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Trends and inequalities in women's use of quality antenatal care, intrapartum care, and immediate postnatal care services in Ethiopia: multivariate decomposition, secondary data analyses of four demographic and health surveys over two decades (2001–2019)

Melese Girmaye Negero [1,2] David Sibbritt,[2] Angela Dawson [2]

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For numbered affiliations see end of article.

Correspondence to
Dr Melese Girmaye Negero; melesegirmaye@gmail.com

ABSTRACT

Objective This study aimed to examine the trends and inequalities in women's use of quality antenatal care (ANC), quality intrapartum care and immediate postnatal care (PNC) services, and the determinants that contributed to changes in receiving these services from 2001 to 2019 in Ethiopia using the Ethiopia Demographic and Health Surveys (EDHSs) data.

Design, outcomes, setting and analysis Secondary data analyses of four waves of nationally representative EDHSs from 2005 to 2019 were conducted. We defined quality ANC as having blood pressure measurement, blood and urine tests, iron supplementation and being informed of pregnancy-related complications during ANC visits; quality intrapartum care as having health facility birth, birth assisted by skilled personnel and newborn put to the breast within 1 hour of birth and immediate PNC as having maternal and newborn PNC within 24 hours of birth. We used control charts, multivariate logistic regression decomposition analyses and equiplots to measure and analyse trends and inequalities over two decades using data from EDHSs 2005–2019.

Results Over the period 2001–2019, there were increases in the percentage of quality ANC (3.7%–39.6%), intrapartum care (3.9%–43.3%) and immediate PNC (2.6%22.1%) services received. However, there were widening inequalities between these services received by women, favouring those from advantageous socioeconomic backgrounds. From 2001–2019, the largest significant increases in the percentage of women receiving quality ANC and immediate PNC services were due to changes in the distribution of sociodemographic and maternal care characteristics, while the largest significant increase in the percentage of women receiving quality intrapartum care was due to changes in the effects of these characteristics.

Conclusions The healthcare system in Ethiopia should expand access to all the recommended maternal healthcare interventions to disadvantaged population subgroups. Universal coverage of quality maternal and newborn healthcare across the continuum is needed. There is also a need to promote ≥4 ANC, early initiation of ANC, girls' and women's education and enabling women's economic empowerment.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ Investigating the coverage, inequalities among population subgroups and determinants of changes in the women's use of quality maternal healthcare services over time can help decision makers in low-income countries identify effective interventions to improve service use.
⇒ Ethiopian demographic and health surveys are nationally representative, which could enhance the generalisability of the findings.
⇒ The multivariate decomposition analysis enabled the identification of factors that had statistically significant associations and positively or negatively contributed to the changes in women's use of quality antenatal care (ANC), quality intrapartum care and immediate postnatal care (PNC) services over the two decades in Ethiopia.
⇒ However, this study shares the limitations of a cross-sectional study design, which makes it difficult to demonstrate cause-and-effect relationships.
⇒ In addition, the Demographic and Health Surveys data collected on maternal and newborn healthcare services did not include all of the WHO's recommendations on ANC, intrapartum care and PNC services.

INTRODUCTION

Quality maternal healthcare, which includes receiving the recommended contents of antenatal care (ANC), intrapartum care and postnatal care (PNC) services, involves evidence-based interventions that reduce maternal and newborn morbidity and

mortality.[1–4] An estimated 74% of maternal deaths could be averted if all women received skilled care before, during and after childbirth to prevent or manage pregnancy and birth-related complications.[5]

Many countries are behind in their efforts to achieve the 2030 Sustainable Development Goals target of reducing the global maternal mortality ratio (MMR) to <70 per 100 000 live births. Sub-Saharan Africa bears the highest burden of maternal mortality, and a significant proportion of maternal and newborn deaths occur in conflict or displacement settings.[6 7] While the MMR in the region has decreased from 878/100 000 live births in 2000 to 542/100 000 live births in 2017, the average yearly reduction rate between 2000 and 2017 was only 2.8%.[8]

In Ethiopia, the MMR has decreased by 53%, from 871 to 412 maternal deaths per 100 000 live births, and the neonatal mortality rate has also reduced by 39%, from 49 to 30 neonatal deaths per 1000 live births over 20 years (1996–2016). However, these death rates remain among the highest globally.[9–12] A study conducted in 32 health facilities in Ethiopia revealed that most did not meet the national maternal and neonatal healthcare quality standards.[13]

Improving healthcare delivery requires a deliberate focus on the quality of health services. The WHO provides clear guidance concerning the recommended interventions during the ANC, intrapartum and PNC services[2 3 14 15] (see online supplemental tables A1-A3). In 2019, the United Nations (UN) General Assembly adopted a resolution that outlined the urgent need for action for Universal Health Coverage with quality services.[16] To achieve these UN goals, it is first necessary to understand the areas where improvements are most needed and what population subgroups are affected. This requires examining the recommended interventions women receive during pregnancy, birth and immediately afterwards and the associated sociodemographic and maternal care determinants over time that may reveal inequalities between population subgroups.

Only a few studies have analysed national data on Ethiopia's quality maternal and newborn healthcare service indicators. A study conducted by Fekadu *et al*[17] indicated that women who had attended ≥4 ANC visits for their last birth, who had secondary or above level education, were from urban areas, were from the richest households and who were employed had higher odds of delivering at health facilities. Mothers who received more ANC interventions such as nutritional counselling and blood testing during ANC visits had higher odds of delivering their babies at health facilities or receiving PNC services.[17] Other studies have examined trends in maternal and newborn health outcomes and care coverage. For example, a study by Berhanu *et al*[18] revealed that 4 years after the launch of the Community-Based Newborn Care programme in 2017 in Ethiopia, the percentage of women reporting at least one ANC visit increased by 15%; ≥4 ANC visits increased by 17% and institutional delivery increased by 40%.[18] While these studies provide a valuable snapshot of some trends and use of healthcare, no studies comprehensively examine trends in quality ANC, quality intrapartum care, immediate PNC services, determinants of these trends and inequalities for receipt of these care services between population subgroups over an extended period in Ethiopia.

A comprehensive assessment of quality ANC, quality intrapartum care and immediate PNC services trends and their sociodemographic and maternal care determinants over an extended period can help healthcare providers, managers and policy makers identify effective sociodemographic and maternal care interventions to improve access to and utilisation of maternal healthcare quality and outcomes. Therefore, this study aimed to assess the trends in providing quality ANC, quality intrapartum care, immediate PNC services and their associated sociodemographic and maternal care determinants over the two decades (2001–2019) in Ethiopia.

METHODS

Study design, data and variables

The study analysed data from Ethiopia Demographic and Health Surveys (EDHSs) from 2005 to 2019. The EDHSs used a stratified two-stage cluster sampling technique selected in two stages using the 1994 Population and Housing Census (PHC) as a sampling frame for the EDHS 2005 survey and the 2007 PHC as a sampling frame for EDHSs 2011, 2016 and 2019.[19 20] Due to the non-proportional allocation of the sample to different regions and their urban and rural areas, a sampling weight was used in all analyses of the EDHSs data to ensure the representativeness of the findings. A total weighted sample of 7307, 7908, 7590 and 3927 mothers with the most recent live birth within the previous 5 years to the surveys 2005, 2011, 2016 and 2019, respectively, were included in the analysis of quality ANC, quality intrapartum care and immediate PNC services over 20 years (2001–2019). While the included EDHSs' data collection time points started in 2005, these EDHSs captured all births occurring between 2001 and 2019.

Note that across the EDHSs, there were slight variations in the definition of skilled personnel. In the 2005 and 2011 EDHSs, skilled personnel were defined as doctors, nurses or midwives, while in the 2016 and 2019 EDHSs, skilled personnel were defined as doctors, nurses, midwives, health officers or health extension workers.[21]

Sociodemographic characteristics

Urban areas include all capitals of administrative regions, zones and districts. Areas with at least 1000 people primarily engaged in non-agricultural activities were declared as urban areas. Rural areas are all areas that are not urban. Urban centres with a population of 100 000 inhabitants or more and regional capitals (irrespective of their population size) are further classified as major urban centres.[22 23] Maternal education was defined as the highest level of the mother's formal education during the

time of the interview. It was categorised into four levels: no education, primary education (1–8 grades), secondary education (9–12 grades) and higher education (above 12th grade).[22] Maternal age at birth was the biological mother's age at her most recent live birth and it was classified into three age groups in completed years: teenage (<20), 20–34 and older mothers (35–49).[22]

A wealth quintile is a score given to a household based on the number and kinds of consumer goods it owns, ranging from a television to a bicycle or car, in addition to housing characteristics such as a source of drinking water, toilet facilities and flooring materials. These scores were derived using the principal component analysis. Nationally, five wealth quintiles are compiled by assigning the household score to each usual (de jure) household member, ranking each person in the household population by their score and dividing the distribution into five equal categories, each comprising 20% of the population. The wealth is then subdivided into five categories, quintiles.[22] The poorest and poorer quintiles were considered poor, while the richest and richer quintiles were considered rich.

Maternal care characteristics

The number of months pregnant at the time of the first ANC visit was categorised as being during the first trimester (<4 months), 4–5 months or six or more months of pregnancy. The number of ANC visits was categorised as no ANC, one ANC contact, 2–3 contacts or four or more ANC contacts. The healthcare facility where ANC was received was categorised as a hospital (government/private), government health centre, private clinic/non-governmental organisation (NGO) health facility or government health post.

Quality ANC during pregnancy for the most recent live birth

ANC, a critical maternal healthcare intervention, provides a platform for important healthcare functions, including health promotion, screening and diagnosis and disease prevention.[2] We applied the WHO's recommendations on ANC for a positive pregnancy experience to measure ANC quality.[2] Accordingly, a woman who attended ANC at least once during pregnancy for her most recent live birth across the four DHSs (2001–2019) was defined to have received quality ANC if she received all the following five recommended interventions during her ANC visits: blood pressure measurement, blood screening for infection and/or anaemia, urine tests for detecting bacteriuria and/or proteinuria, information about pregnancy-related complications and iron supplementation.

Quality intrapartum care for the most recent live birth

We applied the WHO's recommendations on intrapartum care for a positive childbirth experience to measure the quality of intrapartum care across the four DHSs (2001–2019).[3] A mother was categorised as receiving quality intrapartum care if provided with the three recommended interventions during intrapartum care: health facility birth, skilled personnel assisted birth and newborn put to the breast within 1 hour of birth.

Immediate PNC for the most recent uncomplicated live birth

We applied the WHO's recommendations on the PNC of the mother and her newborn to measure the immediate PNC across the four Ethiopia DHSs (2005–2019).[4] Accordingly, a mother and her newborn have received immediate PNC if they received PNC services within 24 hours of birth at health facilities or home (excluding caesarean deliveries).

Statistical analyses

Control charts were used to analyse the trends in the women's use of maternal and newborn healthcare quality from 2001 to 2019.[24] Control charts are used to analyse processes to determine if they are in control (ie, have points randomly distributed within the control limits), which means that the variation observed occurs only from sources common to the process (called common-cause variation). An out-of-control process (ie, has points falling outside the control limits or non-random patterns of points) is considered a special-cause variation.[25 26] Control limits reflect the expected amount of variation when only common causes of variation are present.[25–27] We specifically used the p-control charts as the p-chart monitors the percentage of maternal and newborn healthcare quality rates over time, allowing for varying sample sizes. Eight control chart rules (ie, tests for special-cause variation) were applied to assist with the interpretation of the changes over time (table 1).

Equiplots were used to compare absolute inequality (akin to coverage differences among mothers from wealthy and poor households) between distinct groups over time.[28] Pro-poor inequalities are present when the coverage of quality ANC, quality intrapartum care and/or immediate PNC services decreases with increasing household wealth. Pro-rich inequalities are present when the coverage of these services increases as household wealth increases.[29] Equiplots present disaggregated data using circles (to show the level of intervention coverage in each subgroup) and lines (to show the gaps between subgroups), illustrating inequalities.[28]

Multivariate logistic regression decomposition analysis was employed to inform our understanding of the extent to which each variable independently contributed to the observed change in the women's use of quality ANC, quality intrapartum care or immediate PNC services over time.

Multivariate decomposition provides a way to analyse differences in the outcome between two points in time. This study used the multivariate decomposition for non-linear response models (mvdcmp) procedure in Stata, which is comparable to the Oaxaca-Binder method but runs the non-linear models.[30]

The decomposition procedure divides the total change in the women's use of quality ANC, quality intrapartum care or immediate PNC services over the two decades

Table 1 Control chart rules, 2021

Test	Rule	Problem identified
1.	One point is outside the control limits.	A large shift.
2.	8/9 points on the same side of the centre line.	A small sustained shift.
3.	Six consecutive points are steadily increasing or decreasing.	A trend or drift up or down.
4.	14 consecutive points are alternating up and down.	Non-random systematic variation.
5.	Two out of three consecutive points are more than two sigmas from the centre line in the same direction.	A medium shift.
6.	Four out of five consecutive points are more than one sigma from the centre line in the same direction.	A small shift.
7.	15 consecutive points are within one sigma of the centre line.	Stratification.
8.	Eight consecutive points on either side of the centre line are not within one sigma.	A mixture pattern.

into two portions: the portion that can be attributed to the change in the composition, distribution, coverage or prevalence of the sociodemographic and maternal care characteristics included in the analysis (referred to as the *endowments* portion) and the portion that can be attributed to the change in the effect of these indicators (referred to as the *coefficients* portion).[30]

The coefficients of an explanatory variable are estimates of population parameters that describe the relationship between the explanatory variable and the outcome variable. A positive sign indicates that as the predictor variable increases, the outcome variable also increases. A negative sign indicates that the outcome variable decreases as the predictor variable increases.

A significant association is available when the CI does not include zero.[30] The per cent (pct) entails the magnitude of proportional change that occurred to the outcome variable due to the change in distribution/coverage or effect of an explanatory variable.[30]

The decomposition procedure relies on two key pieces of information: the prevalence of all selected indicators at both points in time and the coefficients derived from multivariate regression models predicting quality ANC, quality intrapartum care or immediate PNC services run separately at both time points.

The *endowments* column quantifies the amount of change in the women's use of quality ANC, quality intrapartum care or immediate PNC services explained by the change in coverage in each selected sociodemographic characteristic or maternal care indicator between the two points in time, assuming that the effect of the sociodemographic characteristic or maternal care indicator was constant across the entire period. The *coefficients* column quantifies the amount of change in the women's use of quality ANC, quality intrapartum care or immediate PNC services explained by a change in the size of effects between the two time points if coverage (the distribution of each variable) had been constant across the entire period. The model assumes the additivity of the components for composition and effect.[30]

Using the statistical software Stata/SE 16.1 for the Windows version,[31] all decomposition analyses employed sampling weights and were adjusted for sampling design (ie, clustering and stratification). Statistical significance was set at $p<0.05$. The number of children a mother has (parity), an important and known maternal care indicator of consideration in maternal care services use, was not included in the final analyses because the variable after several attempted analyses had no statistically significant association with all outcome variables of interest and made our models unstable.

Patient and public involvement statement

None.

RESULTS

Changes in the distribution of mothers' sociodemographic and maternal care characteristics across the two decades in Ethiopia (2001–2019)

Over the two decades of data collected (2001–2019), there was a 25.6% decrease in the percentage of mothers with no education and a corresponding increase in mothers with primary (18.8%) and secondary or above (6.7%). Mothers residing in urban areas increased by 17.4%. Adolescent birth (<20 years) and birth at advanced maternal age (≥35 years) decreased by 1.8% and 2.8%, respectively, while birth at 20–34 years increased by 4.6%. Households with poorer and richer wealth quintiles increased by 2.6% and 0.8%, respectively, while the percentage of middle-income households decreased by 3.4% (online supplemental table A4).

Mothers who received their first ANC visit during the first trimester increased by 15.0%, while those who received their first ANC visit at or after 6 months of pregnancy decreased by 24.3%. The receipt of four or more ANC visits increased by 14.7%. Mothers who received their ANC at government health centres increased by 22.4%, while those who received their ANC at hospitals decreased by 15.1%. Mothers who received quality ANC, quality intrapartum care and immediate PNC increased

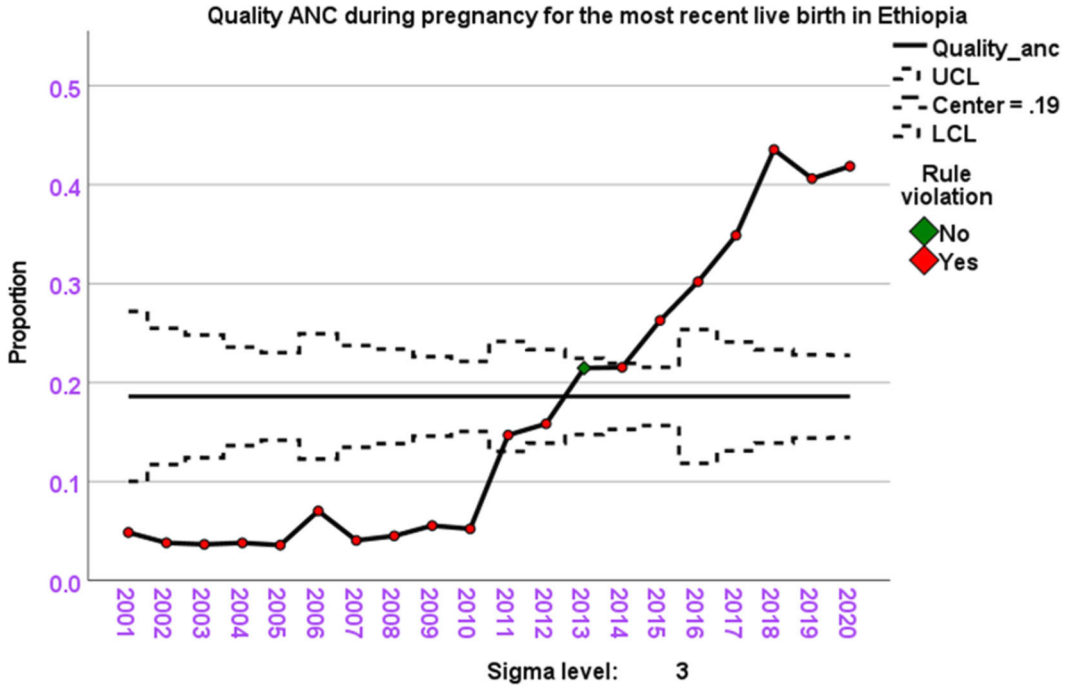

Figure 1 The percentage of mothers receiving all the five components of ANC during their ANC visits in Ethiopia (2001–2019). ANC, antenatal care; LCL, lower control limit; UCL, upper control limit. Quality ANC: blood pressure measured+blood tested +urine tested+iron supplemented, and informed of pregnancy-related complications during last pregnancy. Three sigma level: the data are within three standard deviations from the mean.

by 35.9%, 39.4% and 19.5%, respectively (online supplemental table A4).

Quality ANC

Among mothers who had at least one ANC visit for the last birth, the percentage of mothers who received all the five recommended interventions during their ANC visits increased from 4.7% in 2001 to 26.3% in 2016 and 41.8% in 2019 (figure 1). For all subgroups in maternal education, area of residence, household wealth, mother's age at birth, the number of ANC contacts, the type of health facility where ANC was provided and the number of months pregnant at the first ANC, the receipt of quality ANC increased over the 20-year period. However, during this period, there was a widening gap in the receipt of quality ANC between women with no education and those with higher education (by 25.0%); women residing in rural and urban locations (by 7.5%) and women from the poorest and richest wealth quintiles (by 32.1%). There was also a widening gap in the receipt of quality ANC between adolescent mothers and mothers aged 20–34 years (by 1.2%); women who received one ANC visit and ≥4 ANC visits (by 38.6%); women who attended their ANC at government health posts and hospitals (by 33.0%) and women who had their first ANC at or after 8 months of pregnancy and women who had ANC during the first trimester (by 37.1%) (online supplemental figures A1 and A2).

Quality intrapartum care

Among mothers who received intrapartum care for the last birth, the percentage of mothers who received all three interventions increased from 5.7% in 2001 to 32.6% in 2016 and 46.1% in 2019 (figure 2). For all population subgroups, the number of women who received quality intrapartum care increased over the 20 years. During this period, there was a decreasing gap in the receipt of quality intrapartum care between mothers who had no education and those with higher education (by 16.3%) and women living in rural and urban areas (by 8.3%). However, the gap in the receipt of quality intrapartum care has widened between the poorest and richest quintiles (by 30.1%); mothers aged ≥35 years and adolescent mothers (by 11.9%); women who had no ANC visit and ≥4 ANC visits (by 28.7%) and women who had their first ANC at or after 8 months of pregnancy and during the first trimester (by 6.2%) (online supplemental figures A3 and A4).

Immediate PNC

The percentage of mothers who received immediate PNC for their most recent uncomplicated birth increased from 4.0% in 2001 to 9.3% in 2016 and then to 41.8% in 2019 (figure 3). More women across all subgroups received immediate PNC over the 20 years. However, there was a decline in the rates of mothers with the highest level of education who received immediate PNC.

During this period, there was a widening gap in the receipt of immediate PNC between women with no education and those with higher education (by 23.1%) and women living in rural and urban locations (by 7.4%). There was also a widening gap in the receipt of immediate PNC between the poorest and richest quintiles (by

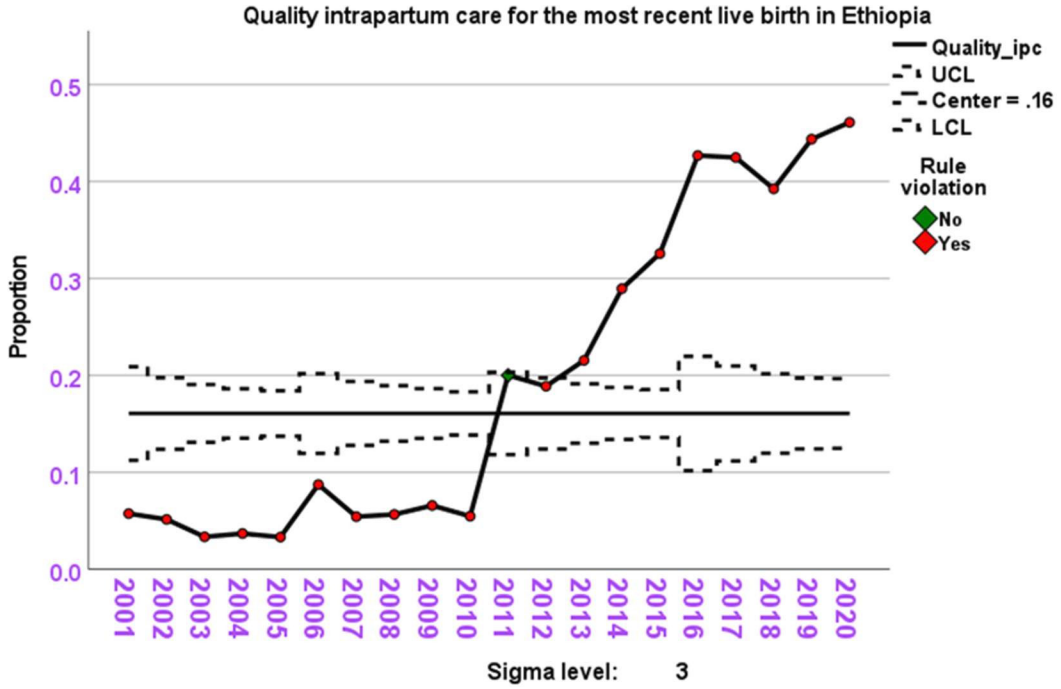

Figure 2 The percentage of mothers receiving all the three components during intrapartum care in Ethiopia (2001–2019). LCL, lower control limit; UCL, upper control limit. Quality intrapartum care: given birth at health facility+birth assisted by skilled personnel and newborn put to the breast within one hour of birth. Three sigma level: the data are within three standard deviations from the mean.

19.8%); mothers aged ≥35 years and adolescent mothers (by 4.0%), women who had no ANC visit and women who had ≥4 ANC visits (by 21.0%) and mothers who had their first ANC at or after 8 months of pregnancy and those receiving care during the first trimester (by 18.9%) (online supplemental figures A5 and A6).

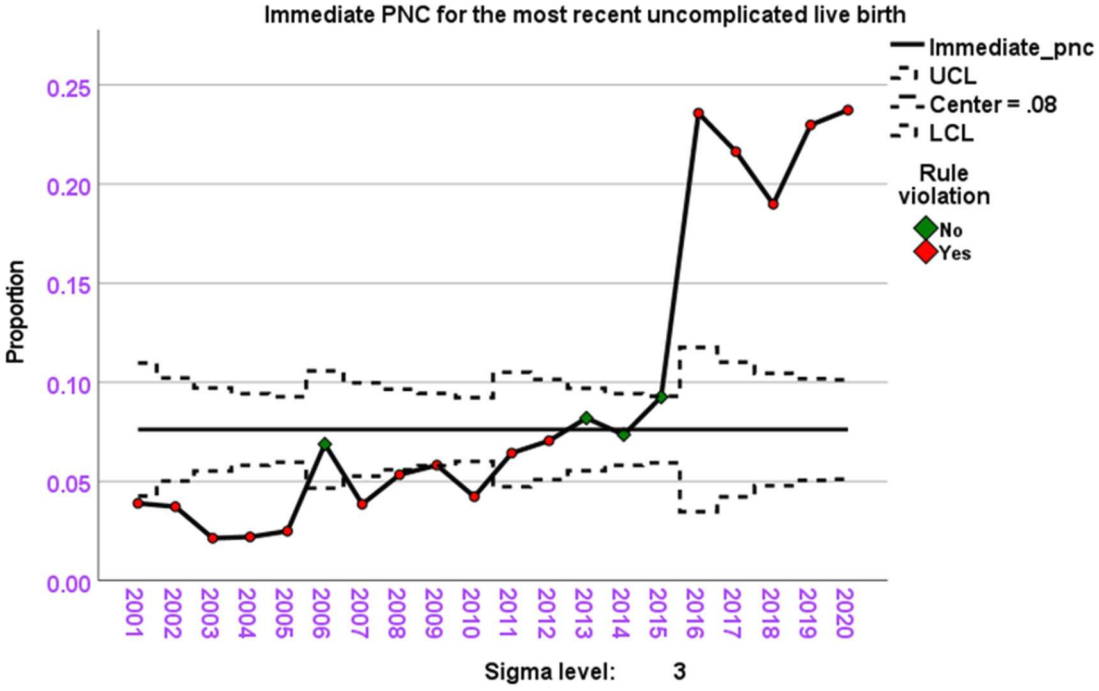

Figure 3 The percentage of mothers and their newborns receiving immediate PNC (within 24 hours of birth) at home or health facilities for their most recent uncomplicated live births in Ethiopia (2001–2019). LCL, lower control limit; UCL, upper control limit. Immediate postnatal care: the mother and her newborn received postnatal care within 24 hours of birth. Three sigma level: the data are within three standard deviations from the mean.

Factors associated with changes in the women's use of quality ANC services over 2001–2019 in Ethiopia

Over this period, 61.2% of the increment in women's use of quality ANC services was associated with between-group changes in the distribution of the predictors (p<0.001), while 38.8% of this increment was associated with the differences in the effect of these predictors (p<0.001) (table 2.).

The increased percentage of secondary or above maternal education over the period significantly increased the receipt of quality ANC by 2.1%, compared with those with no education over the same period (p=0.017). The decreased percentage of middle-income households over the period significantly decreased the receipt of quality ANC by 0.9%, compared with poor households over the same period (p=0.011). The small increase in the percentage of rich households significantly increased the receipt of quality ANC over the same period by 0.3%, compared with poor households over the same period (p<0.001) (table 2.). The improved effect of the rich household wealth index over the period significantly increased the receipt of quality ANC by 8.5%, compared with the poor household wealth indices (p=0.010). The negative effect of advanced maternal age at birth (≥35 years) on the receipt of quality ANC over the two decades significantly decreased the receipt of quality ANC by 3.4%, compared with the effect of adolescent maternal age (<20 years) over the same period (p=0.042) (table 2 and online supplemental table A5).

Over the period, the decreased percentage of 2–3 times ANC visits and the increased percentage of ≥4 ANC visits during pregnancy significantly increased the receipt of quality ANC by 10.4% and 25.2%, respectively (p<0.001). Over the period, the decreased percentage of mothers who received ANC at hospitals and the increased percentage of mothers who received ANC at government health centres significantly increased the receipt of quality ANC by 0.9% (p<0.001) and by 15.6% (p<0.001), respectively. However, the decreased percentage of mothers who received ANC at private/NGO health facilities over 2001–2019 significantly decreased the receipt of quality ANC by 0.02% (p=0.004) (table 2 and online supplemental table A4).

Factors associated with changes in the women's use of quality intrapartum care services over 2001–2019 in Ethiopia

Over this period, 69.3% of the increment in women's use of quality intrapartum care services was associated with the differences in the effects of the predictors (p<0.001), while 30.7% of this increment was associated with the between-group changes in the distribution of these predictors (p<0.001) (table 3).

The increased distribution of poor households and the decreased distribution of middle-income households over the period significantly decreased the receipt of quality intrapartum care by 13.0% (p=0.018) and by 4.8% (p=0.004), respectively, over the same period (table 3 and online supplemental table A4). The decreased effect of secondary or above maternal education and urban residence over the period significantly decreased the receipt of quality intrapartum care by 3% (p=0.039) and by 10% (p<0.001), respectively, over the same period (table 3 and online supplemental table A6).

Over the period 2001-2019, the increased percentage of ≥4 ANC visits and the quality of ANC women received significantly increased the receipt of quality intrapartum care by 30% (p=0.009) and 14% (p=0.039), respectively (table 3 and online supplemental table A4).

Factors associated with changes in the women's use of immediate PNC services over 2001–2019 in Ethiopia

Over this period, 75.7% of the increment in women's use of immediate PNC services was associated with between-group changes in the distribution of the predictors (p<0.001), while 24.3% of this increment was associated with the differences in the effect of these predictors (p<0.001) (table 4).

Over the period, the increased distribution of poor households significantly decreased the women's use of immediate PNC services by 5.9% (p=0.026) (table 4 and online supplemental table A4). The decreased effects of secondary or above maternal education and urban residence significantly decreased the women's use of immediate PNC services by 2.6% (p=0.029) and by 3.1% (p=0.043), respectively (table 4 and online supplemental table A7).

The increased percentage of ≥4 ANC, ANC during the first trimester, quality ANC and quality intrapartum care over 2001–2019 significantly increased the women's use of immediate PNC over the same period by 30.9% (p=0.003), 13.1% (p=0.008), 19.2% (p=0.002) and 60.7% (p<0.001), respectively (table 4 and online supplemental table A4). Conversely, the decreased effect of the women's use of quality intrapartum care over the two decades significantly reduced the immediate PNC use by 2.1% (p=0.009) over the same period (table 4 and online supplemental table A7).

DISCUSSION

There was an overall increment in the percentage of mothers receiving quality ANC, intrapartum care and immediate PNC services over two decades (2001–2019) in Ethiopia. However, these gains were not equally distributed and dependent on the mothers' sociodemographic and maternal care characteristics.

Over the period 2001–2019, the increased distribution of ≥4 ANC visits, ANC at government health centres and higher maternal education contributed the largest significant increase to women's use of quality ANC by 25%, 16% and 2%, respectively, while the increased distribution of ≥4 ANC and quality ANC services contributed the largest significant increase to women's use of quality intrapartum care services by 30% and 14%, respectively. Over the period, the increased distribution of ANC in the first trimester, quality ANC, ≥4 ANC and quality intrapartum

Table 2 Determinants of changes in the women's use of quality ANC services over two decades (2001–2019) in Ethiopia, attributed to changes in the distribution and effects of sociodemographic and maternal care characteristics, multivariate logistic regression decomposition analysis of Ethiopia DHSs 2005–2019 data

	Quality ANC by characteristics			Due to changes in distribution or coverage		Due to changes in effects	
Characteristics	2005 n (%)	2019 n (%)	Difference	Coefficient (95% CI)	Pct.	Coefficient (95% CI)	Pct.
Maternal education							
No education	32 (2.5)	407 (31.7)	+29.2	1.00		1.00	
Primary	18 (3.8)	469 (40.7)	+36.9	0.0038871 (−0.0030632, 0.010837)	1.80	−0.0018736 (−0.0071152, 0.0033679)	−0.87
Secondary+	27 (8.9)	282 (57.9)	+49.0	0.0045164 (0.00079487, 0.008238)*	2.09	−0.00030804 (−0.0017732, 0.0011571)	−0.14
Mother's age at birth							
<20 years	5 (1.7)	145 (37.2)	+35.5	1.00		1.00	
20–34 years	58 (3.9)	893 (40.6)	+36.7	0.000472270 (−0.001901, 0.0028456)	0.22	−0.017919 (−0.044453, 0.0086144)	−8.29
≥35 years	15 (4.6)	121 (36.2)	+31.6	0.000091834 (−0.0018633, 0.002047)	0.04	−0.0073748 (−0.01447, −0.00027921)*	−3.41
Residence							
Rural	41 (2.5)	732 (35.7)	+33.2	1.00		1.00	
Urban	36 (8.2)	426 (48.9)	+40.7	−0.0025596 (−0.011038, 0.0059188)	−1.18	−0.0023792 (−0.005539, 0.00078048)	−1.10
Household Wealth status							
Poor	16 (3.2)	257 (26.1)	+22.9	1.00		1.00	
Middle	12 (3.0)	227 (38.7)	+35.7	−0.00200880 (−0.00356220, −0.00045536)*	−0.93	0.0043435 (−0.0045491, 0.013236)	2.01
Rich	49 (4.2)	673 (50.0)	+45.8	0.00065245 (0.00027534, 0.0010296) **	0.30	0.0184380 (0.0044661, 0.03241) *	8.53
First ANC							
6+ months	14 (1.5)	132 (24.5)	+23.0	1.00		1.00	
<4 months	27 (5.9)	524 (48.0)	+42.1	0.0078726 (−0.0005391, 0.016284)	3.64	−0.00073811 (−0.0021919, 0.00071568)	−0.34
4–5 months	36 (5.1)	495 (39.1)	+34.0	0.0066498 (−0.0016514, 0.014951)	3.08	−0.00153520 (−0.0036, 0.00052965)	−0.71
ANC visits							
Once	6 (1.9)	7 (5.6)	+3.7	1.00		1.00	
2–3 visits	20 (2.4)	338 (30.9)	+28.5	0.022455 (0.013265, 0.031645) ***	10.38	0.0037019 (−0.00059246, 0.0079964)	1.71
4+ visits	50 (5.6)	808 (47.9)	+42.3	0.054570 (0.038013, 0.071127) ***	25.24	0.0045083 (−2.5342e-08, 0.0090167)	2.08
Place ANC received							
Government health post	3 (0.7)	106 (18.9)	+18.2	1.00		1.00	
Hospital	21 (3.9)	189 (55.1)	+51.2	0.0020069 (0.0009906, 0.0030233) ***	0.93	−0.00041416 (−0.0025934, 0.0017651)	−0.19
Health centre	39 (4.6)	808 (42.5)	+37.9	0.0337490 (0.021038, 0.04646) ***	15.61	−0.00157510 (−0.004819, 0.0016688)	−0.73
Private clinic/NGO	13 (7.8)	43 (53.0)	+45.2	−0.000042288 (−0.000070809, −0.000013767)**	−0.02	−0.00052240 (−0.0012649, 0.00022007)	−0.24
Constant						0.08757800 (0.042506, 0.13265) ***	40.50
Total				0.13231 (0.11592, 0.1487) ***	61.19	0.08393000 (0.057162, 0.1107) ***	38.81

*p<0.05, **p<0.01 and ***p<0.001. Coefficients were adjusted for all sociodemographic and maternal care characteristics listed in the table. Quality ANC: blood pressure measured+blood tested+urine tested+iron supplemented and informed of pregnancy-related complications during pregnancy for the last birth.
ANC, antenatal care; DHSs, Demographic and Health Surveys; Pct, per cent.

Table 3 Determinants of changes in the women's use of quality intrapartum care services over two decades (2001–2019) in Ethiopia, attributed to changes in the distribution and effects of sociodemographic and maternal care characteristics, multivariate logistic regression decomposition analysis of Ethiopia DHSs 2005–2019 data

	Quality intrapartum care by characteristics			Due to changes in distribution or coverage		Due to changes in effects	
Characteristics	2005 n (%)	2019 n (%)	Difference (%)	Coefficient (95% CI)	Pct.	Coefficient (95% CI)	Pct.
Maternal education							
No education	74 (1.4)	521 (31.6)	+30.2	1.00		1.00	
Primary	67 (5.8)	638 (49.6)	+43.8	0.032313 (−0.0065372, 0.071164)	7.29	−0.0062808 (−0.024238, 0.011677)	−1.42
Secondary+	124 (34.0)	325 (66.1)	+32.1	0.013545 (−0.00071844, 0.027808)	3.06	−0.012958 (−0.025236,−0.00067952)*	−2.92
Mother's age at birth							
<20 years	46 (4.8)	244 (48.8)	+44.0	1.00		1.00	
20–34 years	189 (4.1)	1085 (43.9)	+39.8	−0.042328 (−0.090195, 0.0055403)	−9.55	−0.0168990 (−0.069948, 0.036151)	−3.81
≥35 years	29 (2.3)	156 (34.4)	+32.1	0.004969 (−0.00045565, 0.010394)	1.12	−0.0066513 (−0.024267, 0.010965)	−1.50
Residence							
Rural	85 (1.4)	934 (37.9)	+36.5	1.00		1.00	
Urban	180 (28.8)	551 (57.0)	+28.2	0.0046032 (−0.024906, 0.034112)	1.04	−0.042263 (−0.059346,−0.025179)***	−9.54
Household Wealth							
Rich	236 (9.4)	844 (59.8)	+50.4	1.00		1.00	
Poor	15 (0.5)	406 (30.3)	+29.8	−0.057548 (−0.10519,−0.0099034)*	−12.99	−0.0038337 (−0.029266, 0.021598)	0.87
Middle	14 (0.9)	235 (34.8)	+33.9	−0.02111 (−0.035446,−0.0067741)**	−4.76	0.0036077 (−0.02303, 0.030246)	0.81
First ANC							
6+ months	52 (6.2)	195 (43.1)	+36.9	1.00		1.00	
<4 months	88 (19.2)	581 (56.6)	+37.4	0.010764 (−0.040553, 0.06208)	2.43	0.0034365 (−0.016298, 0.023171)	0.78
4–5 months	75 (10.9)	606 (52.9)	+42.0	0.017213 (−0.020841, 0.055267)	3.88	0.012188 (−0.014484, 0.038859)	2.75
ANC visits							
Once	12 (3.8)	27 (29.1)	+25.3	1.00		1.00	
2–3 visits	46 (5.9)	433 (45.8)	+39.9	0.017422 (−0.0014419, 0.036286)	3.93	0.024119 (−0.021406, 0.069644)	5.44
4+visits	153 (17.5)	923 (57.7)	+40.2	0.132970 (0.03362, 0.23232) **	30.01	0.032205 (-0.020033, 0.084443)	7.27
Had received quality ANC							
No	196 (10.2)	734 (47.6)	+37.4	1.00		1.00	
Yes	19 (25.7)	653 (59.1)	+33.4	0.060616 (0.0031947, 0.11804) *	13.68	−0.00076614 (−0.0038295, 0.0022972)	−0.17
Constant						0.32103 (0.1799, 0.46217) ***	72.46
Total				0.13614 (0.10754, 0.16474)***	30.73	0.30694 (0.2681, 0.34578) ***	69.27

*p<0.05, **p<0.01 and ***p<0.001. Coefficients were adjusted for all sociodemographic and maternal care characteristics listed in the table. Quality intrapartum care: given birth at a health facility+birth assisted by skilled personnel and the newborn is put to the breast within 1 hour of birth.
ANC, antenatal care; DHSs, Demographic and Health Surveys; Pct, per cent.

Table 4 Determinants of changes in the women's use of immediate PNC services over two decades (2001–2019) in Ethiopia, attributed to changes in the distribution and effects of sociodemographic and maternal care characteristics, multivariate logistic regression decomposition analysis of Ethiopia DHSs 2005–2019 data

	Immediate PNC by characteristics			Due to changes in distribution or coverage		Due to changes in effects	
Characteristics	2005 n (%)	2019 n (%)	Difference (%)	Coefficient (95%)	Pct.	Coefficient (95%)	Pct.
Maternal education							
No education	46 (0.8)	295 (15.2)	+14.4	1.00		1.00	
Primary	49 (4.1)	346 (26.3)	+22.2	0.00569600 (–0.012361, 0.023753)	2.27	–0.0021416 (–0.0099737, 0.0056904)	–0.85
Secondary+	95 (29.6)	174 (41.2)	+11.6	0.00081542 (–0.0063969, 0.0080277)	0.33	–0.0064459 (–0.012222, –0.00067012) *	–2.57
Mother's age at birth							
<20 years	25 (2.5)	126 (24.4)	+21.9	1.00		1.00	
20–34 years	144 (3.0)	591 (22.3)	+19.3	–0.0053018 (–0.022786, 0.012182)	–2.12	–0.015018 (-0.042475, 0.012438)	–6.00
≥35 years	21 (1.5)	99 (19.4)	+17.9	–0.0010302 (–0.0033616, 0.0013012)	–0.41	0.000031903 (–0.0078756, 0.0079394)	0.01
Residence							
Rural	65 (1.0)	521 (18.8)	+17.8	1.00		1.00	
Urban	125 (21.8)	294 (32.2)	+10.4	–0.00095902 (–0.014763, 0.012845)	–0.38	–0.0078419 (–0.015439, –0.00024464) *	–3.13
Household Wealth							
Rich	170 (6.6)	469 (34.4)	+27.8	1.00		1.00	
Poor	11 (0.4)	185 (11.6)	+11.2	–0.014726 (-0.02767,–0.0017819) *	–5.88	0.00049953 (-0.010235, 0.011234)	0.20
Middle	8 (0.5)	161 (22.2)	+21.7	–0.00078689 (-0.0045404, 0.0029666)	–0.31	0.0074121 (-0.004216, 0.01904)	2.96
First ANC							
6+ months	34 (4.0)	74 (14.6)	+10.6	1.00		1.00	
<4 months	63 (14.6)	368 (38.3)	+23.7	0.032859 (0.0085736, 0.057144) **	13.12	0.0049069 (–0.0041395, 0.013953)	1.96
4–5 months	65 (9.6)	347 (28.9)	+19.3	0.015383 (–0.0013483, 0.032115)	6.14	0.0022992 (–0.01009, 0.014689)	0.92
ANC visits							
Once	5 (1.5)	8 (6.0)	+4.5	1.00		1.00	
2–3 visits	35 (4.3)	206 (20.4)	+16.1	0.0057853 (–0.00032493, 0.011896)	2.31	0.0025423 (–0.022434, 0.027519)	1.01
4+visits	120 (14.4)	574 (37.4)	+23.0	0.0773650 (0.025558, 0.12917) **	30.88	0.0070436 (–0.020471, 0.034558)	2.81
Had received quality ANC							
No	151 (7.8)	374 (22.5)	+14.7	1.00		1.00	
Yes	13 (19.0)	416 (40.7)	+21.7	0.047984 (0.017768, 0.0782) **	19.16	0.00074718 (–0.00048678, 0.0019811)	0.30
Received quality intrapartum care							
No	82 (1.3)	206 (11.3)	+10.0	1.00		1.00	
Yes	108 (47.0)	608 (44.7)	–2.3	0.15204 (0.11755, 0.18653) ***	60.69	–0.0052104 (–0.0091021, –0.0013186) **	–2.08
Constant						0.0721020 (–0.0019742, 0.14618)	28.78
Total				0.18958 (0.16482, 0.21435) ***	75.68	0.0609270 (0.032535, 0.089318) ***	24.32

*p<0.05, **p<0.01 and ***p<0.001. Coefficients were adjusted for all sociodemographic and maternal care characteristics listed in the table. Immediate postnatal care: the mother and her newborn received postnatal care within 24 hours of birth (excluding caesarean deliveries).
ANC, antenatal care; DHSs, Demographic and Health Surveys; Pct, per cent; PNC, postnatal care.

care contributed the largest significant increase to women's use of immediate PNC services by 13%, 19%, 31%, and 61%, respectively. A study conducted in southwestern Ethiopia by Negero *et al* shows mothers with four or more ANC contacts during their last pregnancy were seven times more likely to receive skilled personnel-assisted birth than mothers with no or fewer ANC contacts.[32] Women who felt that their ANC was of poor quality will not return for subsequent care.[33] Mothers will not come or bring their newborns to healthcare facilities for timely PNC if they are discouraged by staff or treated poorly at prior visits.[34]

Our study shows widening inequality between rich and poor mothers, between adolescent mothers and mothers aged 20–34 years and their receipt of quality ANC, intrapartum care and immediate PNC services over the period. This concurs with findings from South Africa, where a comparison of serial national household surveys conducted between 2008 and 2012 indicated that inequalities between socioeconomic quartiles for ANC attendance and a doctor's presence at childbirth had worsened over 18 years.[35]

Over the period 2001–2019, the increased utilisation of quality ANC and immediate PNC services was attributed more to the changes in the distribution of sociodemographic and maternal care characteristics than to the changes in the effect of these characteristics, while the increased utilisation of quality intrapartum care was attributed more to the changes in the effect of sociodemographic and maternal care characteristics than to the changes in the distribution of these characteristics. This reveals that improved women's sociodemographic statuses and use of maternal healthcare services over the period 2001–2019 primarily and significantly increased the women's use of quality ANC and immediate PNC services, while the increased effects of these sociodemographic and maternal care characteristics over the period significantly improved the women's use of quality intrapartum care. In Ethiopia, over two decades (1996–2016), school attendance rates have increased significantly for preprimary, primary and secondary education. The gender gap in primary school enrolment has been eliminated, and the primary school attendance rate of young adolescent girls (aged 10–14 years) exceeded that of their male counterparts (80% and 78%, respectively). The gender gap in secondary school attendance rates has narrowed to a 5% difference (higher for boys). The share of children who attended the right grade for their age nearly doubled from 31% in 2000 to 61% in 2016. Between 2000 and 2016, the incidence of child marriage halved, from 20% to 11%; the incidence of teenage pregnancy declined to 13%.[36] However, the illiteracy rate among adult women in Ethiopia remains persistently high despite increased literacy among adolescents since 2000.[36]

Between 2000 and 2016, the coverage of adequate ANC visits increased from 10% to 32%, and skilled personnel-assisted birth from 6% to 33%.[36] These improvements could arguably be causally attributed to the introduction of two community-based national health policies, the health extension program (HEP) and the health development army (HDA), launched after 2000. The HEP, launched in 2003, expanded basic health infrastructure and local human resources (two health extension workers per village). In 2010, the government introduced the HDA policy to increase the efficiency of HEWs and the HEP in reaching every household, with one female HDA team leader for every 30 households.[37] The HDA is a women-centred community movement inspired by military structures and discipline. Its objective was to improve maternal health outcomes[37] by establishing networks of female neighbours who meet at least once per week. Each network has a leader responsible for referring pregnant women and linking them with health workers.

Despite these improvements, our study shows that increases in the distribution of poor households over the period contributed to the largest significant decrease in women's use of quality intrapartum care and immediate PNC services by 13% and 6%, respectively, over the same period. On the other hand, over the period, the increased effect of the rich households contributed the largest significant increase to the receipt of quality ANC by 9%. This highlights the critical need to improve access to the recommended interventions during ANC, intrapartum care and PNC services for mothers of low socioeconomic status and the need to promote women's economic empowerment. Poverty hinders a mother from seeking the recommended maternal healthcare interventions, including institutional delivery.[29] Socioeconomic inequalities in PNC service use have been identified across low-and middle-income countries.[38] In our study, the decreased effect of urban residence and secondary or above maternal education over the period significantly decreased the receipt of quality intrapartum care by 10% and 3% and immediate PNC by 3% and 3%, respectively. This might be due to the rising poverty among urban residents in Ethiopia. Our analysis shows that the distribution of poor households in urban areas in Ethiopia increased by ninefold over the two decades and is likely to be linked to decreased access to quality care. The decreased effect of quality intrapartum care over the period significantly decreased the women's use of immediate PNC services over the same period by 2%. This might be due to the worsening care experience during labour and delivery services over time.

In our study, the decreased percentage of mothers who received ANC at hospitals and the increased percentage of mothers who received ANC at government health centres across the two decades significantly increased the receipt of quality ANC, indicating the benefits of redirecting uncomplicated maternal healthcare services to lower-level health facilities to avoid overcrowding of higher-level health facilities and hence low-quality care. In an analysis paper pleading for the healthcare system redesign for maternal and newborn survival in low and middle-income countries, Roder-DeWan *et al* argued that all deliveries in these settings need to be shifted to

hospitals or other advanced care facilities to bring care in line with global best practices, and there should be investments in boosting the quality of primary care facilities for antenatal, postnatal and newborn care services and mobilising populations to demand high-quality care.[39]

The negative effect of advanced maternal age (≥ 35 years) over the period contributed to the largest significant decrease in women's use of quality ANC services over the same period by 3%, and this signals the necessity to encourage and make sure older mothers receive the recommended interventions during their ANC visits. The risk of poor utilisation of ANC services is higher among older women (≥31 years). Access to ANC clinics could be increased by improving transport, actively engaging community members in their promotion, minimising costs and extending opening hours.[40]

Our study has several limitations. The study shares the limitations of a cross-sectional study design, which makes it difficult to demonstrate cause-and-effect relationships. However, we used four consecutive Ethiopian Demographic and Health Surveys data, which are nationally representative and could enhance the findings' generalisability. In addition, control charts can only be used to assess each variable independently/singularly, without assessing the effects of other variables, as this may not be intuitive to the reader. The multivariate decomposition analysis enabled the identification of factors that positively or negatively contributed to the changes in women's use of quality ANC, intrapartum care and immediate PNC services over the two decades in Ethiopia that could help policy makers and health planners in low-income settings design applicable strategies.

CONCLUSIONS

The women's use of quality ANC, intrapartum care and immediate PNC services increased over 20 years in Ethiopia. However, over the period, the inequality in receiving these services between poor and rich mothers and between adolescent mothers and mothers aged 20–34 years has widened. Over the period, the increased distribution of ≥4 ANC, ANC at the government health centres and secondary or above maternal education contributed to the largest significant increase in women's use of quality ANC. The rich households' increased effect contributed to the largest significant increase in women's use of quality ANC over the same period. The increased percentage of ≥4 ANC and quality ANC services over the period contributed to the largest significant increase in women's use of quality intrapartum care over the same period. However, the increased distribution of poor households, the decreased distribution of middle-income households and the decreased effects of secondary or above maternal education and urban residence contributed to the largest significant decreases in women's use of quality intrapartum care over the period. The increased coverage of first trimester ANC, quality ANC, ≥4 ANC and quality intrapartum care services contributed to the largest significant increase in women's use of immediate PNC services over the period. However, the increased distribution of poor households contributed to the largest significant decrease in women's use of immediate PNC services over the same period.

The healthcare system in Ethiopia should strive to make accessible all the recommended interventions during ANC, intrapartum care and PNC services to the disadvantaged section of the society: non-educated, poor, adolescent (<20 years), older (≥35 years) and rural mothers. Promoting ≥4 ANC visits, ANC during the first trimester, girls' and women's education and enabling women's economic empowerment are needed. Promoting and putting into practice the policy of the universal coverage of quality maternal and newborn healthcare across the continuum are needed.

Author affiliations
[1]School of Public Health, Institute of Health Sciences, Wollega University, Nekemte, Ethiopia
[2]School of Public Health, Faculty of Health, University of Technology Sydney, Sydney, NSW, Australia

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ORCID iDs
Melese Girmaye Negero http://orcid.org/0000-0002-1640-9631

Angela Dawson http://orcid.org/0000-0003-0926-2202

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