

# Impact of the Information Revolution on Antenatal Care Quality in the Oromia and Gambella Regional States, Ethiopia: A Comparative Cross-Sectional Study

Kunuz Hajibedru Abadula<sup>1,2\*</sup>, Abebaw Gebeyehu Worku<sup>3</sup>, Gurmesa Tura Debelew<sup>2</sup>, Muluemebet Abera Wordofa<sup>2</sup>

## Abstract

**Background:** High-quality antenatal care (ANC) is crucial for ensuring the health of both pregnant women and newborns. Health Information Systems (HIS) interventions are believed to play a pivotal role in enhancing ANC quality by and facilitating better use of data related to ANC services. This study was planned to evaluate the impact of HIS interventions on ANC quality.

**Methods:** A comparative cross-sectional survey was conducted from October 15 to 25, 2023. Data were collected on socio-demographic factors and the use of essential ANC services from mothers who visited Health Facilities (HFs) that implemented HIS intervention. HFs were classified as "models" if individuals scored above 90% and "candidates" if they scored between 65% and 90% for the 2015 EFY. A two-stage sampling technique was used to select 840 study participants. The outcome variable was good-quality ANC. It is coded as 1 if they have received all eight components and as zero (0) if individuals received fewer than eight of the recommended essential ANC components. The components included BP measurement, blood and urine tests, iron supplements, and tetanus injections, counseling on nutrition and a birth preparedness plan, and being informed of danger signs. The data were analyzed using SPSS, version 25. To determine the significance of independent variables, bivariable and multivariate logistic regression analyses were performed by, adjusting the odds ratios and calculating 95% confidence intervals.

**Results:** The proportion of mothers who had received all eight essential ANC components was 54% (95% CI: 50.6% to 57.4%). Moreover, 97.4% had at least one ANC visit, with 66.8% attending four or more visits. Nearly two-thirds (61.7%) of visits occurred within the first 4 months. TT immunization (95.0% (CI: 93.3%, 96.3%), BP measurements (92.5% (CI: 90.6%, 94.2%), and IFA supplements (90.6% CI: 88.4% to 92.5%) were the most delivered components. In multivariable logistic regression, mothers attending model health centers were more likely to receive good-quality ANC service than those attending candidate health centers (AOR = 9.23; 95% CI: 5.65, 15.1). Married women are more likely to receive good-quality ANC services than non-married women (AOR = 8.16; 95% CI: 1.62, 41.2).

**Conclusion:** Mothers in model health Facility catchments received high-quality ANC. Sustaining and improving the status of HFs is important to deliver quality health services; furthermore, HIS interventions should prioritize quality improvement and creating demand. [*Ethiop. J. Health Dev.* 2024; 38(SI-2)]

**Keywords:** Antenatal Care, Health Information Systems, Quality Improvement, Ethiopia

## Background

In 2020, the World Health Organization (WHO) reported that 95% of maternal deaths occurred in low-income countries, mainly due to inadequate healthcare access. Notably, Africa had 65% of these deaths, with sub-Saharan Africa's mortality rate of 536 per 100,000 live birth (1). Quality ANC is crucial for detecting pregnancy complications and improving maternal and newborn health outcomes (2). Globally, 88% of pregnant women attend at least one ANC visit; however, only 69% attend the recommended four or more visits (3). In sub-Saharan Africa, adherence to the recommended ANC is approximately 58.53%, with disparities based on wealth and region (4).

Therefore, regular monitoring of ANC adherence is essential to ensure high-quality care for expectant mothers. Research across Africa showed variation in the quality of ANC services, with wealthier women typically receiving better care. (5–7). In Sierra Leone, very few women receive complete ANC, while in Kenya; essential services are provided without consistent follow-up. In the Democratic Republic of the (DRC), ANC services meet quality

standards only half the time (8–10). Studies in Ethiopia show that less than half of women complete recommended ANC visits, and the quality of care varies widely across different regions (11–13).

Research conducted in Mexico City and Ghana, as well as systematic reviews, indicates that the implementation of innovative technologies like electronic medical records (EMR) and mobile health (mHealth) can enhance the quality of ANC services, increase skilled birth attendance, and promote health facility deliveries, especially in low- and middle-income countries (LMICs) (14–18).

Health Management Information Systems (HMIS) are crucial for strengthening health systems, as recognized by the WHO (19). Quality data are essential for informed decision-making in healthcare (20,21). However, many developing countries face challenges in terms of low-quality data and underutilization of health information systems (22). While there has been a shift toward integrating technology to improve these systems, many still depend on outdated paper-based methods (23,24).

<sup>1</sup> Jimma Zone Health Office, Jimma Zone, Oromia Region, Jimma, Ethiopia

<sup>2</sup> Department of Population & Family Health, Jimma University, Jimma, Ethiopia

<sup>3</sup> JSI Research and Training Institute, Inc., Ethiopia Data Use Partnership, Addis Ababa, Ethiopia.

\*Correspondence: Kunuz Hajibedru Abadula -kunuzemu@gmail.com

The 2030 Agenda highlights the importance of technology in achieving health-related Sustainable Development Goals (SDGs) and advocates for accessible, affordable, and secure digital health strategies (25). Health Information Systems (HIS) are essential for improving ANC by enabling better data management (26).

Ethiopia implemented the HMIS in 2008 to aid decision-making despite challenges like limited resources and fragmented leadership, Ethiopia's Ministry of Health has developed a strategic plan to enhance HIS through standardization and key strategies, like the Information Revolution (IR) Model and Capacity Building and Mentoring Programs. This efforts aim to improve health outcomes through data-driven decisions (27,28).

Studies in Ethiopia show that improving HIS and mHealth interventions can lead to better maternal health (MH) services by positively influencing health worker behavior, increasing ANC visits, skilled birth attendance (SBA), and streamlining work processes(29–31).

In the study areas, seven woredas received comprehensive support and HIS enhancements through collaboration between Jimma University and Regional Health Bureaus (RHBs). This initiative aimed to create model health institutions and involved strategies like capacity building, supervision, and improved resource allocation. These efforts are expected to enhance ANC services by providing healthcare professionals with better data access.

According to the information revolution (IR) implementation guideline for (2021-2025), health institutions are categorized into different levels based on their IR implementation stages. Health institutions with an emerging level scoring less than 65% on assessment, emphasizing the need for capacity building in monitoring and evaluation (M&E) infrastructure; the candidate level ranges from 65% to 90%, indicating the importance of basic M&E infrastructure, also has significant room for improvement. The model level represents scores above 90%, focusing on sustaining excellence.

In Ethiopia, research primarily focused on HIS interventions on health system performances, but this study specifically evaluated the quality of ANC service use in relation to the IR implementation assessment status of health centers.

## Methods

### Setting Area

Jimma University was one of six universities in Ethiopia that involved in implementing HIS interventions in the Oromia and Gambella regions. The first JU\_CBMP implementation sites were distributed across seven zones in the Oromia and two zones in the Gambella Region. This study was conducted in four woredas within the Oromia region: Omo Nada, Metu Zuria, Boost, and Dialog/Tajo, as well as the Gambella Zuria woreda

in the Gambella region. The research included 12 health centers catchment populations from 24 kebeles.

### Study design

A cross-sectional comparative study design was employed for this research. A population-based household survey was conducted from October 15 to 25 across five districts, with four located in the Oromia region and one in the Gambella region. The study focused on in candidate, model, and combination model-and-candidate healthcare catchment areas to investigate the relationship between the quality of antenatal care (ANC) and the IR performance status of the health centers.

In the areas where HIS interventions were implemented, health institutions were evaluated and graded on a quarterly assessment of the implementation of an IR as an emerging candidate and model. The "emerging" level indicates a need for capacity building in HIS; while the "candidate" level shows that a monitoring and evaluation (M&E) infrastructure has been established, though there is still room for improvement. The "model" level signifies excellence in the implementation of HIS.

This analysis focuses on the fiscal year 2015 EFY, assessing the quality of ANC service utilization against the HIS performance status of health centers. The study involved 840 households from 12 catchment kebeles, with four centers from each IR category analyzed to assess their impact on data quality and decision-making (32)

### Participants, sample size, and sampling techniques

The target population for this study was women who gave birth in the last 12 months. The sample size was calculated based on the assumption that 55% of mothers received quality ANC from a skilled health provider during their pregnancy (29). In high-IR-performing health centers, it is expected that 66% of women will receive quality ANC services. This is to detect a 10% effect size with a 5% margin of error and a 95% confidence level at  $Z_{\alpha/2} (\alpha=0.05) = 1.96$  and a design effect of 2. The double population proportion formula  $N = 16 p (1-p) / (p_0-p_1)$  was used to calculate the sample size.

A two-stage sampling technique was applied to select a total of 840 (280 from each IR stage) targeted women from the selected kebeles. In the first stage, 24 kebeles were selected by a simple random sample from five woredas (95 kebeles and 26 HCs were available in five HIS intervention woredas). In the second stage, 35 targeted women per kebele were selected with an equal probability of systematic random selection. The sampling frame for the household survey was prepared either using the health post-data or a census conducted before the actual survey. A kebele is the lowest administrative unit, having about 1,000 households.

**Operational definition**

**HIS Intervention packages:** - are a set of activities to be carried out in intervention facilities. These include capacity- building training, mentoring, supportive supervision, and routine performance monitoring and evaluation.

**Information Revolution:** - bringing radical change in data quality and transforming the culture of data use to positively impact population health and health-system performance.

**Mixed Health Centers:-** A combination of candidate and model HCs was selected based on their quarterly assessment scores. , The facilities were modeled for two quarters, while the candidates were modeled for the other two quarters.

**Quality of ANC:** Receipt of eight essential components of ANC services during pregnancy, including blood pressure measurement, collection of blood and urine samples, nutrition counseling, information on birth preparedness plans and danger signs, Tetanus Toxoid (TT) vaccination, and iron and folic acid supplementation.

**Information Revolution:** Implementing radical changes in data quality and transforming the culture of data usage can have a positive impact on population health and the performance of health-systems. A health institution will undergo five stages in the implementation of this initiative. For this study, we focused on candidate health centers and model health centers.

- ▶ **Emerging:** A health unit that performed <65% of the assessment criteria
- ▶ **Candidate level:** a facility or administrative health office that scored 65% to 90% of the assessment criteria
- ▶ **Model:** High-performing health unit with a score of more than 90% > 90% of the assessment criteria
- ▶ **Combined Model:** Model for two concurrent assessments and candidate for the other two assessment periods

**Wealth index:** - It was calculated from 10 different indicators (assets ownership, households' access to basic services, type of the house, etc.) Based on the scores we categorized them into five quintiles and merged the poorest and poor, rich and rich for ease of understanding

- ▶ **Poorest:** Participants with wealth index scores in the lowest quintile.
- ▶ **Poor:** Participants with wealth index scores in the second quintile.
- ▶ **Medium:** Participants with wealth index scores in the middle quintile.
- ▶ **Rich:** Participants with wealth index scores in the fourth quintile.
- ▶ **Richest:** Participants with wealth index scores in the highest quintile

**Variables**

Ethiopia's ANC guidelines emphasize three key elements for pregnant women:

1. Risk Assessment (This includes monitoring blood pressure, and conducting blood, and urine tests),
2. Health Promotion and Education (This focuses on nutrition, preparing for birth, and recognizing signs of potential complications during pregnancies), and
3. Preventive Measures (This involves receiving tetanus immunization and iron/folic acid supplements).

The quality of ANC services is assessed by determining whether women received eight essential components during their ANC visits. These components include measuring blood pressure, conducting urine and blood tests, administering tetanus injections, iron supplements, and offering counseling on nutrition, birth preparedness plans, and pregnancy warning signs.

**Dependent and Independent variables**

The outcome variable examined in this study was the quality of ANC, which is coded as 1 (indicating =yes) if a women received all eight essential components of ANC, and 0 (indicating "no" if she received fewer than eight components. Each of the eight essential ANC components is recorded with a binary response: (yes = 1) or (no = 0), These components include blood pressure (BP) measurement, blood and urine tests, administration of iron supplements and tetanus injections, counseling on nutrition, information about danger signs during pregnancy, and advice on a birth preparedness plan.

The household and woman's questionnaire was adapted from Ethiopian Demographic and Health Survey (EDHS), and previous studies to gather basic demographic information (such as age, marital status, education, and occupations of partners), characteristics of the household's living situation (such as source of water, type of toilet facilities, materials used for the floor and roof) Additionally, the survey assessed ownership of various durable goods (such as electricity, radios, televisions, landline telephone, cell phones, and refrigerators).

Maternal factors considered in this study include the wantedness of pregnancy, the timing, and frequency of ANC visits). The study also took into account the woman's residence and distance from the nearest HFs. This distance was calculated based on the household (HH) GPS location to the nearest HCs and expressed in kilometer.

**Statistical analysis**

The data was collected using SurveyCTO software, and then downloaded and checked for consistency and completeness. After cleaning, the data they were exported to SPSS 25.0 for further analysis. Descriptive statistics (frequency and percentages for categorical variables and mean (standard deviation) or Median (inter -quartile range) for continuous

variables) were used to summarize participant characteristics. The results were presented in text, tables, and graphs.

To assess the relationship between the variables, independent variables with a P-value less than 0.25 in the bivariate analysis were chosen for the multivariate logistic regression analysis. A backward stepwise logistic regression model was developed to identify the most significant predictor variables associated with the quality of ANC services while adjusting for confounding variables. Ultimately, variables with a p-value less than 0.05, a 95% confidence interval, and an adjusted odds ratio (AOR) were presented to illustrate the relationship between the predictors and the quality of ANC services.

#### **Ethical consideration**

Ethical clearance and verbal consent procedures were obtained from the Jimma University Institute of Health Review Board (Ref No.: JUIH/RB/586/23, Date: August 23, 2023). In addition, a letter of support was obtained from the Oromia and the Gambella RHBs, the respective zones, and the

district health offices. The purpose and procedure of data collection were clarified, and confidentiality and privacy were guaranteed. All participants provided verbal informed consent, understanding that their participation was entirely voluntary and that they could withdraw from the study at any time during the interviews.

## **Results**

### **Descriptive summary statistics**

#### **Socio-Demographic and Economic Characteristics of the Study Participants**

Of the 840 women interviewed, their ages ranged from 15 to 49 years. The largest proportion (76%) of the participants was between 20 and 34 years old. Currently, 98% of these women are married. In terms of religion, 47.5% were Muslims and 26.5% were Protestants. Considering the mothers' and partners' education, 28.6% and 22.6% had no formal education, respectively. Eighty-four (84%) of the husbands and 72.4% of the mothers worked in agriculture. Table 1

**Table 1: Socio-Demographic and Economic Characteristics of the Study Participants, Effect of IR Implementation Performance status of HCs on Quality of ANC, Ethiopia, October 2023.**

Characteristics	N= 840	%
<b>Mother's age, at birth years</b>		
15-19	83	9.9
20-34	651	77.5
35-44	106	12.6
<b>Marital status</b>		
Married	820	97.6
Not Married	20	2.4
<b>Mothers' educational status</b>		
No education	240	28.6
Primary (1-8)	423	50.4
Secondary	161	19.2
Higher level	16	1.9
<b>Partner educational status</b>		
No education	193	23.0
Primary (1-8)	380	45.2
Secondary	214	25.5
Higher level	53	6.3
<b>Religion</b>		
Muslim	389	46
Orthodox	191	23
Protestant	227	27
Other	33	4
<b>Mother's occupational status</b>		
Employed	12	1.4
Farmer	621	73.9
Merchant	52	6.2
Unemployed	114	13.6
Others	41	4.9
<b>Partner's occupational status</b>		
Employed	86	10.2
Farmer	735	87.5
Merchant	19	2.3

<b>Wealth Categorized</b>		
Poor	264	31.4
Medium	246	29.3
Rich	330	39.3

**Utilization of ANC Service**

During their most recent pregnancy, a significant majority of women (97.4%) had at least one ANC visit with a qualified health professional. Of these visits, two-thirds (66.8%) of women attended four or more ANC visits. Furthermore, 61.7% of these visits occurred within the first four months of pregnancy.

Out of the total women who attended at least one ANC visit, 87.9% attended at health centers, while 90.2% received the services from either nurses or midwives, while the rest received from Medical doctors, health officers, and HEWs.

**Table 2: Magnitude of Quality ANC Service Utilization, Effect of IR Implementation Performance status of HCs on Quality of ANC, Ethiopia, October 2023.**

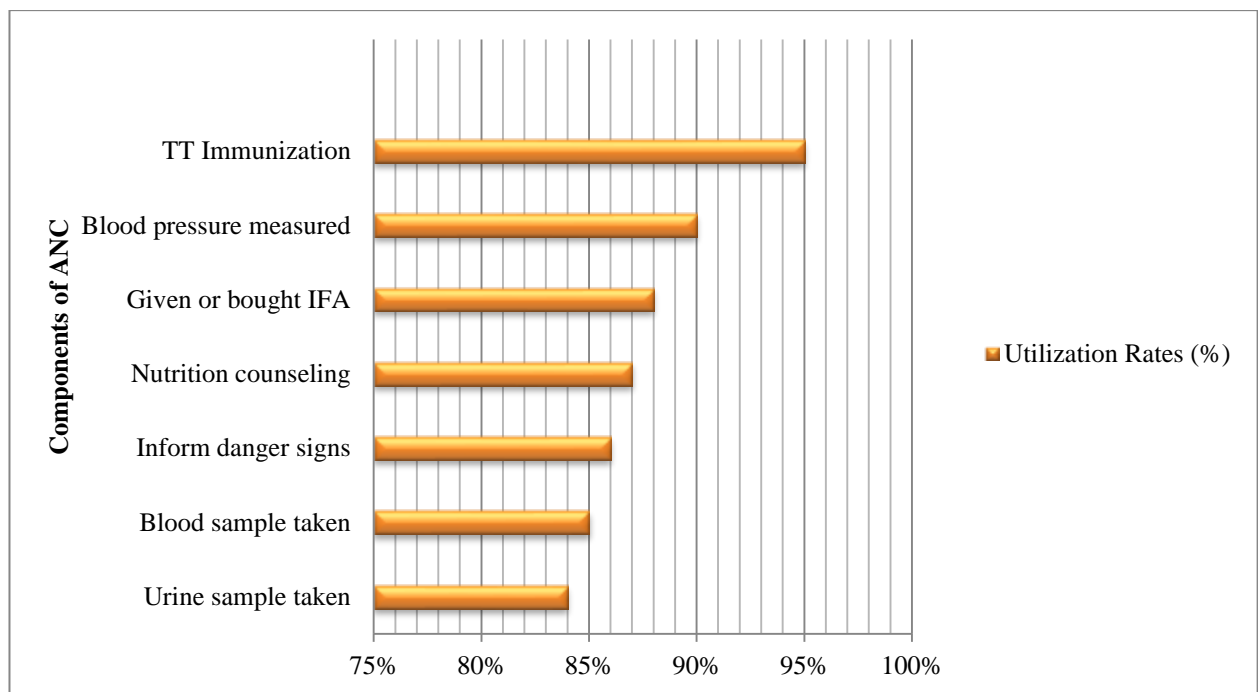
Variables	N	No. (%)	95% CI
<b>At least 1 ANC visit with a skilled provider</b>	<b>840</b>		
Yes		818 (97.4)	96.1, 98.3
No		22 (2.6)	1.7, 3.9
<b>No. ANC visits in the last pregnancy</b>	<b>818</b>		
One to three visits		257 (30.6)	27.6, 33.8
four + visits		561 (66.8)	63.6, 69.9
<b>Timing of first ANC visit</b>	<b>818</b>		
1–4 Months		570 (69.7)	66.5, 72.8
5–9 Months		248 (30.3)	27.2, 33.5
<b>Length of IFA use</b>	<b>818</b>		
0–29 days		91(11.1)	9.1,13.4
30–59 days		165 (20.2)	17.5, 23.0
60–89 days		239 (29.2)	26.2, 32.4
90+ days		329 (39.5)	36.3, 42.9
<b>ANC Provider Type of health worker</b>	<b>818</b>		
Doctor		13 (1.6)	0.9, 2.6
Health officer		12 (1.5)	0.8, 2.5
Nurse/midwife		739 (90.3)	88.2,92.2
Health extension workers		54 (6.6)	5.0, 8.5
<b>ANC Facility</b>	<b>818</b>		
Hospital		52 (6.4)	4.8, 8.2
Health Center		718 (87.8)	85.4, 89.0
health Post		45 (5.5)	4.1, 7.2
Private clinic		3(0.4)	0.1, 1.0

**\*ANC- Antenatal care; IFA; Iron and Folic Acid Supplement**

**Components of antenatal care**

In the most recent pregnancy data, a notable 95% of women attending ANC services received TT vaccinations (CI: 93.3%, 96.3%). Blood pressure measurements were taken for 92.5% of the women (CI: 90.6%, 94.2%). Furthermore, a significant portion, 90.6% (CI: 88.4% to 92.5%), received IFA supplements and over one- third, 39.5% (CI: 36.3% to 42.9%), of them used these supplements for three months or longer. Additionally, 89.0% of the women's blood samples were collected (CI: 86.7%, 91.0%).

Delivery planning and preparation, along with nutritional counseling, were provided to 86.6% of the participants (CI: 84.1% to 88.8%). However, the collection of urine sample and the provision of information on danger signs during pregnancy were the least reported services, both at 85% (CI: 82.9% to 87.7%). Overall, the findings indicate a high uptake of several crucial ANC services components, while highlighting the need for increased focus on urine sample collection and danger sign counseling to enhance the well-being of pregnant women.



**Fig.1: Proportion of Pregnant Women Receiving Essential ANC Components, Effect of IR Implementation Performance status of HCs on Quality of ANC, Ethiopia, October 2023.**

#### Quality Antenatal Care

The proportion of pregnant women who received all eight essential ANC components in the study area was 54% (95% CI: 50.6% to 57.4%). The provision of all eight essential ANC components to pregnant women showed significant variation according to the IR assessment scores in health centers. Specifically, model health centers delivered 77.4% (CI: 72.2% to 82.0%) of these components, while health centers classified as mixed (a combination of model and candidate) provided 60.9% (CI: 55.0% to 66.6%), and candidate health centers offered only 22.8% (CI: 18.1% to 28.1%). These data highlight a notable variation in the standard of ANC services available to pregnant mothers at these facilities.

**Table 3: Information Revolution Assessment Status of Health Facilities and Quality of ANC, Ethiopia, October 2023**

Quality of ANC Services	Model		Combination of Model & Candidates		Candidate		Total	
	#	%	#	%	#	%	#	%
Poor Quality	63	23	106	39	207	77	376	45.97
Good Quality	216	77	165	61	61	23	442	54.03
Total	279	100	271	100	268	100	818	100.00

The analysis demonstrated a significant association between the quality of ANC services and various factors, including socio-demographic characteristics, maternity details, and the IR assessment status of health centers, according to bivariable logistic regression analysis.

Key variables included the IR assessment scores of health centers, the number of ANC visits, pregnancy intention, and the age of the mother at her last childbirth, health insurance membership, maternity characteristics, marital status, the partner's educational background, and the distance to the health center.

The data showed that for each additional year in a woman's age, the odds of receiving high-quality ANC services increased by 1.03 times (AOR = 1.033, 95% CI; 1.008, 1.059).

Women who planned their pregnancies had 3.36-times greater odds of accessing quality ANC services compared to those with unplanned pregnancies (AOR = 3.36), 95% CI; 1.918, 5.903). Additionally, women from households enrolled in community-based health insurance (CBHI) had

a 1.15 times greater likelihood of receiving quality ANC compared to those without CBHI (AOR = 1.149); CI 1.020, 1.975). Furthermore, for every additional kilometer a woman lives away from a health facility, the likelihood of her receiving good-quality ANC decreases (AOR = 0.943, 95% CI; 0.922, 0.965)

After controlling for the effect of potential confounders, the quality of ANC service was significantly associated with the model IR status of health centers. Specifically, women who received ANC services from a model health center had 9.23-times greater odds of receiving good-quality ANC than those women who get services from candidate health centers, with an (AOR = 9.23; 95% CI: 5.65, 15.1). Similarly, women who received ANC services from a combination of candidate and model HC catchments had 3.89 times greater odds of accessing good-quality ANC services compared with those in areas with only candidate health centers (AOR = 3.89; 95% CI: 2.45, 6.19). Furthermore, married women had higher odds of receiving good-quality ANC compared to those not married (AOR 8.16 (95% CI: 1.62, 41.2) Table 4.

**Table 4: The Association between Utilization of Quality ANC and Information Revolution Performance Status of Health Facilities, Multivariate Logistic Regression, Ethiopia, October 2023**

Characteristics	Quality ANC, Number (%)		Unadjusted OR (95% CI)	Adjusted OR (95% CI)	P Value (AOR)
	Good (%)	Low (%)			
<b>IR status of HCs</b>					
Model	216 (77.4)	63 (22.6)	11.63 (7.8, 17.4)	9.23 (5.65,15.1)	<0.001
Mixed	165 (60.9)	106 (39.1)	5.28 (3.6, 7.7)	3.89 (2.45,6.19)	<0.001
Candidate	61 (22.8)	207 (77.2)	1.00	1.00	
<b>Wealth Index</b> N= 840					
Poor	153 (34.6)	102 (27.1)	1.06 (0.75, 1.47)	0.92 (0.62, 1.36)	0.678
Medium	96 (21.7)	138 (36.7)	0.49(0.35, 0.69)	0.54 (0.36, 0.79)	0.002
Rich	193 (43.7)	136 (36.2)	1		
<b>Mother occupation status</b> N=818					
Employed	5(2)	7(2)	1.17 (0.26, 2.8)	1.25 (0.32, 4.84)	0.744
Farmer	335(69.1)	260(70.2)	1.54 (1.08,2.18)	1.58 (1.03, 2.50)	0.036
Merchant	29(6)	22 (5.9)	1.57 (0.83, 2.9)	1.24 (0,59, 2.63)	0.571
Unemployed	73 (23.1)	87 (16.5)	1		

Marital status	N=818				
Married	440 (99.5)	362 (96.3)	7.89 ( 1.76, 35.1)	8.16 (1.62, 41.2)	0.01
Not Married	2 (0.5)	14 (3.7)%	1		

\* *ANC: Antenatal Care; IR: Information Revolution; HCs Health Centers*

### Discussion

The findings of this study highlight the impacts of IR implementation performance on the quality of ANC service improvement. High-quality ANC is vital for enhancing the health of mothers and newborns. It offers health education, prevents diseases, and enables the early identification and management of pregnancy - related complications (33, 34). The consistent use of essential ANC services during pregnancy can lead to improved perinatal outcomes around the time of birth and positively affect women's experience of care (35,36). Moreover, the improving the quality and usage ensures that ANC services are based on reliable information, which ultimately contributes to improved health outcomes for pregnant women and their infants (37,38)

The study findings revealed that the overall quality of ANC stood at 54.0%. This figure is higher than the results from the DHS surveys conducted across various countries and regions. This percentage exceeds those recorded in Pakistan 41.4% (39), Nepal 21% (40), Bangladesh 18% (41), SSA 10.4% (42), Six East Africa countries 11.6% (43), Rwanda 13.1% (44), Cameroon 13.5% (45), and Ethiopia national level (22.48% and 43% for DHS 2016 and Mini EDHS, respectively (46,47). Additionally, the figure is higher than findings from other research conducted in different settings, including Sera Lion 27% and various regions within Ethiopia such as the Sidama region 41.2% (48), Addis Ababa 33.3% (49), Hosanna 31.5% (12), and Harar Towns (24%) (50,51).

The finding of this study might be higher due to the implementation of CBMP intervention in study areas. This intervention includes strategies such as training on data quality and utilization, supportive supervision, mentorship, and regular performance reviews. The improvement in the quality of ANC at HCs can be attributed to the skills and capabilities of healthcare workers in effectively implementing this information revolution. The implementation packages and regular performance review meetings not only improve data quality and utilization but also enhance the overall quality of care and effectiveness of healthcare services. Additionally, these efforts can indirectly strengthen both clinical and administrative management, motivating health professionals to adhere to established guidelines and protocols.

Our research findings suggest that the quality of ANC services in our study was lower compared to other studies conducted in Tamil Nadu, India

(98.6%), (52), Mexico at 74.1% (53), and Pakistan at 61% (54). The potential variation in quality ANC may be due to a variety of factors, including the effectiveness of IR implementations, the scope of geographical coverage, and changes in health system strategies and guidelines.

Moreover, differences in the study design, the tools utilized for assessing ANC quality, the timing of the research, and the specific components of ANC being evaluated might also contribute to the discrepancies. Additionally, our study's focus on the quality of ANC services received during the most recent pregnancy within one year might lead to recall bias among the participants. Factors influencing participant recall include time passed since pregnancy, their capacity to remember, and personal experiences during ANC visits.

The research also showed that successful implementation of IR can improve the quality of ANC services. Health centers with higher IR assessment scores exhibited better ANC quality. Model health facilities perform better in providing quality ANC compared to a combination of model and candidates or candidate HCs, indicating that effective HIS strategies can enhance the delivery of standardized ANC services to pregnant women. Furthermore, the study indicates that marital status influences the quality of ANC received, highlighting potential inequalities in maternal healthcare. Promoting equitable access and outcomes involves addressing both social and individual factors.

The Ethiopian Health Sector Transformation Plan II (HSTP-II) aims to significantly improve the health status of the population. One of the five transformation agendas of HSTP-II is the IR initiative, which envisions healthy, productive, and prosperous Ethiopians through evidence-based decision-making (27). However, challenges such as resource constraints, inadequate infrastructure, insufficient commitment from health workers, and poor leadership in health facilities contribute to e variations in the quality of ANC.

The IR initiative aims to enhance the quality of ANC services by creating model health facilities that strengthen health system inputs, processes, and performance. This study evaluates the quality of ANC services based on the IR assessment status of health centers and compares it to other HIS interventions. The limited research on the impact of HIS interventions on the quality of ANC underscores the importance of examining ANC



quality concerning health centers' IR status to improve maternal healthcare.

The study findings also indicate that married women are likely to receive quality ANC compared to unmarried women. This finding aligns with studies from various developing countries (55), including Lubumbashi in the Democratic Republic of Congo (10) and Ethiopia (56). Unmarried women may avoid seeking ANC services due to fears of social stigma and isolation, resulting in lower utilization of quality services compared to married women. It is important to identify factors affecting ANC usage among different groups to ensure all pregnant women, regardless of marital status, have access to high-quality care.

The disparity in quality ANC usage may be attributed to several factors, including poor readiness of health facilities, lack of trained health workforce, inadequate adherence to guidelines, and job aids. Other possible contributing factors include interpersonal relations between PW pregnant women and providers, low client satisfaction, and technical aspects of quality care or service delivery approaches that negatively affect the quality of ANC. Additionally, improvement in health service management, infrastructure, equipment, diagnostics, and the availability of medicines and commodities are positively associated with good quality ANC (57–59).

### Strength and limitation

The study findings demonstrated that the implementation of IR improved the quality of ANC services. The strength of this study is that effective implementation of IR can enhance both data quality and utilization, ultimately leading to improved ANC quality services. This research is one of the few that explores the impact of HIS interventions effect on ANC quality, making a valuable contribution to existing research. However, the study does have several limitations. These include concerns about generalizability due to its specific context in Ethiopia and its focus on IR implementation. Additionally, there may be potential recall bias associated with self-reported essential ANC components, and the assessment did not consider health facility readiness or healthcare providers' skills.

### Conclusion and Recommendation

The study found that Health Information System (HIS) interventions significantly improved the quality of ANC services. Women living in the catchment areas of model health centers have better access to high-quality ANC services. The study recommends upgrading underperforming health facilities to model facilities and learning centers within a specific timeframe. It also emphasizes the need to focus on enhancing and evaluating the quality of health service delivery. Additionally, the importance of health education and counseling on essential ANC components was highlighted. Further research on HIS interventions in maternal health

services is essential for ongoing improvements in healthcare quality and outcomes.

### Abbreviations

ANC: Antenatal care  
 AOR adjusted odds ratio  
 CBMP: Capacity Building and Mentor-ship Partnership  
 CBHI: Community-based health insurance  
 DHS: Demographic and Health Survey  
 HC: Health center  
 HFs: Health Facilities  
 HMIS: Health Management Information System (HMIS)  
 HIS: Health information systems  
 HIV: Human Immunodeficiency Virus  
 HSTP-II: Ethiopian Health Sector Transformation Plan-II  
 IFA: Iron and Folic Acid  
 IR: information revolution  
 JU: Jimma University  
 MCH: Maternal and Child Health  
 MoH: Ministry of Health  
 SPSS: Statistical Package for the Social Sciences  
 TT: Tetanus toxoid  
 WHO: World Health Organization

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### Availability of data and materials

The corresponding author is available to provide data upon request. You can contact the corresponding author via email.

**Consent for publication:** Not applicable.

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