her as they take half of the pain and labor pain gets prolonged. But if the mother-in-law is present, nothing of this sort happens and the pregnant woman faces labor pain easily.

> A pregnant woman's mother or husband should not be there beside her as they take half of the pain and labor pain delays. And if the mother-in-law is present then nothing of this sort happens and the pregnant woman faces labor pain easily.

> They allowed my sister to come. Actually, it is said that during those 1.25 months, the woman's body is very sensitive and needs extra care. So, my sister took care of me.

3.2. Postpartum period practices

The results show variations in postpartum practices in terms of rituals followed after delivery to celebrate the birth of the baby, how

they practice self-care, diet followed after delivery, and practices adopted to move outside or stay inside the home.

3.2.1. Self-care: after delivery

Many acts of self-care after delivery involved physical acts of soothing their own bodies, such as massage, nipple care, and baths.

> They say that there are black-black 'til (blackheads on the pores of the nipples that need to be removed for the milk to secrete) that do not get removed by themselves; they are to be removed. If not removed, milk will not come…. My sister-in-law told me that you can use a comb also if milk does not come.

Some respondents acknowledged that they were advised certain things by their elders but they opted not to follow that advice due to their actual circumstances and needs.

> There are rituals but they (elders) said nothing to me; I took a bath with warm water on 2nd day after coming from the hospital. They would say not to sit under the fan but it was very hot at that time so without a fan it wasn't possible, my baby also cannot do without a fan.

Participants described a number of different cures or remedies for body pain. Some remedies were purely superstitious (keeping a matchstick between finger and thumb), while others contributed to practices related to limiting mobility and isolation during this time period.

> They told me that you have to take care of yourself like…do not put your hands in cold water at all and like in villages, it is said a lot that you should cover your face for 1 month and 15 days, right? Like cover your face as much as possible, and don't expose too much to the air or to the body so that you do not have any problems.

3.2.2. Mobility after delivery

Women also described restricted mobility in the postpartum period, including restrictions on visiting Hindu temples. This confinement period (40 days) is a time when the mother is believed to be vulnerable and stays indoors/is restricted to the house: "*She cannot go out for 40 days. But she stays with her child*".

Women described a cultural practice of no one touching them for the first 40 days or taking the child directly from her, as a vaginal birth was perceived to make the woman "dirty."

3.2.3. Maternal diet after delivery

After birth, many women consumed nutritious warm foods, such as panjiri (whole-wheat flour fried in sugar and ghee), milk, dal (lentils), chapatti, and porridge. Several foods such as panjiri and milk, in particular, were consumed to promote healing and lactation for the mother.

My mother had made panjiri (high-fat snack), she used to give me milk, she used to ask me to eat warm foods…Mumma gives me milk three times so that I keep producing milk for the baby.

Other women described not being allowed to eat certain things, especially related to the "temperature" of that food.

*Yes, sometimes I crave butter milk but it is cold so I'm not allowed to have it. My husband would say keep it aside, *smiles* he gives me things that are beneficial.*

Participants or their families often worried that the foods they were eating could affect their baby's health. As described in the quotes below, this often led to women restricting their diets due to certain beliefs about how it might impact the baby.

I cherish eating spring rolls but I can't have them. It is said if you eat fried food, the baby will suffer from a cough…. If somebody gives me something to eat then also, I will think twice before consuming whether it is good for my baby or not. It is better if I don't consume it.

It is mostly about my own eating. Like I shouldn't eat oily things or curd. Because she drinks my milk, she might have some problems. I love curd. I do not eat it because of her. Because baby might get cold if I eat curd, oily things, fast food. During pregnancy, I also never had fast food; they said it is not good for the baby in the tummy. Now I don't eat it because she has to drink my milk.

In some cases, women were stopped from eating certain foods by their family members, notably mothers-in-law, because those family members had perceptions about the impact of certain foods.

A few days back, my sister-in-law cooked rice and offered me but my mother-in-law stopped me from eating it as she said it was not good for my health and would directly affect the health of the baby.

3.2.3.1. Rituals after delivery

Women described a range of experiences of after-delivery rituals to celebrate the birth of their newborn. The rituals often involved intimate gatherings of worship and blessings or large gatherings of families with an abundance of food and gifts. We could observe in the present study that, usually, celebrations or family parties were planned for baby boys.

After 45 days, somebody throws a party or anything. Mostly it is done for the baby boy only. It is done less for the baby girls. There is just the custom of doing 21 "chwonki" within 45 days… when the girl is 11 or 21 days old…whether only children are invited or do we have to invite the families also relatives. For 45 days…we are not allowed to wear new clothes or go outside…

However, some respondents described celebrations occurring, regardless of sex: "After coming home from hospital, a lot is done whether it is a boy or a girl; happiness is celebrated."

3.3. Newborn care and feeding practices

Generally, women discussed a few issues with breastfeeding. However, there were some superstitions reported that could cause women to not breastfeed in public:

They say do not feed the baby in front of some stranger. They say then the baby does not feed. If that happens, then we have to remove the evil eye by holding a thing in the hand, circling it around the baby seven times, and then throwing it in flowing water.

Respondents described various home remedies used for infant care and illnesses, commonly "gripe water" to help with constipation, massage (often with mustard oil or clarified butter), and rubbing the baby with asafetida. Some respondents discussed having an awareness about not giving any traditional medicine to babies until 6 months as it can cause infections.

Recommendations around the practice of black pencil (kajal, black soot mixed in butter) being commonly applied to the eyes of babies, and some mothers, as described below, caused tension among doctors and family members:

I cannot apply kajal, I am afraid. Doctors do not recommend applying kajal, as it causes infection, but in the village, as you know, it is said that it will make the eyes bigger. Made by my mother-in-law, I apply that only.

A number of respondents described giving honey to their babies:

Yes, sometimes I give him honey. It is good for children you know and it is homemade. After 7–10 days, I give him it and it is good (beneficial) for cough.

4. Discussion

A variety of cultural beliefs impact women's behaviors and care-seeking ability during pregnancy and the postpartum period in northern India. Some of these are impacted by old beliefs and others are more recent, such as those surrounding mobile phone usage.

It has been found in past literature that dietary restrictions are common in pregnancy and childbirth (10). These dietary restrictions and precautions are often observed under the auspice of protecting the health of newborns or promoting women's recovery. Avoiding certain kinds of food at the time of lactation is primarily perceived to be in the best interest of the baby (25). However, optimal food consumption during the postpartum period is crucial to support the additional nutrient requirements for breastfeeding and to reduce postpartum weight (26).

Contrary to cultural beliefs, dietary restrictions deprive postpartum and lactating women of some of the essential nutrients at a time when these are particularly needed: "For example, restrictions on diets, particularly the lack of a substantial meal for the first few days after birth, could have

negative impacts on both the woman's recovery and ability to initiate breastfeeding (27–29)."

The quality and quantity of breast milk is also possibly adversely affected by a restricted diet (27–29).

Another common thread in the pregnancy and postpartum period, which is less well described in the literature, is the practice of restrictions on women's movement during the perinatal and postpartum periods. One previous study in India described how a belief that women should not cross a river during pregnancy may restrict women's access to antenatal care (9). In our study, women described limitations on movement, for example, not being allowed to leave the house or visit certain places. Such restrictions could limit their ability to seek care if needed or lead to loneliness, isolation, and potentially postpartum depression (30). Also, in some Indian Hindu families, the whole family is considered impure during the postpartum period of the mother. No outsiders are allowed to eat or drink in the house until a day determined by caste and until a ritual bath and religious ceremony are performed (31).

However, it was interesting to find that some women described that being restricted to the home felt special, and it seemed to be viewed as a marker of being cared for. Thus, this practice can potentially, at least in certain circumstances, be positive for some during this period. Relatedly, overall, the women in our sample seemed to feel supported during pregnancy and the postpartum period, which is likely to lead to better pregnancy and postpartum health outcomes (32, 33).

There is also a practice of restrictions on women's movement during the perinatal and postpartum periods. The various reasons for these are the norms around privacy for breastfeeding, which could potentially reduce breastfeeding exclusivity or duration, especially if women have to work outside the home and are unable to breastfeed in public.

In India, different ceremonies may or may not be practiced after birth based on the sex of the baby. There is a great deal of literature on gender preferences, where some women see having a son as a greater blessing and express disappointment in having a daughter (12, 14). While holding a ceremony may not in itself be harmful to the infant's or mother's health, these practices internalize and perpetuate gender inequality and could also cause emotional distress and depression to mothers who do not produce a male child. This is a reflection of gender inequality and unequal gender norms. It is important to note that nowadays, many families celebrate the birth of a girl, which may be impacted by social media, but this was not supported by the study population. Only a few respondents were of the opinion that a lot is done whether it is a boy or a girl; happiness is celebrated.

Another finding was related to restrictions on women's phone usage while pregnant and during the postpartum period due to beliefs about the potential ill-health effects of exposure to phones on women and infants. It is important to consider this in view of the low care seeking from health facilities by the family accompanied by less-than-optimal home visitation by the providers. This can seriously compromise the health of the mother and the baby, despite mhealth platforms providing an increased possibility of reaching women with accurate health information and support (33).

There is a recent and growing body of literature from India describing the intricacies of the gender gap in phone usage. A recent paper outlined how, even if, nominally, women have access to a phone, its use is very restricted due to gender norms around usage, including who gives permission for the phone to be used and for what purposes it can be used (34).

A few infant practices were described which are causes for concern, particularly the practice of feeding babies honey and of putting kajal (black soot mixed in butter) on the eyes, which has also been found in previous studies (10, 12). Honey, or any processed foods containing honey, should not be given to children under 1 year of age because introducing honey too soon may cause infant botulism by Clostridium botulinum spores found in honey and honey products. These spores turn into bacteria in the bowels and produce harmful neurotoxins in the body (35).

Kohl (surma) is an eye preparation in the ultra-fine form of specially processed "Kohl Stone" (galena) mixed with other active ingredients (36). It has been found to be used in babies with the idea of keeping the eyes cool, improving vision, strengthening the eyes, and protecting the baby from the evil eye. Studies have revealed that "Kajal" comprises galena (PbS), minium (Pb3O4), amorphous carbon, magnetite (Fe3O4), and zincite (ZnO) (37). Prolonged application may cause excessive lead storage in the body, affecting the brain and bone marrow, and causing convulsions and anemia (37). Dirty fingers and sharp and uneven fingernails of the caregivers are potentially harmful to the child's eyes (37). There is a need to concentrate on health education regarding the potential harm of some of these practices in the communities where such customs are followed.

5. Conclusion

Understanding community practices and beliefs is a vital step in improving early neonatal outcomes, because only after identifying knowledge gaps and harmful behavior can community-based programs be tailored to the needs. Our findings have identified several socio-cultural practices that need to be addressed to help improve maternal and infant health outcomes and prevent unintentional harm. Many traditional practices remain in the pregnancy and postpartum period in India, but it appears that new behaviors and beliefs are also arising, which are at the intersection between culture (gender norms) and technology.

This study has many strengths, including looking in depth at an understudied set of practices through qualitative interviews with women living in rural communities in northern India. However, as with all studies, there are limitations. The present study was conducted using a small sample size; with study participants from only one rural area. Expanding the project into other locations would be beneficial. Additionally, we only collected data from women, and since decisions are often made at a household level, collecting the opinions and views of other family members would enhance future research.

Developing strategies that address and, where possible, integrate mothers' traditional beliefs and modern approaches to postpartum care are essential. Additionally, developing

culturally sensitive messaging to help reduce potentially harmful practices and strengthen positive ones (such as social support) should also be a priority among programs and policymakers. Despite declining maternal and neonatal mortality, it remains important to focus on the promotion of an exclusive breastfeeding diet and adequate fluid and nutrition for the mother. Further research exploring other cultural practices (e.g., religion/spirituality) in this location and practices in other locations would be valuable.

Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Ethics statement

The studies involving humans were approved the Institute Ethics Committee of the Postgraduate Institute of Medical Education and Research (PGIMER), Chandigarh, and the University of California, San Francisco. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

AA: Conducting and translating Interviews, compiling results & drafting the manuscript. MD: Design of Study Proposal, execution of study, checking results, drafting the manuscript. JL: compiling results and drafting the manuscript. PS: Conducting and translating Interviews. DB: checking results, reviewing the drafts. RB: Design of Study Proposal, reviewing the drafts. AE: Design of Study Proposal, checking results, and drafting the manuscript. AK: checking results, reviewing the drafts. VK: checking results, reviewing the drafts. PS: checking results, reviewing the drafts. ND: Design of Study Proposal, checking results, and drafting the manuscript. All authors contributed to the article and approved the submitted version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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The impact of a blended multidisciplinary training for the management of obstetric haemorrhage in Mbeya, Tanzania

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Background: The Maternal Mortality Rate (MMR) in Tanzania is 78 times higher than that of the UK. Obstetric haemorrhage accounts for two-thirds of these deaths in Mbeya, Tanzania. A lack of healthcare providers' (HCPs') competencies has been the key attribute. This study measured the impact on HCP's competencies from a blended training programme on obstetric haemorrhage.

Methods: A "before and after" cohort study was undertaken with HCPs in 4 hospitals in the Mbeya region of Tanzania between August 2021 and April 2022. A multidisciplinary cohort of 34 HCPs (doctors, nurses, midwives, anaesthetists and radiologists) were enrolled on a blended face-to-face and virtual training course. The training was delivered by a multidisciplinary team (MDT) from London, UK, assisted by local multidisciplinary trainers from Mbeya, Tanzania and covered anaesthetic, obstetrics, haematology and sonographic use.

Results: There were 33 HCP in the cohort of trainees where 30/33 (90.9%) of HCPs improved their Anaesthesia skills with a mean score improvement of 26% i.e., 0.26 (−0.009 −0.50), 23 HCPs (69.7%) improved obstetric skills 18% i.e., 0.18 (−0.16 to 0.50), 19 (57.6%), (57.6%) improved competences in Haematology 15%.i.e., 0.15 (−0.33 to 0.87), 20 out of 29 HCPs with ultrasound access (68.8%) improved Sonographic skills 13%.i.e., 0.13 (−0.31 to 0.54). All 33 HCPs (100%) presented a combined change with the mean score improvement of difference of 25% i.e., 0.25 (0.05−0.66). The deaths attributed to obstetric haemorrhage, the mortality rate declined from 76/100,000 to 21/100,000 live births. Actual number of deaths due to obstetric haemorrhage declined from 8 before training to 3 after the completion of the training.

Conclusion: This comprehensive blended training on anaesthetic surgical, haematological, and sonographic management of obstetric haemorrhage delivers a significant positive impact on the detection, management and outcomes of obstetric haemorrhage.

What is already known on this topic?

Previous studies investigating preventable deaths from obstetric haemorrhage have identified that a large proportion can be attributed to provider-related factors such as incomplete or inappropriate management of bleeding before, during or after birth. Training has been shown to improve such outcomes, however different training modalities have had a variable impact.

What this study adds

The blended training design, which includes a simulation component, has proven successful in knowledge and skills transfer in the recognition and management of obstetric haemorrhage in Tanzania and could easily be implemented in other low and middle-income countries (LMIC) with engagement from local maternity units.

How this study might affect research, practice or policy

Scaling up and evaluation of multidisciplinary training programmes using blended learning methods is needed in LMIC to reduce maternal deaths from obstetric haemorrhage. Blended training allows for continuing learning and development of HCP's competencies in obstetric haemorrhage management. It offers the opportunity for engagement and empowerment of local healthcare providers when new clinical techniques are introduced.

Introduction

Obstetric haemorrhage remains the leading cause of direct maternal mortality worldwide, disproportionately affecting pregnant women in low and middle-income countries (1) where 94% of maternal deaths occur (2). Obstetric haemorrhage accounts for a third of all maternal deaths. Each year, about 14 million women experience postpartum haemorrhage (PPH) resulting in about 70,000 maternal deaths globally (3). PPH, formally defined as blood loss exceeding 500 ml following vaginal birth and 1,000 ml following caesarean, accounts for three-quarters of all obstetric haemorrhage deaths (4). The majority of deaths related to PPH occur within 24 h of delivery, suggesting inherent risks at the time of birth (5, 6).

Maternal deaths in Tanzania (7, 8) are 78 times higher compared to that of the UK (9, 10) with obstetric haemorrhage as the cause in 38% to 69% of cases (11–13). In Mbeya, Southwest Tanzania, only half of pregnant women receive the minimum standard of obstetric care and maternal deaths are 776 per 100,000 live births (14).

Evidence presented by the UK maternal mortality surveillance system MMBRACE identified that improvement in care may have made a difference in outcome in 37% of cases of maternal deaths they investigated (10). The use of multiple interventions to control haemorrhage, including oxytocin, misoprostol, tranexamic acid, new surgical techniques and blood transfusion, are all recommended to help achieve haemodynamic stability (15). Blood loss due to failure of the uterus to contract after birth can be minimised if oxytocin is available and given, but it is clear that many women die shortly after childbirth due to this medication not being readily available or not recognised as useful (16).

The most common causes of Obstetric haemorrhage (OH) are known as "the 4 T's"; uterine aTony, Trauma, Tissue (retained) and coagulopathy (Thrombin) (17). Many of these features are better recognised and managed following a robust multidisciplinary (MDT) training approach and identification of pre-existing risk (18) alongside access to effective intrapartum care of OH (19).

Evidence from Northern Tanzania showed that teams, skills training, and realistic simulated scenarios can reduce OH complications (20). The COVID-19 pandemic made virtual teaching the optimum route of delivery. We therefore sought to test the use of a virtual blended training programme with HCPs in Mbeya, Tanzania. We hypothesized that blended training (instruction/physical simulation) delivered virtually by UK and Tanzanian experts, supplemented by simulation training, alongside structured assessment, would improve HCPs' knowledge and skills in managing massive obstetric haemorrhage (MOH) cases in Mbeya, Tanzania.

Materials and methods

Design

A "before and after" cohort study to investigate the effectiveness of blended training for the management of MOH was conducted in four hospitals in Mbeya, Tanzania from the baseline in August 2021 to completion in April 2022. Institutional and Tanzanian ethical approval was obtained for all sites before the commencement of the intervention and data collection.

Setting

The study was conducted in four hospitals in Mbeya—Mbeya Zonal Referral Hospital (MZRH), Mbeya Regional Referral Hospital (Mbeya RRH), Mbalizi Designated District Hospital (Mbalizi DDH) and Igawilo City District Hospital (Igawilo DH). The project was publicised widely at the hospital sites. Hospital management and stakeholders were engaged before recruitment to facilitate uptake and to ensure that there was support for those enrolled to complete the course. HCPs from the 4 hospitals were approached and self-registration took place in each of the sites supported by a local dedicated study team.

Participants

Multidisciplinary teams from the four hospitals were recruited from all seven available groups of HCPs involved in caring for pregnant women including; medical doctors (graduate and

specialist obstetricians), midwives, nurses, anaesthetists and anaesthetic nurses, laboratory technicians and sonographers.

Intervention

The intervention consisted of 4 modules: (1) Risk assessment (2) Surgical, Haematological and Medical Treatments for Management (3) Anaesthetic considerations (4) The Role of Ultrasound to Improve Diagnosis.

The training was delivered virtually through an online platform with instructors from University College London (UCL) and Queen Mary University London (QMUL). The platform provided students with a mix of live interactive lectures and practical sessions that were delivered at a set time to each of the four sites, so students could view and engage together. The intervention ran over 10 consecutive weeks with 4 areas covered sequentially. The areas covered included: (1) Risk assessment (2) Surgical, Haematological and Medical Treatments for Management (3) Anaesthetic considerations (4) The Role of Ultrasound to Improve Diagnosis.

Each module contained regular teaching/demonstrations at a specific for the HCPs participating and delivered live through the educational platform. Appropriate resources such as guidelines and protocols were uploaded to the platform so students could review them before and after sessions. These resources were recovered from the World Health Organisation, Royal Colleges and GLOWM websites (21–23). In the risk assessment module students were taught about recognising and initial management of deteriorating patients, A–E assessment, situation, background, assessment and recommendation (SBAR) techniques and how to estimate blood loss. Live lectures were complemented by additional practical demonstrations. All sessions were recorded and uploaded to the platform shortly after airing so students could review the content at their leisure. Module 2 lasted 3 weeks and covered haematological considerations, medical management, basic (B-lynch/ tamponade) as well as advanced surgical skills to manage PPH. Again, sessions were complemented with practicals for B Lynch and balloons (condom) training. The anaesthetic module covered the choice of regional vs. general, airway management and fluid resuscitation. The ultrasound module covered basic ultrasound relevant to the risk of bleeding and practical sessions about equipment and views. All four modules also had a tutorial session at the end in which students fed back short answer responses they had been sent at the beginning of the module and had time to ask questions and clarify details. All modules had pre and post-quiz within the content that required completion to access and move on to the next module.

Additional face-to-face practical training sessions (for surgical techniques) were facilitated by local experts from MZRH who also helped to facilitate the simulation training days in conjunction with the UK training team (interacting virtually).

Simulation training session

All students undertook one-day simulation training with a pass/fail assessment built in. Students were offered a variety of dates so all could attend at least one session. Advanced life-like mannequins (human patient simulators) were used in simulated scenarios to represent realistic clinical obstetric environments. Participants performed in their clinical roles and communicated via the SBAR tool (24) around emergency obstetric haemorrhage cases and their management through newly learned techniques.

Assessment took place by the UK team observing an end-of-day full clinical scenario in which all HCPs participated in in their normal professional capacities.

Formal assessment and data collection

Information about risk factors, rates of haemorrhage, morbidity and mortality was collected and verified through onsite visits to mortuaries and by review of case notes from the individual participating hospitals.

Changes in HCP knowledge and skills were assessed through an initial baseline assessment, and online written assessments before and after each module, followed by an end-of-training formal written assessment under exam conditions that covered all components of the course. Data was collected using Epi-Collect 5 software. Assessment scores for individual modules were generated from the pre and post-module scores for each component and overall for the course. Both overall mean score changes and improvement of individual HCP scores were reported. In the final overall assessment, a pass mark of above 75% was required to achieve a certificate of competency. Students who did not make this grade were allowed one further attempt in similar conditions with different examination questions.

In addition to the pre and post-module-based competencies, specific practical and management skills were also assessed including special cases of OH risk, blood loss estimation, blood transfusion practices, use of balloon tamponade, and B-lynch compressive sutures.

Statistical analysis

Analyses were performed using GraphPad Prism Version 9.4.0 (453) and R 4.1.1. The distribution of data was assessed using the D'Agostino and Pearson test, Anderson–Darling test, Shapiro–Wilk test and Kolmogorov-Smirnov tests for normality vs. lognormality. Ordinary one-way ANOVA, paired and unpaired two-tailed Student t-tests were applied to normally distributed data and the Mann–Whitney test and Kruskal–Walis test was applied to not normally distributed data. Šídák's multiple comparisons test was used to assess the total score difference before and after the module.

Paired pre and -post-test data were analysed for each module, and respondents were only included if they completed both assessments. Individual test score improvement was visualized using connected scatterplots and the distributions of pre and post-test data were visualized with boxplots, separated by module. For each module, the percentage of participants that improved was calculated. 95% confidence intervals for mean improvement, which was calculated as post-training score minus

pre-training score, were estimated using a percentile bootstrap with 1,000 bootstrap replicates.

Maternal mortality rates were reported as absolute and calculated as the number of maternal deaths per 100,000 live births. The pre-training and post-training mortality rates were compared for the four hospitals individually, as well as cumulatively from data analysed during the month before and the month after the training. Fisher's exact tests were used for proportion comparison due to small death counts.

Results

The project targeted a total of 25 HCPs, with a male-to-female ratio of 1:1. However, due to high interest from HCPs, a total of 34 HCPs were enrolled with a distribution of 8 females (23.5%) and 26 males (76.5%). The characteristics of the HCPs recruited are described in Table 1.

HCPs were from a range of multidisciplinary groups including; anaesthetic nurses working in obstetrics, laboratory technicians, clinical officers, nurses, midwives and doctors including those working specifically in obstetrics. The 34 participants represented 30.8% of all available HCPs in the region ($n = 107$). Importantly, 15 out of 34 (43%) were midwives and anaesthetic nurses working in obstetrics (representing 43% of available staff in the region), or 15 out of 34 (26.5%) were medical doctors and obstetricians representing 13 out of 34 38%) of available HCPs in the region. Staff came from all hospitals with proportionally more from the regional centre, MZRH.

Before the final assessment, one HCP (obstetrician) had to drop out due to a hospital site transfer, so outcome data is reported for the remaining 33 HCPs.

Overall assessment scores

Of all participants, 32/33 (96.9%) passed the end-of-training final assessment (with 9 individuals repeating the assessment as they did not achieve the benchmark score of >75% on their first attempt) as shown in Figure 1. Of note, there were 6/33 (18.2%) who achieved a distinction score of >90% at the first sitting of the final assessment. These participants were invited to be program "champions" and identified as potential future local facilitators in the scale-up of the programme.

Individual module assessment

Early sufficient antenatal identification of haemorrhage risk was recognised by 5 out of 34 (15%) participants in a written assessment before the training module and by 18 out of 33 (55%) participants after the module with maximum improvements among doctors (Figure 2) and Supplementary Figure S1.

In the anaesthesia module, the average score initially was 28.1% ± 15.6% ranging from 0% to 65.2% was improved to the average score of 55.3% ± 9.2% ranging from 30.4% to 73.9%. No one scored above 75% in the anaesthesia pre-training assessment before training and again no one scored above 75% in the post-training assessment.

With regards to obstetric surgical and medical interventions, there was an average score of 55.3 ± 9.2 ranging from 30.4 to 73.9 with 11 participants scoring > 75% in pre-module assessments. In the post-module assessment, 27 participants (81.8%) scored >75%. The average score initially was 66.3 ± 16.4 ranging from 40 to 100 which rose to 81.4 ± 13.8 ranging from 50 to 100, after training. score. The use of balloon tamponade increased from 11/34 (32.3%) to 26/33 (78.8), the use of the B-lynch suture from 11/34 (32.3%) to 25/33 (75.7), the need for internal iliac artery ligation and total abdominal hysterectomy (TAH) from 11/34 (32.3%) to 24/33 (72.7).

In the training for the choice of Whole Blood, Fresh frozen plasma and Platelets concentrate Transfusion initially, the average score was 54.9 ± 27.1 with only one out of 34 participants (2.9%) scoring at or above 75% before the module with the mean score 20.2, (95%CI of mean 17.53–22.9). After training the average score was 78.3 ± 18.8 ranging from 50 to 100 with 21 out of 33 HCPs presenting a score above 75% competency on Blood transfusion Supplementary Figure S2. The detailed distribution is shown in the Supplementary Figure S3.

About the ultrasound module, HCPs were surveyed before the training. 29/33 HCPs had access to or were already using ultrasound in their clinical practice. After the module, 15 participants reported that they would not access ultrasound in routine practice. In terms of knowledge improvement, three participants scored >75% in the pre-training assessment which improved to nine in the post-training assessment. Initially, the average score was 22.5% ± 30.5% and changed to 48.7% ± 33.9% (Supplementary Figure S4).

The combined knowledge presented an average score of 46.9% ± 17.8% ranging from 9.3% to 79.1% before training. The average score of combined knowledge after training was 78.4% ±

TABLE 1 total number of health care providers by cadres, gender and facility of training.

Cadre credential	Freq.	Proportion	Gender	Freq.	Proportion
Anaesthetic nurse	3	8.8	Female	8	23.5
Clinical officer (health assistant)	3	8.8	Male	26	76.5
Lab technician	1	2.9	Facility	Freq.	Proportion
Medical doctor (obstetrician)	11	32.4	ICDH	6	17.7
Midwife	9	26.5	MDDH	9	26.5
Nurse	4	11.8	MRRH	8	23.5
Sonographer	3	8.8	MZRH	11	32.4
	34	**100.0**		**34**	**100.0**

FIGURE 1
General proportion of the performance and distribution of the HCPs before and after training on identification of obstetric haemorrhage.
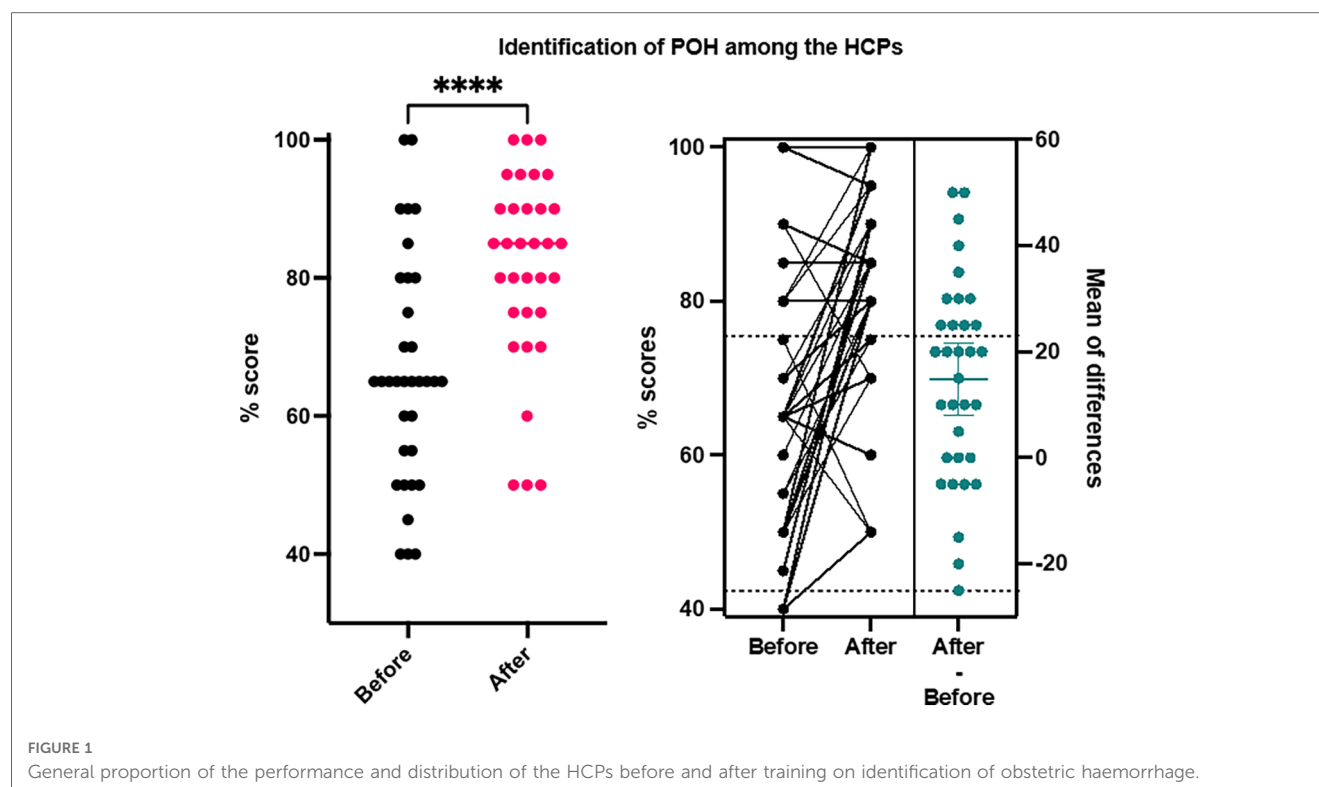
10.7% ranging from 62.8% to 97.7%. There were 21 out of 33 (63.6%) scoring above 75% cut point.

Mean score assessment

There were 30/33 (90.9%) of HCPs improved Anaesthesia skills with a mean score improvement of 26% i.e., 0.26 (−0.009 −0.50). There were 23 HCPs (69.7%) who improved their skills on the use of the latest obstetric skills and Balloon tamponade and knowledge with a mean score improvement of 18% i.e., 0.18 (−0.16 to 0.50). There were 19 HCPs (57.6%) who improved competencies in Blood loss measurement and transfusion knowledge with a mean score improvement of 15% i.e., 0.15 (−0.33 to 0.87). There were 20 out of 29 HCPs (68.8%) who improved Sonographical skills with a mean score improvement of 13% i.e., 0.13 (−0.31 to 0.54). All 33 HCPs (100%) presented a combined change with the mean score improvement of difference of 25% i.e., 0.25 (0.05–0.66) as shown in Figure 2.

Maternal mortality rates

Maternal mortality rates came down in hospitals at different levels of service provision with 95% significance (MZRH ($p = 0.01$), MRRH ($p = 0.025$), Mbalizi DDH (0.018) and Igawilo DH ($p = 0.73$. There were 32 deaths before training which reduced to nine deaths ($p < 0.001$) after the training. This represents a reduction in maternal mortality rates from 295/100,000 to 85/100,000 live births. For deaths attributed to obstetric haemorrhage, the mortality rate

declined from 76/100,000 to 21/100,000 live births after implementation of the training (Table 2) which in absolute terms represents a decline from 8 to 3 maternal deaths due to obstetric haemorrhage in the month after training completed.

Deaths due to other unspecified causes at the referral hospital, MZRH, dropped before and after training from 12 to 4, while deaths due to MOH halved from 4 to 2. At MRRH, deaths due to other unspecified causes dropped from 4 to 3 and deaths due to haemorrhage halved after training, albeit in small numbers ($n = 2–n = 1$). At Mbalizi DDH, no deaths due to haemorrhage were recorded after training ($n = 2$ before). At Igawilo District Hospital, no maternal deaths secondary to haemorrhage were recorded before or after training the detailed distribution is shown in the Supplementary Figure S5.

Discussion

In this project, we were able to determine the effectiveness of a virtually-delivered, real-time, blended training programme designed for a range of HCPs who work with pregnant women in Mbeya, Tanzania. There was a training coverage of 30.8% of all HCPs in both Mbeya urban and rural public hospitals although there was a male majority which represented somewhat the doctor cadre. We were not powered to look at differences between female and male learners in this project The number of participants assessed meets the criteria for the 30 participants rule' for external validity of the Pre—Post studies (25). In this study, we were able to produce evidence of effective training methods to improve obstetric haemorrhage management in Mbeya, Tanzania.
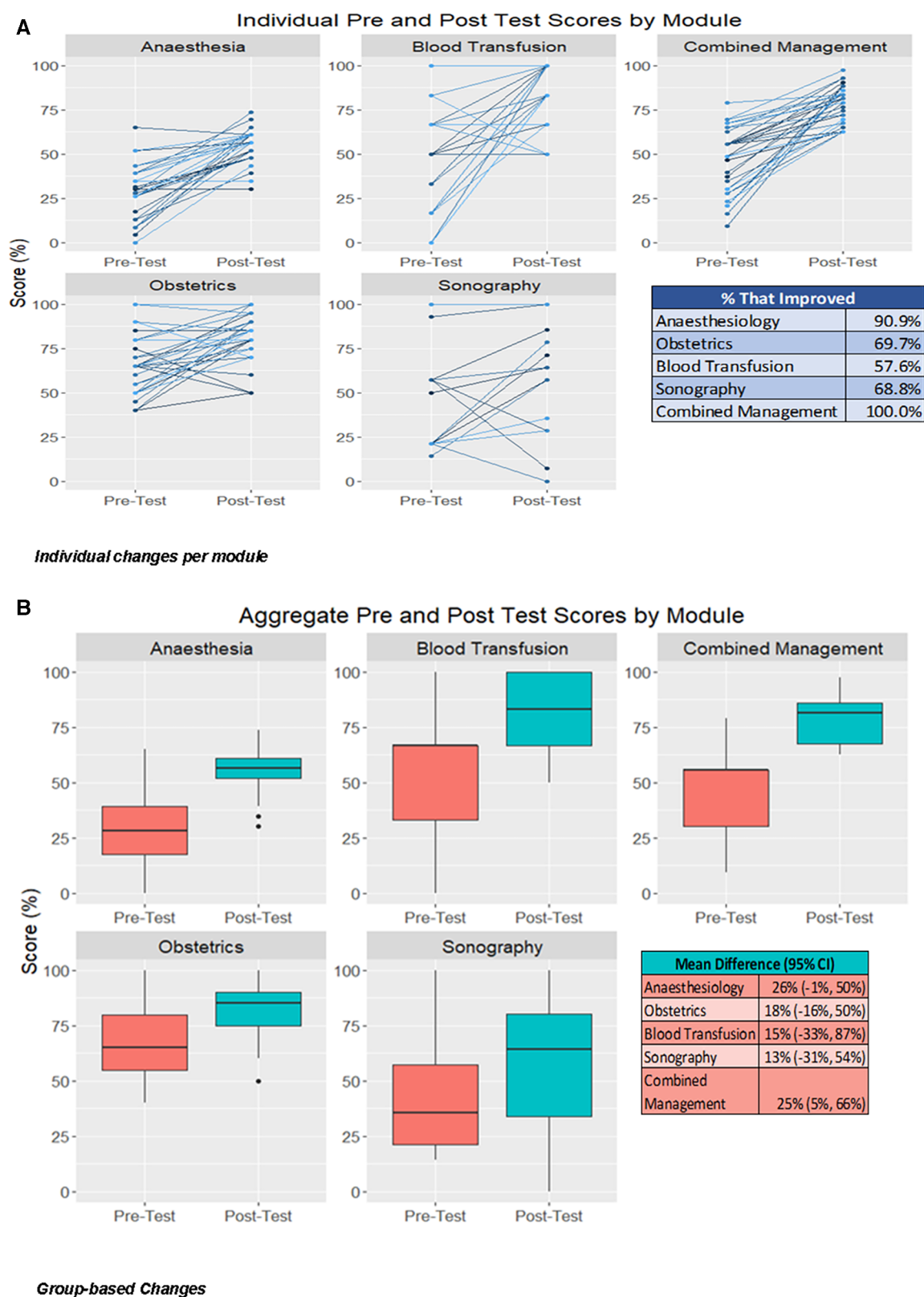
FIGURE 2
Individual and Group changes in all modules. (A) Individual changes (B) Group-based Changes.

The use of this well-coordinated blended training (London—Mbeya Project) provided evidence of competency among 32 of 33 HCPs who finished the training and passed the final assessment (96.9%).

Knowledge and competency, as captured by standardised assessments in the 4 modules and the final simulation assessment were shown to have been significantly improved by completion of the course. In-

TABLE 2 Maternal mortality by hospital.

Maternal mortality by hospital											
	Pre-training (August 2021)					Post-training (April 2022)					
Hospital	Live births	Maternal deaths: cause PPH	Maternal deaths: cause other	Total maternal deaths	Total mortality rate (per 100,000 live births)	Live births	Maternal deaths: cause PPH	Maternal deaths: cause other	Total maternal deaths	Total mortality rate (per 100,000 live births)	p-value
MZRH	4,365	4	12	16	366.55	5,159	2	4	6	116.30	0.02
MRRH	1,671	2	4	6	359.07	3,127	1	3	4	127.92	0.1
Mbalizi DDH	1,990	2	5	7	351.76	2,431	0	1	1	41.14	0.03
Igawilo DH	2,479	0	2	2	80.68	3,455	0	1	1	28.94	0.58
Total	10,505	8	23	31	295.10	14,172	3	9	12	84.67	<0.001

service training has previously been shown to be effective in addressing obstetric haemorrhage at different levels of service provision in varied settings in Tanzania and sub-Saharan African countries (26).

Poor outcomes following obstetric haemorrhage are often attributed to lack of anticipation, delays in detection and prompt life-saving treatment (27). This study also reports a nearly 5-fold increase in the detection of bleeding risk. The project provided evidence of an increase in the identification of haemorrhage from 15% to 55% and an increase in combined obstetric haemorrhage management by 25%. This project feeds into strategies to ensure quality maternity care and Universal Health Coverage (UHC) (28, 29) that is demanded by the Tanzanian National Surgical, Obstetrics and Anaesthesia Plan (NSOAP) (30).

When assessing variances in baseline, improvement and end-line between different cadres of HCP recruited, it was apparent that our method provided a reduction in obstetric haemorrhage cases. We did not identify any major changes in personnel employed, equipment or drugs available throughout the study (reported through site visits and data collection) that would have directly influenced outcomes. The differences in knowledge seen between groups in the pre-module assessment disappeared after training. This means task shifting from surgeons, anaesthetists and obstetricians to non-physician clinicians (NPCs) and non-specialist physicians (NSPs) is possible when blended training is carried out as previously recommended by Falk and co-workers in 2020 (31). Our study highlights the opportunity to train the 4 modules in different cadres including non-physicians with a guided communication strategy in the fight against PPH. This finding needs to be tested in other settings in sub-Saharan Africa. From observations on simulation days, SBAR communication (24, 32) was a useful tool for communicating and handing over tasks between the cadres when Balloon Tamponade, B-Lynch sutures, choice and timing of blood transfusion were needed. In our training, SBAR communication provided sufficient guidance in task sharing needed for obstetric haemorrhage management (32).

The COVID-19 pandemic made it challenging to deliver this training in person by the UK team as originally planned. However, this presented an opportunity to develop a new virtual platform with real-time face-to-face local facilitation, which to our knowledge has not been used before in this setting. We found that an interactive web-based educational platform can provide a viable solution to training that could be extended to other medical fields and that can overcome barriers associated with traditional teaching methods, including cost and travel as shown in India (33). Additional benefits of the online modules format included the ability to recap content at one's own time and pace, improving the transferability of knowledge (34). Live delivery to groups facilitated discussion (both with the facilitator and each other) and enabled peer-to-peer learning. We found that it was possible to teach the practical skills, traditionally taught face to face, using a combination of our blended online approach and simulation, initially described by Sheen and colleagues (35) We have shown that blended training can have an impact (34, 36) in improving the management of obstetric haemorrhage.

We were also able to show a reduction in maternal mortality due to haemorrhage after the training was implemented in the 4 hospitals recruited. Although our study was not powered to detect

a difference in mortality rates, this effect is worth exploring further through the up-scaling of this project. A recent randomised controlled trial (RCT) on a one-day course to reduce PPH found a reduction of severe PPH cases while case fatality did not improve (37). Our course was comprehensive, encompassing various aspects of PPH prevention, but more importantly, the training took place over several months which allowed for better consolidation and translation into a more sustained change in clinical practice and hence could explain this finding.

Given the small number of HCPs in this study, further evaluation and potential up-scaling of the blended training programme is required to validate our findings in broader contexts. The blended design makes it easily transferable and the use of local experts as co-leads can be recreated in other settings to help facilitate delivery of the programme. The model delivers "champion" HCPs identified during training, who can become future local trainers, enabling the up-scaling of training in the region and the maintenance of competencies. The next step of training would be a "train the trainers" course to ensure trainers are adequately equipped to deliver training so the initiative can become self-sustaining.

Study limitations

The project was implemented during the COVID-19 pandemic which required the revision of some of the face-to-face simulation training planned. However, adapting to this meant we were able to deliver an almost entirely virtual course, although simulation training did require local face-to-face facilitators (with virtual training offered to these experts before the simulation day). The presence of local experts was necessary as the group had not previously undertaken simulation training and close guidance aided engagement with this component. With more experience and exposure to simulation training, local facilitation should be possible in any scale-up of the programme.

Conclusion

Findings support further evaluation of the up-scaling of the training programme to other regions of Tanzania and other LMICs. The blended design of online and face-to-face training using local experts as co-leads to facilitate simulation-based training makes it easy to transfer knowledge and skills. The bringing together of multidisciplinary teams in local hospitals aided skills transfer and a sense of belonging. Evidence is provided that blended training can potentially help improve HCP knowledge and skills in the effective management of obstetric haemorrhage which has a critical role in reducing maternal deaths.

Author's note

The reflexivity statement for this paper is linked as the online **Supplemental Files Figures 5**. for the Obstetric project in Mbeya (London-Mbeya Project), Tanzania.

Data availability statement

The original contributions presented in the study are included in the article/**Supplementary Materials**, further inquiries can be directed to the corresponding author.

Ethics statement

The study was approved by Mbeya Medical Research Ethics Committee (MMREC) and National Health Research Ethics Committee (NatHREC). The study was conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

BM: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. AT: Data curation, Investigation, Methodology, Writing – original draft. KM: Formal Analysis, Investigation, Software, Visualization, Writing – review & editing. MC: Formal Analysis, Software, Validation, Visualization, Writing – review & editing. DM: Conceptualization, Data curation, Investigation, Methodology, Supervision, Writing – review & editing. HH: Conceptualization, Data curation, Formal Analysis, Investigation, Writing – review & editing. SB: Conceptualization, Data curation, Investigation, Supervision, Writing – review & editing. EK: Conceptualization, Data curation, Investigation, Methodology, Supervision, Writing – review & editing. MK: Writing – review & editing. MK: Data curation, Investigation, Methodology, Supervision, Writing – review & editing. SS: Project administration, Writing – original draft, Conceptualization, Data curation, Formal Analysis, Investigation, Methodology. SH: Conceptualization, Data curation, Funding acquisition, Investigation, Methodology, Project administration, Writing – original draft, Writing – review & editing.

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are the sole responsibility of the authors and do not necessarily reflect the views of any agency. Contributors BM and SH conceptualised this study, performed the analysis and drafted the manuscript. MC and KM supported the data analysis, supported the interpretation of the study results and revised the manuscript. AT, DM, MK and EK provided the data and information on the implementation of the training programme and supported the interpretation of the results. HH, SB, MK, MP, SH and SS provided UK-based expert training sessions. SS supported the conceptualisation of this study. All authors reviewed the manuscript.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fgwh.2023.1270261/full#supplementary-material

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Check for updates

Determinants of short birth interval among married multiparous women in Chinaksen district, eastern Ethiopia: a case-control study

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Background: The short birth interval is a common public health issue that affects women's and children's health in sub-Saharan Africa. Despite a higher burden of short birth intervals reported in Ethiopia, there is limited evidence to indicate the primary risk factors, particularly in rural eastern Ethiopia. Therefore, this study assessed the determinants of the short birth interval among married multiparous women in Chinaksen district, Eastern Ethiopia.

Methods: A community-based case-control study was conducted among randomly selected 210 cases and 210 controls from April 01 to June 30, 2019. The total sample size (219 cases and 219 controls) were calculated using Epi-Info software version 7.2. Data were entered using EpiData version 3.1 and analyzed using SPSS version 27, and multivariable logistic regression analyses conducted to identify the determinants of short birth intervals. Adjusted odds ratio (AOR) with a 95% confidence interval (CI) was used to report the strength of association and statistical significance declared at p-value < 0.05.

Results: The women in the young age group (AOR = 2.33, 95% CI: 1.03, 5.26), missed their antenatal care visits (AOR = 2.23, 95% CI: 1.18, 4.21), failed to utilize postpartum contraceptives (AOR = 5.98, 95% CI: 3.62, 9.89), did not attend postnatal care visit (AOR = 1.86, 95% CI: 1.13, 3.05), nonexclusive breastfed (AOR = 4.05, 95% CI: 2.18, 7.52), short and medium period of breastfeeding (AOR = 4.00, 95% CI: 1.34, 12.10) and (AOR = 3.56, 95% CI: 1.62, 7.82), respectively and female sex of preceding child (AOR = 1.92, 95% CI: 1.18, 3.12) were the important risk factors of short birth interval.

Conclusions: Women's age, antenatal care visits, postnatal care attendance, utilization of postpartum contraceptives, exclusive breastfeeding practice, duration of breastfeeding, and sex of the preceding child were the primary predictors of short birth intervals. Improving the utilization of maternal healthcare services in health facilities would be imperative to prevent and reduce short birth intervals, and its negative consequences.

KEYWORDS

optimal birth interval, determinants, married women, semi-pastoral community, Ethiopia

Introduction

The period between two successive live births is known as the birth interval. The World Health Organization (WHO) states that the ideal birth interval is between two consecutive live births of 33–59 months, whereas a short birth interval is between two successive live births of less than 33 months (1). Short birth interval is a severe public health issue that affecting about 25% of live births worldwide. The problem is most common in developing countries that 33% of short birth intervals occurring in Central Asia and 57% in Sub-Saharan Africa (SSA) (2). Ethiopia is another country where the issue is more serious, affecting 53% of live births each year (3).

The short birth interval is the most important factor influencing maternal, neonatal, and child health outcomes (4). Short birth intervals also increase the likelihood of unfavorable pregnancy outcomes such as premature birth, low birth weight, intrauterine growth restriction (5–7), obstructed labor, maternal hemorrhage, anemia, and cesarean birth (1, 4). Globally, an estimated 20.5 million neonates are born with low birth weight each year, and of these, 48% (9.84 million) from Southeast Asia, 24% (4.92 million) from sub-Saharan Africa, and 17% (3.49 million) from Ethiopia (8, 9). In addition, short birth intervals raise the risks of maternal, neonatal, and child morbidity, mortality, and disability (5, 10, 11). It increases the risk of neonatal death by 2.3, perinatal mortality by 3.8, and maternal mortality by 1.7 times. Accordingly, the neonatal mortality rate per 1,000 live births was 18 in the world, 27 in SSA, and 92 in Ethiopia (3, 12). The maternal mortality rate per 100,000 live births was 210 in the world, 231 in Lower and Middle Income countries (LMIC), 534 in SSA, and 412 in Ethiopia (13, 14). On the other hand, short birth interval has a major contribution to increasing the overall fertility rate in developing countries. The total fertility rate was 2.31 births per woman in the world (15), and the rate is much higher in SSA (4.7) (16) and Ethiopia (4.6) (14).

The Ethiopia Federal Ministry of Health suggested the optimal birth interval of 33–59 months between two consecutive pregnancies recommended for promoting women's and children's health (17). However, around 53% of multiparous women in Ethiopia had short periods between consecutive live births (14). A previous study indicated that 56% of women had short birth intervals in rural eastern Ethiopia (18).

Previous studies suggested that women demographic characteristics, including their age at first marriage, occupation, educational status, and wealth index, were predictors of short birth intervals (19, 20).

The previous risk factor studies were analyzed secondary data (21) and addressed the significance of short birth intervals (18), but there is a scarcity of information on their major preventable determinants. Additionally, some previous studies used a birth interval of less than 36 months as the cutoff point and parameter to diagnose short birth intervals (20, 22), and they used a cross-sectional design (23), which is unsuitable for identifying factors that contribute to short birth intervals. Despite the higher reported prevalence of short birth intervals, evidence showed that the main risk factors for short birth intervals were scarce in rural eastern Ethiopia. Given that, it is essential to comprehend the underlying causes that are affecting the short birth interval in a different manner. Therefore, this study revealed determinants of short birth intervals among married multiparous women in semi-pastoral communities of Chinaksen District, Eastern Ethiopia.

Methods and materials

Study design and setting

A community-based case-control study was conducted from April 01 to June 30, 2019, in Chinaksen district. Chinaksen is one of 20 districts in the East Hararghe Zone, located 659 kilometers (km) east of Addis Ababa, the capital city of Ethiopia, and a semi-pastoral area in rural eastern Ethiopia. Administratively, the district was divided into three urban and 49 rural kebeles, with 119,123 estimated total population in 2018, 26,217 women of reproductive age group, and 4,284 pregnant women. According to the district health office annual report 2018, there are 49 health posts and eight health centers offering general healthcare services.

Population and sampling

The source population was all married women in the Chinaksen district who had at least two consecutive live births within the five years preceding data collection. The married multiparous women in randomly selected kebeles who had at least two successive live births in the previous five years and who were permanent residents of the district were included in the study. Critically ill and mentally ill women who were unable to respond to interviews, those who had twin births, who had caesarian delivery, who had a history of preceding neonatal death or abortion, and who did not live with their husbands within the last five years were excluded from the study. Cases were married women with birth intervals of less than 33 months who had at least two consecutive live births within the previous five years in randomly selected kebeles of the Chinaksen district, whereas controls were those who had a birth interval of 33 months of two subsequent live births during the data collection period.

Epi-Info software version 7.2 was used to calculate the total sample size ($n = 438$) using a two-population proportion formula (unmatched case-control study) with the following assumptions: a 95% confidence level, 80% power, 5% margin of error, one-to-one controls to cases ratio, 69% proportion of exposed control, AOR of 1.99 (19), and 10% non-response proportion. The final sample size needed for this study was 438 (Cases 219 and Controls 219).

A multistage stratified sampling technique was used to identify the study participants. *First*, we divided kebeles into urban ($n = 3$) and rural ($n = 49$) kebeles. *Second,* one urban and 17 rural kebeles were randomly selected. The house-to-house census conducted in randomly selected kebeles, and eligible households (cases and controls) were identified by recording the birth dates of the last

two children. Birth certificates and immunization cards were used to determine the children's birth dates, and health extension workers were consulted for those without birth certificates and immunization cards. Households with eligible women were assigned identification numbers to construct a sampling frame, and a total of 1,259 eligible households (682 cases and 577 controls) identified. *Then*, separate sampling frames build for the cases and controls in each kebeles. *Finally*, the estimated sample size was distributed proportionally to each kebeles (based on the actual number of cases and controls), and eligible participants were recruited using a simple random sampling technique. Participants not present for at least three data collection trips were considered non-respondents. When there were two or more eligible women in one selected household, only one eligible woman was selected using the lottery method (Figure 1).

Data collection tool and measurement

Data were collected from both cases and controls using pretested structured questionnaires adapted from relevant published literatures (3, 19, 20, 24–26). The questionnaire includes socio-demographic information, reproductive health factors, healthcare-related factors, and birth interval (case/control). The questionnaire first developed in English was translated into the local language (Afan Oromo), and returned back to English by two professionals fluent in both languages. Eighteen trained data collectors collected the data through house-to-house visits using face-to-face interviews. Six trained supervisors with principal investigator were supervised the overall data collection process.
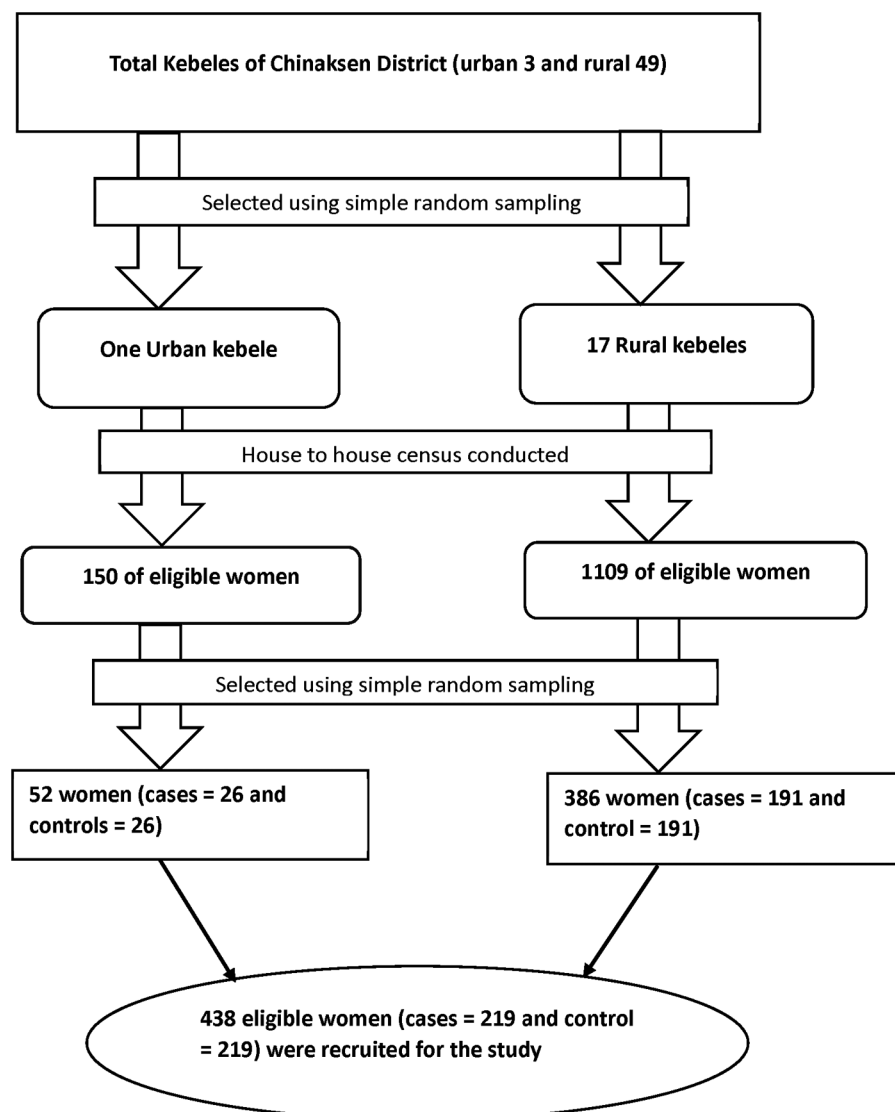
FIGURE 1
A flow diagram of sampling procedure.

Decision-making autonomy

It was measured by four dichotomous (yes/no) items (Cronbach α = 0.72) asking about women's household decision-making autonomy, and each item coded "1" when answered "yes" and coded "0" when answered "no". The women had low decision-making autonomy when scored "0," medium decision-making autonomy when scored "1–3," and high decision-making autonomy when scored "4" (27–29).

Wealth index

It was calculated using a standard instrument with 36 dichotomous (yes/no) items asking about domains of the family's wealth level (domestic animals, durable assets, other productive assets, and housing circumstances) (14). We found strong internal consistency of items (Cronbach α = 0.81) and principal component analysis utilizing the varimax rotation approach to estimate composite wealth index factors and the wealth status of the cases and controls.

Data quality control

Standard questionnaires adapted from validated scales and relevant published literature were used to maintain the data quality. The questionnaire first prepared in English was translated into the local language (Afan Oromo) by two experts who certified in both languages and back to English. We pretested the questionnaires on 5% of the total sample size (11 cases and 11 controls) to ensure validity in a non-selected kebele (Kalaroga) in the district, and the revisions were made, accordingly. Eighteen data collectors were trained to collect the data under supervision six supervisors after receiving training for one days on the objective of the study and the data collection technique. Before beginning the statistical analysis, composite index scores were generated and tested, which could improve the validity of the measurements and associated computed indices and the estimates were used in the study.

Data processing and analysis

After ensuring completeness and consistency, the data was entered into EpiData version 3.1 for control data entry and then exported to SPSS version 27 for analysis. Descriptive statistics such as frequency, measure of central tendency, and measure of dispersions were employed to characterize the case and control populations. Before analysis, the internal consistency of the items was checked for composite index scores for decision-making autonomy (Cronbach α = 0.72) and wealth index (Cronbach α = 0.81) using reliability analysis.

Bivariable logistic regression analyses were conducted to determine the factors associated with short birth intervals among married women. Multivariable logistic regression analyses were fitted to determine the significant risk factors for short birth intervals using a backward stepwise (Likelihood Ratio) method of model building, and the overall model adequacy was confirmed using the Hosmer and Lemeshow goodness of fit test (p-value >0.05). Adjusted Odds Ratio (AOR) with a 95% confidence interval (CI) was used to report the strength of the association, and the statistical significance declared at a p-value <0.05.

Results

Characteristics of participants

A total of 210 cases and 210 controls with a 96% response rate participated in the study. The median age and interquartile range (IQR) of cases and controls were 28 years (IQR = 8; 25th percentile = 27 and 75th percentile = 35) and 30 years (IQR = 6; 25th percentile = 24 and 75th percentile 30), respectively, with 59.0% of cases and 60.0% of controls were between the ages of 25 and 34 years old. The majority (74.3%) of cases and 73.3% of controls had no formal education, and about 86.2% of cases and 78.1% of controls were housewives in their occupation. Almost all (97.1%) of cases and 95.7% of the controls were Muslim by religion (Table 1).

Sixty-one (29.0%) of cases and fifty-four (26.7%) of controls were married before the age of 18 years old, with the median age at first marriage and IQR for both cases and controls were 19 (IQR = 3; 25th percentile = 17 and 75th percentile = 20) years old. About 47.6% of cases and 39.5% of the controls were given the first childbirth at less than 20 years old, with the median age at first childbirth and IQR for both cases and controls being 18 years old(IQR = 3; 25th percentile = 18 and 75th percentile = 21). The majority (69.5%) of cases and 90% of controls received antenatal care visits during the previous pregnancy. Around 79.0% of cases and 29.5% of the controls did not utilize postpartum contraceptives during the preceding birth. Among delivery places of a preceding childbirth, 61.0% of cases and 29.0% of controls were home delivery, and about 59.5% of cases and 30.0% of controls did not attend postnatal care visits during the preceding birth. The majority (60.0%) of cases and 89.5% of controls were exclusively breastfed the preceding child, and around 6.7% of cases and 21.0% of controls breastfed for greater than 24 months. Regarding the sex of the previous child, 56.7% of cases and 37.1% of controls were female. Nearly one in every four (23.3%) cases and one in every four (25.7%) controls had higher decision-making autonomy (Table 2).

Determinants of short birth interval

Women's age, Antenatal care (ANC) attendance, Postnatal Care (PNC) attendance, Postpartum contraceptives (PPC) use, Exclusive Breastfeeding (EBF), Duration of breastfeeding, and sex of preceding child were the determinants of short birth intervals.

Women in the less than 24 years age group were two times more likely (AOR = 2.33, 95% CI: 1.03, 5.26) to have short birth intervals than those in the greater than 34 years age group. Women who did not receive ANC visits during the preceding pregnancy were two times (AOR = 2.23, 95% CI: 1.18, 4.21) more

TABLE 1 Socio-demographic characteristics of participants in Chinaksen district, eastern Ethiopia, 2019 (*n* = 420).

Characteristics	Categories	Cases (%)	Controls (%)
Age (in years)	≤24	54 (25.7)	26 (12.4)
	25–34	124 (59.0)	126 (60.0)
	≥ 35	32 (15.2)	58 (27.6)
Residence area	Rural	189 (90.0)	184 (87.6)
	Urban	21 (10.0)	26 (12.4)
Ethnicity	Oromo	176 (83.8)	162 (77.1)
	Somale	22 (10.5)	31 (14.8)
	Amhara	9 (4.3)	14 (6.7)
	Gurage	3 (1.4)	3 (1.4)
Religion	Muslim	204 (97.1)	197 (93.8)
	Orthodox	6 (2.9)	10 (4.8)
	Protestant	0 (0.0)	3 (1.4)
Education	No formal education	156 (74.3)	144 (68.6)
	Primary school	43 (20.5)	40 (19.0)
	Secondary school	5 (2.4)	8 (3.8)
	College and above	6 (2.9)	8 (8.6)
Husband education	No formal education	140 (66.7)	119 (56.7)
	Primary school	54 (33.3)	73 (43.3)
	Secondary school	6 (2.9)	4 (1.9)
	College and above	10 (4.8)	14 (6.7)
Occupation	Housewife	181 (86.2)	164 (78.1)
	Merchant	19 (9.0)	32 (15.2)
	Employed	10 (4.8)	14 (6.7)
Husband occupation	Farmer	164 (78.1)	165 (78.6)
	Merchant	27 (12.9)	16 (7.6)
	Employee	14 (6.7)	22 (10.5)
	Daily labor	5 (2.4)	7 (3.3)
Wealth index	Poor	67 (37.9)	75 (35.7)
	Medium	83 (39.5)	76 (36.2)
	Rich	60 (28.6)	59 (28.1)
Decision making autonomy	Low	68 (32.4)	33 (15.7)
	Medium	93 (44.3)	123 (58.6)
	High	49 (23.3)	54 (25.7)

TABLE 2 Reproductive and health care characteristics of the study participants in chinaksen district, eastern Ethiopia, 2019 (*n* = 420).

Reproductive characteristics	Categories	Cases (%)	Controls (%)
Age at first marriage	≥ 18	149 (71.0)	154 (73.3)
	<18	61 (29.0)	56 (26.7)
Age at first delivery	<20 years	100 (47.6)	83 (39.5)
	≥ 20 years	110 (52.4)	127 (60.5)
Parity	≤ 4	152 (72.4)	136 (64.8)
	> 4	58 (27.6)	74 (35.2)
Number of live children	≤2	93 (44.3)	58 (27.6)
	3–4	70 (33.3)	86 (41.0)
	≥5	47 (22.4)	66 (31.4)
ANC attendance of previous pregnancy	No	64 (30.5)	21 (10.0)
	Yes	146 (69.5)	189 (90.0)
Place of previous delivery	Home	128 (61.0)	61 (29.0)
	Health facility	82 (39.0)	149 (71.0)
PNC visit of preceding birth	No	125 (59.5)	63 (30.0)
	Yes	80 (40.5)	147 (70.0)
PPC use following preceding birth	No	166 (79.0)	62 (29.5)
	Yes	44 (21.0)	148 (70.5)
EBF of preceding child	No	84 (40.0)	22 (10.5)
	Yes	126 (60.0)	188 (89.5)
Breastfeeding duration of preceding child (in months)	≤12	30 (14.3)	11 (5.2)
	13–24	166 (79.0)	155 (73.8)
	>24	14 (6.7)	44 (21.0)
Sex of preceding child	Male	91 (43.3)	132 (62.9)
	Female	119 (56.7)	78 (37.1)
Intention of last child	Unintended	71 (33.8)	21 (10.0)
	Intended	139 (66.2)	189 (90.0)
HDA meeting attendance	No	115 (54.8)	69 (32.9)
	Yes	95 (45.2)	141 (67.1)

ANC, antenatal care; EBF, exclusive breastfeeding; HDA, health development army; PNC, postnatal care; PPC, postpartum contraceptives.

Discussion

Although a higher burden of short birth intervals was reported in SSA countries, including Ethiopia, the evidence determining the main risk factors of short birth intervals was insufficient in rural eastern Ethiopia. Therefore, this study identified factors associated with short birth intervals among multiparous women in the Chinaksen district in Eastern Ethiopia. The women's age, ANC attendance, PNC attendance, PPC use, EBF practice, breastfeeding duration, and sex of the preceding child were the determinants of short birth intervals.

This study indicated that the odds of a short birth interval among women who were less than or equal to 24 years old were two times higher than those who were greater than 34 years old. This finding was supported by findings of studies conducted in Mieso, eastern Ethiopia (19), Dembecha, northwest Ethiopia (30), Dessie, northern Ethiopia (31), and Bangladesh (5). Early marriage is more common in rural eastern Ethiopia due to cultural norms. Younger women are more sexually active and fertile; however, they are less likely to use reproductive health services, including contraceptives, for birth spaces in semi-pastoral communities. In addition, young women could not decide to use modern contraceptives without their husband's

likely to have short birth intervals compared to their counterparts. Women who did not utilize PPC during their previous childbirth were almost six times (AOR = 5.98, 95% CI: 3.62, 9.89) more likely to have short birth intervals than those who utilized PPC. The odds of a short birth interval were 1.86 times higher among women who did not attend PNC visits during the previous birth (AOR = 1.86, 95% CI: 1.13, 3.05) compared to those who attended PNC visits. The odds of a short birth interval were four times higher among women who did not practice exclusive breastfeeding their previous child (AOR = 4.05, 95% CI: 2.18, 7.52) than those who had exclusively breastfed their previous child. Breastfeeding duration of the preceding child of less than or equal to 12 months and 13–24 months increased the risks of the short birth interval by 4 and 3.5 times, respectively (AOR = 4.00, 95% CI: 1.34, 12.10) and (AOR = 3.56, 95% CI: 1.62, 7.82), compared to breastfeeding duration of greater than 24 months. The odds of short birth intervals among women who have been female preceding a child were 1.9 times (AOR = 1.92, 95% CI: 1.18, 3.12) higher than those who had a male preceding child (Table 3).

TABLE 3 Determinants of short birth intervals among married multiparous women in Chinaksen district, eastern Ethiopia, 2019 (n = 420).

Characteristics	Category	Cases n (%)	Controls n (%)	COR (95% CI)	AOR (95% CI)
Age (in years)	≤24	54 (25.7)	26 (12.4)	**3.76 (1.99, 7.11)***	**2.33 (1.03, 5.26)***
	25–34	124 (59.0)	126 (60.0)	**1.78 (1.08, 2.93)***	1.29 (0.69, 2.41)
	≥ 35	32 (15.2)	58 (27.6)	1	1
Educational status	No formal education	156 (74.3)	144 (68.6)	**3.25 (1.25, 8.41)***	1.71 (0.52, 5.56)
	Primary school	43 (20.5)	40 (19.0)	**3.22 (1.16, 8.94)***	2.15 (0.61, 7.62)
	Secondary school	5 (2.4)	8 (3.8)	1.87 (0.44, 7.99)	4.02 (0.76, 21.30)
	College and above	6 (2.9)	18 (8.6)	1	1
Wealth index	Poor	67 (31.9)	75 (35.7)	0.88 (0.54, 1.43)	0.52 (0.27, 1.01)
	Medium	83 (39.5)	76 (36.2)	1.07 (0.67, 1.73)	0.69 (0.37, 1.28)
	Rich	60 (28.6)	59 (28.1)	1	1
Decision making autonomy	Low	68 (32.4)	33 (15.7)	**2.27 (1.29, 4.01)***	1.70 (0.82, 3.50)
	Medium	93 (44.3)	123 (58.6)	0.83 (0.52, 1.33)	0.92 (0.51,1.67)
	High	49 (23.3)	54 (25.7)	1	1
ANC attendance of previous pregnancy	No	64 (30.5)	21 (10.0)	**3.94 (2.30, 6.76)***	**2.23 (1.18, 4.21)***
	Yes	146 (69.5)	189 (90.0)	1	1
Parity	≤ 4	152 (72.4)	136 (64.8)	1.43 (0.94, 2.16)	1.07 (0.53, 2.53)
	> 4	58 (27.6)	74 (35.2)	1	1
Delivery place of previous birth	Home	128 (61.0)	61 (29.0)	**3.81 (2.54, 5.73)***	1.56 (0.92, 2.64)
	Facility	82 (39.0)	149 (71.0)	1	1
PPC following previous birth	No	166 (79.0)	62 (29.5)	**9.01 (5.77,14.06)***	**5.98 (3.62, 9.89)***
	Yes	44 (21.0)	148 (70.5)	1	1
PNC visit of preceding child	Yes	125 (59.5)	63 (30.0)	**3.43 (2.29, 5.14)***	**1.86 (1.13, 3.05)***
	No	85 (40.5)	147 (70.0)	1	1
EBF of preceding child	No	84 (40.0)	22 (10.5)	**5.70 (3.38, 9.59)***	**4.05 (2.18, 7.52)***
	Yes	126 (60.0)	188 (89.5)	1	1
Breast feeding duration (in months)	≤12	30 (14.3)	11 (5.2)	**8.57 (3.43, 21.42)***	**4.00 (1.34, 12.10)***
	13–24	166 (79.0)	155 (73.8)	**3.37 (1.77, 6.38)***	**3.56 (1.62, 7.82)****
	>24	14 (6.7)	44 (21.0)	1	1
Sex of preceding child	Female	119 (56.7)	78 (37.1)	**2.21 (1.50, 3.27)***	**1.92 (1.18, 3.12)****
	Male	91 (43.3)	132 (62.9)	1	1
Participate on HDA meeting	No	115 (54.8)	69 (32.9)	**2.47 (2.66, 3.67)***	1.29 (0.75, 2.23)
	Yes	95 (45.2)	141 (67.1)	1	1

ANC, antenatal care; AOR, adjusted odds ratio; COR, crud odds ratio; EBF, exclusive breastfeeding; HDA, health development army; PNC, postnatal care; PPC, postpartum contraceptives.
*p < 0.05; **p < 0.01; ***p < 0.001.
Bold values indicate for significant variables.

permission. It is worrisome that young women were more likely to be affected by short birth intervals. Encouraging and empowering young women to utilize reproductive health services is essential for reducing and preventing short birth intervals (32).

The finding of this study revealed that ANC attendance was significantly associated with short birth intervals. Women who did not receive ANC during the preceding pregnancy were two times more likely to have short birth intervals as compared to those who received ANC. This could be a fact because the women who utilized reproductive health services from health facilities might counseled on optimal birth interval and postpartum contraceptive utilization.

The use of postpartum contraceptives protects against short birth intervals. Given that the women missing an opportunity to use postpartum contraceptives during the previous birth were five times more likely to have short birth intervals compared to their counterparts. This finding was consistent with studies done in southern Ethiopia (26), northwest Ethiopia (33), northern Ethiopia (34), eastern Sudan (25), and Nigeria (35). This could be because the use of postpartum contraception can reduce and

prevent the chances of unwanted pregnancy, lowering fertility and lengthening the birth interval (36). The mechanisms should established in place to increase women's intentions to utilize immediate postpartum contraception (32).

This study also revealed postnatal care visit was a significant predictor of short birth interval. The odds of having a short birth interval among women who did not receive postnatal care were higher compared to their counterparts. This outcome was in agreement with that of a study conducted in southern Ethiopia (37). Women who did not receive postnatal care may have missed the opportunity to use maternal health care services and receive health information on unwanted pregnancy and preventive techniques.

In addition, this study found that women who did not exclusively breastfeed their preceding child were four times more likely to have short birth intervals than their counterparts; this could be because exclusive breastfeeding causes lactation amenorrhea, which decreases the likelihood of pregnancy owing to hormonal influences. The duration of breastfeeding was also a major risk factor for short birth intervals. Women who breastfed

for a short period had a higher risk of having a short birth interval than those who breastfed for more than 24 months. This finding was in agreement with the study conducted in different regions of Ethiopia (19, 23, 30, 31, 38), Kenya (39), Nigeria (35), and Myanmar (24). This could be because breastfeeding has a contraceptive effect due to negative feedback processes in the hypothalamic-pituitary-ovarian axis.

Furthermore, women with the female sex of the preceding child were more likely to have short birth intervals than those with the male sex of the preceding child. The finding was consistent with similar studies conducted in Ethiopia (19, 20, 31). Women who had female children from previous births were eager to become pregnant again till they got a son child.

The study's strength is that it used a community-based case-control study design to evaluate the predictors of short birth intervals in a semi-pastoral community. The study's limitation is because the women respond to some questions concerning earlier birth events, recall bias might affect a trues relationship between exposure and outcome. The study did not consider qualitative data, and hence, this study was conducted among semi-pastoral communities; the results may not be representative of married multiparous women in Ethiopia.

Conclusions

This study indicated that young age, failure to attend ANC visits, missed opportunity to use postpartum contraceptives, did not receive postnatal care services, nonexclusive breastfeeding, a short duration of breastfeeding, and female sex of the preceding child were independent risk factors of short birth interval. Encouraging all women in the reproductive age group to utilize respectful maternal healthcare services during the antepartum, intrapartum, and postpartum periods would be essential for preventing and reducing the burden of short birth intervals, and its negative consequences. In addition, encouraging optimal breastfeeding practice at the community level would be needed to reduce and prevent short birth intervals.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The study was conducted according to the Helsinki Declaration for Human Subjects Research (40). The study was also approved by the Institutional Health Research Ethical Review Committee of the College of Health and Medical Sciences, Haramaya University, Ethiopia (Ref.no: IHRERC/096/2019). Written informed consent was obtained from all participants after explaining the purpose and benefits of the study.

Author contributions

BA: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Software, Validation, Writing – original draft. AU: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Software, Supervision, Validation, Writing – original draft, Writing – review & editing. BM: Formal analysis, Methodology, Supervision, Validation, Writing – original draft. YD: Methodology, Supervision, Validation, Writing – original draft. HA: Conceptualization, Methodology, Supervision, Writing – original draft. AA: Formal analysis, Investigation, Methodology, Writing – original draft. MY: Conceptualization, Methodology, Supervision, Validation, Writing – original draft. AM: Data curation, Methodology, Writing – original draft, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Women's status, empowerment, and utilization of skilled delivery services in Papua New Guinea: an empirical analysis based on structural equation modeling

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Background: Skilled birth attendants (SBA) facilitate identifying and overcoming labor problems and saving lives. With one of the highest maternal death rates in the Asia-Pacific area, SBA utilization during childbirth among Papua New Guinea (PNG) women remains low. Women's status and empowerment are important factors in maternal and child health services and critical to maternal and child health development. This study is intended to apply structural equation modeling based on data from the Demographic and Health Survey (DHS) to evaluate the causal relationship between women's status, empowerment, and SBA utilization in PNG and the mechanisms of their influence.

Methods: This study employed data from the 2016−2018 Papua New Guinea Demographic Health Survey (PNG DHS), which recruited 18,175 women aged 15−49 years. A multi-stage sample and a structured questionnaire were used to collect information on maternal health, women's empowerment, and related topics. STATA 17.0 was used to describe the data, while MPLUS 8.2 was employed for structural equation modeling and pathway analysis.

Results: The two empowerment dimensions of household decision-making (standardized path coefficient, $\beta = 0.049$, $p < 0.05$) and access to health services ($\beta = 0.069$, $p < 0.01$) were positively associated with SBA utilization, while the association between attitudes toward partner violence and SBA utilization was not statistically significant. In addition, mediation analysis revealed that education indirectly influenced SBA utilization through access to health services ($\beta = 0.011$, 95% CI: 0.002, 0.022).

Conclusion: The findings confirmed the direct and indirect effects of women's status and empowerment on SBA utilization in PNG. Therefore, a call for further evidence-based interventions in PNG and possibly Pacific Small Island Developing States (PSIDS) is needed to improve women's educational attainment, household decision-making, and access to health services to enhance maternal and newborn health and well-being.

KEYWORDS

Papua New Guinea, women's empowerment, status of women, skilled birth attendants, structural equation modeling

1 Introduction

According to Sustainable Development Goal 3.1 (SDG-3.1), the maternal mortality ratio (MMR) is a global public health issue (1), with approximately 287,000 maternal deaths worldwide in 2020 and 41.8% occurring in least developed countries (2). Papua New Guinea (PNG) is the largest Pacific Small Island Developing State (PSIDS) (3), having one of the highest MMRs in the Asia-Pacific region (4), still faces significant obstacles in achieving SDG-3.1. Most PNG maternal deaths are caused by postpartum hemorrhage, sepsis, embolism, and other complications resulting from pregnancy or delivery (5).

Skilled birth attendants (SBAs) can effectively overcome problems during labor (6, 7), thereby considerably reducing maternal and neonatal mortality and contributing to the SDG-3.1 and SDG-3.2 goals (1). However, only half (56.5%) of women in PNG have SBA during childbirth (8), significantly lower than the average SBA utilization in the Western Pacific region (9). Thus, there is a need to explore possible pathways affecting SBA utilization to improve maternal and child health.

Prior studies have investigated supply-side challenges to SBA consumption among PNG women, such as recurring shortages of primary healthcare resources (e.g., human, material, and financial) and ineffective or inefficient primary healthcare systems (10–14). Demand-side barriers, such as socio-economic factors (e.g., poverty and low education levels), cultural factors (e.g., beliefs and customs that favor traditional delivery), and geographic factors (e.g., physical distance and lack of transportation) also affect the demand, access, and utilization of SBA among PNG women (15–17).

In addition, gender inequality is one of the significant barriers to SBA utilization among women in PNG that severely hinders the continued development of maternal and child health (18). PNG is the most gender-inequitable country globally, with a Gender Inequity Index (GII) ranking of 169/170 in 2021 (19). Some studies indicated that gender inequality in PNG stems from the entrenched patriarchy in society and the perpetuation of gender-based subversive violence to sustain patriarchy and further gender inequality (20–22), resulting in the low status of women and the denial of human rights and essential health services (23, 24). Related global research and policy reports indicated that strategies to eliminate gender inequality must involve efforts to improve the status of women and empower them to create an enabling environment for women to protect their health within patriarchal systems (25, 26).

Women's status, or social status, is equivalent to "women's recognized social position within a society's hierarchy," profoundly influenced by socio-economic, cultural, political, and other structural contexts (27, 28). Women's educational attainment is the most prevalent indicator of their social standing (29). Education facilitates women's understanding of their rights and maternal health services (30), including utilizing SBA (31). Improving women's education is essential for achieving public health in low- and middle-income countries (LIMCS) (32).

Women's empowerment is typically defined as "the process by which those who have been denied the ability to make strategic life choices acquire such an ability (33)." Extensive empirical research shows that women's status and empowerment in developing countries positively impact SBA utilization (29, 31, 34–38). However, empirical research on the Pacific is more limited than in regions such as Asia and Africa. Meanwhile, the definition, conceptualization, and

measurement of women's empowerment are often different and controversial in other studies due to each country's various socio-economic and cultural contexts and the fact that women's empowerment is a complex underlying structure whose internal causal processes are not yet transparent (39). For example, on the dimension of women's empowerment, the most relevant studies applying Demographic and Health Survey (DHS) data included attitudes toward partner violence and household decision-making to measure the impact of women's empowerment on SBA utilization (29, 34–38). Some additionally incorporated elements like access to health services, gender-based negotiation, and social independence, which may often be independently valid in different contexts (29, 34–38), were also considered. Moreover, although the multidimensional structure of women's empowerment has received increasing attention in terms of measurement methods (40), the majority of studies used summary measures or composite indices, which make it difficult to comprehend the contribution of each item to the dimensions and to explain the direction and patterns of change in women's empowerment. In addition (34–36), few scholars have explored the mechanisms of action and potential pathways between the status of women, empowerment, and SBA utilization based on factor analysis and structural equation modeling (SEM).

Consequently, the purpose of this study was to use a nationally representative dataset of PNG to apply exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) to propose and validate potential structures of women's empowerment (household decision-making, attitudes toward partner violence, and access to health services). Furthermore, SEM was used to assess and test the causal relationship between women's status, empowerment, and SBA utilization and its effective mechanism of action to improve the practical experience for enhancing women's SBA employment.

1.1 Conceptual framework

This study is based on a comprehensive conceptual framework of "Gender Stratification Theory" to determine the social determinants of women's underuse of reproductive health services in PNG (41). Figure 1 depicts the advances in women's status as measured by education and feedback on women's empowerment, which in turn increase women's adoption of the SBA. Specifically, the theory and framework emphasize that women with more power will have more freedom to act independently and have control over their lives (e.g., household decision-making and access to health services).

The age of the first marriage mediates the path between education and SBA use. Three potential agent dimensions refer to the predictive path proposed by Shimamoto et al. (38). Specifically, a woman with a higher level of education tends to marry later (42–44), has more decision-making power in the household (45), has better access to health services (46) (which may also reflect the freedom of physical mobility) (47), and is better able to cope with domestic violence (48). In empirical studies of women's empowerment employing DHS data, these three potential proxy dimensions are utilized more frequently. In contrast, this study also considers the sociodemographic characteristics of women and families as potential confounders and whether women have received effective antenatal care (ANC) services (49).
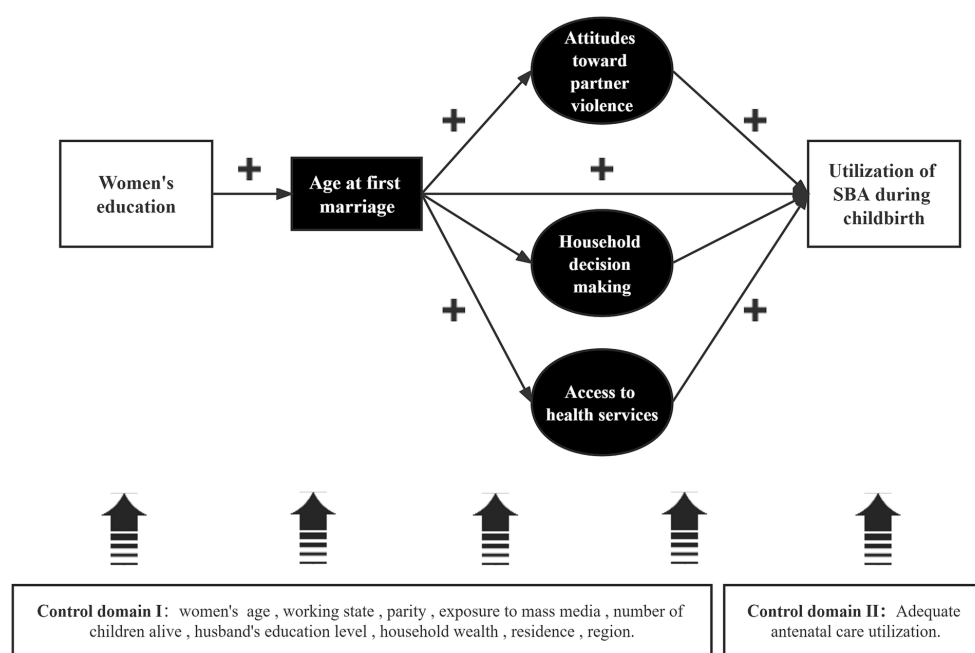
FIGURE 1
Predicted pathways for the impact of women's status and multidimensional empowerment on SBA use.

2 Methods

2.1 Data sources

This study employed cross-sectional data from the 2016–2018 Papua New Guinea Demographic and Health Survey (PNG DHS) to validate the association between women's status, empowerment, and SBA use. The PNG DHS is a national survey of PNG residents aged 15–49 years in PNG. One of its objectives is to give updated information on the current primary population and health indicators, including maternal health, women's empowerment, and demographic characteristics.

2.2 Sample design

The PNG DHS used the 2011 PNG National Population and Housing Census (NPHC) census units (CUs) as the sampling frame. The 22 provinces of PNG are divided into 43 sampling strata that distinguish between urban and rural differences, with no rural sampling strata in the Capital District. Each stratum was sampled using a two-stage stratified sampling method to obtain the sample. The first stage involved the selection of 800 CUs using probabilities proportional to size technique; the second stage used equal probability systematic sampling to select 24 households from each cluster, resulting in a final sample of approximately 19,200 households.

2.3 Study participants and sample size

The PNG DHS interviewed all eligible women (aged 15–49) in the family who were permanent residents of the family or visitors and had

stayed at home the night before the survey. 18,175 women were identified for individual interviews, of which 15,198 completed the interview, and the response rate was 84%.

The study sample was restricted to married/cohabiting women who reported giving birth within the past 5 years. As traditional empowerment indicators focus more on the marital context (33), data on empowerment variables (e.g., women's participation in decision-making) were collected only for married/cohabiting women. The sample of unmarried women was excluded, giving a total of 5,358 complete cases (weighted) after excluding outliers and missing values.

2.4 Data collection tools and techniques

The PNG DHS collected data using three structured questionnaires: household, women, and men. The questionnaires were modified from the standard Demographic and Health Survey Phase 7 questionnaire (DHS-7) to adequately represent PNG DHS-related questions and were pretested by trained enumerators (8).

2.5 Analysis strategies and measures

This research implemented SEM with latent variables, which are composed of fundamental structural and measurement models. In this study, the measurement model defines the link between three latent variables (i.e., household decision-making, attitudes toward partner violence, and access to health services) and their respective observable variables (indicators of individual empowerment). The structural model section describes the associations between the above latent variables. Five endogenous variables (whose cause is external to the model) and several exogenous variables are included (caused by

one or more variables within the model). Endogenous variables include SBA utilization, household decision-making power, attitudes toward partner violence, access to health services, and age at first marriage. Exogenous variables included the sociodemographic characteristics of women and families and the efficiency of antenatal service utilization.

2.6 Endogenous variables

SBA utilization during childbirth was used as a dichotomous variable. Based on the 2016–2018 PNG DHS final report, 1 represented the use of SBA during childbirth, i.e., the respondent was assisted by a doctor/midwife/nurse (including trained community health workers)/trained village health volunteer at their last delivery, and 0 represented SBA was not used during childbirth, i.e., the previous delivery was assisted by a village birth attendant, family member, friend, or no one.

The DHS calculated age at first marriage as a continuous variable based on the century-month code between the respondent's birth and first marriage/cohabitation.

Household decision-making was measured as a latent variable through three variables, i.e., who decides on the following: (1) the respondent's health care; (2) large household purchases; and (3) visits to family/relatives. These three variables were recoded as dichotomous, with the joint/respondent decision alone being recoded as 1 and husband/partner/other person decision alone as 0.

As a latent variable, attitudes toward partner violence were measured using five variables, namely whether a respondent considered it to be justifiable for a wife to be beaten when she (1) went out without permission; (2) neglected her children; (3) argued with her husband; (4) refused to have sex with her husband; and (5) burned food. These five variables were recoded as dichotomous, with respondents' perception of injustice recoded as 1 and justice do not know as 0.

Access to health services was measured as a latent variable by three variables, i.e., whether the respondent had difficulty in accessing health care in terms of (1) the money needed for treatment, (2) the distance to the health facility, (3) the permission to visit the health facility, and (4) going to the health facility alone. These four variables were recoded as dichotomous variables, with respondents perceiving no difficulties being recoded as 1 and significant difficulties as 0.

2.7 Exogenous variables

Based on the availability of data and the findings of previous PNG studies (15), 11 exogenous variables were included in this study, of which women's education level was expressed as a continuous variable to reflect their highest years of education. Adequate antenatal care utilization was defined as a dichotomous variable according to the WHO (12), indicating whether the maternal participation in four or more antenatal visits, with 1 described as "yes" and 0 as "no." The remaining variables were sociodemographic characteristics of women and households and were considered covariates.

The sociodemographic characteristics of women included the following variables: women's age, parity, and number of children alive, which are included in the model as continuous variables. Work status

is a dichotomous variable indicating whether women have been working in cash or kind for the last 12 months, with 1 defined as "employed" and 0 as "unemployed/unpaid employment." Exposure to mass media is a dichotomous variable reflecting whether women have been exposed to at least one of reading newspapers, watching television, and listening to the radio, with 1 defined as "yes" and 0 as "no."

The sociodemographic characteristics of households include the following variables: As a multi-categorical variable, the DHS constructed a composite index using principal components analysis based on the household's consumer goods and housing characteristics. This index forms the corresponding household wealth quintile, which is defined as "poorest," "poorer," "middle," "richer," and "richest" from 0 to 4, respectively. Place of residence as a dichotomous variable, defined as 1 for urban and 0 for rural; region as a multi-categorical variable, defined as 0–3 for "Highland Region," "Islands Region," "Mormes Region," and "Southern Region."

2.8 Model analysis and steps

The study analysis was divided into three steps: first, descriptive analyses were conducted using STATA statistical software (version 17.0) on the full sample, where categorical variables were provided as percentages and standard errors, whereas continuous variables were presented as means and standard errors.

Second, Bartlett's spherical and Kaiser-Meyer-Olkin (KMO) tests were performed using STATA statistical software. After the test results supported further factor analysis, the sample was randomly halved using the "splitsample" command, as recommended by relevant studies (50).

The data were then transferred to Mplus statistical software (version 8.3), where robust weighted least squares (WLSMV) estimates were applied to the two samples for exploratory factor analysis (EFA) and confirmatory factor analysis (CFA), respectively. The WLSMV estimation is appropriate for handling non-normal and categorical data (51). The EFA section was applied with a GEOMIN oblique rotation. The number of retained domains was determined by the scree plot and Kaiser's criterion (retention of principal components with eigenvalues ≥ 1) (52). Items with small factor loadings ($< | 0.3 |$) and cross-loading were excluded, and Cronbach's alpha coefficient was used as a measure of internal consistency (53). The CFA section validated the consistency of structure by the statistical significance of the model fit indices and unstandardized path coefficients, with the model fit indices selected to be more applicable to large samples, root mean square error of approximation (RMSEA) for categorical data, comparative fit indices (CFI), standardized root mean square residuals (SRMR), and Tucker- Lewis Index (TLI) (54).

Finally, the WLSMV estimator linked to the Probit function was applied in the Mplus statistical software (version 8.3) to estimate the model fit index, the statistical significance of the standardized path coefficients, the magnitude of the effect, and its direction for SEM. SEM can effectively control for measurement error to obtain estimates superior to those of regression analysis. The bootstrapping product coefficient method with 500 draws was applied to test the significance of indirect effects. Mutual covariation between exogenous variables is recognized because of the probability of their correlation. Conversely, mutual covariation between error terms of the assigned dimensions is enabled due to the possibility of correlation between unobserved

components of the underlying structure. The analyses utilized complicated sampling procedures to account for individual weights, clusters, and sampling strata to get nationally representative PNG data.

3 Results

3.1 Descriptive analysis results

According to the descriptive statistics in Table 1, 57.82% of women used the SBA during their last birth, while 51.42% participated in ANC services four times or more. Regarding women's empowerment, the mean scores of their family decision-making power and attitudes toward partner violence were in the upper middle range.

Concerning the sociodemographic characteristics of women/ families, the average age of women was 30.04 years, the average age at first marriage/first cohabitation was 19.55 years, the average number of years of schooling was 5.40 years, the average number of children was approximately 3, the majority (83.47%) of women were unemployed or unpaid, and nearly half (46.86%) had exposure to mass media; the majority (89.28%) of women lived in rural areas, about two fifths (28.10%) were from the Momase region, and 21.17% of women's households were in the poorest quintile.

3.2 EFA and CFA analysis results

The Kaiser-Meyer-Olkin (KMO) test result was 0.77 ($\chi^2 = 18387.045$, $df = 55$, $p = 0.000$), reflecting the applicability of the data to the factor analysis. We split the sample randomly into two independent samples. Half of the sample was used for EFA to explore potential structure ($n = 2,612$), and the other half was used for CFA to test the validity of the structure ($n = 2,612$). The results are as follows:

The EFA section retained three factors based on the Kaiser criterion and the scree plot (see Figure 2), which were rotated to identify three dimensions of women's empowerment: attitudes toward partner violence, household decision-making, and access to health services, explaining 78.66% of the total variance. The factor loadings for the three-factor structure ranged from 0.690 to 0.954 (see Table 2), and the Cronbach's alpha coefficient for each domain and overall ranged from 0.739 to 0.842, demonstrating good internal consistency (53).

The CFA section indicated the good structural validity of the measurement models based on the significance of the path coefficient (see Table 2) and the model fit index (RMSEA = 0.018, SRMR = 0.047; CFI = 0.991; TLI = 0.988); Mplus limited the path coefficient of the first metric to 1 and therefore did not calculate its statistical significance. The degree of model fit was judged as follows: RMSEA ≤0.05 good fit, ≤ 0.08 acceptable; SRMR ≤0.05 good fit, ≤ 0.1 acceptable; CFI/ TLI ≥ 0.97 good fit, ≥ 0.95 acceptable.

3.3 SEM analysis results

The results of the standardized SEM analysis are shown in Table 3 and Figure 3, and the data fitted to the model indicate a good fit (RMSEA = 0.013; SRMR = 0.046; CFI = 0.976; TLI = 0.964).

TABLE 1 Characteristics of married women who participated and had at least one birth in the last 5 years ($n = 5,224$ unweighted; $n = 5,358$ weighted), PNG DHS 2016–2018.

Variables	Mean/ Percentage (%)	SE
Endogenous variables		
SBA utilization during childbirth		
No	42.18	1.83
Yes	57.82	1.83
Household decision-making(Mean, scored 0–3)	2.36	0.03
Attitudes toward partner violence(Mean, scored 0–5)	2.50	0.05
Access to health services(Mean, scored 0–4)	1.97	0.06
Age at first marriage	19.55	0.11
Exogenous variables		
Women's education level	5.40	0.17
Age	30.04	0.14
Working state		
Unemployed/unpaid employment	83.47	1.35
Paid employment	16.53	1.35
Exposure to mass media		
No	53.14	1.87
Yes	46.86	1.87
Parity	3.38	0.05
Number of children alive	3.20	0.04
Husband's education level		
No education	20.81	1.23
Primary	43.31	1.45
Secondary/higher	35.88	1.68
Household wealth		
Poorest	21.17	1.26
Poorer	20.41	0.98
Middle	20.49	0.98
Richer	19.37	1.03
Richest	18.57	1.90
Residence		
Rural	89.28	0.89
Urban	10.72	0.89
Region		
Southern region	19.25	1.03
Highland Region	38.96	1.85
Momase region	28.10	1.69
Islands region	13.68	0.81
Adequate antenatal care utilization		
No	48.58	1.57
Yes	51.42	1.57

FIGURE 2
Scree plot of eigenvalues plotted against factors, including 12 variables used for EFA.
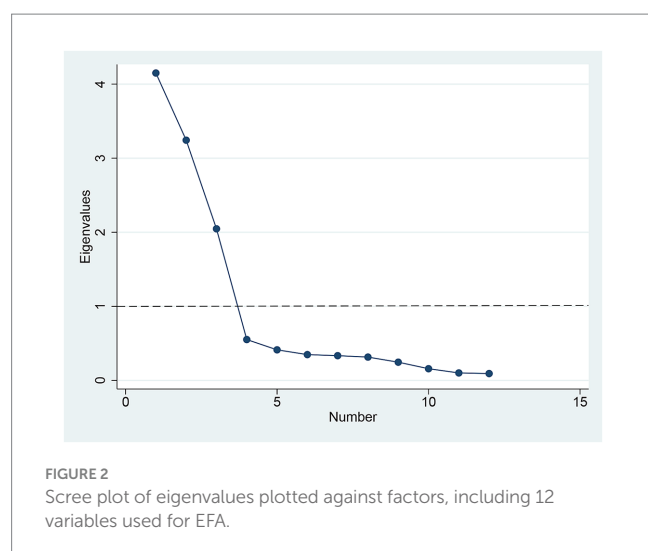
TABLE 2 Results of factor analysis of women's empowerment indicators, PNG DHS 2016–2018.

Latent structure	Loading(EFA)	p-value (CFA)
Attitudes toward partner violence		
Neglects children	0.884	–
Goes out without telling their husband	0.895	0.000
Argues with husband	0.891	0.000
Refuses to have sex with their husband	0.858	0.000
Burns food	0.791	0.000
Household decision-making		
Women's health care	0.880	–
Large household purchases	0.783	0.000
Visiting relatives/family	0.895	0.000
Access to health services		
Distance	0.954	–
Money	0.822	0.000
Alone	0.852	0.000
Permission	0.690	0.000

Two empowerment variables, household decision-making power (standardized path coefficient, $\beta=0.049$, $p<0.05$) and access to health services ($\beta=0.069$, $p<0.01$), were positively associated with SBA utilization during childbirth; however, the association among attitudes toward partner violence and SBA utilization was statistically insignificant (see Table 3, column 6). Women's use of SBA was positively associated with higher levels of education, paid employment, adequate use of antenatal services, husband's primary/secondary education, and higher levels of household wealth, and negatively associated with higher parity and less prevalence in the Highlands than the South. Age at first marriage was positively linked with higher

levels of education, older age, adversely linked with higher parity, and more living children; it is lower for women in the Highlands compared to the South and higher for women in the Islands (see Table 3, column 2).

Regarding women's empowerment (see Table 3, columns 3–5), attitudes toward partner violence are positively correlated with women's high levels of education and paid employment and negatively correlated with their husbands' primary/secondary education. Women in the Momase and Highlands regions have more tolerant attitudes toward partner violence than women in the South region. In addition, household decision-making was positively associated with women's high level of education, older age, and husbands' primary/secondary education. However, it was negatively associated with older age at first marriage, and women living in the Highlands had more household decision-making power than in the South. Access to health services was positively associated with women's high level of education, older age, paid work, exposure to mass media, higher level of household wealth, living in the city, husbands' primary/secondary education,and negatively associated with older age at first marriage.

The bootstrap test results showed that women's education influenced SBA consumption through multiple pathways (see Table 4), with the standardized total indirect effect being significant ($\beta=0.013$, 95% CI: 0.002, 0.026), but only the indirect effect pathway mediated by access to health services was significant ($\beta=0.011$, 95% CI: 0.002, 0.022), accounting for 7.69% of the total standardized effect, indicating the importance of access to health services in the influence of women's educational level on SBA utilization.

4 Discussion

This study investigated the relationship and influential mechanisms among the status of women, women's empowerment (represented by three latent variables), and SBA utilization. The model encompassing women's status, empowerment, and SBA utilization in Papua New Guinea was validated through factor analysis. The SEM estimation results indicated that the status and empowerment of women in PNG have significant direct and indirect effects on SBA utilization. Notably, the impact of women's empowerment on SBA utilization necessitates careful consideration of regional, cultural, and economic contexts.

Drawing on established research and theoretical frameworks (29, 31, 34–36), this study proposed the validated three-factor model of women's empowerment (decision-making power in the household, attitudes toward violence, and access to healthcare), confirming the viability of employing multiple dimensions to measure women's empowerment at the individual level in PNG. Additionally, the outcomes of the factor analysis endorse the adoption of a more extensive set of empowerment indicators, facilitating a more comprehensive assessment of women's empowerment.

The study found a significant influence of education on the age at first marriage, women's empowerment (across three dimensions), and SBA utilization, aligning with findings in related studies within developing countries. Improved education levels have the potential to prevent early marriage and detrimental marital predispositions (42). However, caution is warranted in exploring the connection between education and age at first marriage due to potential bidirectionality (55). Meanwhile, education manifested a favorable

TABLE 3 Standardized path coefficients for structural equations, PNG DHS 2016–2018.

Predictors in the equation (X)	Dependent variables				
Endogenous variables	Age at first marriage	Attitudes toward partner violence	Household decision-making	Access to health services	SBA utilization during childbirth
Age at first marriage		0.024	−0.085*	−0.073*	−0.012
Household decision-making					0.049*
Attitudes toward partner violence					−0.011
Access to Health services					0.069**
Exogenous variables					
Women's education level	0.081***	0.152***	0.118**	0.149***	0.130***
Age	0.861***	0.000	0.216***	0.075*	0.037
Working state					
Paid employment	0.034	0.237***	0.153	0.116	0.100*
Exposure to mass media					
Yes	−0.050	−0.091	0.057	0.179**	0.036
Parity	−0.447***	0.077	−0.188	−0.153	−0.156*
Number of children alive	−0.278***	−0.056	0.022	0.146	0.049
Husband's education level					
Primary	−0.043	−0.217**	0.162*	0.025	0.112*
Secondary/higher	0.030	−0.246**	0.198**	0.130*	0.255***
Household wealth					
Poorer	−0.002	−0.008	−0.159	0.236***	−0.036
Middle	−0.036	0.015	−0.133	0.339***	0.167**
Richer	−0.092	−0.011	−0.106	0.534***	0.296***
Richest	−0.104	0.025	−0.241*	0.827***	0.457***
Residence					
Urban	−0.021	0.107	−0.052	0.273**	0.086
Region					
Highland Region	−0.129***	−0.320***	−0.179*	0.095	0.036
Momase region	0.006	−0.200**	−0.057	−0.008	−0.162**
Islands region	0.168***	−0.134	−0.025	−0.085	0.086
Adequate antenatal care utilization					
Yes					0.501***

***p < 0.001, **p < 0.01, *p < 0.05. Reference groups: working state, unemployed; exposure to mass media, none; husband's education level, uneducation; household wealth, poorest; residence, rural; region, South region; Adequate antenatal care utilization, none.

impact on economic autonomy (56), with higher educational attainment correlating with increased economic independence. Women endowed with economic autonomy experience heightened financial security and assertive participation in family decision-making (57), thereby diminishing reliance on potentially abusive partners (58). Moreover, education serves as a facilitator for maternal learning, fostering awareness of appropriate maternal and child health services and rectifying improper practices (e.g., solitary or inadequately supported childbirth) and attitudes (30, 59). Furthermore, education is a positive factor in maternal learning, raising awareness of appropriate maternal and child health services, and correcting inappropriate practices and attitudes (30). These

findings underscore the pivotal role of education in advancing both women's empowerment and women's health.

The study also supported the robust correlation between the two dimensions of women's empowerment and SBA utilization in PNG. The extent of women's participation in household decision-making varies in different regions of PNG. For instance, women's livelihoods in Chimbu and Jiwaka are usually determined by their partners or male relatives (60). Advocating for women's participation in household decision-making may prevent women from losing autonomy over their health (61), especially in poor households, where spending on health services often constitutes a significant portion of the budget (62). Enhanced accessibility to health services mitigates
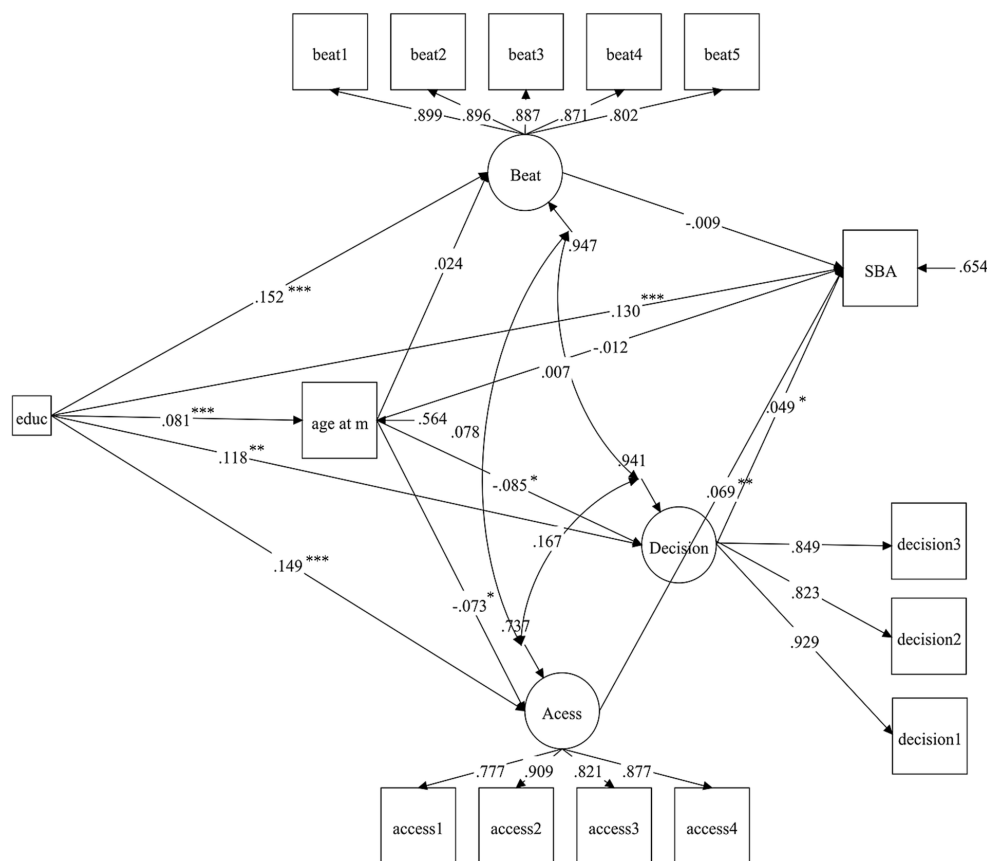
FIGURE 3
Path diagram for structural equation analysis, PNG DHS 2016−2018, ***$p < 0.001$, **$p < 0.01$, *$p < 0.05$. Beat, attitudes toward partner violence; age at m, age at first marriage; decision, household decision-making; Access, access to health services; SBA, SBA utilization during childbirth. Control variables are not shown in the figure.

women's constraints related to income, geographical marginalization, transportation barriers, and safety concerns outside the home when seeking SBA services. This, in turn, contributes to reducing delays in women's utilization of SBA (63). These findings underscore the imperative for governments and policymakers to prioritize comprehensive women's empowerment and emphasize key dimensions to enhance women's empowerment and ensure women's health and well-being.

Our investigation revealed a synergistic impact between education and women's empowerment on SBA utilization. Increases in education and women's empowerment may contribute to accelerating women's utilization of SBA. Correspondingly, research from Tanzania also showed that women's empowerment plays a moderating role between education and SBA utilization, but the dimensions at play are not the same (29). This divergence may stem from the influence of contextual factors such as geography, religion, and culture on women's empowerment (64). Therefore, the design of empowerment programs should be tailored to regional or national realities, aiming to concurrently enhance women's empowerment, eradicate gender inequality, and ameliorate maternal health outcomes.

In PNG, the effect of age at first marriage on SBA utilization is not significant. Although partial evidence from developing countries (65, 66) and the social context within PNG enables the formulation of

hypotheses, the intricate nature of women's behavior in accessing health services (63, 67), particularly in resource-poor settings (68), implies that unobserved mediators may be present in the relationship between age at first marriage and SBA utilization. Furthermore, SEM allows for a correlation between the residual terms of women's empowerment. The SEM results indicate the presence of interconnected unobserved components within the dimensions of women's empowerment, necessitating additional research for elucidation.

As the first theoretically based study in PNG to examine the complex mechanisms of SBA utilization in the context of women's status and empowerment at childbirth using nationally representative data, it could serve as a standard and impetus for future research on similar topics in PNG and other Pacific Island countries. Simultaneously, the application of SEM provides this study with several advantages, such as effectively controlling measurement error and allowing the examination of causal associations between variables. However, there are still some limitations to this study. First, the study sample's representativeness and the results' generalizability are more limited because unmarried women were not included. Second, because the empowerment dimensions are limited to DHS data, the women's empowerment studies cannot have all dimensions that may be examined. Third, despite the advantages of SEM in causal inference,

TABLE 4 Results of standardized bootstrap mediation test, PNG DHS 2016−2018.

Pathways	β	p value	Bootstrapped 95% CI
Total	0.143	0.000	(0.096, 0.185)
Total direct	0.129	0.000	(0.081, 0.174)
Total indirect	0.013	0.029	(0.002, 0.026)
Path of indirect effects			
Age at first marriage	−0.001	0.562	(−0.005, 0.002)
Household decision-making	0.006	0.087	(0.000, 0.014)
Attitudes toward partner violence	−0.002	0.613	(−0.007, 0.004)
Access to health services	0.011	0.029	(0.002, 0.022)
Age at first marriage, then Attitudes toward partner violence	0.000	0.737	(0.000, 0.000)
Age at first marriage, then Household decision-making	0.000	0.203	(−0.001, 0.000)
Age at first marriage, then Access to health services	0.000	0.151	(−0.001, 0.000)

the certainty of causal associations is still limited and must be validated through longitudinal studies based on long-term data.

5 Conclusion

Based on PNG DHS 2016–2018 cross-sectional data, this study validated the mechanism of action between women's status, empowerment, and SBA utilization during childbirth. The findings indicated the multidimensional nature of women's empowerment and validated the direct and indirect impacts of women's status and empowerment on using SBA during childbirth. This evidence suggests further empirical research-based interventions in PNG and possibly PSIDS to improve women's education, household decision-making power, and access to health services through a joint effort at the individual, community, and societal levels to promote women's SBA utilization during childbirth, to improve maternal and neonatal health and well-being in PNG, and to achieve the SGD 3.1 target.

Data availability statement

The datasets generated and analyzed during this study are available in the DHS program repository. This data can be found here: [https://dhsprogram.com/data/dataset/Papua-New-Guinea_Standard-DHS_2017.cfm?flag=1].

Ethics statement

The studies involving humans were approved by Inner City Fund International Institutional Review Board. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

Acknowledgments

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Risk factors associated with anaemia among pregnant women in the Adaklu District, Ghana

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Background: Anaemia during pregnancy is a major public health concern in both advanced and less-developed countries including Ghana. The prevalence of anaemia in Ghana has a serious repercussion on the country's social and economic development. This prevalence has been linked to various factors, including educational level and occupational status.

Methods: A prospective study was conducted to investigate the factors influencing anaemia among 150 pregnant women, aged 15−49 years, who attended antenatal clinics in the Adaklu District of the Volta region of Ghana. Haemoglobin levels were assessed in the first, second, and third trimesters, and a questionnaire was also used to collect data on demographic information and barriers to maintaining haemoglobin levels. The data were analysed using frequencies, percentages, and binary logistic regression.

Results: The prevalence of pregnancy anaemia in the district was 78.5%. The study found that 92% and 8% of pregnant women had excellent and good knowledge on anaemia in pregnancy, respectively. The study also identified several barriers to maintaining an appropriate haemoglobin level during pregnancy, such as long distances to healthcare facilities, non-intake of antimalarial drugs, and lack of nutritious meals. Finally, the study found that low education level, number of pregnancies, and number of children a woman had were significant determinants of anaemia during pregnancy in the district.

Conclusion: The findings of the study suggest that targeted interventions are needed to reduce the burden of anaemia during pregnancy in the district. These interventions should address the social and environmental determinants of anaemia during pregnancy, such as improving access to healthcare facilities and promoting healthy eating habits. In addition, interventions that address social determinants of health, such as education and occupation, may be effective in reducing the burden of anaemia during pregnancy in the district.

KEYWORDS

anaemia, pregnant women, factors, barriers, Ghana

Introduction

Anaemia during pregnancy is a significant issue that affects both developed and developing countries and has significant social and economic implications for the affected nations (1). Anaemia is defined as a decrease in the concentration of haemoglobin below a specific threshold, which depends on various factors such as age, gender, physiological status, smoking habits, and altitude of the population being

evaluated. According to the World Health Organization (WHO), anaemia during pregnancy is defined as a haemoglobin concentration less than 11 g/dl at sea level (2). Kefiyalew (3) also share the view that, during pregnancy, a haemoglobin level below 11 g/dl of human blood is referred to as anaemia. The prevalence of anaemia among pregnant women varies because of the differences in socio-economic status, lifestyles, and health seeking behaviours across diverse cultures during pregnancy (4). Globally, anaemia adversely affects billions of people. About 32.4 million (38%) of the pregnant women had anaemia, with a higher prevalence of 49% in South East Asia (5).

Anaemia affects almost a billion women in their fertility age around the world (6). In 2011, anaemia affects 38% of pregnant women aged 15–49 years and 29% of non-pregnant women globally. However, a higher prevalence was reported in South Asia, Central Asia, and West Africa. Many countries and international bodies have implemented measures that are geared towards preventing and controlling the devastating impacts of maternal anaemia. The periodic data collection and identification of the cause of maternal anaemia will help assess the outcome of the interventions being implemented and the strategies being used by the government to control and prevent maternal anaemia (7). The WHO estimates that 52% of pregnant women in developing countries are anaemic, as against to 23% in the developed world (8). Research conducted in Africa indicated increasing cases of maternal anaemia ranging from 41% to 83% recorded in different geographical settings (9). The Family Health Division (FHD) of the Ghana Health Service Annual Report (10) revealed that the Volta Region had the highest prevalence (50%) of anaemia among pregnant women in their fertility age (15–49). The high rate of maternal anaemia in sub-Saharan Africa (SSA) was a result of most women commencing pregnancy with insufficient iron level and vitamins in the body. Again, the high prevalence of maternal anaemia can be associated with a lack of family planning, poor dietary intake, blood loss during menstruation, and persistent infections.

Socio-economic factors, negative lifestyles, and different cultures have been explicitly implicated as the determinants of high cases of maternal anaemia in SSA (11). In Ghana, research indicates that about 50% of all anaemia cases are as a result of iron deficiency (12). On the contrary, governmental policies such as education on adequate nutritional intake during pregnancy, food fortification with iron and folic acid supplementations, malaria, and worm control have been put in place to contribute to the prevention of maternal anaemia (13).

The study on factors influencing anaemia in pregnancy in Ghana is important for several reasons. Firstly, anaemia is a major public health concern in Ghana, with high prevalence rates among pregnant women. According to the 2014 Ghana Demographic and Health Survey (GDHS), the prevalence of anaemia among pregnant women in Ghana was 63%, indicating a significant burden of the disease (14). Anaemia during pregnancy is also associated with adverse maternal and foetal outcomes, such as preterm delivery, low birth weight, and maternal mortality (15). Understanding the factors that contribute to anaemia during pregnancy in Ghana can inform

the development of effective interventions to reduce the burden of the disease.

However, there is limited research on the factors influencing anaemia during pregnancy in Ghana. Previous studies have focused on individual risk factors, such as iron deficiency and dietary habits, but there is a need for a more comprehensive understanding of the social and environmental factors that contribute to anaemia during pregnancy. According to a study by Tawiah et al. (16), social determinants of health, such as educational level and occupation, are important predictors of anaemia during pregnancy in Ghana. Therefore, a study that examines a broad range of factors, including social and environmental determinants, can provide a more comprehensive understanding of the factors that contribute to anaemia during pregnancy in Ghana. Identifying the factors that contribute to anaemia during pregnancy in Ghana has practical implications for the development of effective interventions. According to the World Health Organization (2), interventions that address multiple factors, such as iron supplementation, nutrition education, and antenatal care, are more effective in reducing the burden of anaemia during pregnancy. This study investigated the factors influencing anaemia among pregnant women attending antenatal clinics (ANCs) in the Adaklu District.

Methods

Study setting

The research was carried out in five health centres in the Adaklu District (Waya, Ahunda, Nutifafa, Soda, and Helekpe).

Study design

The study was a quantitative one in which the factors associated with anaemia among pregnant women were investigated. A prospective study design was used to conduct this research in the Adaklu District where baseline data were obtained from participants' records and participants were followed up until their third trimester. All expectant women who voluntarily signed the consent forms and were willing to participate in the study had their first trimester data collected from their ANC health records. In order to acquire further level data and track the evolution of anaemia, participants in their first trimesters were followed up for both the second and third trimesters while those in their second trimester were followed up for their third trimester haemoglobin level data. This design was deemed appropriate since it is less susceptible to research biases than other observational studies. Prospective studies are more robust than retrospective studies in establishing the temporal relationship between exposure and outcome (17). This is because prospective studies collect data on exposure and outcome over time, thus reducing the potential for recall bias. In the context of anaemia among pregnant women, a prospective design is also appropriate because it allows for the collection of data on risk factors for anaemia during pregnancy,

such as dietary habits and antenatal care attendance, which may change over time. A cohort design means that follow-up is done on a homogenous group of people at a point in time. This study took place from May 2019 to August 2020.

Sampling procedure

The sampling procedure for the study was census. The researcher used voluntary participation to sample the participants. This technique is a quantitative method that attempts to collect information from all eligible participants in a defined population; hence, all pregnant women attending ANCs in the district were sampled for the study. Regarding the sample size, the study used census to collect data from all registered pregnant women who were attending the antenatal clinics at Adaklu health centres and were available during data collection. Pregnant women with bleeding disorders were excluded from the study. The total number of registrants in the Adaklu District over the period of 3 months was 169. Out of the 169 pregnant women, 19 were unwilling to participate. The reasons were unknown; hence, 150 pregnant women were sampled for the study.

Data collection

Data were gathered using a questionnaire designed to elicit information from the participants. Data were collected on the prevalence and knowledge level of pregnant women about anaemia, perceived barriers to maintaining an appropriate haemoglobin level, health education given by health professionals to the pregnant women, and factors that determine anaemia among pregnant women. Secondary data on haemoglobin levels were obtained from participants' folders.

Ethics approval

Ethical clearance for the study was obtained from the University of Cape Coast Institutional Review Board (UCCIRB/CES/2019/14). Permission was obtained from the district health directorate, which granted access to the health centres for the data collection. Participants were assured of no risks in participating in the study, anonymity was ensured, and informed consent was also obtained from the participants before data collection.

Data analysis

The data were coded and processed with SPSS version 21.0. Percentages and frequencies were used to analyse the data on prevalence, knowledge, and barriers to maintaining appropriate haemoglobin levels. To ascertain the factors that are associated with maternal anaemia during pregnancy in the Adaklu District, binary logistic regression was used to determine the factors that predicted the development of anaemia in the district (18). The dependent variable was anaemia status dichotomised into

anaemic and non-anaemic. The independent variables were categorical in nature (age, parity, gravida, educational levels, marital status, religion, income level, and occupation).

Results

This section highlights the number of pregnancies among the participants, their demographic characteristics, and their ANC attendance. It also presents the prevalence of anaemia among the participants in the first, second, and third trimesters of pregnancy. These results provide insight into the burden of anaemia among pregnant women in a rural setting of the Adaklu District and the need for interventions to address this issue.

Table 1 represents the socio-economic characteristics of 150 study participants. The mean age of the participants was 27.1 (SD = 3.6). This implies that in average, the participants

TABLE 1 Socio-economic and demographic profiles of the study participants.

Characteristics	$n = 50$	%
Marital status		
Married	114	76.0
Divorced	4	2.7
Single	32	21.3
Number of pregnancies		
2–3	147	98.0
4 or more	3	2.0
Number of children		
No child	37	24.7
1–3 children	77	51.3
4–6 children	36	24.0
Religion		
Christian	115	76.7
Islam	19	12.7
Traditional	16	10.6
Educational levels		
Non-formal	58	38.7
Primary	66	44.0
Vocational	8	5.3
Technical	11	7.3
Secondary	7	4.7
Income in Ghana cedi		
Less than 300	96	64.0
300–500	37	24.7
501–700	9	6.0
701–900	2	1.3
900 and above	6	4.0
Occupation		
Farming	80	53.3
Unemployed	17	11.3
Public servant	12	8.0
Trading	35	23.3
Student	6	4.0
Number of ANC visits		
2–3	85	56.6
4 or more	65	43.4

The median income was about 1,000.00 Ghana cedi monthly.

were in their youthful age. Those who married comprised 76%, while 2.7% were divorced.

In terms of the participants' pregnancy history, all women had previously given birth. In addition, the study revealed that most participants were married Christians who worked as farmers. In terms of ANC visits, 57% of the participants attended two to three times, while the remaining participants attended four or more times.

The study found that 75% ($n = 113$) of the participants were anaemic during the first trimester, 81% ($n = 121$) during the second trimester, and 79% ($n = 118$) during the third trimester. The overall prevalence of anaemia among pregnant women over the three trimesters was 78.3%. With the high prevalence of anaemia among the women, the study further explored maternal knowledge of anaemia. The results indicated that 92% ($n = 138$) of the pregnant women had excellent knowledge of anaemia, while only 8% ($n = 12$) had good knowledge.

The study further investigated barriers to maintaining appropriate haemoglobin levels during pregnancy in the district. Table 2 shows the perceived barriers to maintaining an appropriate haemoglobin level among pregnant women in the Adaklu District. Out of the 150 pregnant women in the district,

92% ($n = 138$) agreed that their partners supported them financially, while 8% ($n = 12$) disagreed with partner support (Table 3). Furthermore, 57.3% ($n = 86$) of the pregnant women agreed that in their community, pregnant women are not allowed to take snails, while 42.7% ($n = 64$) of the pregnant women disagreed. Also, 91.3% ($n = 137$) of the pregnant women agreed that the distance to the health facility was very far, while 8.7% ($n = 13$) of the pregnant women disagreed. The barriers to maintaining appropriate haemoglobin levels, as found in the study, were non-intake of eggs, snails, and antimalarial drugs during ANC visits. Secondly, distance from the healthcare facilities is another potential challenge for the pregnant women in maintaining haemoglobin levels.

The study further explored the components of health education given to pregnant women during ANC visits. Most of the pregnant women, 98% ($n = 147$), agreed that they received education on malaria when they attended an antenatal clinic in the district.

To find out factors associated with anaemia levels among pregnant women, a binary logistic regression was used to determine the factors that are associated with anaemia among pregnant women in the district. Tables 4–6 present results on the determinants of anaemia status during pregnancy within the first,

TABLE 2 Perceived barriers in maintaining appropriate haemoglobin level among pregnant women.

Statements	Adaklu district			
	Agreed		Disagreed	
	N	%	n	%
Whether partner supports me financially	138	92.0	12	8.0
My partner allows me to go for antenatal visits	130	88.7	20	13.3
I am given iron pills for free at the clinic	137	91.3	13	9.7
I do not take folic acid regularly	13	9.7	137	91.3
In my community, pregnant women do not take eggs	48	32.0	102	68.0
In my community, pregnant women do not take snail	86	57.3	64	42.7
The attitude of the health workers is encouraging	115	77.0	35	23.0
I do not have a valid National Health Insurance card	22	14.7	128	85.3
I have taken deworming during pregnancy	115	77.0	35	23.0
I was given antimalarial drugs during ANC visits	102	68.0	48	32.0
My religion accepts blood transfusion	113	75.3	37	24.7
Antenatal visit is not beneficial to me	12	8.0	138	92.0
The distance to the health facility is very far	137	91.3	13	8.7

TABLE 3 Components of health education provided to pregnant women in the study area.

Parameters	Yes		No	
	n	%	N	%
Have you been given health talk on how to prevent malaria?	147	98.0	3	2.0
Have you been given health talk on cleanliness?	144	96.0	6	4.0
Have you been given health talk on the benefits of good nutrition?	143	95.3	7	4.7
Have you been give health talk on the benefits of regular medical check-ups?	143	95.3	7	4.7
Have you been given health talk on adequate rest?	139	92.7	11	7.3
Have you been given health talk on anaemia at ANC?	137	91.3	13	8.7
Have you been given health talk on birth preparedness?	132	88.0	18	12.0
Have you been given health talk on family planning?	127	84.7	23	15.3
Have you been given health talk on effects of alcohol use?	131	87.3	19	12.7
Have you been given health talk on how to prevent worm infestation?	134	89.3	16	10.7

TABLE 4 Determinants of anaemia status during pregnancy in the Adaklu district (trimester 1).

Characteristics	n (%) with outcome	Univariate OR (95% CI)	P-value	Multivariate OR (95% CI)	P-value
Age (years)					
<26	57 (38.0)		0.356		0.541
26–35	78 (52.0)	1.73 (0.34–8.75)		2.07 (0.40–10.70)	
≥36	15 (10.0)	1.18 (0.24–5.92)		2.08 (0.54–8.04)	
Marital status					
Married	114 (76.0)		0.562		0.849
Divorced	4 (2.7)	0.93 (0.41–2.13)		0.90 (0.29–2.74)	
Single	32 (21.5)	0.52 (0.07–4.24)		0.58 (0.06–5.63)	
Number of pregnancies					
2–3	147 (98)		0.502		0.429
4 or more	3 (2)	0.77 (0.36–1.65)		0.53 (0.17–1.63)	
Number of children					
No child	37 (24.7)		0.038		0.566
1–3 children	77 (51.3)	2.71 (0.90–8.19)		1.77 (0.37–8.50)	
4–6 children	36 (24.0)	0.50 (0.16–1.61)		2.24 (0.63–7.94)	
Religion					
Christian	115 (76.7)		0.550		0.186
Islam	19 (12.7)	1.56 (0.33–7.41)		2.89 (0.76–11.05)	
Traditional	16 (12.7)	1.31 (0.19–9.02)		2.28 (0.48–10.83)	
Educational levels					
Non-formal	58 (38.7)		0.807		0.008
Primary	66 (44.0)	0.46 (0.08–2.74)		2.09 (0.15–29.79)	
Vocational	8 (5.3)	0.61 (0.11–3.52)		0.76 (0.06–10.62)	
Technical	11 (7.3)	0.36 (0.03–5.11)		3.03 (0.16–56.36)	
Secondary	7 (4.7)	0.25 (0.02–3.47)		0.17 (0.01–3.00)	
Income (GHC)					
300–500	133 (88.7)		0.523		0.281
>500	17 (11.3)	1.65 (0.35–7.70)		0.47 (0.09–2.59)	
Occupation					
Farming	80 (53.3)		0.308		0.358
Unemployed	17 (11.3)	0.97 (0.11–9.00)		1.11 (0.15–8.31)	
Public servant	12 (8)	0.31 (0.02–5.96)		1.70 (0.20–14.54)	
Trading	35 (23.3)	1.00 (0.07–13.87)		0.18 (0.01–3.76)	
Student	6 (4)	1.73 (0.18–16.87)		0.61 (0.08–4.78)	

second, and third trimester in the Adaklu District, respectively. Univariate and multivariate analyses were used to examine the determinants of anaemia status during pregnancy. The variables used in the model were the age of the respondents, marital status, number of pregnancies, number of children, religion, educational level, income, and occupation; hence, they were all included in the model. The discussion of the results was done based on each trimester. The results show that women with four or more pregnancies (OR = 0.77, 95% CI = 0.36–1.65) were more likely to have anaemia in the first trimester, compared to women who were pregnant for two to three times. Also, anaemia is more likely to affect pregnant women who have had one to three children (OR = 2.71, 95% CI = 0.90–8.19) and four to six children (OR = 0.50, 95% CI = 0.16–1.61) under the first trimester than those with no children.

In the first trimester, under the multivariate outcome, the level of education among pregnant women was a predictor of anaemia. The level of education identified by the pregnant women were primary (OR = 2.09, 95% CI = 0.15–29.79), vocational (OR = 0.76, 95% CI = 0.06–10.62), technical (OR = 3.03, 95% CI = 0.16–56.36), and secondary education (OR = 0.17, 95% CI = 0.01–3.00).

Pregnant women who had vocational and secondary education are more likely to experience anaemia than those with tertiary education. Again, pregnant women without formal education were also discovered to experienced anaemia.

Table 5 shows that educational level is associated with anaemia in the second trimester both in univariate and multivariate analyses. The results indicate that higher educational level decreases the odds of anaemia in the population such that participants with primary education (OR = 7.86, 95% CI = 1.37–45.06), vocational (OR = 5.36, 95% CI = 0.96–29.91), technical (OR = 4.17, 95% CI = 0.47–36.74), and secondary education (OR = 2.08, 95% CI = 0.28–15.77) were at a higher risk of anaemia in the study area than pregnant women with tertiary education. Similarly, in the multivariate analysis, higher educational level decreases the odds of anaemia in the population such that participants with primary education (OR = 12.11, 95% CI = 0.77–190.63), vocational (OR = 4.63, 95% CI = 0.32–68.06), technical (OR = 4.77, 95% CI = 0.25–92.32), and secondary education (OR = 1.69, 95% CI = 0.10–28.00).

Also, in the univariate analysis, it shows that the chances of anaemia in the second trimester decreases with age such that

TABLE 5 Determinants of anaemia status during pregnancy in the Adaklu district (trimester 2).

Characteristic	n (%) with outcome	Univariate OR (95% CI)	P-value	Multivariate OR (95% CI)	P-value
Age (years)					
<26	57 (38.0)		0.068		0.252
26–35	78 (52.0)	2.26 (0.68–7.52)		2.82 (0.55–14.50)	
≥36	15 (10.0)	1.07 (0.35–3.30)		1.54 (0.41–5.81)	
Marital status					
Married	114 (76.0)		0.639		0.461
Divorced	4 (2.7)	0.78 (0.33–1.86)		1.61 (0.50–5.19)	
Single	32 (21.5)	0.39 (0.05–3.22)		0.48 (0.05–4.54)	
Number of pregnancies					
2–3	147 (98.0)		0.587		0.426
4 or more	3 (2.0)	0.81 (0.37–1.76)		0.42 (0.14–1.31)	
Number of children					
No child	37 (24.7)		0.282		0.195
1–3 children	77 (51.3)	1.76 (0.64–4.84)		2.79 (0.55–14.14)	
4–6 children	36 (24.0)	1.05 (0.46–2.39)		2.06 (0.58–7.26)	
Religion					
Christian	115 (76.7)		0.381		0.133
Islam	19 (12.7)	1.71 (0.59–4.94)		2.90 (0.75–11.15)	
Traditional	16 (12.7)	1.66 (0.42–6.72)		1.86 (0.39–8.78)	
Educational levels					
Non-formal	58 (38.7)		0.004		0.003
Primary	66 (44.0)	7.86 (1.37–45.06)		12.11 (0.77–190.63)	
Vocational	8 (5.3)	5.36 (0.96–29.91)		4.63 (0.32–68.06)	
Technical	11 (7.3)	4.17 (0.47–36.74)		4..77 (0.25–92.32)	
Secondary	7 (4.7)	2.08 (0.28–15.77)		1.69 (0.10–28.00)	
Income (GHC)					
300–500	133 (88.7)		0.065		0.982
>500	17 (11.3)	2.62 (0.94–7.27)		0.83 (0.18–3.80)	
Occupation					
Farming	80 (53.3)		0.572		0.828
Unemployed	17 (11.3)	1.04 (0.18–6.04)		0.56 (0.07–4.60)	
Public servant	12 (8.0)	3.75 (0.40–35.54)		1.97 (0.18–21.47)	
Trading	35 (23.3)	0.36 (0.04–2.77)		0.53 (0.03–11.31)	
Student	6 (4.0)	0.96 (0.15–6.01)		0.62 (0.07–5.37)	

women aged 26–35 years (OR = 2.26, 95% CI = 0.68–7.52) and ≥36 years (OR = 1.07, 95% CI = 0.35–3.30) were less likely to have anaemia than younger respondents. In addition, women with higher incomes than >500 GHC (OR = 2.62, 95% CI = 0.94–7.27) were less likely to have anaemia as their odd ratio increases.

Results on the third trimester of pregnancy revealed that pregnant women between the ages of 26 and 35 (OR = 0.17, 95% CI = 0.04–0.67) and those over 36 (OR = 0.17, 95% CI = 0.05–0.67) were more likely to develop anaemia in the third trimesters than those below the ages of 26 years. Also, the number of children was found to be significant as women with one to three children (OR = 0.38, 95% CI = 0.15–1.99) and four to six children (OR = 0.83, 95% CI = 0.38–1.83) were more likely to have anaemia than women without any pregnancy.

Finally, in the third trimester, under the multivariate outcome, the level of education among pregnant women significantly is associated with anaemia. The level of education identified by the pregnant women were primary (OR = 0.12, 95% CI = 0.01–2.67), vocational (OR = 0.15, 95% CI = 0.01–3.45), technical (OR = 0.22, 95% CI = 0.01–5.53) ,and secondary education (OR = 0.25, 95% CI = 0.01–6.28). The results from the levels of education revealed that pregnant women who had primary, vocational, technical, and secondary education are more likely to experience anaemia than those with tertiary education.

Discussion

The overall prevalence of maternal anaemia in the Adaklu District was 78%. The findings revealed that anaemia occurred in all three trimesters of pregnancy, with the highest occurrence in the second trimester. The findings on the prevalence of anaemia among pregnant women indicated that there is a high prevalence of anaemia in pregnancy in the Adaklu District. This high prevalence of anaemia means there is a possibility of an increase in the risk of premature birth, low birth weight babies, and postpartum depression among these women. The plausible reasons for this finding could be irregular intake or non-intake of iron supplements with fruits rich in vitamin C (orange, guava, and pineapple) among the pregnant women. The prevalence of 78% of anaemia suggests that a large proportion of pregnant women in the district are at risk of experiencing adverse maternal and foetal outcomes, such as preterm delivery, low birth weight, and maternal mortality. This high prevalence of maternal anaemia in

TABLE 6 Determinants of anaemia status during pregnancy in the Adaklu district (trimester 3).

Characteristic	n (%) with outcome	Univariate OR (95% CI)	P-value	Multivariate OR (95% CI)	P-value
Age (years)					
<25	57 (38.0)		0.047		0.198
26–35	78 (52.0)	0.17 (0.04–0.67)		0.12 (0.02–0.71)	
≥36	15 (10.0)	0.17 (0.05–0.67)		0.11 (0.02–0.55)	
Marital status					
Married	114 (76.0)		0.284		0.523
Divorced	4 (2.7)	1.50 (0.67–3.35)		0.96 (0.33–2.77)	
Single	32 (21.5)	0.56 (0.05–5.97)		0.43 (0.04–5.19)	
Number of pregnancies					
2–3	147 (98.0)		0.760		0.410
4 or more	3 (2.0)	0.88 (0.40–1.97)		2.16 (0.74–6.27)	
Number of children					
No child	37 (24.7)		0.049		0.104
1–3 children	77 (51.3)	0.38 (0.15–1.99)		0.31 (0.07–1.38)	
4–6 children	36 (24.0)	0.83 (0.38–1.83)		0.82 (0.25–2.68)	
Religion					
Christian	115 (76.7)		0.426		0.353
Islam	19 (12.7)	0.92 (0.32–2.65)		0.98 (0.27–3.55)	
Traditional	16 (12.7)	2.20 (0.57–8.57)		2.73 (0.59–12.76)	
Educational levels					
Non-formal	58 (38.7)		0.894		0.001
Primary	66 (44.0)	1.16 (0.24–5.66)		0.12 (0.01–2.67)	
Vocational	8 (5.3)	0.98 (0.20–4.74)		0.15 (0.01–3.45)	
Technical	11 (7.3)	1.33 (0.17–10.25)		0.22 (0.01–5.53)	
Secondary	7 (4.7)	1.1 (0.16–7.51)		0.24 (0.01–6.28)	
Income (GHC)					
300–500	133 (88.7)		0.759		0.908
>500	17 (11.3)	1.17 (0.42–3.27)		2.54 (0.47–13.51)	
Occupation					
Farming	80 (53.3)		0.193		0.724
Unemployed	17 (11.3)	2.00 (0.35–11.54)		1.40 (0.19–10.47)	
Public servant	12 (8.0)	1.40 (0.20–9.87)		1.34 (0.16–10.11)	
Trading	35 (23.3)	1.00 (0.13–7.10)		0.28 (0.01–8.31)	
Student	6 (4)	1.33 (0.24–8.29)		0.79 (0.10–6.27)	

the Adaklu District is concomitant with the findings of the Ghana Demographic Health Survey (19), which revealed that out of the 25 districts in the Volta Region, the Adaklu District had the highest percentage of 72% in 2016, while the Nkwanta North District was second in the same year with a percentage of 68.8%. Several studies have reported a high prevalence of anaemia among pregnant women in Ghana. For example, a study by Asare et al. (20) found that 73.5% of pregnant women in the Ashanti region of Ghana were anaemic. Another study by Boadu et al. (21) found a prevalence of 63.9% among pregnant women attending antenatal clinics in the Upper West region of Ghana. The high prevalence of anaemia among pregnant women in Ghana is attributable to several factors. One of the main factors is iron deficiency, which is the leading cause of anaemia in pregnancy. Studies have shown that inadequate dietary iron intake is common among pregnant women in Ghana, particularly in rural areas where poverty is high (22, 23). In addition, infections such as malaria and hookworm infestation can contribute to anaemia in pregnancy (2, 22). Other factors contributing to the high prevalence of anaemia in pregnancy in Ghana include poor antenatal care attendance, a lack of knowledge about the importance of nutrition in pregnancy,

and limited access to iron supplements and other interventions (20, 21, 23). This indicates that the anaemia in pregnancy situations has not changed in the district despite several health education sessions at ANCs. There is a need for immediate interventions to curb the problem and reduce its consequences for both the mother and the child.

The findings also revealed that pregnant women in the Adaklu District have a high level of knowledge about anaemia. The high knowledge levels on the nature of anaemia, its signs and symptoms, and prevention measures mean the pregnant women understood the health education they received at the ANC. In general, the increased level of knowledge on anaemia should have led to a reduction in the prevalence of the disease in the district. Unfortunately, the knowledge did not commensurate with the prevalence of anaemia in the district. This could be because knowledge may not always be translated into action, or some pregnant women may not apply their knowledge due to cultural barriers. Cultural norms may be responsible for the high prevalence of anaemia, as pregnant women are prohibited from consuming snails, which are rich in protein and could boost haemoglobin levels. The findings on the knowledge level of

pregnant women on anaemia in the Adaklu District support the findings of Yadav et al. (24) that knowledge did not contribute to the prevalence level.

The findings on perceived barriers to maintaining an appropriate haemoglobin level among pregnant women in the Adaklu District revealed that some pregnant women did not take eggs or snails due to cultural beliefs. Cultural beliefs and practises that limit women's access to nutritious foods and discourage them from seeking medical care during pregnancy can contribute to the high prevalence of anaemia among pregnant women in Ghana (22, 23). Another potential barrier is the long distance to the health facility. The implications of the finding on perceived barriers to maintaining an appropriate haemoglobin level among pregnant women in the Adaklu Districts suggest that socio-cultural beliefs increase the possibility of the pregnant women developing anaemia. In relation to the pregnant women who took dewormers during pregnancy, the outcome is in line with the views of Jufar and Zewde (25) that worm infection is the result of women's craving for soil during pregnancy and may contribute to anaemia. An antenatal visit is beneficial to pregnant women. The long distance to the health facility is a potential challenge. This means that ANC services should be extended to communities in order to reduce the maternal burden of long travels for healthcare. This supports the views of Nisar et al. (26), who endorsed the need to formulate and implement policies like community awareness campaigns to encourage the availability of healthcare professionals and encourage pregnant women to access antenatal services in their communities. In addition, it was identified that most of the pregnant women were financially supported by their partners. Again, their partners allowed them to go for antenatal visits.

Furthermore, the findings revealed that health education is received well by the participants at the ANC. The high endorsement of health talk received at ANCs on the benefits of good nutrition and regular medical check-ups is in support of the earlier observation by Adam (27) in the Central Region, where he found the knowledge level of pregnant women on good nutrition to be about 90%. The consistency of the finding with that of Adam (27) could be that ANC visits are not only for medication but also serve as a contact point for health promoters to interact with pregnant women. Mulepati and Chaudhary (28), Amoakoh-Coleman et al. (29), and the WHO (30) explained the effectiveness of ANC visits by stating that the visits help recognise and distinguish between pregnant women who need special care and those who need normal care. Dhange et al. (31) underscored the reasons for ANC visits for pregnant women even if they have no complications by stating that the principles of ANC are to give health education, conduct screenings, treat minor ailments, and make referrals. That is, ANC visits are at the heart of health education, and pregnant women can best be educated if they are present at the health facilities. In essence, it is during the health talks on ANC that the health promoters can help the pregnant women understand the need to be regulars at the health facility even if they feel they are not ill.

Regarding factors associated with anaemia levels among pregnant women, educational level, number of pregnancies,

number of children, and maternal age were significant determinants of anaemia status in the Adaklu District. This implies that healthcare providers should continuously educate pregnant women. The results of several studies have shown that educational level is a significant factor in the prevalence of anaemia in Ghana. For example, a study by Abizari et al. (32) found that the prevalence of anaemia was higher among school children with lower educational levels. The authors suggest that this may be due to poor dietary habits and inadequate knowledge of good nutrition among children. Similarly, a study by Mensah et al. (33) found that women with lower educational levels had a higher prevalence of anaemia compared to those with higher educational levels. The authors suggest that this may be due to a lack of knowledge about the importance of good nutrition and the need for iron-rich foods. Likewise, Ługowska and Kolanowski (34) pointed out that education is essential for spreading awareness about healthy eating, especially during pregnancy. However, Novivanti et al. (35) revealed that less-educated pregnant women have a lower probability of being anaemic than highly educated ones.

The findings indicated that women who had four or more pregnancies were more likely to develop anaemia in the first trimester. Women who are pregnant already feel more tired than usual because of hormonal changes and a higher demand for nutrients during pregnancy. On the other hand, pregnant women who have given birth to four to six children have a high probability of developing anaemia. Pregnancy imposes an additional burden on the body, particularly for mothers who have already had several children. By lowering the blood's ability to deliver oxygen, anaemia worsens maternal susceptibility. This may make it harder for mothers to handle the physical and emotional strains of carrying another child since it may increase the physical demands of pregnancy. Again, the risk of problems during pregnancy grows for both the expectant mother and the growing foetus. Due to the cumulative demands of prior pregnancies, the bodies of women who have had many pregnancies may already be lacking in vital nutrients like proteins and minerals like iron. These difficulties can lead to maternal and child health problems such as preterm birth, low birth weight, postpartum haemorrhage, and maternal morbidity. The findings of the study are in agreement with Ramulondi et al. (36), who asserted that women who have had several pregnancies may experience postpartum recovery issues due to anaemia. Again, the number of children given birth to by pregnant women had a significant influence on anaemia. Anaemia is more likely to affect pregnant women who have had four to six children under the first trimester. This implies that these women are going through the physical and physiological changes related to pregnancy. Similarly, Stevens et al. (6) reported that anaemia lowers the blood's ability to carry oxygen, which can cause weakness and fatigue during the first trimester of pregnancy. The findings during the third trimester of pregnancy revealed that pregnant women between the ages of 26 and 35 and those over 36 are more likely to develop anaemia in the third trimester. This implies that pregnant women with an increase in age are more likely to develop anaemia. Women's natural iron reserves

naturally decline with age. One of the factors contributing to anaemia during pregnancy is iron deficiency. Di Renzo et al. (37) stated that pregnancy-related anaemia is more likely to occur if the body's iron stores are already low before the pregnancy. Again, chronic diseases such as kidney disease, autoimmune diseases, and gastrointestinal issues are more common in older people. Some of these diseases increase the risk of anaemia during pregnancy by interfering with iron intake, utilisation, or red blood cell formation.

Overall, the educational levels of the pregnant women were significant determinants of anaemia in all three trimesters. The findings showed that anaemia is more common in pregnant women with less education in the second trimester. For the foetus's growth and development as well as their health, pregnant women need higher levels of nutrients such as iron and folate. Women may fail to get enough of these vital nutrients if they are not well informed on the importance of a nutritious diet during pregnancy, which increases their chance of developing anaemia. Again, cultural influences can affect prenatal dietary practises and attitudes. In some societies, dietary limitations or customs during pregnancy may lead to insufficient nutrient intake. For instance, cultural attitudes could encourage dietary restrictions that restrict the diversity of nutrients available to pregnant women or prohibit the use of foods high in iron. Without education on the value of healthy nutrition during pregnancy, women may follow cultural customs that raise their risk of anaemia. Therefore, efforts to address the problem of maternal anaemia should focus on health education and promoting healthy lifestyles among individuals with lower educational levels. These findings also underscore the need for targeted interventions to address factors and reduce the burden of anaemia in the country.

Conclusions

Anaemia is a significant health problem among pregnant women in Ghana. The high prevalence of anaemia is largely attributed to factors such as poor nutrition, parasitic infections, and inadequate antenatal care. The consequences of anaemia during pregnancy are far-reaching and can have adverse effects on both the mother and child. To reduce the burden of anaemia among pregnant women in Ghana, there is a need for a multi-faceted approach that addresses the underlying factors contributing to anaemia in pregnancy in terms of diets, ANC attendance, and socio-cultural beliefs. Iron supplementation, dietary interventions, and deworming are effective interventions to reduce the prevalence of anaemia. However, these interventions need to be combined with efforts to improve antenatal care attendance and health education to promote good nutrition during pregnancy. It is also essential to address the broader social determinants of health, such as poverty and gender inequality, which affect women's access to resources and contribute to poor nutrition. To improve the health outcomes of pregnant women and their babies, there is a need for concerted

efforts by the government, healthcare providers, and the community at large. The government can prioritise the provision of accessible antenatal care services and support programmes aimed at reducing poverty and improving the economic status of women. Healthcare providers can also promote health education and counselling on nutrition during pregnancy, in addition to iron supplementation and deworming interventions. Overall, reducing the burden of anaemia among pregnant women in Ghana requires a comprehensive approach that addresses the underlying factors contributing to anaemia in pregnancy. It is essential to continue research on effective interventions and to work collaboratively to improve the health outcomes of pregnant women in Ghana.

Strengths of the study

The major strength of this study was that it identified risk factors that contribute to anaemia among pregnant women attending antenatal clinics at health centres in a rural setting in Ghana's Adaklu District. The validity and reliability of the research instrument were ensured by pregnant women who visited the antenatal clinics for the first time during the study. The instrument's reliability was assessed using the Kuder–Richardson Formula (KR21), and after adding four extra items to improve the reliability, the KR21 value was found to be 0.815, indicating a very good level of reliability.

Limitations of the study

The study focused on pregnant women who attended ANCs in the Adaklu District. The findings of the study could not be generalised because pregnant women who did not attend ANCs were not part of the study. Secondly, the researchers did not check the haemoglobin levels themselves, so they solely relied on the haemoglobin levels recorded on the pregnant women's antenatal booklets. In spite of its limitations, the study provided vital information on the factors influencing maternal anaemia in the Adaklu District.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by University of Cape Coast, Institutional Review Board. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

Author contributions

ET conceived the study. ET, TH, and NE designed and performed the analysis and the wrote up on data and methods. ET, TH and NE designed the first draft of the manuscript. ET, TH, and NE revised and proofread the manuscript for intellectual content. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Frontiers in Global Women's Health

Receipt of core antenatal care components and associated factors in Ethiopia: a multilevel analysis

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Background: Despite recent promising progress, maternal morbidity and mortality are still unacceptably high in Ethiopia. This is partly attributed to the lack of quality health services. Pregnant women may not receive adequate services that are essential to protect the health of women and their unborn children. This study aimed to examine the extent of receiving prenatal care components and associated factors in Ethiopia. It also assessed prenatal service use inequality between urban and rural residents.

Methods: The analysis was carried out using the 2016 Ethiopian Demographic and Health Survey (EDHS), which is nationally representative survey data. A weighted sample of 4,772 women nested within 595 communities who had live births five years preceding the survey was included in the study. Necessary adjustments were made to account for the design of the survey, and sampling weights were used to adjust for nonproportional allocation of the sample to strata. Bivariate and multivariable multilevel ordered logit models were used to analyze factors associated with receiving comprehensive ANC contents. Statistically significant predictors were identified at p value ≤ 0.05.

Results: Among those women who had at least one ANC visit, only 15% (95% CI: 13, 16) received six core elements of antenatal care. The proportion of mothers who had essential prenatal components in rural areas was less than 13 percentage points. Approximately 43% of women did not receive at least two doses of tetanus toxoid vaccines to protect them and newborn infants against this life-threatening disease. Moreover, the majority of them, particularly those in rural Ethiopia, were not informed about pregnancy danger signs. Mothers who had at least four ANC visits received more types of prenatal components compared to those who had fewer ANC visits. The multilevel regression analysis revealed that receiving adequate ANC content is positively associated with having more frequent ANC visits, attaining a higher education level, being a member of a household in the highest wealth quintile and residing in urban areas.

Conclusion: The evidence implies that the quality of maternal health services needs to be improved. Health programs and interventions should also give priority to rural areas where the majority of Ethiopian women reside.

Introduction

Ethiopia has attempted to expand the supply of essential health services by implementing a 20-year Health Sector Development Program (HSDP) in the past two decades. Accordingly, between 2000 and 2019, there was a 17-fold increase in the number of health posts from 1,023 to 17,162 and a tenfold growth (382–3,678) in the

number of health centers. In the same period, the number of public hospitals in the country increased from 80 to 314 (1, 2). The government has also invested to improve the availability of medical workers by expanding medical colleges throughout the country. As part of the HSDP, the Federal Ministry of Health (FMoH) also introduced an innovative community health extension program to enhance the utilization of maternal and child health services.

To reduce demand side constraints, the country also introduced an exemption policy that guarantees access to maternal and child healthcare services free of charge from public facilities (3). These efforts have contributed to enhancing the utilization of health services. For instance, in 2005, the proportion of institutional delivery was only 5%. In 2019, institutional delivery reached 48%. Between 2005 and 2019, the use of antenatal care services increased from 28% to 74%, and postnatal care service use in the first two days after childbirth rose from 5% to 34% (4, 5). There was also positive progress in reducing infant, child and maternal mortality. The country met the fourth Millennium Development Goal three years ahead of the 2015 deadline by reducing under-five mortality from 205 deaths per 1,000 livebirths in 1990 to 64 deaths per 1,000 livebirths in 2013 (6). Despite such promising progress, a large burden of preventable morbidity exists, and maternal mortality is still unacceptably high. In 2017, the maternal mortality ratio (MMR) in Ethiopia was 401 per 100,000 live births, which was categorized under the high MMR group according to the World Health Organization (WHO) standards (7).

The major causes of maternal mortality in Ethiopia are pregnancy-related and preventable cases such as hemorrhage, obstructed or prolonged labor, hypertensive disorders and infection (8, 9). The key factors contributing to these pregnancy complications are identified to be limited use of modern health services, poor competency of health providers and lack of facilities for obstetric services. Inequality in access to services is also a problem that needs to be addressed. Ethiopia is a predominantly rural country, and approximately 80% of the population lives in rural areas. However, the majority of rural women have limited access to quality health services during pregnancy and delivery (10–12). Accordingly, they may not receive a package of core antenatal care (ANC) services when they visit health facilities.

Since 2022, Ethiopia has adopted the 2016 WHO adopted model of a minimum of eight ANC visits and recipients of services that are effective in protecting the health of pregnant women and their unborn children (13, 14). The prenatal care provision guideline of the FMoH indicates that ANC services provided need to include blood pressure screening, weight measurements, check for pallor, fetal heartbeat and lie, urine test for infection, syphilis, blood group, hemoglobin, and rhesus factor screening. Moreover, pregnant women should also receive iron/folic acid supplements, insecticide-treated bed nets, a minimum of two doses of tetanus toxoid vaccination, deworming, nutrition counseling, and birth preparedness plans (15, 16). However, there is a marked gap in the quality of ANC service provision, and a number of pregnant women do not receive adequate ANC contents according to the national guidelines (17).

Previous studies have mostly investigated sociodemographic determinants of the prevalence and frequency of ANC visits in Ethiopia (18–21). However, there are limited studies that have examined the extent of ANC components and factors contributing to disparities among different segments of the population (16, 22). Related studies have also been conducted using demographic health surveys (DHS) in low- and middle-income countries. However, they did not account for the complex sample design nature of DHS data in the analysis (23–25). Failing to consider complex survey designs could lead to inconsistent coefficient estimates, and the conclusions drawn could be misleading. Moreover, DHSs often intentionally oversample smaller domains among different strata, and inferences made based on the unweighted sample data may be biased (26–29).

This study, therefore, aimed to assess the extent of ANC components received and identify associated factors in Ethiopia using the 2016 Ethiopia Demographic Health Survey. It also examined inequalities in the degree of ANC content provided in urban and rural residents. To do so, it employed appropriate research methods to analyze hierarchical survey data.

Methods and materials

Study design and sampling procedure

This study used the 2016 Ethiopia Demographic Health Survey (EDHS), which is a nationally representative household-based survey. A community-based cross-sectional study design was used in order to collect data from the source population. The sampling frame for the survey was the 2007 Ethiopian Population and Housing Census. Sample households were selected from urban and rural areas using a two-stage cluster sampling design. In the first stage, all regions in the country were categorized into urban and rural areas. Then, 645 enumeration areas (EAs) were selected considering probability proportional to the household size of the clusters. In the selected EAs, a household listing operation was implemented. In the second stage, 28 households per cluster were selected using an equal probability systematic sampling technique from the list of households created. Accordingly, a total of 18,060 households were allocated in the selected 645 EAs. However, due to the nonresponse rate, the survey contains completed interviews for 16,650 households (5,232 urban and 11,418 rural). Within sample households, there are 15,683 completed interviews with women of reproductive age (15–49 years old) (30).

Participants of this study were women aged 15–49 years who had a live birth and made at least one antenatal care visit in the five years preceding the 2016 EDHS survey. Accordingly, a weighted sample of 4,772 women who had ANC visits was included in the analysis.

Variables and measurement

The outcome variables are components of ANC services received among those women who had at least one ANC visit

during their recent live birth. The WHO recommends a core set of ANC services that include the following items: blood pressure measurement, tetanus toxoid vaccination, blood and urine tests, iron tablet supplementation, body weight measurement and counseling about danger signs. Receiving these contents is essential for every pregnant woman to prevent adverse maternal and perinatal outcomes (13). The 2016 EDHS includes information on these core ANC items except body weight measurement. Accordingly, for multivariate analysis, the outcome was measured as the number of core ANC services received out of six contents. In addition to these critical contents, the descriptive analysis also determines whether the women received the nationally recommended ANC items such as intestinal parasite drugs, nutritional counseling and information regarding a birth preparedness plan.

The regression analysis controlled three groups of factors to identify predictors of the outcome. First, it included the individual background characteristics of the mothers, such as age, religion, desire to have a child, number of ANC services received, marital status and education level. Second, the analysis also controlled for the wealth index of the households. Finally, it also included distance to health facilities and type of residence as proxies for community characteristics. Operational definitions of dependent and independent variables used in the bivariate and multivariate analysis are reported in Table 1.

Data analysis

The data were first extracted from the DHS Program website, and analysis was performed using STATA 16. The 2016 Ethiopian demographic health survey was collected using a two-stage cluster sampling design. To analyze data collected through such a complex sample design, it is important to know three types of information—the clustering variable or primary sampling unit, the stratification variable and the sampling weight variable (29, 31). Accordingly, this study was conducted after adjusting for these factors based on the information provided in the 2016 EDHS and using the STATA "svy" commands.

By taking the necessary adjustment for the sample design, the study described the background characteristics of the sample using frequencies and percentages. The distribution of receiving ANC components by urban/rural areas was reported using percentages and 95% confidence intervals (CIs). The weighted proportion of using core contents of prenatal care was estimated among women who had at least one ANC visit and those who made at least four visits. Moreover, multilevel regression models were fitted to identify predictors of the outcome. Classical regression models, such as logit and ordinary least squares, require independence of observations, and employing such models to analyze complex survey designs is not appropriate. In a hierarchical survey such as the EDHS, individuals within a cluster may exhibit similar characteristics, and observations with clusters may not be independent from each other. On the other hand, multilevel models account for cluster-level random effects and allow the dependence of sample individuals within a cluster (32).

Most of the existing studies [e.g. (23, 24, 33),] examined factors associated with receiving components of ANC using binary logit models, whereas this study employed bivariate and multivariable multilevel ordered logit model. The advantage of using ordered logits over binary logits is that the first ones measure the outcome on an ordinal scale. Hence, the models account for even small variations in the outcome among the study individuals, and the results are more informative. In the case of creating binary outcome variables, the precision of estimates decreases since information is lost in the process of combining categories of the outcome (34, 35). In this study, the outcome variable is measured on an ordinal scale and indicates the number of core ANC contents received by mothers included in the study.

As a robustness check, four alternative regressions were conducted after controlling for various covariates. The null model (Model 0) did not contain any explanatory factor, and its purpose was to assess the level of intracluster correlation across communities. Model 1 contained the background characteristics of sample women who had a live birth five years preceding the survey. Model 2 controlled for both individual and household characteristics. The final model (Model 3) incorporated individual-, household- and community-level factors.

TABLE 1 Operational definition of dependent and independent variables.

Variable	Description and categorization
Dependent variable	
ANC components	The number of core ANC components received during the last pregnancy. The core components include blood pressure measurement, tetanus toxoid vaccination, blood and urine tests, iron tablet supplementation and counseling about danger signs
Independent variable	
Age	Age in completed years: 15–19, 20–34, 35–49
Birth order	Birth order of the child: 1st birth, 2–3, 4–5, 6 or more
Wanted pregnancy	The mother desire status of last pregnancy: wanted by then, wanted latter, wanted no more
ANC visit	Number of ANC visit during the last pregenancy: 1, 2–3, 4 or more
Religion	Religious affiliation of the mother: Orthodox, Catholic, Protestant, Muslim, other religion
Marital status	Marital status of the woman: single, married, divorced, other marital status
Education status	Highest education level completed: no education at all, primary, secondary, higher education
Wealth index	The household relative wealth status: poorest, poorer, middle, rich, richest
Distance to the facility	Perception about problem related to distance to the facility: big problem, not a big problem
Residence	Place of residence: urban, rural

Before conducting the multivariate analyses, multicollinearity tests were carried out to check the degree of relationship among the explanatory variables. It was found that the mean variance inflation factor (VIF) was 1.42, which was below the maximum tolerable value of 5, and predictors of the outcomes were not highly correlated (36). To assess differences in the extent of ANC content received across communities, intraclass correlation coefficients (ICCs) of the models were generated. The estimated ICC amounted to more than the 10% threshold, and it was important to control for community-level random effects to consistently estimate the coefficients of controlled covariates (37, 38). The relative proportion of community-level variance that was attributed to controlled factors in the consecutive models was assessed using proportional change in variance (PCV). Finally, crude odds ratios (CORs) and adjusted odds ratios (AORs) were estimated, and statistically significant predictors of ANC contents were identified at p values less than 0.05.

Result

Characteristics of the respondents

The study included a weighted sample of 4,772 women who received antennal care for their most recent birth in the five years preceding the 2016 EDHS. The sociodemographic characteristics of the study participants are reported in Table 2. The majority of women were 20–34 years old (73%), and they were married (91%). During the survey period, approximately 24% of the respondents had only one child, while 21% had six or more children. Most of the study participants were mainly Muslims (41%) and Orthodox Christian (39%). In terms of education status, approximately 33% of individuals attended primary education, while half of them did not attend any education at all. Most of the women reported that they gave birth to children mainly due to their desire to have a baby. Approximately 44% of the women stated that distance to the nearest facility was a major problem in accessing health services. Among the study participants, 3,317 (70%) resided in rural Ethiopia.

Antenatal care visits

Among the weighted women who had live births in the five-year recall period, about 4.4% had only one ANC visit, while 26.5% had two or three visits. The survey indicates that 31.8% of mothers made at least four ANC visits. The characteristics of the mother who received at least 4 ANC visits are reported in Table 3. The results show considerable variations in having at least four ANC visits among different groups of women. For instance, 42% of women with first birth order made at least 4 prenatal care visits, while only 23% of those with 6 or more birth orders did the same. The chi-square test shows that there are statistically significant variations in the proportions of women who had a minimum four ANC visits based on the birth order of the recent child. Similarly, a higher percentage of mothers

TABLE 2 Sociodemographic characteristics of women who received ANC in Ethiopia, 2016 (*N* = 4,772).

Variables	Category	Frequency	Percentage
Age (in years)	15–19	250	5.31
	20–34	3,432	72.84
	35–49	1,030	21.86
Birth order	1	1,151	24.43
	2–3	1,585	33.64
	4–5	1,003	21.29
	6 or more	973	20.65
Wanted pregnancy	Wanted then	3,765	79.90
	Wanted latter	695	14.75
	Wanted no more	252	5.35
ANC visits	1	342	7.26
	2–3	1,750	37.14
	4 or more	2,620	55.60
Religion	Orthodox	1,856	39.39
	Catholic	28	0.59
	Protestant	855	18.15
	Muslim	1,936	41.09
	Other	37	0.79
Marital status	Single	43	0.91
	Married	4,298	91.21
	Divorced	191	4.05
	Other	180	3.82
Educational status	No education	2,340	49.66
	Primary	1,543	32.75
	Secondary	521	11.06
	Higher	308	6.54
Wealth index	Poorest	1,068	22.67
	Poorer	761	16.15
	Middle	706	14.98
	Rich	671	14.24
	Richest	1,506	31.96
Distance to the facility	Big problem	2,088	44.31
	Not a big problem	2,624	55.69
Residence	Urban	1,395	29.61
	Rural	3,317	70.39

who attended higher education (73%) had repeated ANC visits than those with no education at all (24%). It is also found that a significantly higher percentage of women from households in the rich wealth status received at least four ANC services compared to those from poor households. In terms of place of residence, the proportions of women who had four or more ANC visits are 27% in rural areas and 63% in urban areas.

ANC contents received

Among women included in the 2016 EDHS, 60% (95% CI: 57, 63) reported that they took iron tablets for their latest live birth (Figure 1). Relatively more women in urban areas (66%) than in rural areas (59%) received iron supplements. The blood levels of 91% of urban women and 72% of rural women were measured when they attended prenatal services. The proportions of women who had urine and blood tests amounted to 75% and 66%, respectively. Again, sample examinations were considerably higher for mothers in urban areas than for those in rural areas.

TABLE 3 Categorization of women who had at least four ANC visits during their recent pregnancy in Ethiopia, 2016.

Variables	Category	Frequency	Percentage	p-value
Age (in years)	15–19	104	30.7	0.0029
	20–34	1,781	33.7	
	35–49	530	27.0	
Birth order	1	602	42.0	0.0000
	2–3	808	35.4	
	4–5	524	29.9	
	6 or more	481	22.7	
Wanted pregnancy	Wanted then	1,853	33.3	0.0036
	Wanted latter	393	29.8	
	Wanted no more	168	24.2	
Religion	Orthodox	1,124	39.0	0.0000
	Catholic	20	27.8	
	Protestant	526	31.8	
	Muslim	726	25.7	
	Other	19	12.1	
Marital status	Single	34	60.7	0.0240
	Married	2,206	31.4	
	Divorced	81	34.6	
	Other	94	33.4	
Educational status	No education	1,156	24.1	0.0000
	Primary	828	38.5	
	Secondary	263	62.7	
	Higher	167	72.9	
Wealth index	Poorest	305	18.4	0.0000
	Poorer	419	25.3	
	Middle	447	28.1	
	Rich	517	36.2	
	Richest	728	57.4	
Distance to the facility	Big problem	1,108	25.1	0.0000
	Not a big problem	1,306	41.1	
Residence	Urban	608	62.7	0.0000
	Rural	1,805	27.3	

Chi-square (χ^2) test was used to assess where there are significant variations in the proportions of at least four ANC visits among different categories.

For instance, the provision of blood sample test services was higher by 27 percentage points in urban areas. Approximately 57% of mothers took at least two tetanus toxoid injections. During their ANC visits, 66% of mothers received nutritional counseling, and 45% of them were informed about pregnancy danger signs.

The analysis revealed that only approximately 15% of women had a combination of six core components, which included iron tables, blood pressure measurements, urine and blood tests, tetanus injection and information on danger signs of pregnancy. The recipients of essential ANC components in rural areas were less by 13 percentage points than in urban areas. The proportion of women who received all nine contents included in the study was found to be only 2%.

Figure 2 indicates the proportion of women who received various degrees of ANC contents during their recent live births. Approximately 5% of women received only one ANC content, and 10% had three components. The share of women who reported having seven items was 17%. The proportion of individuals who had less than five contents was higher in rural areas than in urban areas, and the reverse holds true. Contrary to expectations, approximately 3% of rural women received none of the nine ANC items included in the analysis, although they

reported using ANC services. On the other hand, almost all sample women in urban areas received at least one ANC component. The coverage of seven ANC contents was 24% in urban areas and 15% in rural areas.

The study also assessed prenatal packages among those women who availed at least 4 ANC visits during their recent pregnancy. As reported in Table 4, 67% of mothers having a minimum of four ANC visits received iron tablets, while only about 9% received parasite drugs. The proportion of women who had blood pressure measurements, urine tests, and blood tests were 81%, 76%, and 80%, respectively. The survey shows that 61% of women received tetanus vaccines and 73% received nutrition supplements. The percentage of women who received counseling about pregnancy danger signs and birth plans were 53.9% and 62.0%, respectively. Despite making frequent ANC visits, only a small proportion of women received all core ANC contents (21%) and all ANC contents (3%).

Factors associated with receiving higher items of ANC contents

The study examined factors affecting the extent of receiving ANC components using multilevel ordered log models. In these estimates, the outcome variable refers to the number of core ANC contents received by women. Table 5 provides crude odds ratios with 95% confidence intervals from the bivariate analysis. It is found that mothers who had four or more ANC visits had 5.6 times higher chance of receiving various types of contents compared to women who had only 1 ANC visit. On the contrary, women who wanted no more pregnancies had a lower chance of receiving all ANC contents compared to women who wanted their pregnancy at that time (COR = 0.68, 95% CI: 0.47, 0.97, p-value = 0.033). Individuals who attend post-secondary educational status had 3 times higher probability of receiving better prenatal services compared to women with no education (95% CI: 1.75, 5.20, p-value < 0.001). The results indicate a significant difference in the likelihood of receiving ANC contents based on place of residence. Women who resided in rural Ethiopia had 88% less chance of receiving more number of prenatal contents than those who resided in urban Ethiopia (95% CI: 0.16, 0.30, p-value < 0.001).

In the multivariate analysis of Table 6, the estimate of the null model (Model 0) indicated that there were statistically significant variations in the odds of the ANC component receiving among clusters (variance = 1.68, p < 0.001). Similarly, the intraclass correlation coefficient (ICC) showed that approximately 34% of the total variance in receiving ANC contents was attributable to differences in the contextual factors across the communities (Table 2). The proportional change in variance (PCV) for models I, II and III were found to be 16%, 21% and 24%, respectively. Thus, in the final model, 24% of the community variance detected in the null model was explained by controlled individual-, household- and community-level factors.

The sociodemographic characteristics of the mothers, such as age, marital status and religion, were not found to be important predictors of ANC components. The results show that the number of ANC visits was positively associated with the content of prenatal services.
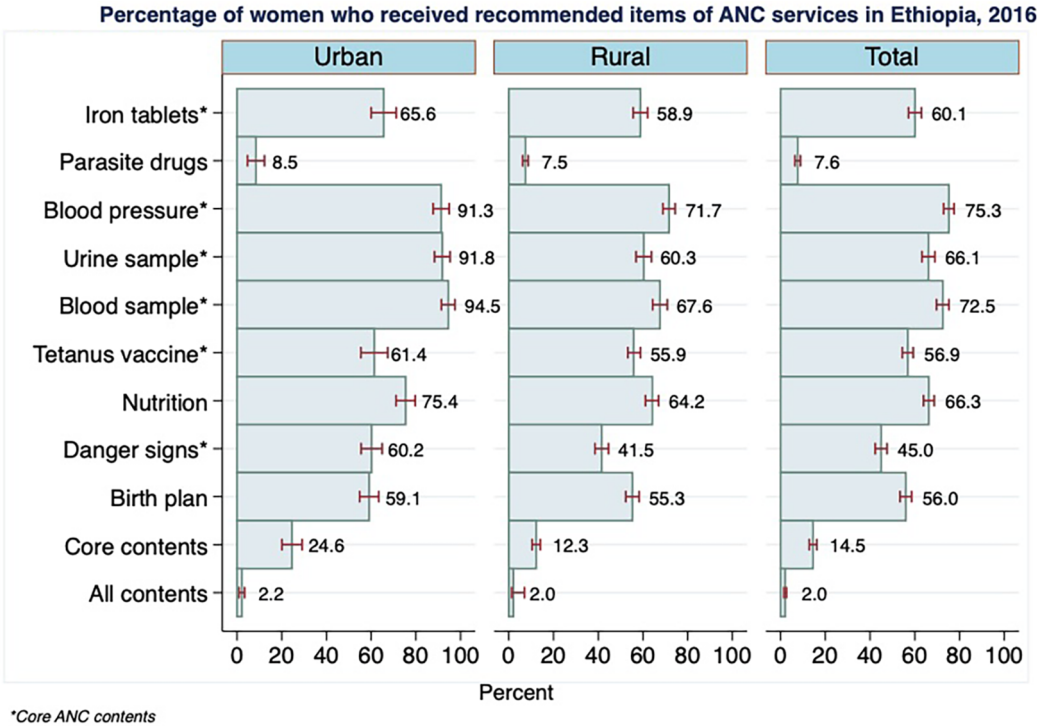
FIGURE 1
Percentage of women who received recommended items of ANC services in Ethiopia, 2016.
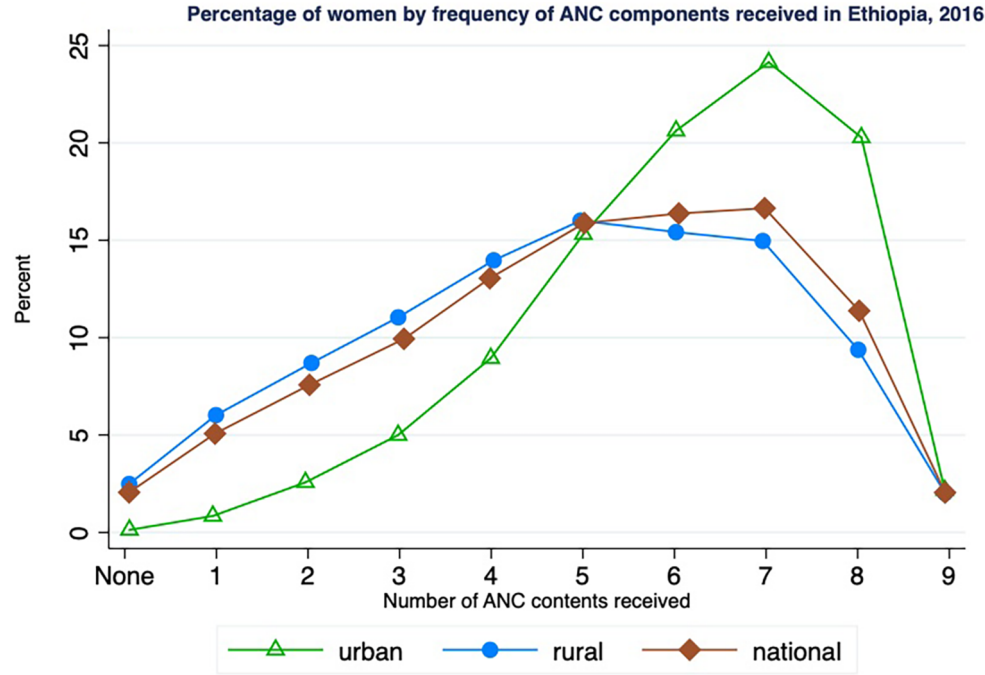

FIGURE 2
Percentage of women by frequency of ANC components received in Ethiopia, 2016.

TABLE 4 Receiving prenatal contents among those women who had at
674 least four ANC visits in Ethiopia, 2016.

ANC content	Percent	95% CI
Iron tablets	66.5	[63.2, 69.6]
Parasite drugs	9.3	[7.6, 11.2]
Blood pleasure measurement	80.6	[77.8, 83.2]
Urine sample test	76.1	[73.0, 79.0]
Blood sample test	80.4	[77.4, 83.1
Tetanus vaccine	61.2	[57.9, 64.3]
Nutrition supplement	73.0	[70.3, 75.6]
Counseling about pregnancy danger signs	53.9	[50.4, 57.4]
Counseling about birth plan	62.0	[58.4, 65.2]
Receiving all core ANC contents	20.7	[18.1, 23.4]
Receiving all ANC contents	2.7	[1.9, 3.8]

Keeping other factors constant, the number of ANC contents received
was 2.84 times greater for those who made two or three ANC visits
than for those who made only one ANC (95% CI: 1.92, 4.20, p-
value < 0.001). Similarly, the components of ANC services were 5.38
times higher for women who made three or more visits (95% CI:
3.64, 7.96, p-value < 0.001). The results were consistent across
alternative model specifications (Table 5).

TABLE 5 Bivariate analysis of factors associated with receiving higher ANC
components in Ethiopia, 2016.

Variables	Category	COR	95% CI	p-value
Age (in years)	15–19	1		
	20–34	1.27	[0.76, 2.12]	0.359
	35–49	1.06	[0.62, 1.79]	0.837
Birth order	1	1		
	2–3	0.90	[0.71, 1.14]	0.390
	4–5	0.73	[0.56, 0.94]	0.017
	6 or more	0.79	[0.60, 1.04]	0.093
Wanted pregnancy	Wanted then	1		
	Wanted latter	0.94	[0.74, 1.20]	0.617
	Wanted no more	0.68	[0.47, 0.97]	0.033
Number of ANC visit	1	1		
	2–3	2.83	[1.92, 4.16]	0.000
	4 or more	5.57	[3.79, 8.19]	0.000
Religion	Orthodox	1		
	Catholic	1.08	[0.33, 3.54]	0.905
	Protestant	1.06	[0.65, 1.73]	0.805
	Muslim	0.84	[0.58, 1.20]	0.325
	Other	0.55	[0.19, 1.54]	0.253
Marital status	Single	1		
	Married	0.92	[0.24, 3.45]	0.897
	Divorced	0.75	[0.18, 3.09]	0.692
	Other	0.60	[0.14, 2.56]	0.487
Educational status	No education	1		
	Primary	1.61	[1.29, 2.01]	0.000
	Secondary	2.63	[1.75, 3.97]	0.000
	Higher	3.02	[1.75, 5.20]	0.000
Wealth index	Poorest	1		
	Poorer	1.22	[0.89, 1.67]	0.212
	Middle	1.26	[0.90, 1.77]	0.177
	Rich	1.62	[1.14, 2.30]	0.007
	Richest	2.91	[1.81, 4.69]	0.000
Distance to the facility	Big problem	1		
	Not a big problem	1.14	[0.89, 1.47]	0.288
Residence	Urban	1		
	Rural	0.22	[0.16, 0.30]	0.000

Education was also found to be an important predictor of
receiving ANC contents in the study country. Those who
attended primary education were 1.5 times more likely to obtain
comprehensive services than those who did not attend formal
education. The adjusted odds ratios for women with secondary
education and those with higher education were 2.10 (95% CI:
1.36, 3.23, p-value = 0.001) and 2.44 (95% CI: 1.36, 3.23, p-value
= 0.002), respectively. Perceived distance to the health facility did
not significantly relate to the outcome of interest. Finally, those
who lived in rural Ethiopia had less ANC services than those in
urban areas (AOR = 0.58, 95% CI: 0.36, 0.94, p-value = 0.026).

Discussion

In the past two decades, Ethiopia has made considerable progress
in expanding access to maternal and child health services. This leads
to noticeable progress in enhancing service utilization in the country.
Accordingly, the proportion of women who had at least one antenatal
care service increased from 28% in 2005 to 74% in 2019. The
utilization of a minimum of 4 ANC visits also markedly improved
from 12% to 43% (5). However, using the 2016 EDHS, this study
indicates that the progress made in expanding access to prenatal
services is not accompanied by the provision of adequate services
required for a better pregnancy outcome. It was found that the
share of women who had essential ANC components was limited
in the country. Among women who had at least one ANC visit
five years preceding the survey, 85% did not receive six items of
core ANC services. Relatively more rural women (88%) did not
receive the required services compared to urban women (75%). On
the other hand, those women who made at least ANC visits
received more types of prenatal components than those who had
fewer visits. The evidence implies that many pregnant women,
especially those in rural areas, were not protected from the risk of
complications that could endanger the lives of both the mothers
and their babies. In addition to demand-side constraints, a lack of
quality services is a problem that causes inadequate use of prenatal
contents in Ethiopia (11, 12).

The share of women having essential ANC service in the 2016
EDHS was relatively larger than a previous study conducted in
Nigeria (5%) but smaller than studies in Nepal (23%) and
Bangladesh (22%) (23–25). Evidence from the Performance
Monitoring for Action 2020 Ethiopian data showed that 28% of
pregnant women received adequate ANC content (16). This
study considered adequate receiving of care if the pregnant
women received at least 9 out of 12 items of ANC contents.
However, in the current study, the outcome was defined as
receiving six core ANC components during a recent live birth.

Measurement of blood pressure and examinations of urine and
blood samples were found to be the most common ANC services
provided in Ethiopia. This is consistent with evidence in Nigeria
and Bangladesh, and this is because these are the very basic
services provided during the first ANC visits (23, 25). Similar to
a study conducted in rural Western Kenya, only less than half of
mothers were informed about the danger signs of pregnancy
during their ANC visits (39). Approximately 43% of women did

TABLE 6 Multivariate analysis of factors associated with receiving higher components of ANC services in Ethiopia, 2016.

Variables (N = 4,772)	Model 0	Model 1	Model 2	Model 3
		AOR (95% CI)	AOR (95% CI)	AOR (95% CI)
Age (ref: 15–19)				
20–34		1.27 (0.71–2.28)	1.28 (0.71–2.30)	1.28 (0.71–2.30)
35–49		1.19 (0.61–2.32)	1.22 (0.62–2.39)	1.21 (0.62–2.38)
Birth order (ref: 1)				
2–3		0.98 (0.75–1.29)	0.96 (0.74–1.26)	0.96 (0.74–1.26)
4–5		0.86 (0.63–1.17)	0.85 (0.62–1.15)	0.85 (0.62–1.16)
6 or more		1.07 (0.75–1.54)	1.03 (0.72–1.47)	1.04 (0.72–1.48)
Wanted pregnancy (ref: Wanted then)				
Wanted latter		1.03 (0.81–1.32)	1.05 (0.83–1.34)	1.05 (0.82–1.33)
Wanted no more		0.81 (0.55–1.20)	0.82 (0.56–1.20)	0.81 (0.55–1.19)
Number of ANC visit (ref: 1)				
2–2		2.84* (1.92–4.19)	2.85* (1.92–4.21)	2.84* (1.92–4.20)
4 or more		5.47* (3.70–8.07)	5.41* (3.66–8.00)	5.38* (3.64–7.96)
Religion (ref: Orthodox)				
Catholic		1.02 (0.29–3.57)	1.03 (0.29–3.64)	1.05 (0.31–3.63)
Protestant		1.03 (0.65–1.62)	1.05 (0.67–1.65)	1.05 (0.67–1.65)
Muslim		0.89 (0.62–1.29)	0.92 (0.63–1.34)	0.92 (0.64–1.34)
Other		0.49 (0.20–1.21)	0.52 (0.21–1.28)	0.53 (0.22–1.29)
Marital status (ref: Single)				
Married		1.19 (0.33–4.31)	1.12 (0.31–4.06)	1.12 (0.31–4.07)
Divorced		1.02 (0.26–4.01)	0.99 (0.25–3.93)	0.99 (0.25–3.94)
Other		0.68 (0.17–2.74)	0.66 (0.16–2.69)	0.66 (0.16–2.70)
Educational status (ref: No education)				
Primary		1.56* (1.23–1.98)	1.50* (1.19–1.90)	1.50* (1.19–1.90)
Secondary		2.35* (1.52–3.64)	2.13* (1.39–3.26)	2.10* (1.36–3.23)
Higher		2.85* (1.66–4.89)	2.49* (1.41–4.39)	2.44* (1.37–4.33)
Wealth index (ref: Poorest)				
Poorer			1.08 (0.77–1.51)	1.08 (0.77–1.50)
Middle			1.08 (0.77–1.52)	1.08 (0.76–1.52)
Rich			1.26 (0.89–1.78)	1.25 (0.88–1.77)
Richest			2.09* (1.29–3.40)	1.97* (1.18–3.29)
Distance to the facility (ref: Big problem)				
Not a big problem				1.07 (0.84–1.37)
Residence (ref: Urban)				
Rural				0.58* (0.36–0.94)
Random effects				
Community level variance (SE)	1.68* (0.17)	1.42* (0.19)	1.32* (0.18)	1.28* (0.17)
ICC	0.338	0.302	0.286	0.280
PVC	Ref	0.155	0.214	0.238

Model 0—null model and no covariates controlled for; Model 1—Controlling for individual level factor; Model 2—Controlling for household level factors; and Model 3—Controlling for community level factors.
*Significant at $p < 0.05$.

not receive the minimum required doses of tetanus toxoid vaccine. This is not according to the Ethiopian ANC service provision guideline and the WHO recommendation of at least two tetanus toxoid injections during the pregnancy period to prevent maternal and neonatal mortality (40, 41).

The study overall indicates that, despite visiting health facilities to seek ANC, many women did not receive adequate services. This is mainly due to a significant health systems failure to deliver essential maternal health services. According to the 2016 Service Availability and Readiness Assessment (SARA) for Ethiopia, Folic acid supplementation were available only in less than 60% of the health facilities that provide antenatal health services. Similarly,

iron supplementation and tetanus toxoid vaccination were not available in about one quarter of health facilities (42).

The estimate from multilevel regression analysis revealed that making more than one ANC visit contributed to receiving a higher number of ANC components. The WHO also recommends that pregnant women make at least four ANC visits to ensure the receipt of necessary prenatal services (13). When pregnant women visit health facilities more frequently, they obtain relevant information and medications that are life saving for both the mothers and their children. The contents of ANC services provided by health facilities also differ according to the pregnancy stages, and women who make only one or two visits may not

receive adequate ANC content (15). Similar to this evidence, a study from Northern Ethiopia found that the number of antenatal care visits was significantly associated with the incidence of tetanus toxoid immunization (41). Related studies in Nigeria and Nepal also indicated that the frequency of ANC visits significantly predicted the contents of services being received (23, 24).

Education was also found to be an important confounder that determined the extent of ANC content received, which was consistent with previous studies in Ethiopia, Nigeria and Bangladesh (16, 23, 25). Educated women could be more aware of pregnancy-related complications and methods to prevent them. Hence, they could also have better healthcare-seeking behavior toward antenatal care services than those who were not educated.

The economic status of the households was also significantly related to the extent of ANC services received. Consistent with results in Nepal and South Ethiopia (24, 43), the poorest segment of the societies was less likely to receive more ANC services compared to the wealth group. This could be due to a lack of financial capacity to cover the direct medical and nonmedical costs required to receive health services. On the other hand, the rich could use more frequent and quality ANC even when service provision prices were expensive to the majority of the households.

Finally, the empirical analysis indicated that the location of residents significantly affected the utilization of antenatal services. In line with reports of studies from Nigeria, Nepal, and Ethiopia, rural residents were less likely to receive ANC components than urban residents (16, 23, 24). Even if access to health care services had expanded in various parts of Ethiopia, there was still urban rural disparity in obtaining access to quality services. Shortages of medical equipment and essential drugs were common problems in health facilities located in rural Ethiopia, where 80% of the population resides. Midwives working in rural public facilities struggled to save the lives of women due to a lack of essential medicines and devices, including thermometers, stethoscopes and weighing scales. Laboratory services were also limited due to scarcity of detergents and equipment (12, 44). Rural people also face transportation and financial constraints to access services available from far distances to their locations (16, 45). In addition, awareness and demand for health services were also poor in rural parts of the country (12, 46–48).

This study provides evidence on the quality of ANC service in Ethiopia by examining the extent to which women receive essential prenatal care components using a nationally representative household-based survey and robust statistical methods. However, the interpretation of the findings needs to be made considering the following limitations. In the study, components of ANC services received were assessed without considering the trimester at the first ANC visit. The 2016 EDHS does not include information on body weight measurement, which is one of the WHO recommended core components of ANC services (13). Moreover, the study is based on a survey that was conducted in 2016 and the results may not reflect recent situations. This is because, during the time of this study, there were no recent demographic and health surveys that contained relevant indicators on the contents of prenatal care received among women who had at least one ANC visit.

Conclusion

The study revealed that the majority of women, especially those in rural Ethiopia, did not receive the essential ANC components required to ensure safe delivery. This calls for designing appropriate policies to expand coverage of adequate ANC service provision in the country. In this regard, it is primarily important to strengthen the health system and make essential maternal health services available in health facilities. To enhance awareness about pregnancy-related complications and preventive methods, creating educational opportunities for women could also be useful. This also encourages women to properly plan pregnancy and to seek maternal health care services. It is also important to expand quality health care services in rural Ethiopia, where there is low utilization of essential health services. Due to scattered settlement and low affordable capacity, there are currently limited private providers in rural Ethiopia. Hence, governmental and nongovernmental organizations need to exert efforts to improve access to essential maternal health services in rural areas. The health agendas of sustainable development goals (SDGs) are also less likely to be achieved unless efforts are being made to reduce maternal mortality and improve the health status of women in rural Ethiopia.

Data availability statement

Publicly available datasets were analyzed in this study. This data can be found here: The data used for this study were obtained from the Demographic and Health Surveys (DHS) Program and are accessible with approval from the DHS Program.

Author contributions

AM is the sole author of this study, and he performed all activities of the research, including conceptualization, conducting data analysis and writing up the manuscript.

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Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Determinants of home delivery among reproductive age women in Bore District, East Guji Zone, Ethiopia: a case–control study

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Introduction: Home delivery, which is the process of childbirth at one's residence rather than in a health facility, is a major reason for maternal mortality caused by obstetric complications, such as sepsis, hypertensive disorders, and hemorrhage. Maternal and child mortality remains high in developing countries despite efforts made to reduce these outcomes. This is mainly due to poor utilization of institution-based healthcare services. Moreover, there is a limited number of studies that have addressed the determinants of home delivery in Ethiopia, including the study area. This study aims to identify the determinants of home delivery in Bore District, East Guji Zone, Southern Ethiopia, in 2022.

Methods: A community-based unmatched case–control study was conducted from 18 May to 5 July 2022 among 498 women (249 cases and 249 controls) who gave birth in Bore District. The case group included women who gave birth at home, while the control group included those who gave their last birth at health institutions. A multistage sampling technique was employed to select the study participants. Data were collected using the KoboToolbox digital software and exported to SPSS Version 26.0 for analysis. A multivariable logistic regression analysis was done to declare the statistical significance of the the association of the the independent variables and home delivery.

Results: The study included a total of 496 respondents with a mean age of 32.5 (SD = ±5.5) for the case group and 33.7 (SD = ±5.2) for the control group. Among the assessed determinants of home delivery were not attending antenatal care (ANC) visits [adjusted odds ratio (AOR) = 5.6, 95% CI: 2.0–15.16], missing pregnant women's conferences (AOR = 3.2, 95% CI: 1.65–8.32), not receiving health education on pregnancy-related complications (AOR = 2.2, 95% CI: 1.1–4.3), inadequate knowledge of pregnancy-related danger signs (AOR = 6.0, CI: 3.0–11.9), inadequate knowledge about pregnancy-related complications (AOR = 3.0, CI: 1.55–6.13), and unfavorable attitude (AOR = 6.9, 95% CI: 2.16–22.6).

Conclusion: In this study, not attending ANC visits, missing pregnant women's conferences, not receiving health education on pregnancy-related complications, inadequate knowledge of pregnancy-related danger signs, inadequate knowledge about pregnancy-related complications, and unfavorable attitudes were identified as determinants of home delivery.

The district health office and other stakeholders should work on strengthening maternal health service delivery through appropriate ANC visits and participation in pregnant women's conferences and improving community awareness about pregnancy at all levels.

Introduction

Home delivery is a global public health problem in low-income countries. It involves giving birth at one's home rather than at a hospital or health center (1). Giving birth at home is largely unplanned, accidental, and mainly supported by unskilled birth attendants, posing significant risks of morbidity and mortality for both the mother and child (2). Using the home environment as a delivery place is shown to be too unsafe in developing countries (3) and is associated with adverse neonatal and maternal outcomes (4). Institutional delivery is one of the key and proven interventions to reduce maternal death. It ensures a safe birth, reduces both actual and potential complications and maternal death, and increases the survival rate of most mothers and newborns (2, 4). The majority of maternal deaths are due to obstetric complications that could have been prevented with adequate medical care by skilled attendants during and after delivery (5). Lack of professionals' attendance during home delivery increases the risk of infection by 10%, postpartum hemorrhage (PPH) by 11%, and HIV/AIDS transmission by 6% to relatives or traditional birth attendants who conduct deliveries without protective equipment (6, 7). As a result of these conditions, an estimated 303,000 women die globally every year with almost 99% of deaths occurring in developing countries (8–10).

The worldwide frequency of home births is 28%, with Europe and Central Asia having the lowest prevalence at 5% and the East Asia and the Pacific regions having the highest prevalence at 38% (11, 12). Studies in some countries have reported that home delivery ranges from as low as 22% in Senegal to as high as 65% in Tanzania and 87.7% in Bangladesh (13, 14). The prevalence of this practice in sub-Saharan African countries is 34% on average. Among reproductive-age women in Ethiopia, the prevalence ranges from 13.5% in 2017 to 66.7% in 2020, making Ethiopia one of the countries with the highest rate of home delivery (1, 4). According to the 2019 report of the Ethiopian Demographic and Health Survey (EDHS), 51% of women gave birth at home (15, 16), of which 35% were assisted by TBAs, 13% by relatives or others, and 3% delivered without any type of assistance (15). Another study conducted in the Oromia region of Ethiopia showed that approximately 59.1% of women gave birth at home, which was higher than that at the national level (15).

A community-based cross-sectional study conducted in Shashamanne town, Ethiopia, revealed a home delivery rate in the town of 68%, due to the absence of labor pain (75.5%), lack of adequate delivery services from health professionals (5.7%), and lack of knowledge about the importance of delivery in health institutions (15.1%) (17).

Studies conducted so far identified residence, educational level of the mother, knowledge of obstetric complications, and gestational age at first antenatal care (ANC) as the main individual-level factors associated with home delivery (1, 5, 16, 17, 18). Few studies also revealed the following community-level factors that determine decisions for home delivery: women living in urban settings, who are literate and influenced by their husbands and relatives, and who have had prolonged labor are more likely to deliver in health facilities (1, 5, 16, 19).

To address the delays of pregnant women in their decisions to seek and receive care from health facilities and their consequences, the Federal Ministry of Health of Ethiopia has shown a strong commitment by promoting human resource development and bringing maternal healthcare services closer to women. The ministry has so far launched an initiative with the slogan "No Woman Should Die While Giving Life" and the general motto "Home Delivery Free Kebeles" (HDF) (15, 16). The Women's Development Army (WDA) also plays a critical role in minimizing the magnitude of home delivery at the local level by identifying pregnant women in the community (20).

Despite the efforts made by the government and other stakeholders to reduce the problems and subsequent consequences of home delivery, studies conducted in different parts of the country showed that most Ethiopian women are giving birth at home and are experiencing problems associated with it (10, 15, 16, 18, 21). With these problems in mind, this study aims to identify the determinants of home delivery in the study area and enable a deeper understanding of the study participants' experiences of issues associated with home delivery.

Conceptual framework

The conceptual framework of this study was adapted from related published literature grouped into sociodemographic, obstetric, service provider, and health facility-related factors (16, 20, 21) (Figure 1).

Methods and materials

Study design, period, and area

A community-based, unmatched case–control study was conducted in Bore District from 18 May to 5 July 2022. The district is one of the areas found in the East Guji Zone, Oromia Region, and is located 450 km away from Addis Ababa. The

FIGURE 1

Conceptual framework for the factors associated with home delivery in Bore District, East Guji Zone, Southern Ethiopia, in 2022.
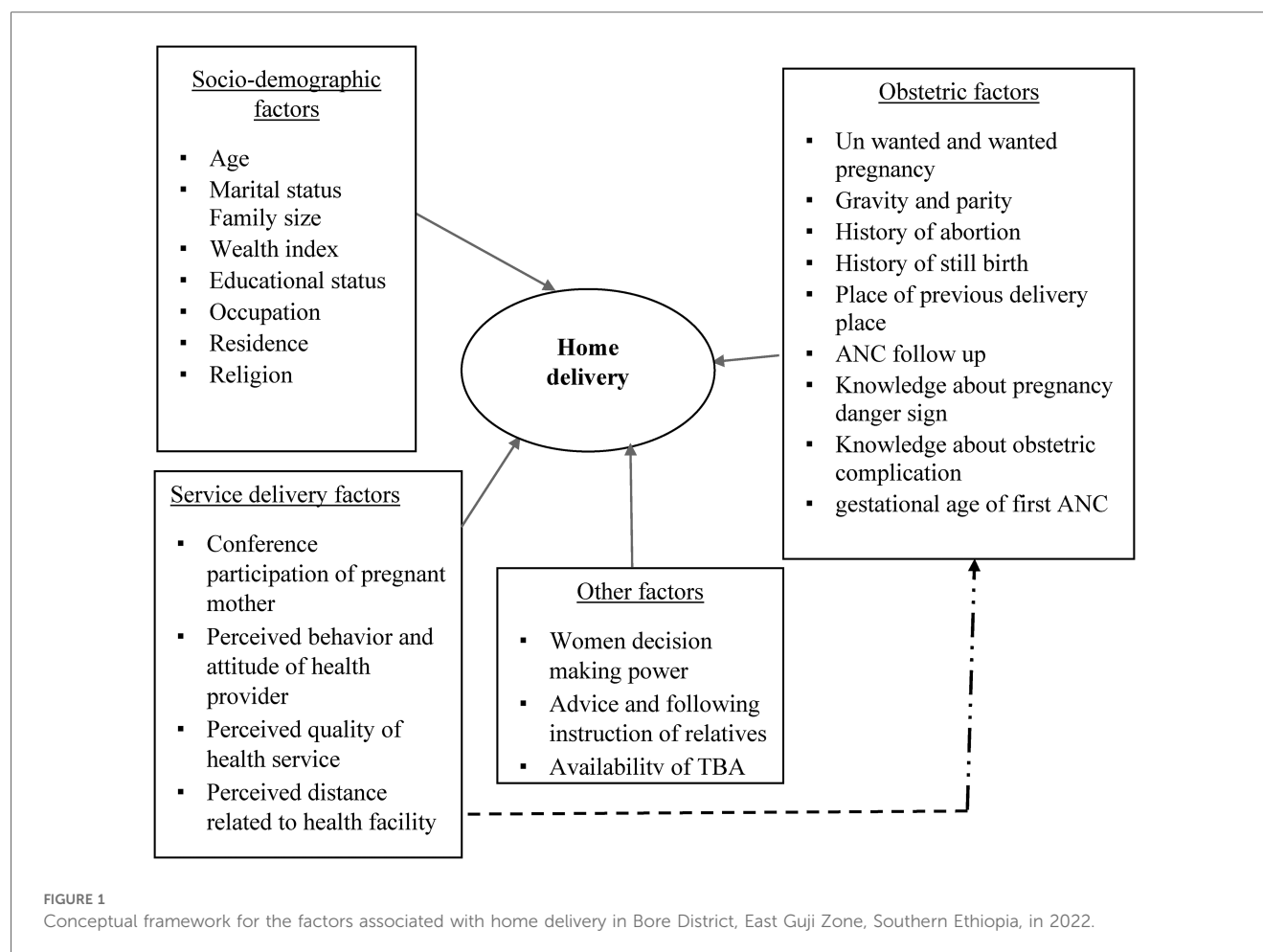
district has 33 kebeles (3 urban and 30 rural kebeles). There are six public health centers, one primary hospital, 33 health posts, and 10 private clinics in the district that provide comprehensive health services, including delivery service, which is free of charge. The total population of the district is approximately 174,941 according to the basic data obtained from the district health office in 2022 (22).

According to the 2021/2022 report of the district health office, the expected number of deliveries is 6,070, of which 2,792 occurred at health facilities. The report from the previous 6 months, based on the data from the district's health post-family folder, indicated that there were 1,298 home deliveries and 1,690 institutional deliveries (Bore District Health Office, 2022)[1].

Study population

All women who gave birth in Bore District 6 months prior to the study were the source population. All randomly selected women who gave birth in the same district 6 months prior to the study were the

study population. Regarding the eligibility criteria, all women who gave birth within 6 months prior to the study and lived in the district for at least 6 months were included in the study.

Sample size determination

The sample size required was calculated using a two-population proportion formula and the EPI INFO version 7.0 statistical software, with an assumption of 95% CI ($Z\alpha/2 = 1.96$), power of 80% ($Z = 0.84$), and case-to-control ratio of 1:1, and by taking P1 as the proportion of cases exposed and P2 as the proportion of controls exposed. Residence in rural mothers was taken as an exposure variable (23) (Table 1).

The calculated sample size with the maximum sample for this study was 226. Considering the design effect of 2% and 10% non-response rates, the final sample size was found to be 498, with a total of 249 cases and 249 controls.

Sampling procedure

A multistage sampling technique was used to select study participants from the selected kebeles in the district. Initially, the

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[1]Source: Bore District Health Office Basic Profile Data, unpublished.

TABLE 1 Sample size determination for the factors associated with home delivery in Bore District, East Guji Zone, Ethiopia, in 2022.

S. no.	Variables	CI	Power	P1	P2	Odds ratio	Number of cases	Number of controls	Total	References
1	Unable to read and write (education status)	95%	80%	32.2	14.3	2.85	97	97	196	(24)
2	Rural resident	**95%**	**80%**	**20.0**	**6.48**	**3.6**	**113**	**113**	**226**	(23)
3	ANC (less than three visits)	95%	80%	21.9	4.47	6	69	69	138	(24)
4	Husbands decided place of delivery	95%	80%	68.0	22.8	7.2	23	23	46	(5)
5	No awareness of pregnancy-related danger signs	95%	80%	60.7	31.9	3.30	53	53	106	(21)
6	Time to health facility >1 h	95%	80%	18.9	4.92	4.5	97	97	194	(24)
7	Negative attitude	95%	80%	37.1	13.6	3.74	61	61	122	(24)
8	Poor knowledge of obstetric complication	95%	80%	90.4	54.1	7.95	28	28	56	(19)
9	Gestational age >16 weeks	95%	80%	55.9	21.6	4.6	37	37	74	(5)
10	Not involved in WDA	95%	80%	45.5	20.2.	3.3	61	61	122	(5)
11	Maternal age <25 years	95%	80%	40.9	19	2.95	77	77	154	(21)

Bold values indicate significant variables considered to calculate sample size from previously published literature.

kebeles found in the district were stratified into rural and urban kebeles. Ten rural and 2 urban kebeles were chosen randomly (using a lottery method) from the 33 kebeles found in the district (3 urban and 30 rural kebeles). Regarding the selection of participants, first, the list of 1,097 eligible women who gave birth in the selected kebeles was taken from family folders found in their respective health posts and used as a sampling frame. Next, all eligible cases and controls were separately identified with their full address from the family folder of nearby health posts for each selected kebele before the actual data collection. A family folder is a registry containing the profiles of all the family members in the kebele. The list of eligible mothers that was obtained from the health posts' family folder was cross-checked with the delivery records in the health posts to ensure that no eligible mother was left out of the sampling frame. Proportional allocation to size was then made to determine the required sample size from each kebele. Finally, a simple random sampling technique was used to select the required 249 cases and 249 controls from each kebele using the household listed as a sampling frame. Local guides were used to reach the mothers. A minimum of three times of revisits was arranged for the eligible mothers who were not present at the time of data collection. The lottery method was used to select one woman in case there were two or more women in an eligible household.

Data collection tool and procedures

Data were collected through face-to-face interviews using interviewer-administered structured questionnaires that were developed from a review of available literature (9, 24, 25). The questionnaire had four parts: sociodemographic characteristics, maternal and obstetric characteristics, facility and service provider characteristics, and cultural beliefs of the respondents. Cronbach's α coefficients were computed to test the internal consistency/reliability of attitude toward delivery services. This was measured using six-point Likert scale-based items, and Cronbach's α was calculated to be 0.84. Six health officers who were recruited from

the district health office conducted data collection under the supervision of two public health workers with a master's degree who also came from the district health office.

Study variables

Dependent variable

Place of delivery (home delivery).

Independent variables

Sociodemographic characteristics: age, marital status, type of marriage, family size, wealth index, educational status, occupation, religion, and place of residence.

Obstetric characteristics: age at first birth, ANC visit, unwanted pregnancy, unplanned pregnancy, knowledge of pregnancy-related danger signs, knowledge of obstetric complications, gestational age at first ANC, gravidity, parity, history of abortion, history of stillbirth, and place of the previous delivery.

Service provider- and health facility-related factors: health information on pregnancy-related conditions, perceived behavior and attitude of health provider, perceived quality of health service, counseling to deliver at a health facility, and perceived distance to a health facility.

Other factors: women's decision-making power, adherence to advice and instructions from relatives, and availability of traditional birth attendants.

Quality assurance

The questionnaire was prepared in English and translated to Afan Oromo by a senior language translator for better understanding and then translated back to English by an independent person to ensure consistency. The data collectors and supervisors received a 2-day training covering the objective of the study, contents of the questionnaire, confidentiality protocols, rights of the respondents, and data

collection approach. A pretest was conducted on 5% of the samples at the Haro kebele, a neighboring kebele to the study district. Following data collection, the principal investigator and supervisors checked the completeness, accuracy, clarity, and consistency of the collected data before downloading and exporting them from the KoboToolbox to Excel. Data in Excel were then converted to SPSS to check for possible outliers, missing values, fulfillment of assumptions, and feasibility for analysis.

Data processing and analysis

The data were collected using the KoboToolbox software; downloaded from there; coded, cleaned, and corrected as needed on Excel; and then exported to SPSS Version 26 for data cleaning and analysis. The exported data were checked for outliers, missing values, and assumptions. The descriptive variables were explained using cross-tabulations, and frequencies were generated for different variables as needed. A bivariable analysis was carried out to identify the candidate variables for multivariable logistic regression. The independent variables with a p-value of <0.25 in the bivariate analysis were then used for further analysis through multivariable logistic regression (to control the confounding effects). The backward model selection method was employed to identify the variables remaining for the final model. Multicollinearity was checked with a standard error (SE) of 2 as the cutoff point. All variables in this study were found to be less than 2 SE. Model fitness was checked with the Hosmer and Lemeshow model goodness-of-fit test at a p-value of > 0.05. Finally, an AOR with a 95% CI at a p-value of <0.05 was used to declare the statistical significance of the association between the dependent variables (home delivery) and selected independent variables.

Measurements and operational definitions

The case group comprised women who had their recent births at home, while the control group comprised women who had their last births at health institutions (16).

Knowledge of participants on the danger signs during pregnancy was measured by using 10 multiple-choice questions about danger signs. The total score for knowledge was dichotomized into inadequate and adequate knowledge by the mean score cutoff point. Inadequate knowledge is defined as a score less than or equal to the mean score for knowledge questions, while adequate knowledge is defined as a score greater than the mean score for knowledge questions (16, 23).

Knowledge of participants on general obstetric complications was measured by using eight multiple-choice questions about obstetric complications. The total score for knowledge was dichotomized into inadequate and adequate knowledge by the mean score cutoff point. Inadequate knowledge is defined as a score less or equal to the mean score for knowledge questions, while adequate knowledge is defined as a score greater than the mean score for knowledge questions (16, 23).

Proximity to a health facility

A participant was considered close to a health facility if she traveled less than or equal to an hour on foot to reach the health facility and considered far from a health facility if she traveled greater than an hour on foot to reach the health facility (21).

Maternal conference

Maternal conference is the practice in which pregnant women form a monthly gathering with one another and with health professionals to discuss their health and well-being.

Attitude toward institutional delivery service

Six-point Likert scale questions were used to assess the attitude of the participants. The variable for attitude was dichotomized into unfavorable and favorable attitudes, based on the mean score cutoff point. An unfavorable attitude is defined as a score less or equal to the mean score for attitude questions, while a favorable attitude is defined as a score greater than the mean score for attitude questions (16, 23).

Wealth index

The wealth index was assessed by using the Equity Tool (asset variables: access to electricity and ownership of electric appliances such as refrigerators, televisions, and radios) and analyzed using the principal component analysis. Before conducting the principal component analysis, the value of each wealth variable was categorized as 0 = no and 1 = yes. After conducting the analysis, the variables were categorized into the first, second, third, fourth, and fifth quintile groups and then transformed into three categories representing the lower, middle, and higher wealth statuses.

Results

Sociodemographic characteristics of the respondents

A total of 496 respondents (248 cases and 248 controls) were involved in this study, resulting in a response rate of 99.6%. The mean age of the study participants was 32.5 (SD = ±5.5) for the case group and 33.7 (SD = ±5.2) for the control group. The majority of the participants in the case group (62.9%) and the control group (58.5%) lived in rural areas. Regarding educational status, 44% of mothers and 18.1% of husbands in the case group and 21% of mothers and 5.6% of husbands in the control group were unable to write and read (Table 2). The wealth index of the households revealed that 39.5% of the control group and 40.7% of the case group had a lower wealth status (Figure 2).

Obstetric characteristics of the respondents

A total of 187 (75.4%) cases and 181 (73.8%) controls had a parity of 2–5. Accordingly, 156 (62.9%) cases and 89 (35.9%) controls had no ANC visit in their last pregnancy. The last pregnancy of 175 (70.6%) cases and 220 (88.7%) controls was planned. Only 78

TABLE 2 Sociodemographic characteristics of the study participants on home delivery in Bore District, East Guji, Ethiopia, in 2022.

Variables	Cases (n = 248)	Controls (n = 248)
	No. (%)	No. (%)
Age (in years)		
15–19	24 (9.6)	15 (6.0)
20–24	76 (30.6)	15 (6.0)
25–29	88 (35.4)	55 (22.1)
30–34	32 (12.9)	85 (34.2)
35–39	28 (11.2)	78 (31.4)
Residence		
Rural	156 (62.9)	145 (58.5)
Urban	92 (37.1)	103 (41.5)
Educational status		
Unable to write and read	109 (44)	52 (21)
Primary school	85 (34.3)	73 (29.4)
High school and preparatory	39 (15.7)	87 (35.1)
Diploma and above	15 (6)	36 (41.5)
Marital status		
Single	16 (6.5)	6 (2.4)
Married	211 (85.1)	216 (87.1)
Widowed	12 (4.8)	21 (8.5)
Divorced	9 (3.6)	5 (2)
Type of marriage		
Monogamy	123 (49.6)	89 (35.9)
Polygamy	125 (50.4)	159 (64.1)
Occupation		
Farmer	32 (12.9)	32 (12.9)
Housewife	146 (58.9)	135 (54.4)
Merchant	54 (21.8)	55 (22.2)
Government employee	16 (6.5)	26 (10.5)
Religion		
Orthodox	68 (27.4)	63 (25.4)
Protestant	146 (58.9)	149 (60.1)
Muslim	34 (13.7)	36 (14.5)
Ethnicity		
Oromo	202 (81.5)	190 (76.6)
Amhara	37 (14.9)	43 (17.3)
Others*	9 (3.6)	15 (6)

*Tigre, guraghe, and silte.

(31.5%) cases and 232 (93.5%) controls reported that giving birth at home is risky for both the fetus and the mother (Table 3).

Health facility- and service provider-related factors

The number of study participants who did not receive counseling about the place of delivery was 125 (50.4%) for the case group and only 12 (4.8%) for the control group. A total of 239 (96.4%) cases and 190 (76.6%) controls had an unfavorable attitude toward health facility delivery service (Table 4).

Availability of traditional birth attendants and decision-making power regarding the place of delivery

A total of 187 (75.4%) cases and 178 (71.8%) controls reported the presence of traditional birth attendants in their locality. Regarding the decision-making of the delivery place, only 105 (42.6%) cases and 56 (22.6%) controls indicated that the decision was independently made by mothers (Figure 3).

Determinants of home delivery

The study showed that women who had no ANC visit had 5.6-fold higher odds of giving birth at home compared to those who had four or more ANC visits (AOR = 5.6, 95% CI: 2.06–15.16). Women who had inadequate knowledge of pregnancy-related danger signs were six times more likely to give birth at home compared to their counterparts (AOR = 6.0, CI: 3.0–11.9). The study also revealed that women who had inadequate knowledge of obstetric complications had threefold higher odds of giving birth at home compared to those who had adequate knowledge of the issue (AOR = 3.0, CI: 1.55–6.13). Women who did not participate in pregnant women's conferences had 3.2 times higher odds of giving birth at home compared to those who
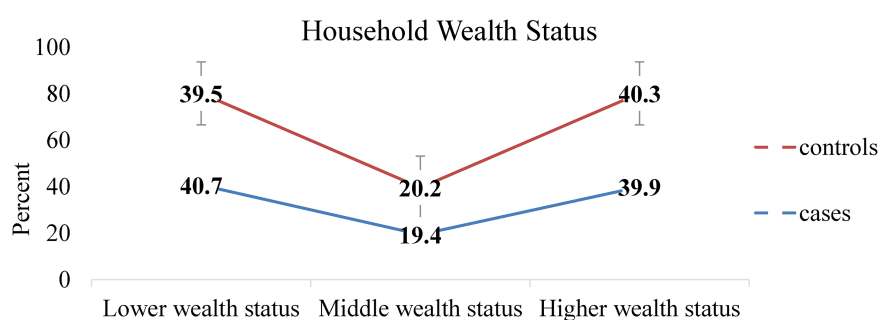

FIGURE 2
Wealth status of households with women who gave birth in Bore District, East Guji Zone, Southern Ethiopia, in 2022.

TABLE 3 Obstetric-related characteristics of women who gave birth in the last 6 months in Bore District, East Guji Zone, Southern Ethiopia, in 2022.

Variables	Cases ($n = 248$)	Controls ($n = 248$)
	No. (%)	No. (%)
Gravida		
Primigravida	15 (6.0)	24 (9.7)
Multigravida	233 (94.0)	224 (90.3)
ANC visits		
No ANC visit	156 (62.9)	89 (35.9)
One–three visits	67 (27.0)	116 (46.8)
Four and above visits	25 (10.1)	43 (17.3)
Place of ANC visit		
Health center	24 (26.1)	104 (65.4)
Health post	64 (69.6)	36 (22.6)
Hospital	4 (4.3)	19 (11.9)
Gestational age at first ANC visit		
Less than or equal to 16 weeks	10 (11)	30 (18.9)
Greater than 16 weeks	81 (89)	129 (81.1)
Last pregnancy intended		
Yes	181 (73)	219 (88.3)
No	67 (27)	29 (11.7)
History of abortion		
Yes	16 (6.5)	28 (11.3)
No	232 (93.5)	220 (88.7)
History of stillbirth		
Yes	5 (20)	17 (6.9)
No	243 (98)	231 (93.1)
Level of knowledge of pregnancy-related danger signs		
Inadequate knowledge	134 (72)	45 (18.8)
Adequate knowledge	52 (28)	194 (81.2
Level of knowledge on obstetric complication		
Inadequate knowledge	100 (66.2)	46 (19.7)
Adequate knowledge	51 (33.8)	188 (80.3)
Importance of delivery at a health facility		
Yes	150 (60.5)	246 (99.2)
No	98 (39.5)	2 (0.8)

TABLE 4 Healthcare provider-related characteristics of the study participants in Bore District, East Guji Zone, Southern Ethiopia, in 2022.

Variable	Cases ($n = 248$)	Controls ($n = 248$)
	No. (%)	No. (%)
Ever got counseling about the place of delivery		
No	125 (50.4)	12 (4.8)
Yes	123 (49.6)	236 (95.2)
Health education on pregnancy-related complications		
No	199 (80.2)	168 (43.5)
Yes	49 (19.8)	140 (56.5)
Maternal conference participation		
No	206 (83.0)	199 (40.0)
Yes	42 (17.0)	49 (60.0)
Proximity to a health facility		
Closest to the health facility	49 (19.8)	36 (14.5)
Far from health facility	199 (80.2)	212 (85.5)
Access to ambulance service		
No	147 (59.3)	111 (44.8)
Yes	101 (40.7)	137 (55.2)
Attitude toward the facility delivery service		
Unfavorable attitude	239 (96.4)	190 (76.6)
Favorable attitude	9 (3.6)	58 (23.4)

pregnancy-related danger signs, mothers' lack of health education on pregnancy and pregnancy-related problems, and inadequate knowledge of obstetric complications are the determinants of home delivery.

The study indicated that women who had inadequate knowledge of pregnancy-related danger signs had increased odds of giving birth at home compared to their counterparts. This result is consistent with the findings of studies conducted in Northern Ethiopia and Bahirdar (16, 23). The reason for this might be because women with inadequate knowledge of pregnancy-related danger signs do not know the consequences of home delivery and, therefore, may not hesitate to do so.

Women who had an unfavorable attitude toward institutional delivery service were more likely to give birth at home compared to those who had a positive attitude toward such service. This finding agrees with the results of studies conducted in Zala woreda, Southern Ethiopia, and Eritrea (24, 26). The unfavorable attitude of women toward such service might result from missing expected service elements like lack of privacy to one's own body in every visit to the health facility or actual or assumed ill treatment of the mothers by health professionals. Such an attitude may promote risk/consequences associated with home delivery. The current study showed that the odds of home delivery were considerably higher among women with inadequate knowledge of obstetric complications. These findings are consistent with the results of previous studies in the Afar region, Ethiopia, and other countries such as Nepal (21, 27). The increased understanding that mothers have about obstetric complications may make them fear these problems after giving birth; therefore, they prefer institutional delivery being assisted by skilled professionals.

Being unable to participate in pregnant women's conferences was significantly associated with home delivery in the current

participated in the conference thrice and higher (AOR = 3.2, 95% CI: 1.65–8.32).

Women who did not receive health education on pregnancy and pregnancy-related complications were 2.2 times more likely to give birth at home compared to their counterparts (AOR = 2.2, 95% CI: 1.1–4.3). Women who had an unfavorable attitude toward health facility delivery services had seven times higher odds of giving birth at home compared to those who had a favorable attitude toward health facility delivery services (AOR = 6.9, 95% CI: 2.16–22.6) (Table 5).

Discussion

This study aimed to assess the determinants of home delivery among women who gave birth in Bore District, Ethiopia. The study found that mothers' lack of ANC visits, mother's lack of participation in pregnant women's conferences, unfavorable attitude toward institutional delivery, inadequate knowledge of
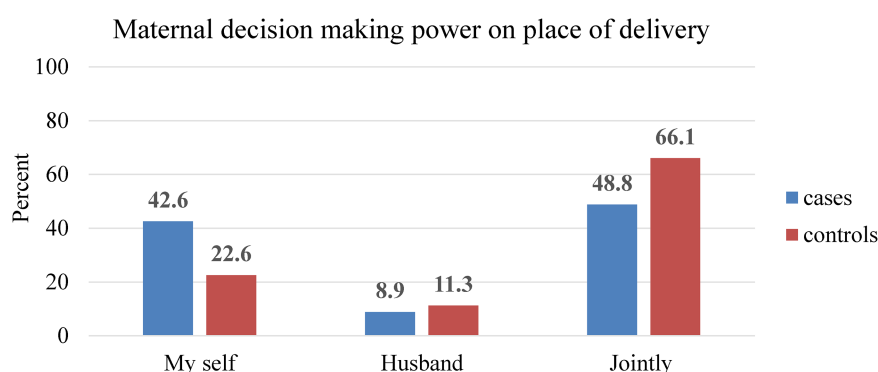
FIGURE 3
Maternal decision-making level on the delivery site in the last pregnancy in Bore District, East Guji Zone, Southern Ethiopia, in 2022.

TABLE 5 Determinants of home delivery in Bore District, East Guji Zone, Southern Ethiopia, in 2022.

Variables	Cases No. (%)	Controls No. (%)	COR (95% CI)	AOR (95% CI)	*p*-value
ANC visits					
No visit	156 (62.9)	89 (35.9)	3 (1.7–5.2)	5.6 (2.06–15.16)	0.001*
One–three visits	67 (27)	116 (46.8)	1 (0.5–1.7)	1.1 (0.4–3.03)	0.287
≥4 visits	25 (10.1)	43 (17.3)	1	1	
Knowledge of pregnancy-related danger signs					
Inadequate	134 (72)	45 (18.8)	11 (7.0–17.5)	6 (3.0–11.9)	0.001*
Adequate	52 (28)	194 (81.2)	1	1	
Knowledge of obstetric complication					
Inadequate	100 (66.2)	46 (19.7)	8 (5.02–12.7)	3 (1.55–6.13)	0.001*
Adequate	51 (33.8)	188 (80.3)	1	1	
Pregnant women's conference participation					
No	206 (83.0)	199 (40.0)	1.2 (1.08–3.8)	3.2 (1.6–8.3)	0.024*
Yes	42 (17.0)	49 (60.0)	1	1	
Health education on pregnancy-related complications					
No	199 (80.2)	108 (43.5)	5.2 (3.5–7.8)	2.2 (1.1–4.3)	0.020*
Yes	49 (19.8)	140 (56.5)	1	1	
Attitude toward the delivery service					
Unfavorable, favorable	239 (96.4)	190 (76.6)	8 (3.91–16.8)	6.9 (2.16–22.6)	0.001*
	9 (3.6)	58 (23.4)	1	1	

*Significant at a *p*-value of <0.05.

study. Women who were unable to participate in the conferences were more likely to give birth at home compared to conference participants. This finding is supported by a study done in Northwest Ethiopia (28). Women who were not involved in the pregnant women's conferences lack information about the benefits of giving birth at a health facility and the complications of home delivery and therefore intend to deliver at home.

Women who had no ANC visit were more likely to give birth at home when compared to those who had four or more ANC visits. This finding is in line with the results of studies conducted in the Tanqua Abergele District in Northern Ethiopia, East Wollega, Zala woreda in Southern Ethiopia, other countries such as Nepal, and Eretria (16, 24, 26, 27, 29). The possible reason may be that women who make fewer visits would be less likely to obtain adequate information and counseling about the advantages of health facility delivery and will therefore favor home delivery

over facility visits. Nonetheless, a study done in Nigeria argues that having an ANC visit was associated with an increased risk of home delivery as women who are told their pregnancy is fine may feel encouraged to deliver at home (30).

Exposure to health education on pregnancy and pregnancy-related problems was another predictor of home delivery in this study. Women who lacked health education on pregnancy and pregnancy-related problems had considerably higher odds of giving birth at home compared to their counterparts. This finding agrees with the results of studies conducted in Shashamanne and Hamer, Ethiopia (5, 31). The health education given may enable women to acquire knowledge on pregnancy and obstetric complications, consequences of delivering at home, and care the mother and child can obtain from delivering at a health institution and may therefore make them develop an interest in delivering at such a place.

Strength and limitation of the study

This study used a community-based case–control study design that could give a strong prediction of home deliveries. As a limitation, the study may be susceptible to recall and social desirability bias since the method involved interviewer-administered questionnaires in data collection. Although multistage sampling is utilized to sample the study populations and gather data, the analysis did not take this attribute into account because data on the variables used for forming clusters were not collected. Finally, there were missing data for some variables.

Conclusion and recommendation

The lack of ANC visits, inadequate knowledge of pregnancy-related danger signs and obstetric complications, lack of health education on pregnancy and pregnancy-related complications, unfavorable attitude toward facility delivery services, and lack of PWC attendance were the identified determinants of home delivery.

The district health office should work to improve institutional delivery through appropriate ANC visits, strengthening pregnant women's conferences, and improving community awareness about pregnancy at all levels. Health professionals should give due attention to pregnancy-related danger signs and complications and husband involvement in pregnant women's conferences. All health facilities in the district should arrange PWC every 2 weeks in each kebele and monthly in health centers in collaboration with HEWs and midwives.

Data availability statement

The raw data supporting the conclusions of this article can be made available by the authors, without undue reservation.

Ethics statement

Ethical approval was obtained from the Ethical Review Committee of College of Health Sciences Salale University. It was presented to the Bore district health office and district administration to obtain official permission to undertake research activities in each of the selected kebeles. All study participants were informed that data was kept private and confidential and used only for research purposes. The participants were assured that they had the right to refuse or withdraw from the study at any time if they were not comfortable with it. Informed verbal consent was also obtained before the interview.

Author contributions

All authors made significant contributions in the conception, study design, execution, acquisition of data, analysis, and interpretation of the work reported, took part in drafting and critically reviewing the article, gave final approval of the version to be published, and agreed to be accountable for all aspects of the work. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Level of optimal antenatal care utilization and its associated factors among pregnant women in Arba Minch town, southern Ethiopia: new WHO-recommended ANC 8+ model

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Background: To fully realize the life-saving and health-promoting benefits of antenatal care (ANC), the latest World Health Organization (WHO) recommendations call for pregnant women to have at least eight contacts with skilled healthcare providers. This increased number of recommended ANC visits represents a shift toward a more comprehensive, individualized approach to prenatal care. The focus is on health promotion, disease prevention, and the early detection and management of complications during pregnancy. However, in sub-Saharan African countries, including Ethiopia, the coverage rate for this level of recommended antenatal care is only 58%. Given this relatively low utilization, identifying the key risk factors that prevent adequate antenatal care would have significant implications for increasing overall ANC uptake in these regions.

Objective: The aim of the present study was to assess the level of optimal antenatal care utilization and its associated factors among pregnant women in Arba Minch town, southern Ethiopia in 2023 using the new WHO-recommended ANC 8+ model.

Methods: An institution-based cross-sectional study was conducted among 416 mothers who were enrolled between 1 December 2022 and 30 January 2023. The total sample size was allocated proportionately to the number of women who delivered at each public health facility. Thus, systematic sampling was applied. Kobo Toolbox was used for data collection and cleaning, which was then analyzed using SPSS Version 26. Statistical significance was determined at a *p*-value <0.05.

Results: In this study, the level of optimal antenatal care was 41% [95% confidence interval (CI): 37−45.3]. The associated factors with optimal antenatal care were the presence of pregnancy danger signs [adjusted odds ratios (AOR) = 4.1, 95% CI: 1.87−8.82], having bad obstetric history (AOR = 3.90, 95% CI: 1.94−7.83), antenatal contact at hospital (AOR = 5.11, 95% CI: 2.28−11.21), having good knowledge about antenatal care (AOR = 2.26, 95% CI:

Abbreviations
ANC, antenatal care; EDHS, Ethiopia Demographic and Health Survey; MMR, maternal mortality rate; SDG, sustainable development goals.

1.15–4.44), women's high decision-making power (AOR = 3.9, 95% CI: 1.2–7.63), and male partner involvement (AOR = 2.0, 95% CI: 1.04–3.78) were positively associated with optimal antenatal care utilization.

Conclusion: The level of optimal antenatal follow-up is still low. Therefore, it is crucial to provide more information during the antenatal contacts to lower the rate of women discontinued from antenatal care.

Introduction

Antenatal care (ANC) is a maternal healthcare service provided by coordinated healthcare professionals to pregnant women to support and maintain their optimal health during pregnancy, delivery, and puerperium, as well as to have and raise a healthy baby. It also provides an opportunity for nutrition, birth preparation, delivery care, and postpartum contraceptive education (1).

The World Health Organization (WHO) has recommended the four-visit ANC model since 2002, which recommends at least four visits, but an updated version with eight ANC contacts was released in 2016 that calls for ANC contacts before 12 weeks of gestation. The word "visit" in the previous model has now changed to "contact" to indicate an active interaction between a pregnant woman and a healthcare provider (1) and the new model is being implemented since Ethiopia adopted the new recommendation and incorporated it in the management protocol for hospitals in 2021 (2).

Women who did attend each of the suggested contacts of ANC are considered to have optimal (adequate) antenatal care (3). Particularly in low-resource settings, women who receive skilled care during pregnancy often "drop out" during a critical period (pregnancy) of care and end up delivering at home or in the community without a certified, properly trained health professional, putting themselves and their newborns at risk (4). Many maternal and prenatal deaths occur in women who have received inadequate and no utilization of ANC (5).

In Africa, the coverage of antenatal care was only 58% (6), with west and central Africa having the lowest ANC coverage (53%) (7). According to the Ethiopia Demographic and Health Survey (EDHS) 2019, the percentage of women who received at least one ANC visit by a skilled professional was 74% and for those who received four or more was 43% (8).

Before the introduction of antenatal care by the WHO in the 2000s, maternal mortality rates (MMRs) were at historically high levels globally. In the 1990s, there were 400 maternal deaths worldwide per 100,000 live births, which today has decreased to 223 deaths per 100,000 live births (9, 10). It has decreased maternal mortality by 34% over two decades However, globally, a woman is still dying every 2 min from almost all preventable causes, which is 800 mothers every day (5).

To combat this, WHO and other stakeholders are working to reduce maternal and child mortality through various intervention programs and strategies, such as through preventable deaths, ensuring good health and wellbeing (11) and the Sustainable Development Goals (SDG) plan to decrease maternal mortality to below 70 maternal deaths per 100,000 live births by 2030 (12).

There is a program that uses Health Extension Workers (HEWs) to mobilize the community to increase attendance at ANC visits. The goal is to provide health education on the advantages of regularly attending ANC appointments, as well as the burdens and risks associated with not visiting for ANC. The program aims to raise awareness and encourage pregnant women to prioritize and attend their recommended ANC checkups.

A different cross-sectional study conducted worldwide revealed that sociocultural and economic barriers, poor access to health services, long distance from healthcare facility services, lack of knowledge, lack of professional advice, poor wealth index, and not developing a danger sign were factors negatively associated with optimal ANC (13–15).

However, in this study, variables such as type of institution, perceived quality of care, level of respectful and non-abuse care and partner involvement were additionally included in this study. Even though some studies have been conducted on the factors contributing to optimal antenatal care utilization in Ethiopia (16, 17), after the introduction of the recommended new ANC model, there is some information and certainly undiscovered factors that were revealed within this study. Therefore, the objective of the present study was to assess the level of optimal antenatal care and the factors related to adequate contacts of antenatal care during pregnancy in Arba Minch town.

Materials and methods

Study design and setting

An institutional cross-sectional study was conducted among postpartum mothers who gave birth at health facilities in Arba Minch town between 1 December 2022 and 30 January 2023. The town is located 505 km southwest of Addis Ababa, the capital city of Ethiopia, and 275 km away from Hawassa, the commercial and administrative center of the southern region. According to the 2022 population projection, Arba Minch town has a total population of 201,049 (101,130 male, 100,019 female) (18). The town has two public hospitals, one private hospital,

and two health centers. All the health facilities provide perinatal care, with 15 nurses and 30 midwives providing antenatal care in those health facilities. The public health institutions in the town are expected to serve more than half a million people in the town and nearby districts (19).

Study participants

The study participants were mothers initially booked for antenatal care visits and who gave birth in public health facilities in Arba Minch town and were available during the data collection period. Those willing to give information were included while those mothers critically ill on the day of data collection and referred from other facilities outside Arba Minch were excluded from the study.

Sample size determination

The sample size was calculated using a single population proportion formula: $n = (za)^2 \frac{p(1-p)}{d^2}$, considering the following assumptions: the magnitude optimal antenatal care utilization analysis from Ethiopian EDHS (43%) (20), with a 95% confidence interval (CI), and 5% margin of error.

$$n = (za)^2 \frac{p(1-p)}{d^2}$$

$$n = (1.96)^2 \frac{0.43(1-0.57)}{0.05^2} = 378$$

With a 10% non-response rate included, a final sample size of 416 was obtained.

Sampling technique and procedure

Two public hospitals and two public health clinics serve the population by offering both curative and preventive services in Arba Minch town. This study considers all public health centers and hospitals in the town. The mothers were then enrolled if they gave birth at these healthcare institutions. The systematic sampling technique was used to determine the sample size for four healthcare facilities. As a result, the total numbers of participant from all four facilities was determined using the delivery registration book from the previous year for the same months (i.e., December to January). According to the 2021 report of each health facility's annual skilled birth attendant report, at similar times in the past 2 months, 496 women delivered in Arba Minch General Hospital, 204 mothers gave birth in Dilfana Primary Hospital, 160 women delivered in Secha Health Center, and 100 women gave birth in Woze Health Center. These women were used as the sampling frame. The respondents were then found using a systematic random sampling method. As a result, the first respondent was chosen by lottery among the first k intervals, and the other research participants were chosen by every 'k'th (i.e., every second) value for all institutions until the required total sample size was reached (i.e., 416) (Figure 1).

Data collection tool and data quality management

The questionnaire used was an interviewer-administered semi-structured questionnaire adapted from relevant literature (13, 21–25) with modifications and employed for data collection. The tool consists of four sections: sociodemographic, institutional, personal factors, and reproductive variables. The questionnaire was designed in the English and Amharic languages. Women who gave birth in public health facilities in Arba Minch town were enrolled by applying
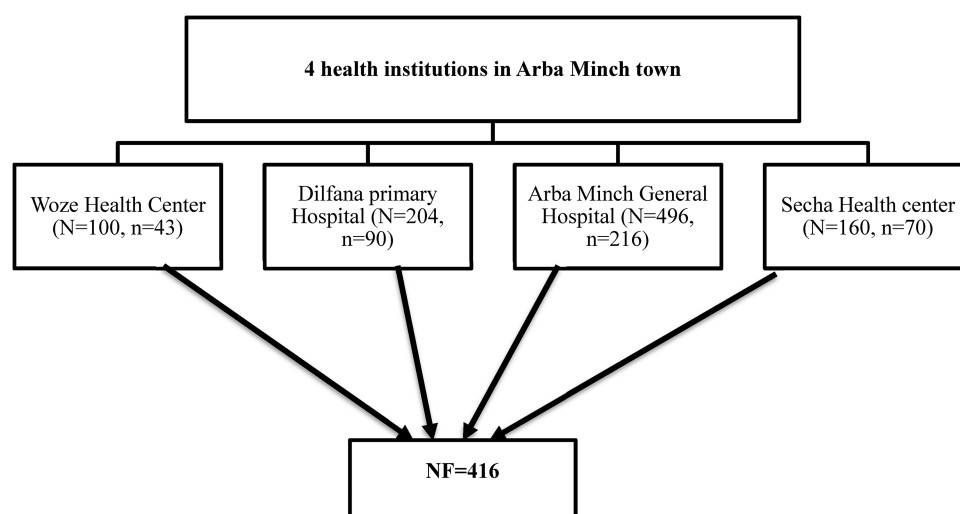
FIGURE 1
A schematic diagram shows the proportional allocation of the sample size of each health institution in Arba Minch town.

systematic sampling depending on case flow of the same 2 months of the previous year, using it as a sampling frame. Pre-testing of the questionnaire was carried out 2 months before the commencement of the data collection among 20 mothers who gave birth in Shalle Health Center and all the necessary corrections were made based on the pretest result to avoid any confusion and for better completion of the questions. Then, four nurses and three midwives were recruited for data collection based on their past experience and fluency in the local language, and they were supervised by two master holder midwives. Checking for double data entry, consistency, missing values, and outliers was done by the supervisors and principal investigator, and comments and measures were undertaken throughout the data collection period.

Data analysis and entry

The data were coded, collected, cleaned, and entered using Kobo Toolbox and exported to Statistical Package for Social Science (SPSS) Version 26 for analysis. Inconsistencies and missing values were checked by running frequencies and other data explorations. Descriptive statistics, such as frequency distributions and mean and standard deviation, were computed. A bivariate analysis was carried out primarily to check which independent variables had an association with that of the dependent variable. Independent variables with marginal associations ($p < 0.25$) in the bivariate analysis, which are biologically plausible and showed significant association in the previous studies, were entered into a multivariate logistic regression analysis to detect the association with antenatal dropout. The multicollinearity was checked among independent variables and the Hosmer–Lemeshow test was used to check the appropriateness of the model for analysis. Finally, adjusted odds ratios (AOR) and a 95% CI were estimated to assess the strength of associations and statistical significance was declared at a p-value <0.05. The results were presented using tables, figures, and texts.

Study variables

Dependent variable

The dependent variable was optimal antenatal care (Yes/No).

Independent variables

Independent variables were as follows: demographic factors, such as maternal age, level of education, marital status, parity, employment status, woman's occupation, husband's educational status, husband's occupation and residence; health facility related, such as insurance status, distance to health facility, cost of transportation, and dissatisfaction with the information provided during ANC visit, type of institution, waiting time, and counseling on danger signs, level of respectful and non-abuse care; reproductive (obstetric) factors, such as desire for pregnancy, previous mode of delivery, parity, danger signs, and bad obstetric history (BOH); and

personal factors, such as attitude, client's satisfaction, client knowledge, and partner support.

Operational definition and measurements

Optimal antenatal care: women were regarded to have optimal antenatal care if they attended each suggested visit according to the new WHO recommendation of 2016 or on another hand it included those neither have delay registration of ANC nor discontinue from the services (3).

Knowledge of ANC: the overall level of antenatal care knowledge was evaluated by scoring responses that measured participants' knowledge based on the descriptions below: a score of 1 was assigned if the participant had knowledge and a score of 0 if they did not. A total score and a mean score were computed, with a score less than the mean indicating poor knowledge and a score equal to or higher than the mean indicating good knowledge (26).

Attitude toward ANC was measured using a 4-point Likert scale (1 = strongly agree, 2 = agree, 3 = disagree, and 4 = strongly disagree). Positive attitude was assigned for those scored above the mean and negative attitude was assigned if they scored below the mean (27).

Women's decision-making power: this was one of the key indicators that measure the level of women's involvement in household decision-making regarding consumption, expenditure, and reproductive choices. Decision-making power was labeled as high if the mother was involved in making decisions independently or with others and labeled as poor if she was never involved in decision-making (28).

Distance from the facility: long distance was defined as taking more than 60 min to reach the health facility and short distance was defined as taking less than 30 min (22).

Types of institution: hospital, health center, or health post to which they preferred to go.

Partner support: partner support was assessed using a modified eight-item Spousal Support Scale (SSS) that was customized based on the local context. SSS scores were in the range of 8–48, and reverse scoring was used (5 = strongly agree to 1 = strongly disagree). A score higher than the mean value indicated that the respondent had a positive perception of partner support (29, 30).

Health insurance status: this was categorized as mothers with or without an insurance card that allowed them free health services (13).

Waiting time: a prolonged waiting time was defined as waiting for services for >30 min and not prolonged if receiving services within 30 min (31).

Results

Sociodemographic characteristics of study participants

All participants ($n = 416$) were actually interviewed and provided accurate information, yielding a response rate of 100%.

The mean age of the women was 29.7 ± 6 years (range 18–42 years). The majority of the participants ($n = 276$, 52.9%) were Orthodox Christians. The majority of the women ($n = 204$, 49%) were housewives and 164 (39.4%) could read and write. Of the study participants, 364 (83.2%) had a monthly income of more 5,000 Ethiopian birr (Table 1).

Facility-related factors

Of the participants, 205 (73.3%) stated that they waited longer than 30 min to get the ANC service. Of the respondents, 37 (8.9%) said that they traveled more than 1 h to get the ANC service, and 121 (29.1%) traveled to the health center on foot and 29 (9%) were transported by mule or horse. The majority of women (81.5%) who traveled by car or motor paid more than 20 Ethiopian birr to arrive at a medical facility and receive ANC care. The majority (82.2) had a previous history of ANC visits. Only 46 (11.1%) respondents said that they were not counseled about ANC services during a previous pregnancy by health professionals and only 14 (3%) mothers reported that they had experienced a good level of respect and non-abusive care (Table 2).

Reproductive and personal factors

Most mothers ($n = 358$, 84%) were multiparous and had more than two children, and 306 (73.6%) mothers said the pregnancy

TABLE 1 Sociodemographic characteristics of study participants in Arba Minch town ($n = 416$), 2023.

Variables	Response	Frequency	Percent (%)
Age(in years)	<20	7	1.7
	20–24	90	21.6
	25–29	103	24.8
	30–34	88	21.2
	35 and above	128	30.8
Residence	Rural	130	31.3
	Urban	286	68.8
Maternal education	Unable to read and write	99	23.8
	Able to read and write	164	39.4
	Primary	91	21.9
	Secondary school and above	62	14.9
Maternal occupation	civil servant	81	19.5
	Farming	23	5.5
	house wife	204	49.0
	Traders	108	26.0
Husband education	Unable to read and write	87	20.9
	Able to read and write	175	42.1
	Primary	64	15.4
	Secondary school and above	90	21.6
Husband occupation	Farming	151	36.3
	Traders	96	23.1
	civil servant	168	40.4
Income (ETB)	<2,500	13	3.1
	2,501–5,000	57	13.7
	>5,000	346	83.2

TABLE 2 Facility-related factors of ANC among study participants in Arba Minch town, southern Ethiopia, 2023 ($n = 416$).

Variables	Response	Frequency	Percentage
Distance in time	≤30 min	42	10.1
	30–60 min	337	81.0
	>1 h	37	8.9
Mode of transportation	Horse/on foot	150	36.1
	By car	266	63.9
Cost of transport (ETB)	≤20	77	18.5
	>20	339	81.5
Advice about ANC	Yes	370	88.9
	No	46	11.1
Waiting time (min)	≤30	111	26.7
	>30	305	73.3
History of ANC	Yes	342	82.2
	No	74	17.8
Level of respect	Good level of respect	14	3.4
	Poor level respect	402	96.6

was wanted. Most mothers (270, 81%) gave birth through spontaneous vaginal delivery (SVD) previously, and 129 (31%) women had a history of bad obstetrics, such as stillbirth, congenital anomalies, abortion, and neonatal death. Of the mothers, 49 (21.9%) had a history of pregnancy danger signs and some complications. The majority ($n = 342$, 82.2%) had a previous history of antenatal care. Overall, 238 (57.2%) study participants had high decision-making autonomy for the utilization of maternal and neonate healthcare services (Table 3).

Level of optimal ANC

From a total of 416 women booking an ANC follow-up, the magnitude of optimal ANC was 170 (41%, 95% CI: 37–45.3): 246 (59%) were found to either discontinue (29.7%) or delay registration (70.3%) as assessed according to the modified WHO recommendation (Figure 2).

Factors associated with optimal ANC

Assumptions for logistic regression, such as large enough sample (minimum of 10 observation for each independent variables), residuals (>3), normal distribution [Shapiro Wilk's test ($p > 0.05$) and visual inspection of histogram, normal Q-Q plots, and box plots] and no multicollinearity [with Spearman correlation < 0.7 or collinearity diagnosis (tolerance > 0.1 and variance inflation factor (VIF) < 10)] before categorization of variables were checked. Finally, the Hosmer–Lemeshow test was checked for model fitness (sig = 0.418).

In the bivariate binary logistic regression, those variables with $p < 0.25$ were candidates for multiple logistic regression and statistical significance was declared at a p-value < 0.05 as below. Thus, age, maternal education, maternal occupation, marital status, parity, religion, type of institution, mode of transport, husband's education, husband's occupation, distance, counsel on ANC, waiting time, having community insurance card, income,

TABLE 3 Reproductive and personal factors of ANC among study participants in Arba Minch town, southern Ethiopia, 2023 (n = 416).

Variables	Options	Frequency (n)	Percentage
Insurance card	Yes	265	63.7
	No	151	36.3
Parity	Primipara	67	16.1
	Multipara	349	83.9
Wanted pregnancy	Yes	306	73.6
	No	110	26.4
Had history of ANC	Yes	342	82.2
	No	74	17.8
Mode of delivery	SVD	270	81
	C/S	63	19
Media exposure	Yes	321	77.2
	No	95	22.8
Bad obstetric history	Yes	138	33.2
	No	278	76.8
Pregnancy danger signs	Yes	91	21.9
	No	325	78.1
Knowledge of ANC	Good knowledge	212	51
	Poor knowledge	204	49
Patients' attitude	Positive attitude	241	57.9
	Negative attitude	175	42.1
Partner support	Good	231	55.5
	Poor	185	44.5
Women autonomy	Yes	178	42.8
	No	238	57.2

unwanted pregnancy, exposure to media, BOH, pregnancy danger signs, patients' attitude toward ANC, partner support, level of respect, women's autonomy, and knowledge about ANC were candidates for multivariate analysis.

This study's multivariable logistic regression analysis revealed that types of health facilities, parity, bad obstetric history, pregnancy danger signs, patients' knowledge, partner involvement,

and women's autonomy all had a statistically significant association with the outcome variable, optimal ANC (Table 4).

The types of health facilities had a positive association with optimal ANC, with mothers attending their ANC services at hospital being five times more likely to receive adequate ANC than those attending services at health centers (AOR = 5.1, 95% CI: 2.28–11.21).

Furthermore, mothers who did have a BOH were four times more likely to receive optimal ANC contact compared to those who did not have a BOH, such as still birth, congenital anomaly, neonatal death, and recurrent abortion (AOR = 3.90, 95% CI: 1.94–7.83). Knowledgeable mothers were found to consume ANC services. Those with good knowledge were twice as likely to receive an ANC follow-up compared to their counterparts (AOR = 2.26, 95% CI: 1.15–4.44). Mothers who did experience any danger signs during this pregnancy were four times more likely to obtain full ANC than those who did not (AOR = 4.1, 95% CI: 1.87–8.82).

Mothers with high decision-making power were 3.9 times more likely to have optimal ANC contacts according to schedules (AOR = 3.9, 95% CI: 1.2–7.63).

Those mothers whose husbands were involved in ANC were twice as likely to have optimal antenatal care compared to those without support from their partners (AOR = 2.0, 95% CI: 1.04–3.78).

Discussion

The present study revealed that the level of optimal antenatal care was 41%. This finding is in line with a study of the general population (43%) (32). However, this finding is higher than in a study conducted in Debra Tabor, northwest Ethiopia (35.3%) (33). Tanzania revealed similar results, where only 10% of mothers received the recommended antenatal care follow-up
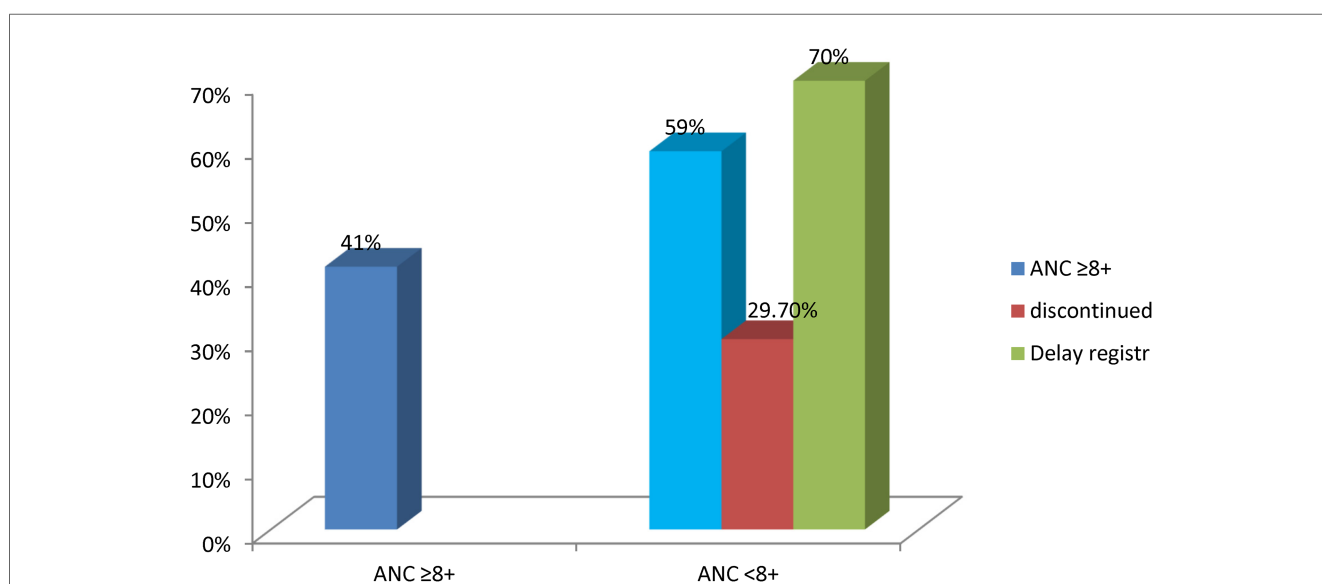

FIGURE 2
The level of optimal antenatal care among study participants at Arba Minch town, southern Ethiopia, 2023 (n = 416).

TABLE 4 Multivariate logistic regression analysis results for variables associated with optimal ANC among pregnant mothers who gave birth at Arba Minch health facilities (N = 416).

Variables		Optimal ANC		COR (95% CI)	AOR (95% CI)	p-value
		Yes (%)	No (%)			
Health facility	Center	20 (18.2)	90 (81.8)	1	1	
	Hospital	150 (49)	156 (51)	4.33 (2.54–7.38)	5.1 (2.28–11.21)	0.000*
BOH	Yes	82 (59.4)	56 (40.6)	3.16 (2.07–4.83)	3.9 (1.94–7.83)	0.000*
	No	88 (31.7)	190 (68.3)	1	1	
Pregnancy danger signs	Yes	64 (71.1)	27 (29.7)	4.89 (2.92–8.14)	4.1 (1.87–8.82)	0.000*
	No	106 (32.6)	219 (67.4)	1	1	—
Partner involvement	Yes	98 (42.4)	133 (57.6)	5.43 (3.62–8.19)	2.0 (1.04–3.78)	0.037*
	No	148 (80)	37 (20)	1	1	
Women's autonomy	Autonomous	31 (17.4)	147 (82.6)	1	1	—
	Not autonomous	139 (58.4)	99 (41.6)	6.65 (4.65–8.21)	3.9 (1.2–7.63)	0.000*

1, Reference group; COR, crude odd ratio.
*p < 0.05 (statistically significant).

(34), along with a study conducted in Kilifi town, Kenya (32%) (35). However, this finding is lower than in a study conducted in Nigeria in 2016 (62%) (36). This may be acceptable given that all the research mentioned above provided data using focused ANC, which was easy to return and had a low dropout rate.

Women's knowledge of ANC is crucial in the utilization of ANC services during pregnancy. This finding revealed that those mothers with a good knowledge of ANC were about twice as likely to receive more ANC visits compared to those with a poor knowledge of ANC. This is in line with studies conducted in Pakistan (37), Ghana (26), Somalia (38), and Gonder town, Ethiopia (39). It is known that women who are knowledgeable about ANC services are more likely to comprehend and appreciate the services offered during ANC.

The odds of optimal antenatal care among those women with BOH were four times higher compared to those without bad obstetric history. This finding is supported by a study conducted in Rwanda (40). Women may be afraid of a recurrence, which could be the cause of bad outcome.

The use of adequate antenatal care services was substantially correlated with the development of danger signs during pregnancy. Women who did experience a danger sign during their pregnancy were four times more likely to continue attending prenatal care appointments than those who did not. This result is in line with studies conducted at Bahir Dar Zuria (21) and Shashemane, south Ethiopia (41), which indicates that mothers were more likely to use the services when they were aware of pregnancy risk factors. Because they were worried about the repercussions, they might not have ever skipped an appointment.

The completion of the ANC follow-up was statistically and favorably related to having authority over medical decision-making. The odds of those mothers with optimal ANC follow-up were four times higher among those mothers with high decision-making power compared to their counterparts. This finding was consistent with that from Pakistan (42) and northwest Ethiopia (23). This may be because women with control over healthcare decisions may have greater mobility, fewer financial concerns, and the ability to travel independently to receive care. In addition, there may be a relationship between autonomy and other factors, including women's education and urban residence, both of which are related to an increased likelihood of using maternal healthcare.

This study also found that greater involvement of a male partner was seen among women receiving complete ANC follow-ups per the schedule. Women with support from their partners were twice as likely to receive all recommended antenatal follow-ups when compared to their counterparts. This finding was supported by studies conducted in Gulu district, Uganda (43), and Addis Ababa, Ethiopia (30, 44). A potential reason for the link could be that when male partners become more involved, their knowledge grows and they adopt a more favorable attitude toward maternal health services.

Types of health institution at which they were receiving ANC services have to be positively correlated with adequate ANC. Those mothers receiving their antenatal care at hospitals were five times more likely to obtain recommended ANC visits compared to those with an ANC follow-up at health centers. This may be justified as more sophisticated services and counseling are given at the hospital level with better health professionals.

Strengths and limitations of the study

The sample size employed in this study supports the generalizability of the results to all women in the study area who are of reproductive age. Information in the survey is based on self-reports, so there may be social desirability bias and recall bias. Thus, medical record cards are in parallel checked to minimize recall bias. In addition, the entire literature review for the study was conducted according to focused antenatal care, which reduced the accuracy of the comparability.

Conclusion

This study showed that the study area had a low level of optimal antenatal care. Bad obstetric history, danger signs of pregnancy, ANC follow-up at hospital, as well as women's autonomy, male partner involvement, and good knowledge are factors associated

with optimal ANC. Therefore, it is important to provide more information during the antenatal contacts to increase the rate of women receiving all eight recommended visits (contacts).

Data availability statement

The original contributions presented in the study are included in the article/**Supplementary Material**, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving humans were approved by Arba Minch University (IRB/DD 1328/2022). The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

DDD: Conceptualization, Investigation, Software, Writing – original draft, Writing – review & editing. GF: Software, Supervision, Validation, Methodology, Writing – review & editing. HA: Conceptualization, Investigation, Methodology, Software, Writing – review & editing. MC: Conceptualization, Data curation, Investigation, Supervision, Writing – review & editing. HW: Conceptualization, Investigation, Methodology, Software, Writing – original draft.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fgwh.2024.1259637/full#supplementary-material

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Women of reproductive age's use of maternal healthcare services and associated factors in Liben district, East Borena zone, Oromia Regional State, Ethiopia

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Background: One of the most important health interventions for reducing maternal morbidity and death is the use of maternal healthcare services. In Ethiopia, maternal healthcare services are not well utilized, particularly in rural pastoralist communities, despite their significance. Therefore, the purpose of this study was to evaluate the use of maternal healthcare services and the characteristics that are related to it in the East Borena zone. Techniques: In September 2020, a community-based cross-sectional survey was carried out in Liben with 416 randomly selected mothers. Mothers who had given birth within the 12 months before the study comprised the respondents. Questionnaires given by interviewers were used to gather the data. The data were transferred to SPSS version 20 for analysis after being entered into Epi-Info version 4.1 for coding. The Kolmogorov-Smirnov, Hosmer, and Lemeshow goodness of fit tests were employed, along with descriptive statistics. Additionally, multivariate and binary logistic regression analyses were carried out. 95% CI and the odd ratio were used to examine the relationship between the outcome and predictive variables.

Results: At least one prenatal visit was received by 60% of moms. Only 21.2% and 17.5% of women had given birth in a medical facility and made use of early postnatal care services. The use of antenatal care was strongly correlated with maternal education [AOR = 2.43 (95% CI: 1.22–4.89)], decision-making capability [AOR = 2.40 (95% CI: 1.3–23.3)], felt compassionate and respectful treatment [AOR = 0.30 (95% CI: 0.18–0.50)], and intended current pregnancy [AOR = 0.22 (95% CI: 0.12–0.37)]. Moms b/n ages 15–19 had a 3.7-fold higher probability of giving birth in a hospitals than moms b/n ages 35 and 49 [AOR = 1.74 (95% CI: 1.02–3.08)]. Mothers who lived far away were 1.02 times less likely to give birth at a hospital than those who could reach one within an hour (AOR = 1.74;95% CI: 1.02, 3.08). While recent use of antenatal care [AOR = 5.34 (95% CI: 1.96–8.65)], planned current pregnancy, and knowledge of using postnatal care were shown to be strongly correlated with danger indicators [AOR = 2.93 (95% CI: 1.59–5.41)], knowledge of danger signs [AOR = 3.77 (95% CI: 2.16–6.57)] and perceived compassionate and respectful care were significantly associated with institutional delivery.

Conclusion: Overall the prevalence of maternal healthcare services utilization was far below the national and regional targets in the study area. Thus, promoting institutional services, raising community knowledge, empowering women to make decisions, and enhancing the infrastructure of the health sector.

Introduction

An estimated 2.9 million children die in the first month of life, and 289,000 mothers worldwide die during or shortly after pregnancy and childbirth each year (1). Poor women living in rural regions have a lower likelihood of receiving quality maternity healthcare services in less developed nations (1). Ninety-nine percent of maternal deaths worldwide occur in developing nations. 62% of maternal deaths worldwide occur in Sub-Saharan Africa alone (2). Due to their geographic location, African women are disproportionately at risk of death or disability from pregnancy and childbirth, even though the majority of maternal fatalities are preventable (3).

Maternal healthcare service usage is low, which contributes to the high number of maternal deaths that happen during labor, delivery, and the first few days following childbirth, especially in low- and middle-income countries (4). The health of the mother and the unborn child depends on receiving the right care during pregnancy and delivery facility (4). It is essential to provide professional care, ideally in a medical setting, for expectant mothers, new mothers, and the postpartum period (5). Every woman, without exception, needs expert, trained care when giving birth in a setting that respects her birthing culture, is close to her home, and is appropriate for her level of safety (6). Ethiopia is not an exception to the rule that most low-resource countries have significant challenges related to the low utilization of maternal healthcare services (7). Notwithstanding the government's dedication to provide healthcare facilities to the general public via the Health Extension Service Package (HESP), the nation has encountered difficulties in raising the use of high-quality maternity healthcare services (8). In Ethiopia's remote pastoral areas, healthcare facilities and services are underequipped and of poor quality. The few health centers that are currently in operation lack the necessary supplies, equipment, and basic medications (9). A previous study clearly demonstrated that utilization of available maternal healthcare services is also very low in Brazil (10). According to a recent mini-Ethiopia Demographic Health Survey (EDHS) 2019 report, 70% of rural women received at least one antenatal care (ANC) visit from a skilled provider, including health extension workers. Only 40% and 29% of rural women delivered at health facilities and received early postnatal care, respectively (10). In general, the utilization of maternal healthcare services is a complex behavioral phenomenon influenced by several factors at both individual and community levels. Therefore, to improve maternal and child health, barriers limiting the utilization of maternal healthcare services must be identified and addressed at all levels of the healthcare system. Thus, the purpose of this study was to understand the current status of the utilization of maternal health care services by elucidating the various factors influencing the use of these services in the study area.

Rationality of study

The use of maternal healthcare services (MHS) is a complicated behavioral phenomenon that involves appropriate postnatal care (PNC) services, the number of prenatal care (ANC) visits that are advised, and the delivery of a child by a skilled birth attendant (SBA) (11). Focused prenatal care lowers healthcare costs in underdeveloped nations by limiting the number of visits for pregnancies that are low-risk. Personalized treatment, early disease detection, quality of visits, and readiness for birth-related issues are prioritized by FANC over the number of clinic visits (12). Many sociodemographic and economic factors, including the woman's age, education, employment status, parity, media exposure, household income, awareness and knowledge of antenatal care services, cultural beliefs, woman's autonomy, availability, and access to health care, are linked to the use of antenatal care (13). Zone, marital status of the woman, husband's educational attainment, occupation, awareness of pregnancy danger signs, interval between births, information source, punctual visits, and transportation issues were all significant factors influencing the use of ANC services for the general population (14, 15).

Methods

Study setting, design, and population

Childbearing women who had given birth in the 12 months previous to the survey of residents of Liben district, East Borena Zone, Southern Ethiopia, participated in a community-based, cross-sectional study. Ninety-five (195) of the district's 191,494 inhabitants are female. 19,990 women of reproductive age are thought to reside in the district overall. In the District, there are sixteen health posts and six health centers. The dates of this study's conduct were September 15, 2020–23, 2020.

Sample size and sampling technique

The required sample size of eligible mothers was determined using a single-population proportion formula. The following assumptions were made: the proportion of institutional delivery in the rural community of the Oromia region, according to the mini-EDHS-2019 report, was 40% (10), with a 95% confidence level, a 5% margin of error, and an expected 10% non-response rate. The final sample size was calculated to be 416. A p-value of 40 is incredibly low, suggesting that there is little confidence in the findings and that the null hypothesis is not likely to be rejected. Still, I made an effort to give the sources a lot of thought. In general, it is inappropriate for this investigation at the district level. However, it ought to be controlled throughout the ideation and proposal creation phases.

The participants were selected using the following steps: first, six rural kebeles (the smallest administrative unit) were selected from the 16 kebeles in the district using a simple random

sampling technique. The census was carried out in the selected kebeles to identify mothers who had given birth in the year prior to the survey. The proportional distribution of the sample size for each selected kebele was determined. Finally, mothers were selected using a systematic random sampling method.

Inclusion and exclusion criteria

Women who had given birth in the last 12 months and had been residents of the Liben district for at least six months were included. I used meticulous study design, including techniques like employing objective measures, to overcome recall bias. Mothers who were critically ill and unable to respond to interviews were excluded.

Operational definition

Antenatal care

Throughout her pregnancy, an expectant mother should receive at least eight ANC visits, according to the recent WHO Focused Antenatal Care (FANC) Framework.

Child bearing age

The total of age-specific fertility rates divided by the sum of age-specific rates, weighted by the middle of each age group, where a represents the middle of each age range (17.5, 22.5… 49.5) or early 30s and late 20s.

Maternal healthcare services include antenatal, delivery, and postnatal care services. Institutional delivery refers to childbirth either in public or private healthcare facilities attended by skilled attendants such as midwives, nurses, doctors, and health officers Postnatal care refers to care given to mothers after childbirth by healthcare professionals in the first 48 h after delivery at a health facility.

Data collection tool and method

Quantitative data were collected using a structured and semi-structured questionnaire. The questionnaire was based on a review of relevant previous studies and literature. Face-to-face interviews were conducted at respondents' homes. The main contents of the tool included socio-demographic characteristics, maternal obstetric characteristics, health facility-related factors, and maternal healthcare service utilization.

Data management and quality

The English questionnaire was revised before being translated into the local tongue and then back into English for uniformity. The tool was pretested on 5% of a comparable population. Six diploma nurses who spoke the local languages well participated in the data collection process. As supervisors, two BSc healthcare experts were hired. During the two days of data collection, all supervisors and data collectors received training based on the principal investigator's

guide. The supervisors and primary investigators kept a careful eye on every action and gave the data collectors additional guidance and assistance. Every day, the data were examined for inconsistencies, missing information, incompleteness, and improper answers. Following data cleaning, Epi Data version 4.1 was used to code data, and SPSS version 20 was used for analysis.

Statistical analysis

Summary statistics of means and percentages were used to describe the study population. Bivariate and multivariate logistic regression analyses were performed to identify associations between independent and outcome variables. Variables with a p-value of ≤0.25 on bi-variable regression analysis were further entered into the multivariable binary logistic regression model to control for possible confounding variables. The Hosmer–Lemeshow test was used, and the model adequately fit the data at a p-value of >0.05. Multi-collinearity between the independent variables was assessed using a variance inflation factor of <10. Crude and adjusted odds ratios with 95% CI were used to determine the strength of association between the outcome variables and independent variables. Statistical significance was set at $p \le 0.05$.

Results

Socio-demographic characteristics

A total of 416 women of reproductive age who had given birth in the year before before the survey were interviewed, with a response rate of 100%. Of these respondents, 261 (63%) were aged 20–34 years, with a mean (+SD) age of 26.5(±6.5) years. Of the study participants, 399 (96%) were married. The dominant ethnic group was Oromo, which accounted for 84% of total respondents; 60% were Wake-feta (the indigenous religion of Oromo people) and 32% were Muslim. More than two-thirds (78%) had never attended school and most (85%) were housewives. Regarding decision-making regarding maternal healthcare service utilization, the majority (61%) reported that such decisions were made jointly by husband and wife (Table 1).

Obstetric characteristics of respondents

Regarding obstetric history, 167 respondents (40%) became pregnant for the first time before the age of 19. Almost half (51%) had had five or more pregnancies. Fifteen women (3.6%) had experienced a stillbirth. For 244 respondents (59%), their most recent pregnancy was planned and intentional (Table 2).

Maternal healthcare services utilization

Of all respondents included in the study, 249 (60%) had received at least one ANC service during their last pregnancy.

TABLE 1 Socio-demographic characteristics of the study participants in Liben district, Southern Ethiopia, September, 2020 (n = 416).

Socio-demographic characteristics		Frequency	Percentage
Age of respondents	15–19 years	91	22
	20–34 years	261	63
	35–49 years	64	15
Marriage status	Currently married	399	96
	Divorced & widowed	17	4
Religion	Wake-Feta	250	60
	Muslim	134	32
	Christian	32	8
Ethnicity	Oromo	322	83.7
	Somali	89	21
	Others	5	1.3
Women education	No education	330	78
	Primary & above	86	22
Husband education	No education	270	65
	Primary & above	146	35
Women occupation	House wife	352	84.6
	Merchant	35	8.4
	Civil servant	17	5.1
	Students	12	2.9
Family wealth index	Poor	152	37.6
	Medium	133	32
	Rich	131	31.4
Family size	1–3	29	7
	4–5	128	31
	6 & above	259	62
Decision maker for MHSU	Women alone	60	14
	Husband alone	101	25
	Jointly husband & wife	255	61
Travel time to health facility	<1 h	210	51
	≥1 h	206	49
Access to emergency ambulance	Yes	142	34
	No	274	66

Family wealth index measure using easy-to-collect information on a household's possession of certain goods, such televisions and bicycles, building materials used to construct homes and kinds of water access and sanitary facilities are utilized to create the wealth index.
Justification for journey time to the medical institution: Any mother seeking care shouldn't have to travel more than an hour to a medical facility, per the 5-year health reform policy.

TABLE 2 Obstetric characteristic of the study participants, Liben district, Southern Ethiopia, September 2020, (n = 416).

Variable		Frequency	Percentage (%)
Age at first pregnancy	≥18 years	167	40
	19–24 years	216	52
	≥25 years	33	8
Gravidity	1	56	13
	2–4	149	36
	≥5	211	51
Stillbirth history	Yes	15	3.6
	No	401	96.4
Abortion history	Yes	11	2.6
	No	405	97.4
Planned current pregnancy	Yes	244	59
	No	172	41
Attended ANC in last pregnancy	Yes	249	60
	No	167	40
Frequency of antennal care (n = 249)	<4 visits	139	56
	≥4 visits	110	44
First ANC visit (n = 249)	Before 16 weeks	61	25
	16–36 weeks	178	69
	After 36 weeks	10	4
Place of last delivery	Home	328	78.8
	Health facility	88	21.2
Utilized postnatal care with 48 h	Yes	73	17.5
	No	343	82.5
Know at least one danger signs	Yes	163	39
	No	253	61
Experienced severe illness in last pregnancy	Yes	105	25
	No	311	75
Felt clients privacy is maintained at HF	Yes	183	44
	No	233	56
Is working time of HF is convenient	Yes	331	80
	No	85	20
Felt compassionate and respectful health care at HF	Yes	219	53
	No	197	47
Main reason for last home delivery (328)	Long distance of HF	156	47
	Wish to deliver with family	58	18
	Prefer TBAs	46	14
	Not trust HF	39	12
	Others	29	9

Of these, 138 (55%) had received the service from health extension workers at healthcare clinics. Nearly 25% of the women made their first antenatal visit during the first 16 weeks of pregnancy. Among the ANC service users, 56% had made fewer than four antenatal visits (Table 2). Women cited different reasons for not attending ANC in their recent pregnancies. Little or no knowledge, a feeling of healthiness, a long distance from home to healthcare facilities, work overload at home, and long waiting times for services at healthcare facilities were the major reasons reported for not attending ANC services (Figure 1).

Among respondents, only 88 (21.2%) delivered their baby at a healthcare center/hospital with the assistance of skilled healthcare workers. The majority (78.8%) delivered at home with the assistance of a traditional birth attendant (TBA) and relatives. Women cited different reasons for wanting to deliver at home, such as long distance to healthcare facilities, wishing to deliver in the presence of family, preferring TBAs, and not trusting healthcare facilities (Table 2). Regarding postnatal care service utilization, only 73 (17.5%) of respondents received postnatal care services within 48 h of delivery at a healthcare facility (Table 2).

Factors associated with maternal healthcare services utilization

According to the multivariate logistic regression analysis, maternal education, decision-making power regarding maternal
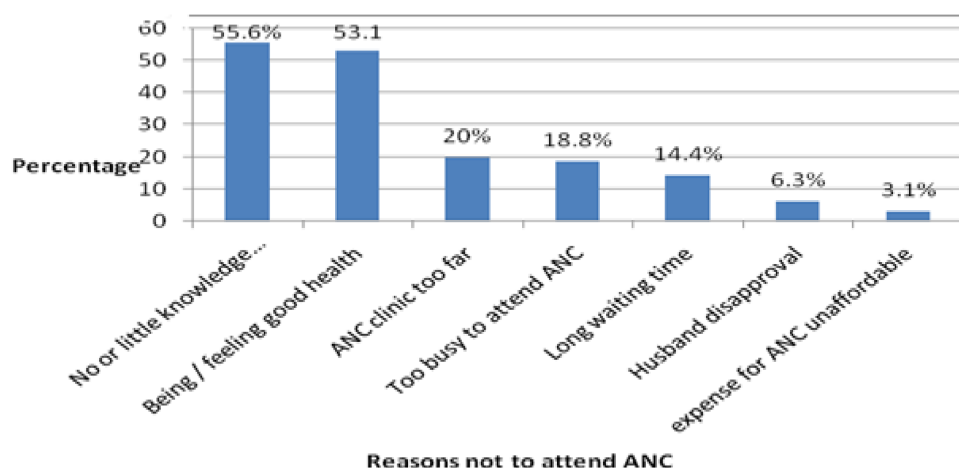
FIGURE 1
Reasons cited by the study participation for not attending ANC services, Liben district, Southern Ethiopia, September, 2020. ANC, antenatal care; PNC, postnatal care; HF, health facility.

healthcare service utilization, perceived compassionate and respectful care at healthcare facilities, and planned current pregnancy were significantly associated with the utilization of ANC. Mothers who had completed primary and above education were 3.7 times more likely to utilize ANC services when compared to women with no education (AOR = 3.69; 95% CI: 2.05, 6.62). Mothers who could decide on maternal healthcare services utilization with their husband were 2.4 times more likely to attend ANC visits than women who could not (AOR = 2.4; 95% CI: 1.32, 3.34). Furthermore, women who perceived no compassionate and respectful care at healthcare facilities were 70% less likely to utilize ANC services than women who perceived compassionate and respectful care (AOR = 0.30; 95% CI: 0.18, 0.50). Respondents who had unplanned current pregnancies were 68% less likely to utilize ANC services when compared those who had planned their pregnancies (AOR = 0.78; 95% CI: 0.12, 0.37) (Table 3).

The likelihood of delivering at a healthcare institution (health center and hospital) was 3.7 times more likely for mothers aged between 15 and 19 years than for those aged between 35 and 49 years (AOR = 3.73; 95% CI: 1.53, 6.04). Regarding time to travel to a healthcare facility, mothers who could reach one within an hour were 1.74 times more likely to deliver there (a healthcare center or hospital) compared to those who live further away (AOR = 1.74; 95% CI: 1.02, 3.08). Additionally, mothers who recognized at least one danger sign in pregnancy were 3.7 times more likely to deliver at a healthcare facility (healthcare center or hospital) compared to those who did not (AOR = 3.77; 95% CI: 2.16, 6.57) (Table 2).

Regarding early postnatal care utilization, attending antenatal services in recent pregnancy, planned pregnancy, and knowledge of danger signs in pregnancy were variables that showed an association with postnatal care utilization. Accordingly, those mothers who had attended an ANC visit in their last pregnancy were 5.3 times more likely to utilize early postnatal care services

than those who had not (AOR = 5.34; 95% CI: 1.96, 8.65). The likelihood of utilizing early postnatal care services was 2.2 times more likely for mothers who had planned their pregnancy than for those who had not (AOR = 2.19; 95% CI: 1.07, 4.41).

Discussion

This study set out to assess the level of maternal healthcare service utilization in the Liben district of Southern Ethiopia's Oromia region, as well as the factors that are linked to it. The current study's data indicates that 60% of ANCs were used. This result is consistent with a research that was carried out in the Womberma district (64%) (13). A study carried out in the districts of Enderta (70%) and Kombolcha (86%) revealed increased ANC consumption, which contrasts with the current findings (11, 16). In this study, 21.2% of patients received care through an institutional setting. 78.8% of the women gave birth at home with the help of TBAs and family members. This number is less than that of studies done in the Enderta district (38%), Holeta (61%), and Goba (47%) (11, 17, 18). It is comparable with the study done in rural Kombolicha (20.9%) (16). The survey also showed that only 17.5% of early PNCs were used. This result is consistent with research that was carried out in the rural Jabitena district (20%) (19). It is, however, less than comparable community-based studies carried out in Hossana town (20, 21) and Enderta district (11), where early PNC was obtained by 47% and 51% of women, respectively. The temporal difference between these studies, variations in study settings, and sociodemographic features of the study area could all be contributing factors to this mismatch. Furthermore, the study was carried out in a pastoralist rural district, where the education and decision-making authority of women may be important indicators of the use of healthcare services by mothers. The majority of rural villages have an uneven and small number

TABLE 3 Bi-variable and multivariable analysis results of maternal healthcare service utilization and its associated factors among childbearing Age of women in liben district, September, 2020.

Factors associated with ANC utilization					
		Antenatal care utilized		COR & 95% CI	AOR & 95% CI
		Yes (n = 249)	No (n = 167)		
Mother education	No education	179	151	1.00+	1.00+
	Primary & above	70	16	3.69 [2.05, 6.62]*	2.43 [1.21, 4.89]*
Decision maker for MHSU	Women alone	47	13	5.07 [2.44, 5.54]*	4.91 [1.93, 6.56]*
	Both partners	160	95	2.36 [1.47, 3.78]*	2.40 [1.32, 3.34]*
	Husband alone	42	59	1.00+	1.00+
Planned current pregnancy	Yes	184	60	1.00+	1.00+
	No	65	107	0.19 [0.13, 0.30]*	0.22 [0.12, 0.37]*
Compassionate & respectful care	Yes	168	51	1.00+	1.00+
	No	81	116	0.21 [0.14, 0.32]*	0.30 [0.18, 0.50]*
Factors associated with institutional delivery					
		Institutional delivery		COR & 95% CI	AOR & 95% CI
		Yes (n = 88)	No (n = 328)		
Maternal age	15–19 years	35	56	3.01 [1.38, 6.53]*	3.73 [1.53, 6.04]*
	20–34 years	42	219	0.92 [0.44, 1.91]	0.88 [0.39, 1.98]
	35–49 years	11	53	1.00+	1.00+
Travel time to HF	<1 h	55	155	1.86 [1.14, 3.01]*	1.74 [1.02, 3.08]*
	≥1 h	33	173	1.00+	1.00+
Compassionate & Respectful care	Yes	67	152	3.69 [2.16, 6.11]*	2.93 [1.58, 4.40]*
	No	21	176	1.00+	1.00+
Knowledge of danger signs	Yes	60	103	4.68 [2.82, 7.12]*	3.77 [2.16, 6.57]*
	No	28	225	1.00+	1.00+
Factors associated with early PNC utilization					
		Postnatal care utilized		COR & 95% CI	AOR & 95% CI
		Yes (n = 73)	No (n = 343)		
Recent ANC utilization	Yes	68	181	12.1 [3.51, 19.6]*	5.34 [1.96, 8.65]*
	No	5	162	1.00+	1.00+
Planned current pregnancy	Yes	56	188	2.71 [1.51, 4.86]*	2.19 [1.07, 4.41]*
	No	17	155	1.00+	1.00+
knowledge of danger signs	Yes	52	111	5.17 [2.97, 6.01]*	2.93 [1.59, 5.41]*
	No	21	232	1.00+	1.00+

COR, crude odds ratio; AOR, Adjusted odds ratio; CI, confidence interval; MHSU, maternal healthcare service utilization; HF, health facility.
*Significant at p-value <0.05, 1.00+ reference category.

of healthcare facilities are usually uneven and restricted in rural communities.

According to this study, the use of healthcare services by mothers is correlated with sociodemographic factors including age and educational attainment. Compared to women without any formal education, those who had completed primary school and above had 2.4 times higher odds of using ANC. In addition, moms between the ages of 15 and 19 were 3.7 times more likely than mothers between the ages of 35 and 49 to use institutional delivery. This result is in line with other research from the Enderta, South Omo, and Tigre regions (11, 12, 22).

In addition, moms who could make decisions either by themselves or in conjunction with their husbands were more likely to use ANC than mothers whose husbands made decisions on their own. This outcome is in line with research done in the towns of Holeta and Enderta (11, 17). This could be explained by the fact that women's education plays a critical role in enabling them to be economically independent and to make

decisions about maternal healthcare services. This, in turn, enhances their understanding of basic healthcare services and encourages behaviors related to seeking health.

It was observed that pregnant women who used ANC and PNC were more likely to have planned their pregnancies than unplanned ones, probably because of their increased concern for the health and welfare of their unborn child. This result is in line with research findings from Abuna-Gindeberet, Debre-Tabor town, and Wombera (13, 14, 23).

This study also demonstrated that mothers who felt that healthcare providers treated them with compassion and respect had a higher likelihood of using ANC and giving birth in a hospital than mothers who did not. These outcomes are in line with those observed in the districts of Kombolcha and Ambo (16, 21, 24–28). This suggests that women's decisions to utilize or not use a specific type of maternal healthcare service are significantly influenced by the attitudes of healthcare practitioners toward women's healthcare.

According to this study, using a PNC and having understanding of obstetric risk indicators were highly predictive of institutional delivery. Compared to mothers who did not voluntarily indicate any obstetric danger indicators, mothers who were aware of at least one obstetric danger sign were more likely to use institutional delivery and PNC services. This result is consistent with research from the rural Jabitena district (19, 29, 30). This makes sense because early diagnosis, management, and prevention of obstetric danger signals are the main reasons why women and their families should seek medical attention as soon as possible. Awareness of these indicators is a key component in encouraging pregnant women and their families to seek medical attention as soon as possible in order to prevent, identify, and treat obstetric danger indicators.

According to the results of the current study, moms who could get to the hospital in under an hour were 1.74 times more likely to use institutional birth. This result is consistent with research by Enderta and Butajira (11, 31–35). Compared to women seeking ANC, laboring women have less time to get to a hospital. Furthermore, a greater distance between medical institutions and little access to public transit may be linked to higher transportation expenses.

Similar to findings in Hossana, Holeta town, and Ambo district, another noteworthy finding of the current study indicated that recent ANC utilization increased utilization of PNC (17, 20, 24). According to this research, ANC is a crucial starting point for additional maternal healthcare treatments. Pregnant women who use these services are fully informed about the benefits of hospital birth and early postpartum care, as well as the essential follow-up during their pregnancy. But none of the moms who had been for prenatal care made use of PNC (36, 37).

Strengths and limitations of the study

Because the interviewers conducted the data collection, they were able to clarify any topics that the respondents were unsure of, which increased the accuracy of the information gathered. There was no triangulation of qualitative data collection methods; just the quantitative method was employed. Thus, it is recommended that researchers who are interested in this subject incorporate qualitative methodologies.

Conclusion

The study area's overall consumption of maternal healthcare services fell well short of the planned expansion and transformation of the health system. The low rate of use of maternity healthcare services in the research region suggests that there is still more to be done to enhance the health of women. The study also showed a strong relationship between ANC utilization and maternal education, decision-making authority, perceived caring and respectful treatment, and current intended pregnancy. While recent antenatal care utilization, planned current pregnancy, and knowledge of danger signs were significantly associated with PNC utilization, mothers' age, time to travel to health facilities, knowledge of danger signs, and perceived compassionate and respectful care were associated with institutional delivery. Consequently, taking into account these established contributing variables and offering education and training on these issues to the community potentially enhance and maintain the use of maternal healthcare services in the community.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary Material, further inquiries can be directed to the corresponding author.

Ethics statement

Ethical clearance and approval were obtained from the Ethical Committee of Research and Community Service of the Educational Development Center (EDC) of the Negele Health Science College. Permission was obtained from the district health office. Oral informed consent was obtained from all participants. Confidentiality and anonymity were ensured. The participants were informed that their participation was voluntary. Verbal informed consent was obtained from all subjects before the study, and written informed consent was obtained from legally authorized representatives before the study.

Author contributions

MD: Conceptualization, Formal Analysis, Investigation, Visualization, Writing – original draft, Writing – review & editing. SM: Methodology, Software, Validation, Writing – review & editing. GA: Project administration, Supervision, Writing – review & editing.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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