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Assessment of healthcare facilities' readiness to provide antenatal care in Ethiopia: facility based study using service provision assessment data

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Abstract

Background Readiness of healthcare facilities is essential for delivering quality healthcare services. There is limited evidence on the antenatal care (ANC) readiness of healthcare facilities in Ethiopia. This study aimed to assess the readiness of ANC services and its influencing factors in Ethiopian healthcare facilities.

Methods A secondary data analysis was performed using data from the Ethiopian Service Provision Assessment conducted from 11th August 2021 to 4th February 2022. A total of 905 healthcare facilities from nine regions and two city administrations in Ethiopia that provided ANC were included. Healthcare facilities' ANC readiness was evaluated using 22 indicators across five domains: trained staff and ANC guidelines (3), basic medical equipment (4), medicines and commodities (4), infection prevention tools (6), and diagnostic tests (5). A higher score in each domain indicated greater readiness to deliver recommended ANC. A Generalized Poisson regression model identified factors influencing each domain of ANC readiness indicators. Data analysis was conducted using Stata software version 16.

Results The total number of ANC readiness indicators in healthcare facilities ranged from two to seventeen. The mean score for each indicator of ANC readiness in healthcare facilities was as follows: trained staff and guidelines (1.36/3, SD = 0.96), basic medical equipment (3.20/4, SD = 0.99), medicines and commodities (1.95/4, SD = 1.36), infection prevention tools (4.33/6, SD = 1.51), and diagnostic tests (2.22/5, SD = 1.80), based on the included indicators in each domain. Regression results showed lower availability of medicines and commodities, infection prevention tools, and diagnostic tests in clinics and rural facilities. Trained staff and ANC guidelines were less available in private healthcare institutions, health posts, and clinics. Conversely, medicines and commodities were more available in healthcare facilities in the Afar, Amhara, and Somali regions.

Conclusion Most healthcare facilities in Ethiopia lacked key ANC readiness indicators, which are crucial for comprehensive ANC and achieving maternal and child health Sustainable Development Goals. Strategic interventions are needed to ensure ANC readiness indicators are available in healthcare facilities and to address disparities by facility type, managing authority, location and region.

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Keywords Antenatal care, Service provision assessment, Healthcare facility, Readiness, Ethiopia

Text box 1: Contributions to the literature

- Improving maternal and newborn health requires healthcare facilities' readiness to provide quality ANC.
- Few studies evaluated healthcare facilities' readiness to provide quality ANC and its determinants in Ethiopia.
- We applied generalized Poisson regression to assess healthcare facilities' readiness for ANC using the recent Ethiopian Service Provision Assessment data.
- In general, most healthcare facilities in Ethiopia lack ANC readiness indicators, which are important for achieving maternal and child health Sustainable Development Goals.
- Urgent action is needed to ensure facilities' readiness for ANC and address disparities across facility type, managing authority, location, and region.

Background

Maternal and neonatal mortality rates are commonly used to evaluate the quality of care and medical advancements in perinatal health [1]. Although maternal and neonatal deaths have declined globally following two consecutive global campaigns including the Safe Motherhood Initiative (1987–2000) and the Millennium Development Goals (2000–2015), they continue to remain high in many low- and middle-income countries (LMICs). After the conclusion of the Millennium Development Goals campaign in 2015, still 800 women lost their lives daily, and many more experienced morbidity, disabilities, and long-term health complications due to pregnancy and childbirth, the majority of whom were in LMICs [2]. Maternal and neonatal health issues continue to be one of the global priorities included in the Sustainable Development Goals (SDGs) introduced by the United Nations in 2015. One of their targets is to reduce maternal and neonatal deaths to less than 70 per 100,000 live births and 12 per 1,000 live births, respectively, by 2030 [3]. A few years after the introduction of the SDGs, two projection studies indicated that global maternal deaths may reduce to 167 per 100,000 live births by 2030 [4] and 42 out of 48 Sub-Saharan Africa (SSA) countries may still miss the SDG target for reducing neonatal mortality [5]. This underscores the need for increased effort and investment to assist with the reduction of maternal and neonatal mortality and achieve the related SDGs, particularly in LMICs. A key priority for achieving this goal is addressing disparities in access to and quality of maternal and newborn healthcare [1].

In 2020 SSA, the region where Ethiopia is situated, recorded the world's highest maternal death at 545 deaths per 100,000 live births, representing 70% of global maternal deaths [6]. SSA also has the highest global neonatal mortality rate, with 28 deaths per 1,000 live births, accounting for 45% of all newborn deaths worldwide in 2018 [5]. The lifetime risk of maternal death in SSA is 400 times higher than in Australia and New Zealand [6], and a newborn in SSA has a tenfold higher risk of dying within the first month than a newborn in high-income countries [5]. The leading causes of maternal deaths in SSA are obstetric haemorrhage (28.8%), antenatal hypertensive disorders (22.1%), pregnancy-related infections (11.5%), and non-obstetric complications (18.8%) [7]. Neonatal deaths are attributed to delayed initiation of breastfeeding, low birthweight, lack of maternal tetanus vaccination, and infrequent ANC [8, 9]. The majority of maternal and neonatal deaths, as well as other complications, can be prevented, identified, and treated through quality and timely maternal healthcare services including antenatal care (ANC) [10, 11].

ANC provided to pregnant women by skilled medical professionals aims to safeguard the health of both the mother and the baby throughout pregnancy. ANC plays a crucial role in early detection of pregnancy-related risks and complications, ensuring access to essential services such as health education, disease prevention, vaccination, diagnostic tests, and treatments [11]. It also provides an opportunity for women to communicate with their healthcare providers, thereby increasing their likelihood of utilizing skilled birth attendant services [12, 13]. Due to its paramount importance, ANC is considered one of the core interventions for improving maternal and neonatal health [14].

Despite significant progress in maternal and neonatal health and wellbeing during the recent decades, healthcare systems in Ethiopia face challenges in delivery to pregnant women and the country still has a long way to reach the maternal and newborn-related SDG targets [15]. A nationwide study in Ethiopia in 2018 revealed that only half of the healthcare facilities providing ANC had the necessary resources to deliver recommended care, with a clear discrepancy by facility type and region [16]. Achieving universal coverage of maternal and newborn health care requires healthcare facilities to be ready to provide the required services to pregnant women and newborns [17]. While a previous nationwide study conducted six years ago assessed the readiness of healthcare facilities for ANC in Ethiopia, it employed linear regression [16]. However, studies with a non-negative integer outcome variable should consider Poisson regression for more accurate estimation [18].

Therefore, the focus of this study was to assess the readiness of healthcare facilities using indicators of readiness to deliver the recommended ANC according to established standards in Ethiopia. Employing these metrics

is important in uncovering disparities within a nation, revealing possible imbalances in resources and evaluating the effectiveness of healthcare systems in addressing the health requirements of the population [19]. It also helps to evaluate the capacity of healthcare facilities to deliver the required services addressing possible challenges [16].

Methods

Data source

Data were sourced from the Ethiopian Service Provision Assessment (ESPA) survey, conducted from 11th August 2021 to 4th February 2022. The survey was conducted by the Ethiopian Public Health Institute in collaboration with the Ethiopian Ministry of Health, with support from the United States Agency for International Development (USAID) [20]. We accessed the data through the Demographic and Health Surveys (DHS) website (www.dhsprogram.com) after obtaining ethical approval from relevant authorities.

Setting

The research was conducted in Ethiopia, an East African nation known for its multi-ethnic composition and diverse population. Ethiopia shares its borders with Sudan to the west, Somalia and Djibouti to the east, Eritrea to the north, and Kenya to the south, covering a total area of 1,112,000 square kilometres [21]. During the ESPA data collection period, Ethiopia was administratively divided into ten regional states: Afar, Amhara, Benishangul-Gumuz, Oromia, Somali, Gambella, Tigray, Harari, Sidama, Southern Nations Nationalities and Peoples' Region (SNNPR), and two administrative cities (Addis Ababa and Dire Dawa) [22]. The Ethiopian health system is organized into three tiers of service delivery: primary, secondary, and tertiary healthcare levels [20]. Figure 1 illustrates the types of healthcare facilities and the number of people each facility is intended to serve within its tier (Fig. 1).

Sampling

The 2021/2022 ESPA was carried out among a stratified random sample of healthcare facilities in nine of the ten regions and the two administrative cities of the country, with the Tigray region being excluded due to security concerns. Initially, healthcare facilities in the country were categorized by both region and type. The clinics within each region were further stratified according to their designated classification based on their capacity to provide skilled human resources and infrastructure (higher, medium, lower, and specialty clinics) [20]. All hospitals across the nation were included due to their limited number, while health centers were sampled proportionally across regions. In Dire Dawa and Harari, all health centers were included in the survey due to their smaller numbers. Health posts were sampled across the designated regions and cities, ensuring appropriate

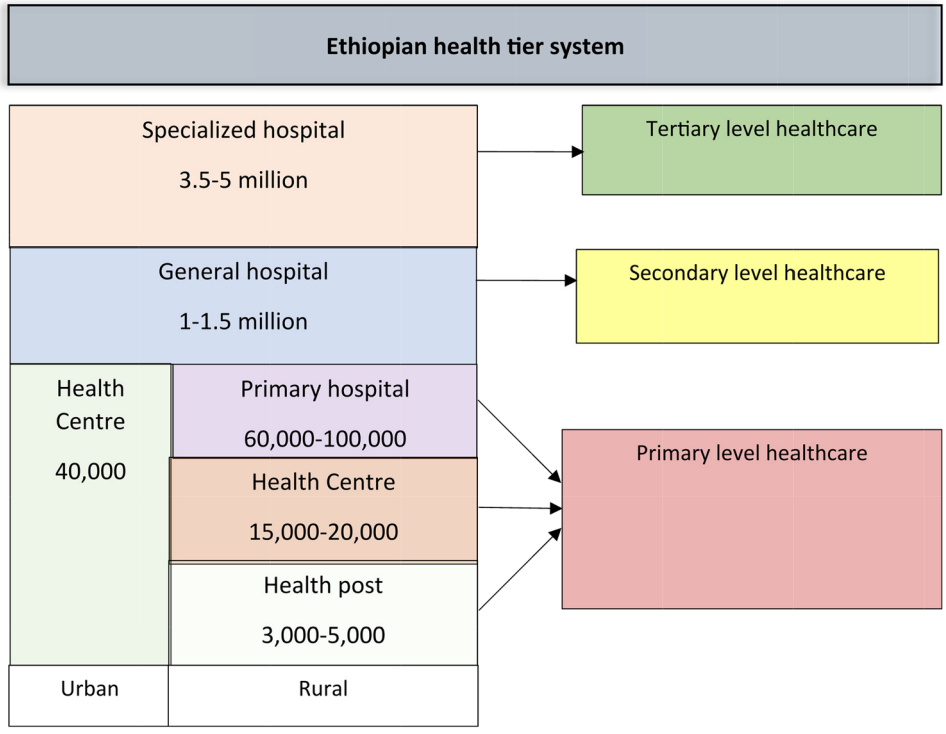

Fig. 1 The healthcare tier system in Ethiopia

power calculation for consistent survey precision across all included regions and cities. As a result, 1,407 healthcare facilities were considered as potential study sites. However, because some facilities were either closed or converted into COVID-19 care centers, 1,158 healthcare facilities participated in the survey out of which 905 (78%) offered ANC services [20].

Data collection tools

The survey employed standardized tools developed by the World Health Organization (WHO) to facilitate cross-country comparisons and included adequate samples for sub-national and facility-specific estimates. The tools comprised three questionnaires (Facility inventory, Health care provider, and Client exit interview questionnaires) and one observation checklist. Of these, the Facility Inventory Questionnaire was used to collect data on healthcare facility readiness for priority services including ANC [23]. The tool was used to collect data on specific items like the facility's location, operational status, support systems, and infrastructure. The tool was initially developed in English and subsequently translated into the two languages of the country (Amharic and Afan Oromo) and was pretested before its administration in the survey. Finally, the Amharic, English, and Afan Oromo versions of the questionnaire were used to conduct the interviews [20].

Data collection procedure

Data collection was conducted electronically using the Census and Survey Processing System (CSPro) software by trained data collectors who underwent an intensive four-week training program. More details of the data collection procedure can be found in the ESPA report [20]. The survey aimed to assess healthcare facilities' readiness for child health, ANC, family planning, and other services. The current study specifically reports on the healthcare facilities readiness for ANC services only.

Main outcome variable

The main outcome of the present study was the readiness of healthcare facilities to provide standardized ANC. The readiness of healthcare facilities for ANC services were assessed across the availability of five indicators: trained staff and guidelines for ANC, basic medical equipment, medicines and commodities, infection prevention tools, and diagnostic tests. These indicators must be available in a healthcare facility providing the service, as specified in the Service Availability and Readiness Assessment (SARA) manual [24] and other studies [20, 25]. A total of 22 ANC readiness indicators were expected to be available in a healthcare facility providing the service, such as three indicators for trained staff and ANC guidelines, four indicators for basic medical equipment, four indicators for medicines and commodities, six indicators for infection prevention tools, and five indicators for diagnostic tests. Each indicator was given a score of 1 if available on the day of the survey, and 0 if not available (Supplementary Table 1). The total score ranged from two to seventeen, and a higher score for each domain indicated that the facility was more prepared to provide ANC at its recommended level [24].

Independent variables

After conducting an extensive literature review [16, 25, 26], we pinpointed factors that may influence healthcare facilities' readiness to provide ANC. Administrative region, facility type, facility's managing authority, and facility location were considered as independent variables. The comprehensive details regarding the study variables have been provided in Supplementary Table 2.

Data management and analysis

Data analysis was performed using STATA (Version 16; StataCorp, College Station, TX). Descriptive statistics were reported as frequencies and percentages. Additionally, given multiple indicators for each domain, we computed mean scores of ANC readiness indicators for each domain reported with their standard deviation (SD). Four domains of ANC readiness indicators (the availability of trained staff and guidelines for ANC, basic medical equipment, medicines and commodities, and infection prevention tools) were assessed across all healthcare facilities ($n = 905$). However, one domain of ANC readiness indicators (availability of diagnostic tests) was assessed among 704 healthcare facilities, excluding 201 health posts that did not conduct diagnostic tests and referred clients to other healthcare facilities according to the country's context [20].

We employed Poisson regression model to identify the factors explaining each domain of ANC readiness indicators, since our outcomes were count variables. The standard Poisson regression assumes that the mean and variance are equal, a condition known as equidispersion [18]. However, the mean availability of trained staff and guidelines for ANC, basic medical equipment, medicines and commodities, infection prevention tools, and diagnostic tests in healthcare facilities in the current study was 1.36 (standard deviation (SD) = 0.96), 3.20 (SD = 0.99), 1.95 (SD = 1.36), 4.33 (SD = 1.51), and 2.22 (SD = 1.80), respectively. This indicated that their means were greater than their variances, suggesting a violation of the assumption of standard Poisson regression due to either underdispersion or overdispersion. As a result, we applied the most suitable model, the Generalized Poisson regression (GPR), an extension of Poisson regression, to obtain precise results [27].

The generalized Poisson probability function for the number of each ANC indicator domain (Y) in a healthcare facility can be represented as:

$$\begin{aligned}\Pr\left(Yi = yi\right) &= f\left(yi,\ \mu i\,\theta\right)\\ &= \left(\frac{\mu i}{1+\theta\mu i}\right)^{yi}\left(\frac{1+\theta yi}{yi!}\right)^{yi-1}\\ &\exp\left(\frac{-\mu i\left(1+\theta yi\right)}{1+\theta yi}\right),\ yi = 0,\ 1,\ 2,\ldots\end{aligned}$$

where μi represents the mean of the function, defined as $E\left(Y_i \mid x_i\right) = \mu_i = f\left(x_i\right) = \exp\left(x_i\beta\right)$, where x_i is a vector of independent variables, β is a vector of coefficients to be estimated and the variance of Yi is $E\left(Yi \mid xi\right) = \mu i\left(1+\theta\mu i\right)^2$ [27].

We performed both bivariable and multivariable GPR analyses to assess the relationships between each domain of the ANC readiness indicators and the independent variables. All independent variables with a p-value less than 0.20 in the binary GPR analysis were included in the multivariable GPR model. However, for the multivariable GPR, the significance level was set at a p-value of less than 0.05. The findings from the multivariable GPR model were reported using incidence rate ratios (IRRs) alongside 95% confidence intervals (CIs). The study adhered to the guidelines of Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) for cross-sectional studies.

Table 1 Distribution of healthcare facilities offering antenatal care in Ethiopia, 2021/2022

	Frequency (*n* = 905)	Percentage
Region	62	6.9
Addis Ababa		
Afar	36	4.0
Amhara	149	16.5
Oromia	205	22.7
Somali	68	7.5
Benishangul Gumuz	28	3.1
SNNP [β]	141	15.6
Gambella	43	4.8
Sidama	81	9.0
Dire Dawa and Harari	92	10.2
Location		
Urban	450	49.7
Rural	455	50.3
Managing Authority		
Public	752	83.1
Others[∞]	153	16.9
Facility type		
Hospital	364	40.2
Health centres	267	29.5
Health posts	201	22.2
Clinics	73	8.1

β SNNP: South Nations Nationalities & people's; ∞: mission/faith-based, non-profit, military, prison, and private for profit

Results

Characteristics of healthcare facilities

The study included a total of 905 healthcare facilities, with 22.7% (*n* = 205) located in the Oromia region and 50.3% (*n* = 455) situated in rural parts of the country. The majority (83.1%) of the facilities were public, and 40.2% (*n* = 364) of them were classified as hospitals (Table 1).

Antenatal care readiness indicators in healthcare facilities in Ethiopia

Figure 2 illustrates ANC readiness indicators by percentage in healthcare facilities in Ethiopia. Among the 905 facilities included in the current study, the majority were equipped with sharps container (94.3%), examination bed (93.4%), hand sanitiser (86.3%), adult weighing scale (85.7%), latex glove (84.9%), blood pressure machine (82.7%) and tetanus toxoid vaccine (82.3%). Out of 704 healthcare facilities that offered diagnostic tests, 89.3% conducted blood group detection test.

The distributions of ANC readiness indicators by facility type

Table 2 displays the distribution of ANC readiness indicators within its respective domain across healthcare facility type, noting that some overlapping exists between them. The availability of trained staff and guideline for ANC were highest in hospitals (40.9% & 53.9%) and lowest in clinics (19.2% & 27.4%), respectively. Blood pressure apparatus and adult weighing scales were found in 52.2% and 62.2% of health posts, respectively. The availability of folic acid and combined iron-folic acid tablets ranged from 24.7% and 19.2% in clinics to 41.6% and 37.5% in health centers, respectively. Soap and running water were available in 39.3% of health centers and 38.3% of health posts, respectively. Regarding diagnostic tests, 32.4% of hospitals and 32.9% of clinics were equipped to conduct syphilis tests, whereas 41.2% of health centers and 57.5% of clinics were capable of providing haemoglobin tests (Table 2). We also calculated the mean score for each domain of ANC readiness indicators by considering the indicators included within each domain. Based on this, the average availability of ANC readiness indicators in healthcare facilities in Ethiopia, along with their standard deviations, was as follows: trained staff and guidelines (1.36, SD = 0.96), basic medical equipment (3.20, SD = 0.99), medicines and commodities (1.95, SD = 1.36), infection prevention tools (4.33, SD = 1.51), and diagnostic tests (2.22, SD = 1.80), based on 3, 4, 4, 6, and 5 indicators, respectively. Figure 3 provides additional details on the mean availability of each domain of ANC readiness indicators by healthcare facility type. Trained staff

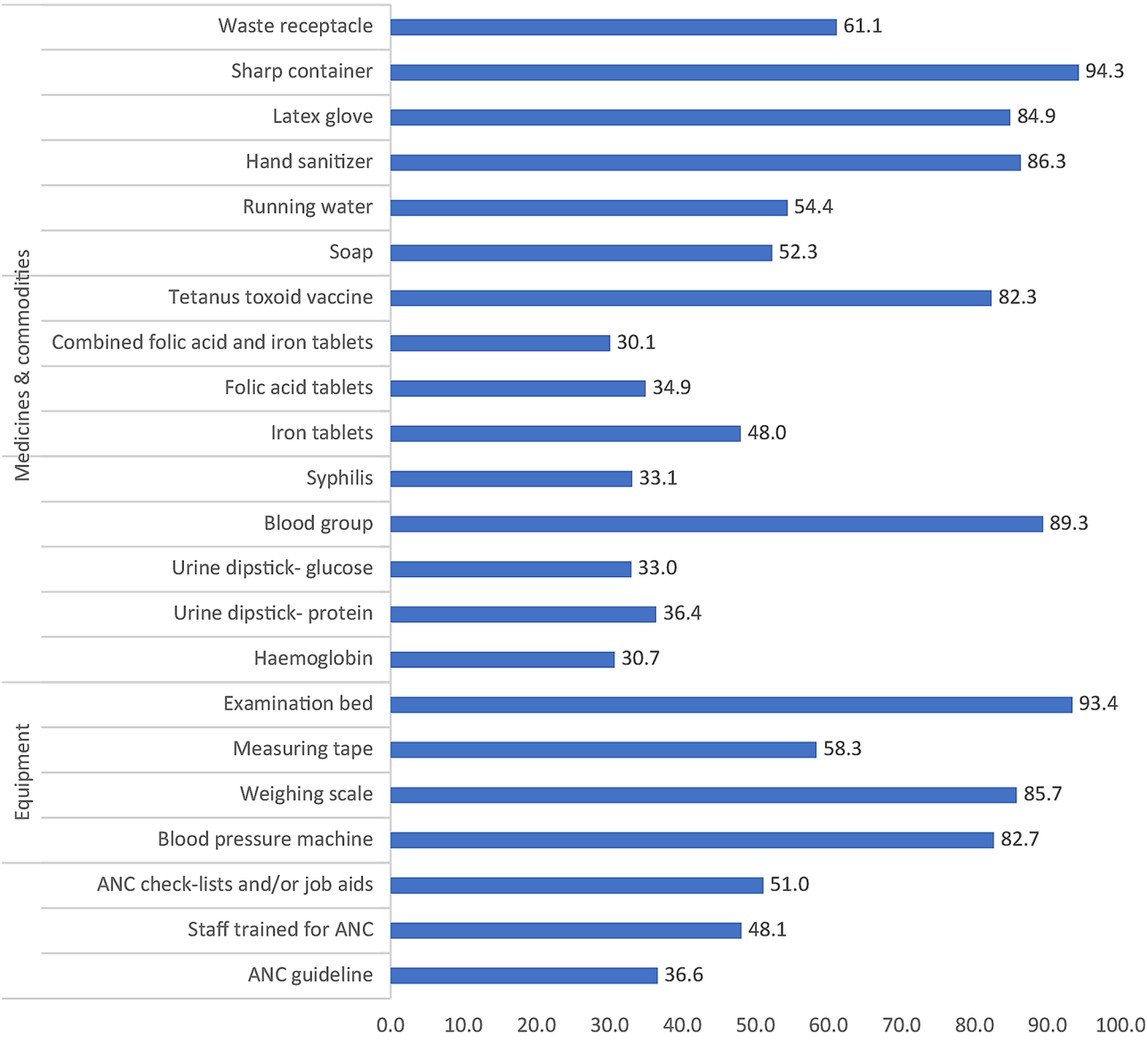

Fig. 2 Antenatal care readiness indicators in healthcare facilities in Ethiopia

and guidelines for ANC ranged from 0.68 (SD = 0.83) in clinics to 1.49 (SD = 0.97) in health centers; basic equipment ranged from 2.27 (SD = 1.27) in health posts to 3.48 (SD = 0.48) in hospitals; medicines and commodities ranged from 1.07 (SD = 1.33) in clinics to 2.25 (SD = 1.35) in health centres, infection prevention tools ranged from 3.79 (SD = 1.39) in health posts to 4.93 (SD = 1.39) in clinics, and diagnostic tests ranged from 2.08 (SD = 1.72) in health centre to 2.33 (SD = 1.8) in hospitals (Fig. 3).

Determinants of each domain of ANC readiness indicators in healthcare facilities in Ethiopia

The results from the GPR in Table 3 show that region, facility location, facility type, and managing authority are significantly associated with at least one domain of ANC readiness indicators.

Compared with Addis Ababa, the regions of Afar, Oromia, SNNP and Gambella had less availability of trained staff and guidelines for ANC by 24%, 31%, 26%, and 47%, respectively. They were also lower in other facilities compared to the public by 26%, and less prevalent in health posts by 22% and clinics by 24% compared to hospitals ($p < 0.05$).

Basic equipment was less likely to be available in health posts (by 38%). While the medicines and commodities were more available in Afar, Ahmara, Somali and Dire Dawa and Harari regions (by 38%, 27%, 63% and 31%, respectively), they were less available in rural areas and clinics (by 16% and 46%, respectively) ($p < 0.05$). The

Table 2 Distribution of the availability of antenatal care resources at healthcare facilities in Ethiopia, 2021/2022

Tracer item	Hospital (*N* = 364) *n* (%)	Health centres (*N* = 267) *n* (%)	Health posts (*N* = 201) *n* (%)	Clinics (*N* = 73) *n* (%)
Staff and guidelines				
ANC Guideline	196 (53.9)	142 (53.2)	77 (38.3)	20 (27.4)
ANC job aid	192 (52.8)	151 (56.6)	103 (51.2)	16 (21.9)
Staff trained for ANC	149 (40.9)	104 (39.0)	64 (31.8)	14 (19.2)
Basic equipment				
BP machine	336 (92.3)	236 (88.4)	105 (52.2)	71 (97.3)
Weighing scale	335 (92.0)	251 (94.0)	125 (62.2)	65 (89.0)
Measuring tape	234 (64.3)	182 (68.2)	74 (36.8)	38 (52.1)
Examination bed	362 (99.5)	259 (97.0)	153 (76.1)	71 (97.7)
Medicines & commodities				
Iron tablets	189 (51.9)	135 (50.7)	709 (39.3)	31 (42.5)
Folic acid tablets	120 (33.0)	111 (41.6)	67 (33.3)	18 (24.7)
Combined folic acid and iron tablets	106 (29.1)	100 (37.5)	52 (25.9)	14 (19.2)
Tetanus toxoid vaccine	304 (83.5)	255 (95.5)	171 (85.1)	15 (20.6)
Diagnostics tests				
Haemoglobin	324 (89.0)	110 (41.2)	N/A	31 (57.5)
Urine protein	129 (35.4)	96 (36.0)	N/A	31 (42.5)
Urine glucose	121 (32.2)	80 (30.0)	N/A	31 (42.5)
Blood group	362 (99.5)	219 (82.0)	N/A	48 (65.8)
Syphilis	118 (32.4)	91 (34.1)	N/A	24 (32.9)
Infection prevention tools				
Soap	228 (62.6)	105 (39.3)	85 (42.3)	55 (75.3)
Running water	246 (67.9)	115 (43.1)	77 (38.3)	54 (74.0)
Hand sanitizer	340 (93.4)	212 (79.4)	160 (79.6)	69 (94.5)
Latex glove	299 (82.1)	232 (86.9)	167 (83.1)	70 (95.9)
Sharp container	344 (94.5)	251 (94.0)	194 (96.5)	64 (87.7)
Waste receptacle	267 (73.6)	160 (59.9)	78 (38.8)	48 (65.8)

N/A = Not applicable

availability of infection prevention tool was less likely in Afar, Oromia, SNNP, Gambella and Dire Dawa and Harari regions (by 15%, 11%, 22%, 34%, and 20%, respectively), rural areas, health centres and health posts (by 5%, 8% and 13%, respectively), but more available in other facilities by 13% ($p < 0.05$). The distribution of diagnostic tests was not equal across the settings as they were less available in Oromia and Dire Dawa and Harari regions (by 50% and 30%, respectively), rural areas and health centres (by 17% and 18%, respectively). These tests were, however, more available in Somali and Benishangul Gumuz region (by 39% and 78%, respectively ($p < 0.05$).

Discussion

In this nationwide secondary data analysis of healthcare facilities in Ethiopia, 905 facilities providing ANC were included. The average ANC readiness indicators in healthcare facilities were as follows: trained staff and guidelines (1.36), basic medical equipment (3.20), medicines and commodities (1.95), infection prevention tools (4.33), and diagnostic tests (2.22), based on 3, 4, 4, 6, and 5 indicators by WHO, respectively. Our study shows significant associations between domain of ANC readiness indicators and facility type, location, managing authority, and region. The availability of medicines and commodities, infection prevention tools, and diagnostic tests was lower in rural healthcare facilities. However, the availability of medicines and commodities was found to be higher in facilities in the Afar, Amhara, and Somali regions.

The 2016 WHO ANC model emphasizes that updated training and ANC-specific materials, such as guidelines and job aids improves women's pregnancy experiences [28]. Research indicates that proper training enhances healthcare providers' performance [29] and clinical guidelines equip service providers across all levels of the health system with evidence-based knowledge and skills to deliver standardized services [30]. Job aids are visual tools designed to assist healthcare providers in effectively communicating information with patients through a combination of easy-to-understand graphics and text [31]. A recent nationwide study in Ethiopia found that ANC guidelines and trained staff increased counselling on pregnancy danger signs by 24% and 37%, respectively [32]. However, poor healthcare provider performance hinders quality care in LMICs, including Ethiopia [33]. Our current study, consistent with a nationwide study

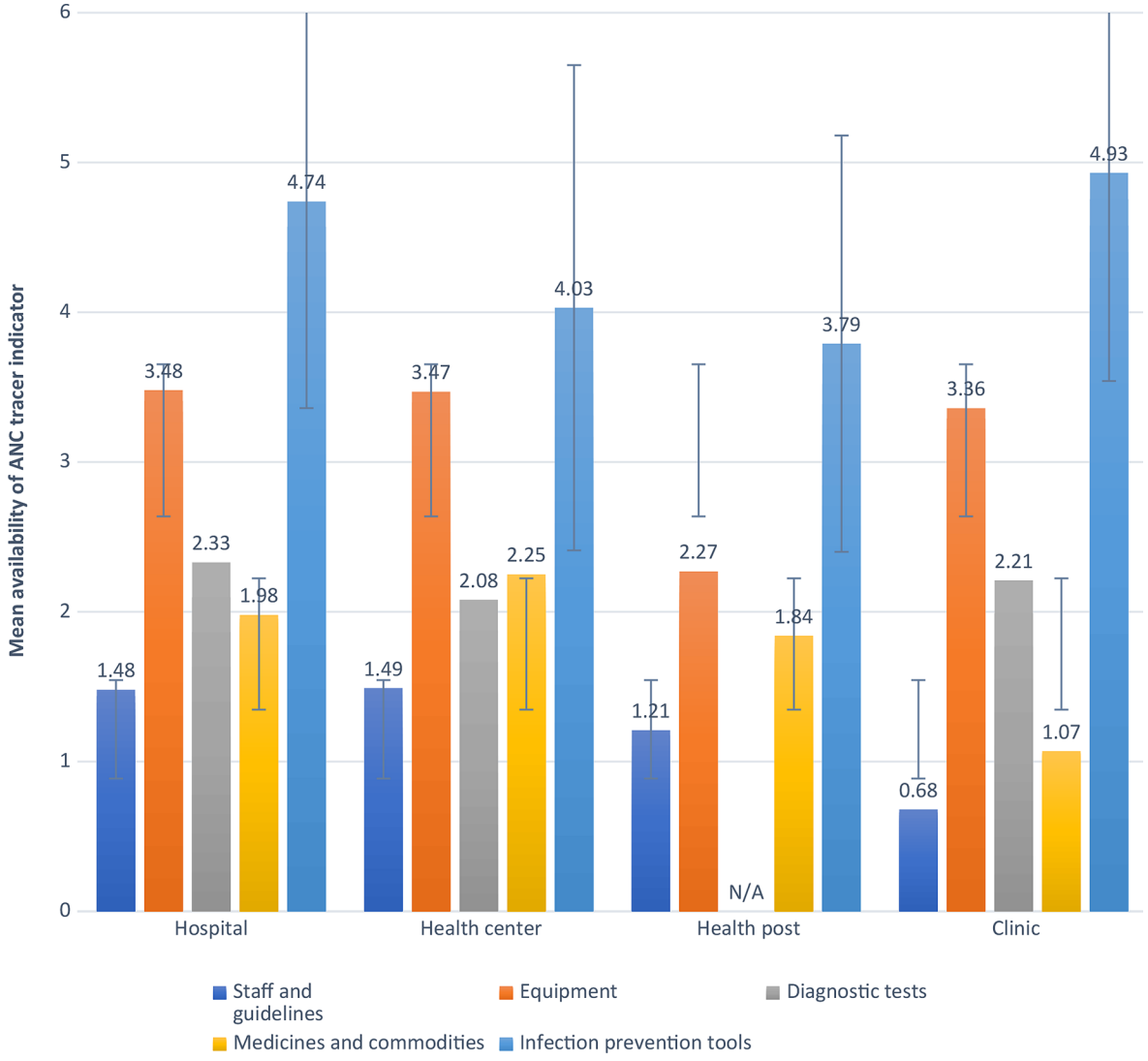

Fig. 3 Mean scores of each domain of ANC readiness indicators by the type of healthcare facility in Ethiopia

by Defar et al. [16], showed limited ANC readiness indicators in most of healthcare facilities in Ethiopia. This underscores the need for trained staff, ANC guidelines and job aids in every ANC-providing facility to ensure quality ANC services.

Measuring maternal blood pressure, weight, and fundal height at every ANC contact is crucial for preventing and managing pregnancy related hypertension, abnormal weight, and foetal growth abnormalities [11]. Our study highlights the need for all essential ANC medical equipment in healthcare facilities across Ethiopia. The lack of measuring tape, weighing scale, and blood pressure machine hinders accurate assessment of foetal growth, maternal weight, and blood pressure. Likewise, inadequate examination beds hinder thorough physical examination during every ANC contact.

The limited infection prevention tools during ANC provision may hinder healthcare providers from protecting themselves, preventing infection spread, and properly disposing of medical waste, affecting both staff and pregnant women. The hormonal, immunological and physiological changes during pregnancy can make the women more susceptible to some infectious diseases, such as influenza, uterine infection, vaginal candidiasis, bacterial vaginosis, and COVID-19 [34, 35]. Healthcare associated infection has a substantial impact on society's overall well-being, leading to illnesses, death, and financial strains [36]. Research shows that healthcare associated infections have a 17% prevalence in Ethiopia partially due to limited infection prevention tools [37].

The routine ANC diagnostic tests are vital and should be available in all healthcare facilities to enable early disease detection, intervention, and management [38]. Our study revealed that routine ANC diagnostic tests in Ethiopia are not frequently available. The findings align with a previous study indicating limited diagnostic tests,

Table 3 Determinants of each domain of antenatal care readiness in healthcare facilities in Ethiopia

Variables	Domain				
	Trained staff and ANC guideline IRR (95% CI)	Basic equipment IRR (95% CI)	Medicines and commodities IRR (95% CI)	Infection prevention tool IRR (95% CI)	Diagnostic tests IRR (95% CI)
Region					
Addis Ababa	1	1	1	1	1
Afar	0.76* (0.58, 0.99)	0.96 (0.76, 1.2)	1.38* (1.07, 1.80)	0.85* (0.76, 0.97)	0.76 (0.55, 1.04)
Amhara	0.88 (0.73, 1.07)	0.99 (0.84, 1.17)	1.27* (1.04, 1.56)	0.96 (0.88, 1.05)	0.92 (0.76, 1.13)
Oromia	0.69* (0.57, 0.84))	0.94 (0.80, 1.11)	0.88 (0.72, 1.08)	0.89* (0.82, 0.96)	0.50* (0.41, 0.62)
Somali	0.85 (0.68, 1.06)	1.04 (0.86, 1.29)	1.63* (1.30, 2.04)	0.97 (0.88, 1.08)	1.39* (1.09, 1.75)
Benishangul Gumuz	1.10 (0.84, 1.44)	1.06 (0.82, 1.36)	1.25 (0.93, 1.67)	0.98 (0.86, 1.12)	1.78* (1.35, 2.34)
SNNP	0.74* (0.60, 0.90)	0.85 (0.71, 1.02)	0.88 (0.71, 1.10)	0.78* (0.71, 0.86)	0.94 (0.76, 1.16)
Gambella	0.53 * (0.40, 0.70)	0.99 (0.80, 1.24)	0.96 (0.72, 1.28)	0.66* (0.59, 0.75)	1.16 (0.89, 1.52)
Sidama	0.97 (0.78, 1.20)	1.15 (0.95, 1.39)	1.09 (0.86, 1.37)	0.99 (0.90, 1.10)	1.04 (0.81, 1.33)
Dire Dawa and Harari	0.81 (0.66, 1.00)	0.96 (0.80, 1.16)	1.31* (1.05, 1.63)	0.80* (0.72, 0.88)	0.70* (0.54, 0.89)
Location					
Urban	1	1	1	1	1
Rural	0.97 (0.87, 1.08)	0.99 (0.90, 1.08)	0.84* (0.76, 0.94)	0.95* (0.91, 0.99)	0.83* (0.74, 0.94)
Managing authority					
Public	1	1	1	1	1
Others∞	0.74* (0.63, 0.88)	0.93 (0.81, 1.07)	0.99 (0.84, 1.18)	1.13* (1.06, 1.21)	1.03 (0.87, 1.22)
Facility type					
Hospital	1	1	1	1	1
Health centres	0.95 (0.84, 1.06)	0.96 (0.87, 1.06)	1.12 (0.99, 1.26)	0.92* (0.87, 0.97)	0.82* (0.72, 0.93)
Health posts	0.78* (0.68, 0.90)	0.62* (0.55, 0.71)	0.97 (0.83, 1.12)	0.87* (0.81, 0.92)	N/A
Clinics	0.76 * (0.61, 0.93)	0.98 (0.82, 1.18)	0.54* (0.4, 0.69)	0.97 (0.89, 1.07)	0.83 (0.67, 1.03)
Observation	905	905	905	905	704
R^2	0.08	0.25	0.05	0.07	0.07

N/A: Not applicable

SNNP: South Nations Nationalities & people's

∞: mission/faith-based non-profit. military. prison. and private for profit

*: significant at $p < 0.05$

with haemoglobin tests available in only 39.3% of healthcare facilities in Ethiopia [16]. Insufficient diagnostic tests may hinder addressing common health issues during pregnancy before impacting the mothers and their unborn children. For instance, anaemia, preeclampsia and gestational diabetes mellites can increase the risk of adverse pregnancy outcomes including perinatal deaths and the absence of the required tests may impede detection [39, 40].

Certain medicines are essential for the health of both the mother and fetus during pregnancy. Iron tablets greatly reduce maternal morbidity and mortality by preventing or treating iron-deficiency anaemia [41]. Folic acid is important for preventing adverse perinatal outcomes such as neural tube defect, low birth weight, stillbirth, miscarriage and congenital anomalies [42]. The WHO has advised a daily dose of oral iron and folic acid supplementation for pregnant women [11]. Also, tetanus toxoid vaccine effectively prevents both maternal and neonatal tetanus [43]. The current study found that these medicines are not readily available in most ANC providing facilities in Ethiopia. This finding is alarming as these preventable problems remain common, negatively affecting pregnancy outcomes across the country [44, 45].

The GPR results revealed significant disparities in ANC readiness indicators in relation to facility type, locations, regions and managing authorities in Ethiopia. Despite expectations, our findings showed that healthcare facilities in the Somali, Afar, and Amhara regions had better ANC medicine and commodity than those in Addis Ababa. Similarly, the availability of diagnostic tests for ANC was higher among healthcare facilities in the Somali and Benishangul Gumuz regions. The observed regional disparities might be due to differences in ANC utilization and the implementation of USAID support during the data collection for this study. A nationwide study in Ethiopia showed that ANC utilization is higher in Addis Ababa than in other regions [46]. This suggests that the greater demand for ANC in Addis Ababa compared to other regions could contribute to the observed shortages in the city. Furthermore, the Afar, Benishangul

Gumuz, and Somali regions received USAID support, which included training for 18,000 healthcare professionals and supplies for 400 facilities over five years [47].

Our study found ANC readiness indicators were lower in health centers, clinics, and health posts compared to hospitals, and lower in rural than urban facilities. These results align with a study in ten LMICs, which found hospitals exhibited higher healthcare service readiness, particularly for basic medical amenities [38]. Our results, raise concerns about the readiness of lower level healthcare facilities for ANC. Rural healthcare facilities, mostly lower level, are key providers for underserved communities, play a crucial role in addressing health challenges in LMICs [38]. Therefore, equipping rural and lower-level facilities with ANC readiness indicators is crucial for providing the recommended ANC and increasing service utilization in rural communities.

The present study also revealed that governmental (public) healthcare facilities had higher availability of trained staff and ANC guidelines, but lower availability of infection prevention tools compared to non-governmental (private) facilities which is a matter of concern. To tackle this issue, partnership collaboration between public and private healthcare sectors should be encouraged to hasten progress toward universal health coverage [48, 49].

Strengths and limitations of the study

The main strength of our study was the use of the most recent nationally representative healthcare facility data, providing a comprehensive view of the situation across in Ethiopia. As a result, the findings offer valuable insights into the current status of healthcare system across the country and factors affecting their readiness for ANC services. It will also help policymakers in improving healthcare facilities' readiness to provide ANC services to reach the SDGs' target of universal healthcare coverage and decrease maternal and neonatal mortality rates by 2030. Despite this, our study had some limitations that need to be indicated. Due to the constraints of secondary data analysis, the factor analysis was restricted to only four variables. We also opted to analyze the unweighted data because applying weighting for GPR could potentially influence the regression estimates [50]. Furthermore, due to the cross-sectional nature of the survey, the present study could not establish causal associations. Additionally, our study did not investigate the specific challenges or opportunities for the significant disparities in ANC readiness across regions, facility types, and managing authorities. Further future studies, including both quantitative and qualitative studies, are required to address these limitations and contribute to the improvement of maternal and neonatal health in Ethiopia.

Conclusion

Readiness of healthcare facilities for ANC services in Ethiopia is vital to ensure comprehensive care for pregnant women, thereby contributing to the achievement of maternal and neonatal health-related SDGs. This nationwide study revealed that the majority of healthcare facilities in Ethiopia lacked most of ANC readiness indicators required to deliver the service. Moreover, significant disparities in the availability of the indicators were shown in relation to facility type, location, managing authority, and region. Given the importance of standardized ANC in preventing the majority of maternal and newborn health problems, strategic investments in training healthcare professionals for ANC and ensuring the availability of the remaining necessary ANC resources are required.

Abbreviations

ANC	Antenatal Care
CIs	Confidence Intervals
EDHS	Ethiopian Demography and Health Survey
ESPA	Ethiopian Service Provision Assessment
GPR	Generalized Poisson regression
IRRs	Incidence rate ratios
LMICs	Low and middle-income countries
SARA	Service Availability and Readiness Assessment
SD	Standard deviation
SDGs	Sustainable Development Goals
SNNP	South Nations Nationalities & people's
SSA	Sub-Saharan Africa
USAID	United States Agency for International Development
WHO	World Health Organization

Supplementary Information

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Supplementary Material 1

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Author contributions

All authors played a vital role in advancing this research. AA conducted an extensive review of relevant literature and carried out data analysis to draft the initial manuscript. MK and AW contributed to refining the study design, overseeing the data analysis process, and reviewing and editing the final manuscript. TG provided important technical assistance and carefully reviewed the manuscript for accuracy. Ultimately, AA took on the task of submitting the final version for publication, having obtained approval from all authors involved in this study.

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Data availability

The data used in this research were obtained from ESPA datasets available on the DHS website at (www.dhsprogram.com).

Declarations

Ethical clearance and agreement to participate

We obtained ethical clearance from the Demographic and Health Surveys (DHS) program, Ethiopian Midwives association and the Human Research Ethics Committee at the University of New South Wales. All procedures followed the specified protocols outlined in the SPA survey [20]. Since the data was anonymized, obtaining informed consent from the participants was unnecessary. The dataset was treated with utmost confidentiality.

Consent for publication

N/A.

Competing interests

The authors declare no competing interests.

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