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Trends and contributors of complete continuum of maternal healthcare service utilization in Ethiopia: a multivariate decomposition analyses



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Abstract

Background Most maternal deaths are preventable by accessing essential maternity healthcare services. However, maternal mortality rates remain high in Ethiopia partly due to only a few women using a complete Continuum of Maternal Healthcare Services (CMHS). This study aims to assess trends and contributors for complete CMHS utilization in Ethiopia.

Methods Ethiopian Demography and Health Survey (EDHS) 2011–2019 data were used to assess the trends of complete CMHS utilization. A total weighted sample of 10,768 women (3333 in 2011, 4590 in 2016, and 2845 in 2019) were included in the analysis. A logit-based multivariate decomposition analysis was undertaken to assess the change in the proportion of complete CMHS utilization and its contributors between 2011 and 2019.

Results In Ethiopia, trends of complete CMHS utilization among women increased from 9.6% (95% CI 8.4, 10.9) in 2011 to 29.9% (95% CI 27.3, 32.6) in 2019. In the decomposition analysis, 60.6% of the difference in the proportion of complete CMHS utilization was explained by the differences in the composition of women's characteristics, and 39.4% was attributed to coefficients of characteristics. As such, equalizing the number of women who attended school at secondary level or higher, had television, initiated antenatal care (ANC) visits in the first trimester, were aware of pregnancy-related complications, delivered by caesarean section for their most recent childbirth, were from poorer households, gave urine and blood samples during pregnancy in 2019–2011 levels, would reduce the differences between 2011 to 2019 in complete CMHS utilization. In contrast, equalizing the number of women from richer (higher) household wealth categories in 2019–2011 levels would increase the 2011–2019 gaps in complete CMHS utilization.

Conclusion While progress has been made, complete CMHS utilization was low in Ethiopia. Differences in the composition of characteristics and effect of coefficients had a substantial contribution to the change in complete CMHS utilization between 2011 and 2019. Adopting a multi-faceted approach that considers the unique challenges within the country, including women's education, wealth status, and quality of care, will improve CMHS utilization. Empowering women through education can enhance their decision-making ability regarding their own health.

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Keywords Continuum, Decomposition, Ethiopia, Maternal Health Services, Trends

Plain English Summary

The United Nations (UN) Member States set a global target, and they signed an agreement, to achieve less than 70 maternal deaths per 100,000 live births by 2030. Ethiopia has signed that agreement. However, it has one of the highest rates of maternal mortality in sub-Saharan Africa. To curb such a high burden of maternal mortality, various clinical interventions, including basic emergency management of obstetric care and comprehensive emergency management of obstetric care and comprehensive emergency management of obstetric care and comprehensive emergency management of obstetric care were implemented. Community-based interventions, such as health extension programs and women's health development army have been also employed in Ethiopia. Continuum of maternal healthcare service (CMHS) is among the key intervention strategies to reduce maternal, neonatal, and infant morbidity and mortality. This study aims to measure the trends and identify contributors to complete CMHS utilization between 2011 and 2019.

In Ethiopia, substantial improvement in complete CMHS utilization has been shown despite the overall coverage being low compared with the 2030 target. In this study, the women's characteristics changed over time, which was the major contributor to the CMHS utilization changes over time. Therefore, adopting a multi-faceted intervention that considers the key challenges within the country, including women's education, wealth status, and quality of maternity care, will improve CMHS utilization. More specifically, improvements such as maternal healthcare awareness, early initiation of antenatal care visits, medical interventions (e.g., monitoring health parameters during pregnancy, caesarean delivery), access to television, and women's empowerment will be collectively or individually helpful to achieve universal CMHS utilization in Ethiopia.

Background

Maternal health is the health of women during pregnancy, childbirth, and the postpartum period [1]. Globally, approximately 287,000 women die each year (about 800 women every day) of pregnancy and childbirth-related causes [2, 3]. This is despite the Maternal Mortality Ratio (MMR) having dropped by 34% (339-223 maternal deaths per 100,000 live births) worldwide between 2000 and 2020 [3]. Achieving the Sustainable Development Goal (SDG) of MMR to less than 70 maternal deaths per 100,000 live births by 2030 is a critical global target [4]. However, the global average annual maternal mortality reduction rate was about one-third of the 6.4% needed to achieve the SDG by 2030 [5]. Maternal mortality rates also vary widely by country and region, with the highest rates of maternal deaths occurring in Low and Lower-Middle Income Countries (LLMICs) [3], with maternal deaths in Sub-Saharan Africa (SSA) accounting for more than two-thirds (70%) of the global burden [3].

In Ethiopia, there has been a 70% reduction in MMR from 1400 per 100,000 live births in 1990–420 per 100,000 live births in 2013, a decline of 5% per annum [6]. Despite this remarkable success, the World Health Organization (WHO) reported Ethiopia still had a very high MMR of 267 deaths per 100,000 live births equalling 3.6% of global maternal deaths in 2020 [3]. In contrast, Ethiopia's population accounted for just 1.5% of the global population in 2022 [7]. In addition, about 30% of child-bearing-age women have unintended pregnancies,

and 38% of pregnant women experience one or more complications, such as severe bleeding and prolonged labour in Ethiopia [8, 9]. However, the majority of maternal deaths are preventable through the provision of high-quality care during pregnancy, childbirth, and the postnatal period [10, 11].

The Ethiopian government strengthening is Reproductive, Maternal, Neonatal, and Child Health (RMNCH) interventions to end preventable maternal and child deaths and aims to achieve Universal Health Coverage (UHC) by 2030 [12]. The UHC service coverage index of 80% of essential health service utilization is a critical target to ensure access to quality health services by 2030 [13, 14]. Progress toward UHC requires ongoing efforts to improve health systems and expand access to quality health services for all [14]. Continuum of maternal health service (CMHS) is among the vital strategies to reduce maternal morbidity and mortality. Continuum of maternal healthcare service is the integrated and seamless provision of care and services to women throughout their pregnancy, childbirth, and postpartum period [15]. However, only 25.5% of Ethiopian women had received complete CMHS in 2022 [16]. The Ethiopian government provides maternal health services free of charge at public health facilities to ensure access to pregnancy and childbirth-related healthcare services [17].

Health service utilization is an approach that considers the perspectives of healthcare professionals, the



Fig. 1 Conceptual framework for a continuum of maternal healthcare services

production of services, and the preferences and circumstances of patients [18]. Applying health service theoretical models is critically important to explain various determinants of health service utilization [19]. Andersen's behavioural model for health service utilization is among these theoretical models that can be employed to elucidate the multifaceted factors influencing women's utilization of healthcare services. This model provides a structured lens to analyse and interpret the complexities of healthcare utilization behaviours in terms of predisposing, enabling, and illness-specific factors that shape people's decisions on healthcare seeking [20, 21]. The first category, predisposing factors encompasses the socio-demographic and socio-cultural characteristics of respondents that precede their health conditions and offer insights on shaping individuals' healthcare behaviour. The second category is enabling factors, facilitators that empower individuals to access healthcare services effectively and explore the practical resources and support systems. The third category, need factors, focuses on the immediate determinants prompting individuals to seek health services. This dimension probes into the perceived health status of respondents, shedding light on the intrinsic motivations and urgencies driving healthcare utilization [20, 21]. Our conceptual framework is illustrated using these three components of Andersen's health service utilization model (Fig. 1).

Early initiation of ANC visits, closer distance to health facilities, arranging birth preparedness and complication readiness plans, attending higher education, planned pregnancy, and autonomy of women from previous studies were the facilitators for CMHS utilization [16, 22]. However, no studies conducted at a national level have prompted the need for rigorous examination and analysis of the trends and contributing factors influencing the change in the proportion of complete CMHS utilization in Ethiopia. This study aims to uncover the factors for the change in complete CMHS utilization in Ethiopia using decomposition analysis. The findings will contribute to a nuanced understanding of the dynamics and offer actionable insights for policymakers seeking to enhance maternal healthcare programs in Ethiopia. This study promises to be a pivotal resource in informing evidencedriven decisions, ultimately fostering nationwide improvements in complete CMHS utilization.

Methods and materials

Study design and settings

Secondary data analysis was undertaken to measure the trends of complete CMHS utilization using Ethiopian Demographic and Health Survey (EDHS) data from 2011 to 2019. We used data from Tigray, Afar, Amhara, Benishangul-Gumuz, Gambela, Harari, Oromia, Somali, and South Nation, Nationality, and People (SNNP) regions of Ethiopia, and two city administrations (Addis Ababa and Dire-Dawa). The public healthcare sector in Ethiopia is organized into a three-tier system that aims to provide comprehensive healthcare services to the population of Ethiopia. The details of Ethiopia's healthcare system are described in the 2015 Health Sector Transformation Plan (HSTP) of Ethiopia [12].

Sample and data sources

All women who had at least one ANC visit for their recent childbirth during the survey period from EDHS 2011 to 2019 were eligible for the study. The EDHS is a nationally representative survey conducted in Ethiopia to gather data on various demographic and health indicators. These surveys were conducted under the Ethiopian Public Health Institute (EPHI) Division of the Ethiopian Ministry of Health (MoH). The data is publicly available at https://www.dhsprogram.com/ data/dataset_admin/login_main.cfm. The EDHS is based on the Population and Housing Census conducted by the Ethiopian Central Statistical Agency (CSA), and its sampling frame employed Enumeration Areas (EAs) [23–25]. These EAs are geographical units smaller than administrative units used for conducting surveys. In each EDHS from 2011 to 2019, each region of Ethiopia was stratified into urban and rural areas, resulting in a total of 21 sampling strata. Samples of EAs were selected independently in each stratum in two stages. In the first stage, a total of 624 EAs (437 rural and 187 urban) in 2011, 645 EAs (443 rural and 202 urban) in 2016, and 305 EAs (212 rural and 93 urban) in 2019 were selected with proportional allocation to EA size. In the second stage, household listing operations were performed in all selected EAs. On average, 27-32 households per cluster were selected proportional to the cluster size using systematic sampling. Relevant variables were extracted from Individual Record (IR) file datasets. In the data cleaning procedure, we applied the following phases to identify the eligible women in each dataset. In the first phase, we excluded women who did not give birth before the survey period. In the second phase, we excluded those women who did not have at least one ANC visit. In the third phase, we excluded missing data, including "do not know" responses and non-dejure residents. Finally, total weighted sample of 10,768 women (3333 in 2011, 4590 in 2016, and 2845 in 2019) were included in the study (Fig. 2). The details of sampling procedures are described in the EDHS reports [23–25].

Study variables

Complete CMHS was the outcome variable. Socioeconomic characteristics, such as the age of women, religion, maternal education, residence (urban vs. rural), current marital status, geographic region, age at first birth, household's wealth index, obstetric history (e.g., the timing of the first ANC visit, urine and blood samples taken during pregnancy, measuring blood pressure during pregnancy, caesarean delivery for women's most recent childbirth), radio ownership, and television ownership, and access to electricity, were covariates. Continuum of maternity care is an integrated and seamless provision of care and services to women throughout their pregnancy, childbirth, and postpartum period. This involves the use of four or more ANC visits, facility birth attendance, and postnatal care to ensure the health and well-being of the woman [15]. We categorized the responses for each broad category of maternal healthcare services as "no" and "yes" recoded as 0 and 1, respectively. If women reported "no" for one or more of these maternal healthcare services, we considered them as not receiving complete CMHS. On the contrary, women who reported "yes" to all three broad maternal healthcare services were considered to have complete CMHS [15]. In this study, we used the old WHO guideline [26], which recommends a minimum of four ANC visits as a standard of ANC care. This guideline was used across all surveys, including in 2019, as Ethiopia started implementing the updated 2016 WHO recommendations which require at least eight ANC contacts for a positive pregnancy experience from February 2022 onward. In addition, a woman was considered to have had a postnatal care visit if a woman had a health check before discharge, after discharge, or after delivery at home. Additionally, we operationalised some of the independent variables that needed operational definitions for further clarity. As such, we considered a woman had been aware of or being informed about pregnancy-related complications if she was told about at least one of the following signs of pregnancy complications: vaginal bleeding, vaginal gush of fluid, severe headache, blurred vision, fever, abdominal



Fig. 2 Final sample sizes included in the analyses

pain, and convulsion. A woman was considered to have an ANC visit in her first trimester or early initiation of an ANC visit if she had at least one ANC visit within her first three months of pregnancy.

Data management and analysis

Stata software was used to analyse the data (Stata Corp. 2023. Stata Statistical Software: Release 18. College Station, TX: Stata Corp LLC). After extracting relevant variables and data cleaning, we appended 2011, 2016,

and 2019 EDHS data to show the trends and applied a multivariate decomposition analysis. Before any statistical analysis, the data were weighted using survey weight to adjust differences in the probability of selection to maintain the survey's representativeness and to get reliable estimates. Descriptive statistics were reported in the form of texts, figures, and tables.

Trend and decomposition analysis We performed decomposition analysis to identify the main factors

influencing the observed changes over time in the utilisation of CMHS amongst Ethiopian women. Firstly, we divided the survey rounds into three phases: Phase One 2011-2016, Phase Two 2016-2019, and Phase Three 2011–2019. Descriptive analysis was undertaken to show the variations in complete CMHS utilization stratified by various covariates over time. The multivariate decomposition analysis model decomposes the probability of the change in the outcome variable into two components, compositional and coefficient effects [27, 28]. Compositional (endowment) effects are the changes or differences in outcomes that arise due to the varying composition of a population or group, rather than changes in individual behaviors or characteristics. On the other hand, coefficient effects are the changes in outcomes that arise due to differences in the influence of specific factors (coefficients) or behavioral effects on the outcome of interest. We used mvdcmp STATA command to assess the contribution of covariates [27]. In this analysis, we assessed the probability of the change in the proportion of complete CMHS utilization using the reference group (EDHS 2011) and the comparison group (EDHS 2019). We defined A and B as the comparison year 2019 and reference year 2011 surveys, respectively. The logistic regression model for the logit function of complete CMHS utilization can be represented as follows:

$$A - B = F(X_A \beta_A) - F(X_B \beta_B)$$

=
$$\underbrace{[F(X_A \beta_A) - F(X_B \beta_A)]}_{F} + \underbrace{[F(X_B \beta_A) - F(X_B \beta_B)]}_{C}$$
(1)

In Eq. (1), we have chosen group A as the comparison group and group B as the reference group. The E component in Eq. (1) is attributed to compositional differences weighted by coefficients of the comparison group or endowments, usually called the explained The E component also reflects component. counterfactual comparison of the difference in covariates from group A's perspective (that is, the expected difference if group A were given group B's distribution of covariates). The C component is attributed to changes in the coefficients weighted by the characteristics of the reference group, which is usually labelled as the unexplained component. The C component also reflects a counterfactual comparison of outcomes from group B's perspective in which the expected difference if group B experienced group A's behavioural responses to X [27]. In our study, E represents a counterfactual comparison of the difference in the characteristics of complete CMHS utilization for 2019 (that is, the expected difference in complete CMHS utilization if the 2019 survey was given the 2011 distribution of covariates). On the other hand, C depicts a counterfactual comparison of complete CMHS utilization from the 2011 perspective. This was the anticipated difference in complete CMHS utilization when the participants in the 2011 survey experienced similar behavioural responses with that of the 2019. Beta (β) coefficient and 95% confidence interval were used to determine the factors contributing to the change in proportion of complete CMHS utilization between 2011 and 2019.

Results

Study characteristics

We identified 10,768 (3333 in 2011, 4590 in 2016, and 2845 in 2019) women who met the inclusion criteria with a response rate of 96.8%. Of these, about 72.1% of women aged 20-34 years participated in 2011. In addition, around 14.4% of participating households had a female as the head of the household in 2016. Over the study period, the proportion of women with no schooling at all had declined from 53.0% in 2011 to 43.9% in 2019, while completion of secondary and/or higher education increased from 9.8% to 16.4% between 2011 to 2019, respectively. The proportion of women who were aware of potential pregnancy-related complications increased from 20.5% in 2011 to 60.4% in 2019. The proportion of women who had caesarean section delivery increased from four percent in 2011 to eight percent in 2019. Approximately 73.4% and 70.2% of women in 2011 and 2019 were from rural areas, respectively. The proportions of women from the poorest and middle household wealth status increased from 2011 to 2019, while the proportions for the richer and richest wealth status declined from 2011 to 2019 (Table 1).

Trends and (Dis)continuity of maternal healthcare services

In Ethiopia, complete CMHS utilization among women with at least one prenatal care visit increased from 9.6% (95% CI 8.4, 10.9) in 2011 to 29.9% (95% CI 27.3, 32.6) in 2019. As previously described, we partitioned the trends over the study period into three phases to show the differences in complete CMHS utilization. There was a large increase (20.3%) in complete CMHS utilization between 2011 and 2019, with a large proportion of this increase occurring in the most recent phase, that is, a 15.0% change between 2016 and 2019 (Fig. 3). Each component of CMHS utilization (four or more Antenatal Care (ANC4+) visits, birthing in a health facility and post-partum care (PNC) visits) also increased from 2011 to 2019. Notably, about 45.0% of women had adequate ANC4+visits in 2011. This increased to 51.1% in 2016 and to 58.1% in 2019. Similarly, 23.5% of women gave birth in a health facility in 2011, rising to 45.3% in 2016 and 64.4% in 2019. In addition, 17.5% of mothers had PNC visits in 2011 which increased to 26.0% in 2016 and

Table 1 Characteristics and distribution of study participants in each survey from 2011 to 2019 in Ethiopia

Characteristics	Categories	Percentage distribution (%)			
		EDHS 2011 (n = 3333)	EDHS 2016 (n=4590)	EMDHS 2019 (n = 2845)	
Age of women in years	< 20	4.21	5.24	5.36	
	20-34	72.05	72.88	73.72	
	≥35	23.74	21.88	20.92	
Age at first childbirth in years	<15	6.19	5.66	14.22	
	15–19	55.04	56.10	47.83	
	≥20	38.77	38.25	37.96	
Sex of household head	Male	82.67	85.64	87.25	
	Female	17.33	14.36	12.75	
Place of residence	Urban	26.55	18.20	29.77	
	Rural	73.45	81.80	70.23	
Religion	Orthodox	46.56	42.17	41.44	
	Catholic	1.08	0.91	0.22	
	Protestant	21.68	22.20	27.24	
	Muslim	29.14	33.09	30.21	
	Others*	1.54	1.63	0.89	
Maternal education	No education	53.03	54.36	43.89	
	Primary education	37.16	33.08	39.73	
	Secondary/ Higher	9.81	12.57	16.38	
Antenatal care visit at 1st trimester	No	74.04	67.58	62.51	
	Yes	25.96	32.42	37.49	
Parity	1	21.11	22.77	23.00	
	2–4	44.90	44.26	47.33	
	≥5	33.99	32.97	29.67	
Current marital status	Unmarried	8.69	6.12	5.60	
	Married	91.31	93.88	94.40	
Family size	<5	33.28	35.63	37.26	
<i>`</i>	≥5	66.72	64.37	62.74	
Told about pregnancy-related complications	No	79.51	55.28	39.56	
	Yes	20.49	44.72	60.44	
Caesarean delivery	No	95.94	96.46	92.04	
	Yes	4.06	3.54	7.96	
Blood pressure measured during pregnancy	No	28.27	24.71	11.77	
	Yes	71.73	75.29	88.23	
Urine sample taken during pregnancy	No	59.28	34.22	25.96	
	Yes	40.72	65.78	74.04	
Blood sample taken during pregnancy	No	46.05	27.53	20.89	
	Yes	53.95	72.47	79.11	
Wealth index	Poorest	12.77	16.74	13.87	
	Poorer	17.57	19.80	19.82	
	Middle	18.56	20.91	20.24	
	Richer	20.66	20.12	19.64	
	Richest	30.44	22.42	26.43	
Owned television	No	85.30	85.55	78.37	
	Yes	14.70	14.45	21.63	
Owned radio	No	50.31	69.23	69.35	
	Yes	49.69	30.77	30.65	

Characteristics	Categories	Percentage distribution (%)			
		EDHS 2011 (n = 3333)	EDHS 2016 (n = 4590)	EMDHS 2019 (n = 2845)	
Access to electricity	No	No 72.80		63.37	
	Yes	27.20	23.80	36.63	
Region	Tigray	10.02	10.15	9.32	
	Afar	0.80	0.77	1.11	
	Amhara	22.78	22.56	23.91	
	Oromia	36.66	34.04	37.05	
	Somali	1.46	2.51	2.19	
	Benishangul-Gumuz	1.12	1.20	1.33	
	SNNP	20.28	23.58	19.44	
	Gambela	0.53	0.32	0.57	
	Harari	0.34	0.29	0.31	
	Addis Ababa	5.53	3.98	4.19	
	Dire Dawa	0.47	0.61	0.60	

Table 1 (continued)

EDHS: Ethiopian Demography and Health Survey; Others*: Traditional beliefs and other religion



Fig. 3 Trends of maternal healthcare services among women who gave birth and had at least one ANC visit from 2011 to 2019 in Ethiopia

46.3% in 2019. In this study, the largest discontinuation of care across the consecutive cares occurred between ANC4 + and delivery in 2011, and between first ANC and ANC4 + during 2016 and 2019 (Fig. 4).

Changes in complete CMHS by selected variables

Remarkable variations in complete CMHS utilization across various women's characteristics were observed.

As such, an increment of complete CMHS utilization over time was observed in most categories of variables in every phase. A significant increase in complete CMHS utilization with a point percentage difference of 15.8% among urban residents was observed during the third phase (2011–2019). The positive change in complete CMHS utilization was observed across all wealth groups, levels of women's education, and marital status between



Fig. 4 (Dis)continuity of maternal healthcare service utilization among women who had at least one ANC in their recent birth from 2011 to 2019 in Ethiopia

2011 and 2019 with a point difference of 24.9%, 12.7%, and 20.7% for the richest, secondary and/or higher education, and married women categories, respectively. Overall, full complete CMHS utilization rose between 2011 and 2019, with increases across regions ranging from the lowest of 0.6% in Gambela to the highest of 38.0% in Benshangul-Gumuz. However, there was one region (Harari) where a 0.1% decline was seen (Table 2).

Decomposition analysis

In this study, our findings highlight an increase in complete CMHS utilization over time among women who had at least one ANC visit for their last birth from 2011 to 2019 in Ethiopia. The decomposition analysis indicated both changes in the characteristics of the selected women and shifts in the effects of these characteristics played a role in this observed increase. Just 60.6% of the proportion differences in complete CMHS utilization were explained by the differences in the composition of women's characteristics, and 39.4% of the change in the proportion of complete CMHS utilization was attributed to the change in coefficients (Table 3).

Differences due to the composition of characteristics (Endowments)

In this multivariate decomposition analysis, maternal education, ANC visits in the first trimester, awareness

Table 2 Prevalence of complete CMHS utilisation and its point percentage differences among women by selected characteristics from 2011 to 2019

Characteristics	EDHS 2011 (n = 3333)	EDHS 2016 (n = 4590)	EMDHS 2019 (n = 2845)	Point percentage differences of complete CMHS (%)		
				2011-2016	2016-2019	2011-2019
Complete CMHS	9.56	14.89	29.89	5.33	15.00	20.33
Age of women in years						
< 20	3.58	11.83	20.00	8.25	8.17	16.42
20-34	11.23	15.43	30.72	4.20	15.29	19.49
≥35	5.52	13.83	29.52	8.31	15.69	24.00
Age at first childbirth in years						
<15	8.44	8.73	23.98	0.29	15.25	15.54
15–19	6.91	11.78	25.33	4.87	13.55	18.42
≥20	13.50	20.37	37.86	6.87	17.49	24.36
Sex of household head						
Male	8.34	13.43	29.19	5.09	15.76	20.85
Female	15.34	23.58	34.67	8.24	11.09	19.33
Place of residence						
Urban	28.25	36.01	44.08	7.76	8.07	15.83
Rural	2.80	10.19	23.88	7.39	13.69	21.08
Religion						
Orthodox	13.48	21.37	38.47	7.89	17.1	24.99
Catholic	4.55	0.88	0.00	- 3.67	- 0.88	- 4.55
Protestant	6.55	11.00	20.03	4 4 5	9.03	13.48
Muslim	6.04	10.27	27.70	4.73	1743	21.66
Others	3 1 1	1.69	14.03	- 1 4 2	12.34	10.92
Maternal education	5.11	1.05	11.00	1.12	12.51	10.52
No education	3.04	957	20.26	6.53	10.69	17.20
Primary	10.30	15.74	30/0	5 35	14.75	20.08
Secondary/higher	41.60	35.66	54.27	- 5.94	18.61	12.67
Antenatal care visit at 1st trimester	41.00	55.00	54.27	5.54	10.01	12.07
No.	5.83	10.03	21 73	4.20	117	15.80
Vor	20.10	25.02	12 50	4.20	10.40	12.29
Parity	20.19	25.02	45.50	4.05	10.40	23.31
1	10.25	10.22	/1 12	0.00	21.0	22.20
1	10.55	19.23	41.15	6.70	21.9	10.27
2-4	10.00	0.07	29.55	0.79	12.40	19.27
20 Current marital status	5.42	9.27	22.07	5.65	12.0	16.05
	12.00	22.20	20.62	0.20	7.24	16.62
Unmarried	12.99	22.38	29.62	9.39	7.24	16.63
Married	9.23	14.40	29.91	5.17	15.51	20.68
Family size	12.20	10.00	25.64	4.61	17.64	22.25
<5	13.39	18.00	35.64	4.61	17.64	22.25
≥5	7.65	13.17	26.48	5.52	13.31	18.83
Aware about pregnancy-related complications		0.64		2.45	7.40	10.50
No	5.46	8.61	16.01	3.15	/.40	10.60
Yes	25.44	22.65	38.98	- 2./9	16.33	13.54
Caesarean delivery						
No	7.82	12.99	27.49	5.17	14.5	19.67
Yes	50.50	66.58	57.72	16.08	- 8.86	7.22
Blood pressure measured during pregnancy						
No	1.23	2.40	13.86	1.17	11.46	12.63

Table 2 (continued)

Characteristics	EDHS 2011 EDHS 2016 EMDHS 2019 (n = 3333) (n = 4590) (n = 2845)			Point percentage differences of complete CMHS (%)		
				2011-2016	2016-2019	2011-2019
Yes	12.84	18.99	32.03	6.15	13.04	19.19
Urine sample taken during pregnancy						
No	2.34	3.50	11.44	1.16	7.94	9.10
Yes	20.06	20.82	36.36	0.76	15.54	16.30
Blood sample taken during pregnancy						
No	2.06	3.17	10.33	1.11	7.16	8.27
Yes	15.95	19.35	35.06	3.40	15.71	19.11
Wealth index						
Poorest	2.95	6.14	11.15	3.19	5.01	8.20
Poorer	1.56	8.74	19.34	7.18	10.6	17.78
Middle	1.62	10.79	22.44	9.17	11.65	20.82
Richer	3.42	11.58	33.31	8.16	21.73	29.89
Richest	25.94	33.65	50.81	7.71	17.16	24.87
Owned television						
No	4.35	10.91	22.40	6.56	11.49	18.05
Yes	39.80	38.46	57.05	- 1.34	18.59	17.25
Owned radio						
No	5.96	12.41	27.33	6.45	14.92	21.37
Yes	13.19	20.48	35.70	7.29	15.22	22.51
Access to electricity						
No	2.76	9.65	21.29	6.89	11.64	18.53
Yes	27.74	31.68	44.78	3.94	13.1	17.04
Region						
Tigray	12.45	32.40	48.41	19.95	16.01	35.96
Afar	7.08	10.98	21.98	3.90	11.00	14.9
Amhara	5.48	13.42	32.68	7.94	19.26	27.20
Oromia	5.12	6.73	23.29	1.61	16.56	18.17
Somali	8.77	9.55	9.95	0.78	0.40	1.18
Benishangul-Gumuz	6.34	16.10	45.35	9.76	29.25	38.01
SNNP	9.17	13.32	23.67	4.15	10.35	14.5
Gambela	21.54	14.39	22.13	- 7.15	7.74	0.59
Harari	32.93	25.74	32.79	- 7.19	7.05	- 0.14
Addis Ababa	49.06	58.90	66.22	9.84	7.32	17.16
Dire Dawa	27.97	26.57	46.40	- 1.40	19.83	18.43

Table 3 Overall decomposition of the change in percentage ofcomplete CMHS from 2011 to 2019 in Ethiopia

Components	Coefficient (95% CI)	Percentage (%)
Differences due to composition of characteristics (Endowments) (E)	0.123 (0.099, 0.148)*	60.6
Differences due to coefficients (effect of characteristics) (C)	0.080 (0.050, 0.111)*	39.4
Residual (R)	0.203 (0.178, 0.229)*	

*p-value < 0.05

of pregnancy-related complications, urine, and blood samples taken for assessment during pregnancy, household wealth status, and ownership of television and caesarean delivery were contributors to the change in the probability of complete CMHS utilization between 2011 and 2019. As such, differences in the proportion of women aware of pregnancy-related complications and those who gave urine and blood samples for health assessment during pregnancy explained most of the rise in complete CMHS utilization from 2011 to 2019 with percentage contributions of 23.4%, 12.5%, and 11.0%, respectively. The differences in the proportion of women who initiated ANC in the first trimester, owned television, women from lower household wealth groups, and delivered by caesarean section for their most recent childbirthing also increased complete CMHS utilization from 2011 to 2019 with a corresponding percentage contribution of 5.4%, 5.7%, 0.9%, and 1.9%. Equalizing the number of secondary or higher school-attended women in 2019–2011 levels would reduce the 2011–2019 CMHS utilization gaps by 2.9% (E_{β} =0.006). On the contrary, equalizing the number of women from richer wealth groups women in 2019 to 2011 levels would increase the 2011–2019 CMHS utilization gaps by 0.7% (E_{β} = - 0.001) (Table 4).

Differences due to the effects of characteristics (Effect of Coefficients)

In our findings, rural residence, measuring blood pressure during pregnancy, and household wealth status had a significant contribution to complete CMHS utilization. On average, women who had BP measurements during pregnancy in 2019 reduced the CMHS utilization by 25.2% (C_{β} =-0.051) compared with women in 2011. On the contrary, the average CMHS utilization among rural and wealthier women in 2019 increased by 15.8% (C_{β} =0.032) and 7.7% (C_{β} =0.016) compared with women in 2011, respectively (Table 4).

Discussion

This study examines the trends of complete continuum of maternal healthcare service utilization in Ethiopia. Providing continuum of maternal healthcare service is one of the key strategies to reduce maternal, neonatal, and infant morbidity and mortality. In this study, trends of complete CMHS utilization, including ANC4+, health facility delivery, and PNC utilization, rose from 2011 to 2019. In a decomposition analysis, the changes in the characteristics and shifts in the effects of these characteristics played a significant role in the observed increase in complete CMHS utilization between 2011 and 2019. Importantly, our analyses show that about 60.6% and 39.4% of the differences in the proportion of complete CMHS utilization are explained by the changes in the composition and effects (coefficients) of women's characteristics, respectively. The variation in complete CMHS utilisation was observed across various characteristics of women between 2011 and 2019. More specifically, distribution of women who were aware of pregnancy-related complications, gave urine and blood samples for assessment during pregnancy, and women who had ANC visits in the first trimester contributed to the largest reduction in 2011-2019 gaps on complete CMHS utilisation.

In this study, complete CMHS utilisation increased over time from (9.6%; 95% CI 8.4, 10.9) in 2011 to (29.9%; 95% CI 27.3, 32.6) in 2019. Four or more ANC (ANC4+) visits also increased from 45.0% in 2011 to 58.1% in 2019. Likewise, health facility child birthing service utilization increased from 23.5% in 2011 and 64.4% in 2019. In addition, 17.5% and 46.3% of mothers had PNC visits in 2011 and 2019, respectively. The completion of CHMS in 2011 was lower compared to findings from the Chelia district (21.5%) [29], Gode district (13.5%) [30], and meta-analysis report (25.51%) [16] in Ethiopia. However, the findings from the more recent 2019 survey were higher than those reported in the Chelia district, Gode district, and the meta-analysis [16, 29, 30] in Ethiopia. Similarly, the 2019 findings on the completion of CHMS in Ethiopia were higher than those reported in Africa overall (20.9%) [31], as well as in Kenya (20%) [32], Guinea (20%) [33], Tanzania (10%) [34], and Uganda (10.7%) [35]. However, the 2019 findings were lower compared to Zambia (38%) [36]. This variation might be explained by differences in the study population, study area, and study period. Specifically, previous studies included women who had no ANC visits, delivered at a health facility or received postnatal care, which may have underestimated the continuum of maternity care. Accordingly, the changes in complete CMHS utilisation over time were similar to the findings in Pakistan [37]. Such an increase in completions of CMHS utilisation over time in the current study was likely due to the introduction of the Health Development Army (HDA) in 2011, which is a significant development in Ethiopia's healthcare system and has played a crucial role in strengthening the Health Extension Program (HEP) by mobilizing communities and creating awareness about various health issues, including maternal healthcare [38-40]. In addition, improvement of access to ambulance services had a positive contribution to improving maternal healthcare services by addressing access to transportation [41]. In contrast, utilisation of each broad component of the maternal healthcare service (ANC4+, health facility delivery, and PNC) is still very far from the 2015 HSTP of Ethiopia [12].

An increase in the number of women who attended secondary or higher school from 2011 to 2019 increased the proportion who had complete CMHS utilization. This finding was consistent with other studies conducted in Ethiopia [16, 42, 43], Kenya [44], Nigeria [45], India [46], and Pakistan [37]. Higher completion of CMHS among educated women may be due to educated mothers being more likely to understand and engage in formal communication with healthcare providers. This could lead to better comprehension of medical advice and information related to maternal health, including information about Table 4 Contributions of factors for the change in the percentage of complete CMHS utilization from 2011 to 2019 in Ethiopia

Variables	Difference due to endowments (E)		Difference due to coefficients (C)		
	Ε _β (95% CI)	Percent	C _β (95%Cl)	Percent	
Age of women in years					
<20	Ref		Ref		
20-34	0.0008(-0.0011, 0.0027)	0.38	- 0.0379(- 0.0986, 0.0228)	- 18.63	
≥35	- 0.0028 (- 0.0065, 0.0008)	- 1.39	- 0.0045(- 0.0261, 0.0171)	- 2.21	
Age at first childbirth					
<15	Ref		Ref		
15–19	- 0.0010(- 0.0063, 0.0044)	- 0.47	0.0214(-0.0056, 0.0485)	10.55	
≥20	- 0.0003(- 0.0009, 0.0004)	- 0.12	0.0167(-0.0031, 0.0365)	8.21	
Sex of household head					
Male	Ref		Ref		
Female	- 0.0005(- 0.0035, 0.0025)	- 0.26	0.0014(-0.0045, 0.0073)	0.69	
Place of residence					
Urban	Ref		Ref		
Rural	- 0.0011(- 0.0036, 0.0013)	- 0.55	0.0319(0.00002, 0.0641)*	15.80	
Maternal education					
No education	Ref		Ref		
Primary education	0.0010(- 0.0003, 0.0023)	0.50	- 0.0004(- 0.0111, 0.0102)	- 0.22	
Secondary/higher	0.0060(0.0013, 0.0106)*	2.93	- 0.0016(- 0.0053, 0.0022)	- 0.76	
ANC at first trimester					
Yes	0.0110(0.0058, 0.0161)*	5.40	- 0.0020(- 0.0083, 0.0042)	- 0.99	
Parity					
1	Ref		Ref		
2-4	- 0.0016(- 0.0032, - 0.0001)*	- 0.81	- 0.0051(- 0.0201, 0.0098)	- 2.53	
≥5	0.0020(- 0.0018, 0.0058)	0.99	0.0049(-0.0125, 0.0222)	2.39	
Current marital status					
Unmarried	Ref		Ref		
Married	0.0006(-0.0023, 0.0034)	0.29	0.0296(-0.0133, 0.0725)	14.56	
Family size					
<5	Ref		Ref		
≥5	0.0001(-0.0019, 0.0021)	0.06	- 0.0070(- 0.0253, 0.0113)	- 3.43	
Aware of pregnancy-related complications					
Yes	0.0475(0.0284, 0.0667)*	23.36	- 0.0003(- 0.0059, 0.0053)	- 0.13	
Caesarean delivery					
Yes	0.0039(0.0011, 0.0067)*	1.92	- 0.0010(- 0.0026, 0.0006)	- 0.50	
Measured blood pressure during pregnancy			,,		
Yes	- 0.0030(- 0.0181, 0.0120)	- 1.49	- 0.0512(- 0.0905, - 0.0118)*	- 25.16	
Took urine samples during pregnancy					
Yes	0.0255(0.0030.0.0479)*	12.53	0.0005(-0.0143.0.0154)	0.25	
Took blood samples during pregnancy	,,,,,				
Yes	0.0224(0.0025, 0.0423)*	11.01	0.0034(-0.0208.0.0276)	1.66	
Wealth index	(,,,,				
Poorest (Lowest)	Ref		Ref		
Poorer (Lower)	0.0018(0.0002, 0.0035)*	0.91	0.0112(-0.0006, 0.0230)	5 5 1	
Middle	0.0013(-0.00003.0.0025)	0.62	0.0124(0.0013_0.0235)*	6.08	
Richer (Wealthier)	- 0.0014(- 0.0022 - 0.0005)*	- 0.67	0.0156(0.0037_0.0276)*	7.69	
Richest (Wealthiest)	-0.0025(-0.0022, 0.0003)	- 1.23	0.0154(-0.0066, 0.0374)	7.57	
	0.0023(0.0071, 0.0021)	1.25	0.0151(0.0000, 0.0571)	1.37	
Vec	0.0115(0.0045.0.0185)*	5 65	0.0023(-0.0038.0.0084)	117	
Owned radio	0.0112(0.0012, 0.0102)	دن.د	0.0023(0.0030, 0.0004)	1.12	
Vec	0.0006(0.00930.0006)	022	- 0.0033(- 0.0163 0.0007)	- 162	
	0.0000(- 0.0065, 0.0090)	0.32	0.0033(- 0.0103, 0.0037)	- 1.02	
Vec		0.76	- 0.0054(- 0.0176 0.0069)	_ 267	
Constant	0.0013(-0.0032, 0.0003)	0.70		- 2.07	
COnstant			U.UDZO(- U.IUIU, U.1000)	10.11	

 $E_{\beta}: Coefficient of the effect of endowments \ C_{\beta}: Coefficient of the effect of characteristics; *P-value < 0.05$

pregnancy complications and their consequences. Education may also empower mothers with the autonomy to make informed decisions about seeking care for maternal and child healthcare services. As such, women who have decision-making autonomy can decide to receive the full range of the CMHS throughout maternity care [47]. Educated mothers are also more likely to understand the effect of unfavourable community cultures related to childbirth attendants. This is because some mothers preferred traditional birth attendants (TBAs) over other options for childbirth because they believed TBAs respected their culture and cultural beliefs and practices [48]. In addition, educated mothers had a higher knowledge level regarding obstetric complications and danger signs during pregnancy [49]. This awareness may contribute to a better understanding of the benefits of a continuum of maternal healthcare services and prompt quicker responses and actions to address potential health risks [16].

This study also suggests the timing of the first ANC visit plays a significant role for the trends in complete CMHS utilisation. An increase in the proportion of mothers who initiated their first ANC visit in the first trimester from 2011 to 2019 contributed to the increase in the proportion of complete CMHS utilization. This implies an increase in early ANC visit (before 16 weeks) had a positive effect on the trends of complete CMHS utilization across time compared with late initiation of first ANC visit. This finding is supported by evidence from Southern Ethiopia [50], as well as from Central and Northwest Ethiopia [51, 52]. This is likely due to early initiation of ANC being vital for comprehensive maternal care. Early ANC provides an opportunity for timely interventions, health education, and support, ultimately contributing to better maternal and infant outcomes [50]. Importantly, pregnant women are encouraged to seek ANC services as soon as they become aware of their pregnancy and to attend all scheduled visits for optimal prenatal care.

The change in composition of household wealth status was another significant factor contributing to the change in the proportion of complete CMHS utilization. In this study, a decrease in the proportion of wealthier women from 2011 to 2019 in the sample would reduce the expected level of complete CMHS utilization. This implies women from wealthier households receive more CMHS. These wealthier women are also more likely to have received better education. These findings are consistent with the findings in Ethiopia [53], Cambodia [54], Pakistan [37], and Indonesia [55]. Therefore, strengthening the provision of free maternity healthcare may contribute to reducing disparities in access to maternity services and promote the well-being of mothers regardless of financial constraints [56]. Despite the introduction of free maternity care in Ethiopia, there has been a decline in the completion of CMHS, especially among the poorest household wealth categories. This decline is associated with the high costs encountered during maternity healthcare service utilization, including transportation costs, food costs for accompanying individuals, and indirect non-medical costs [53, 56].

Households who owned television had a positive influence on complete CMHS utilisation. Again, this reflects household wealth and reinforces the findings discussed above. An increase in the composition of women who owned television in the sample from 2011 to 2019 contributed to a rise in the percentage of completion of CMHS utilization. This can be associated with women's exposure to mass media which can promote their utilization of maternal healthcare services [37, 57]. This is likely due to mass media being a powerful tool for disseminating information, which can help to share information on the significance of early prenatal care, the importance of skilled birth attendance, and the benefits of regular check-ups during and after pregnancy to the communities. Mass media can also play a crucial role in influencing and shaping societal perceptions on maternal healthcare services, potentially reducing stigma or misconceptions, and encouraging positive healthseeking behaviours.

Maternal awareness of pregnancy-related complications, including vaginal bleeding, vaginal gush of fluid, severe headache, convulsion, blurred vision, fever, and abdominal pain, contributes to a rise in the percentage who have complete CMHS utilisation. This is in agreement with other studies in Ethiopia and Nandagudi, India [58, 59]. This is probably because by empowering women with information about these danger signs, not only does this help them make informed decisions, but also encourages timely seeking of healthcare services [58]. Prenatal education, regular check-ups, and open communication between pregnant women and healthcare professionals facilitate the uptake of essential components of comprehensive maternity care which contribute to better outcomes for both mothers and their babies [59].

Taking urine and blood samples for assessment during pregnancy are also factors that can affect the proportions of complete CMHS utilization. An increase in the composition of women whose urine and blood samples taken for health assessment during pregnancy, contributes to an increase in the proportion who receive complete CMHS utilization. This is because antenatal screening for blood pressure, anaemia, blood group, Rhesus (Rh) factor, malaria and pre-eclampsia are essential maternity services to ensure quality ANC [60, 61]. Maternal urine test

during pregnancy is a fundamental component of ANC, which helps healthcare providers to identify potential pregnancy-related complications and infections early in pregnancy, allowing for timely intervention and appropriate management [60]. Blood testing during pregnancy is also an important pregnancy assessment for early identification of pregnancy related complications including anaemia and Rh incompatibility [60]. In addition, maternal healthcare counselling based upon a pregnant woman's blood and urine test results is effective for raising awareness and promoting continuity of care for both mothers and newborns. Evidence-based healthcare counselling can also contribute to a positive attitude change toward healthcare services and encourages women to prioritize their health throughout the entire continuum of maternal care.

An increase in the incidence of caesarean delivery from 2011 to 2019 contributed to a rise in the proportion of complete CMHS utilization. This is because operative deliveries are associated with certain risks and potential complications for women during their postnatal period. As such, it is likely women who have operative deliveries may be more likely to engage with post-partum followup. This is consistent with reports of PNC utilization in Sierra Leone [62], Indonesia [63], and Ethiopia [64, 65]. Postnatal checkup is a crucial aspect of the CMHS and can serve as a valuable mitigation strategy to minimize potential risks associated with childbirth and postoperative complications [64, 65]. In addition, PNC allows healthcare professionals to monitor a woman's physical and emotional well-being after childbirth, identify complications or concerns, and offer appropriate interventions in the early stages [65].

In this study, we identified that there was still a debate on the interpretation of multivariate decomposition analyses for a binary health outcome (in this case, complete CMHS utilization) with the binary grouping variable (in our study, survey year, 2011 and 2019). Even in this study, there were controversies among the authors regarding the interpretation of our findings, particularly the interpretation of the effect of coefficients (the unexplained component). As such, some researchers, such as Powers et al. [27], recommend considering a counterfactual comparison for the interpretation of both composition and coefficient of characteristics. On the other hand, other researchers suggested the coefficients of each covariate of the comparator are considered as an average treatment effect of the corresponding covariate over the reference group for the unexplained component [66]. In our study, we used a combination of the two approaches to interpret our findings; specifically, we used the counterfactual comparison for the explained component and the average treatment effect approach for the unexplained component.

Strengths and limitations

This study is the first report to highlight the trends of complete CMHS utilisation among women who gave childbirth, and who had at least one ANC visit in Ethiopia, using a national representative EDHS data. In this study, a multivariate decomposition analysis was also used to identify the various factors contributing to complete CMHS utilization. This analysis provides evidence for informed decision-making, particularly in prioritising interventions. Consequently, policymakers can use the findings to identify and quantify the impact of various factors on the continuity of maternity care. Furthermore, policymakers can use these findings to design targeted policies and strategies to address the most influential factors impacting the continuity of care. However, our study has some constraints. In this study, we did not specify when the health check should occur during the PNC period due to the absence of this data for postnatal maternal health check-ups in 2011. Missing data and missing variables were also limitations of this study, as reported in Fig. 2. For example, access to and reading of newspapers (which has been shown to influence CMHS utilisation), distance between home residence and a health facility, and women's autonomy, have been previously collected in the EDHS survey but were not included in the mini-EDHS 2019 dataset used herein.

Conclusion

While progress has been made, complete CMHS utilization was low, ranging from 9.6% in 2011 to 29.9% in 2019 in Ethiopia. Overall, three-fifths of the percentage change in complete CMHS utilization between 2011 and 2019 was due to differences in the composition of the factors influencing continuity of care included in our analysis. In Ethiopia, the adoption of the new WHO recommendation of 8 ANC visits as the standard for ANC in 2022 will be a challenge. Thus, the goal to provide complete continuum of maternity care in Ethiopia focuses on the need for more comprehensive interventions to achieve national and international maternal health targets. Adopting a multi-faceted approach that considers the unique challenges within the country, including women's education, wealth status, and quality of maternity care, will improve CMHS utilization. Improvements in various aspects of maternal healthcare, including awareness, early initiation of ANC visits, medical interventions like caesarean delivery, monitoring health parameters during pregnancy, and women's

empowerment, will be collectively or individually helpful to the completion of CMHS utilization.

Abbreviations

ANC	Ante Natal Care
CMHS	Continuum of Maternal Healthcare Services
CSA	Central Statistical Agency
EA	Enumeration Area
EDHS	Ethiopian Demography and Health Survey
EPHI	Ethiopian Public Health Institute
HF	Health Facility
HH	Households
LLMICs	Low and Lower-Middle-Income Countries
MMR	Maternal Mortality Ratio
МоН	Ministry of Health
PNC	Post-Natal Care
RMNCH	Reproductive, Maternal, Neonatal, and Child Health
SDGs	Sustainable Development Goals
SSA	Sub-Saharan Africa
TBAs	Traditional Birth Attendants
WHO	World Health Organization
UHC	Universal Health Coverage

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Author contributions

All authors made substantial contributions to the study's conception and design. AD initially conceived the study, performed the statistical analysis, and wrote the main manuscript. AD also prepared all of the figures included in the manuscript. AD, MMW, CTR, MNM, AW, and JHS revised the manuscript. All authors also agreed to be personally accountable for the author's contributions and to ensure that questions related to the accuracy or integrity of any part of the work. Finally, all authors read and approved the final version to be submitted for publication.

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Declarations

Ethics approval and consent to participate

We obtained data use approval from the DHS Program. We also obtained ethical approval from the Human Research Ethics Committee (HREC) of Flinders University, Australia, with project number 6229 which is part of the first author's PhD research work.

Consent for publication

Not applicable.

Competing Interests

The authors declare no competing interests.

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