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Is socioeconomic inequality in antenatal care coverage widening or reducing between- and within-socioeconomic groups? A case of 19 countries in sub-Saharan Africa

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ABSTRACT

Maternal health statistics have improved in many countries in sub-Saharan Africa (SSA). Still, progress remains slow in meeting the Sustainable Development Goals (SDG) targets. Accelerating antenatal care (ANC) coverage is critical to improving maternal health outcomes. To progress, countries should understand whether to target reducing health disparities between- or within-socioeconomic groups, as policies for achieving these may differ. This paper develops a framework for decomposing changes in socioeconomic inequalities in health into changes in between- and within-socioeconomic groups using the concentration index, a popular measure for assessing socioeconomic inequalities in health. It begins by noting the challenge in decomposing the concentration index into only between- and within-group components due to the possibility of an overlap created by overlapping distributions of socioeconomic status between groups. Using quantiles of socioeconomic status provides a convenient way to decompose the concentration index so that the overlap component disappears. In characterising the decomposition, a pro-poor shift occurs when socioeconomic inequality is reduced over time, including between- and within-socioeconomic groups, while a pro-rich shift or change occurs conversely. The framework is applied to data from two rounds of the Demographic and Health Survey of 19 countries in SSA conducted about ten years apart in each country. It assessed changes in socioeconomic inequalities in an indicator of at least four antenatal care visits (ANC4+) and the count of ANC visits (ANC intensity). The results show that many countries in SSA witnessed significant pro-poor shifts or reductions in socioeconomic inequalities in ANC coverage because pro-rich inequalities in ANC4+ and ANC intensity become less pro-rich. Changes in between-socioeconomic group inequalities drive the changes in ANC service coverage inequalities in all countries. Thus, policies addressing inequalities between-socioeconomic groups are vital to reducing overall disparities and closing the gap between the rich and the poor, a crucial objective for the SDGs.

1. Introduction

Globally, maternal mortality declined from 339 to 223 deaths per 100,000 live births between 2000 and 2020, representing a 34.3% aggregate or a 2.1% average annual decline (World Health Organization, 2023). Between 2000 and 2015, representing the Millennium Development Goals (MDG) era, the maternal mortality ratio declined by 2.7% annually, and the Sustainable Development Goals (SDG) era using available data (2016–2020), showed stagnation (or a marginal decline) in progress with a 0.04% average annual increase. Between 2021 and 2030, an average annual maternal mortality ratio decline of 11.6% is required to achieve the SDG target by 2030 (World Health Organization, 2023). However, with the current pace of progress achieved during the SDG era (2016–2020), it is estimated that the maternal mortality ratio will decline from 223 in 2020 to 222 deaths per 100,000 live births in 2030 (World Health Organization, 2023), which is still far off from the

Abbreviations: ANC, Antenatal Care; ANC4+, at least four Antenatal Care; EA, Enumeration Area; DHS, Demographic and Health Survey; LMIC, Low and Middle-Income Countries; SEI, Socioeconomic Inequalities; SSA, Sub-Saharan Africa; SDG, Sustainable Development Goals; WHO, World Health Organization.

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70 deaths per 100,000 live births SDG target (United Nations Development Programme, 2015). Sub-Saharan Africa (SSA) accounted for about 70% of global maternal deaths in 2020. It had the worst maternal mortality ratio among other regions globally, with an estimated 545 deaths per 100,000 live births in 2020 (World Health Organization, 2023). Most maternal deaths occur from preventable or treatable complications during pregnancy or childbirth or manageable pre-existing conditions such as high blood pressure, haemorrhage, infection, embolism, and unsafe abortion (Musarandega et al., 2021; Say et al., 2014). Quality antenatal care (ANC) prevents maternal deaths, including helping to make adequate arrangements for safe delivery, early detection of adverse symptoms and effective referral and reducing the prevalence of anaemia (Carroli et al., 2001).

While the World Health Organization (WHO) previously recommended a minimum of four ANC visits for optimal maternal health outcomes and revised this in 2016 to at least eight ANC contacts for uncomplicated pregnancies (World Health Organization, 2015, 2016), there is no doubt that adequate ANC visits are beneficial to pregnant women, especially as countries aspire towards achieving universal access to quality health services (World Health Organization & World Bank, 2014). Many low and middle-income countries (LMICs) have significantly improved ANC coverage, even though coverage rates are lower than those from wealthier regions of the world (Moller et al., 2017; Victora et al., 2012). There are significant challenges in the quality of ANC services provided (Arsenault et al., 2018) and inequality in the use of quality ANC services (Bobo et al., 2021), with poorer women in SSA often left behind (Ambel et al., 2017; Nwosu & Ataguba, 2019; Obse & Ataguba, 2021; Victora et al., 2012). With many countries in SSA recording an increase in ANC service utilisation over time, Ethiopia, Ghana, Kenya and Tanzania are countries where wealthier groups benefitted more, leading to widening inequalities, while in Rwanda, Uganda and Zimbabwe, inequalities were reduced, benefiting women from lower socioeconomic groups (Abekah-Nkrumah, 2019; Ambel et al., 2017; Asamoah & Agardh, 2017; Asuman et al., 2021; Makate & Makate, 2017; Seidu et al., 2022). Widening ANC service utilisation inequalities means that many countries are off-track on health and wellbeing-related SDGs and reducing inequalities in all forms (United Nations Development Programme, 2015). It, therefore, remains critical to understand how countries are progressing in increasing ANC coverage and closing the gaps by reducing inequalities between the wealthy and poorer populations to leave no one behind (Watkins, 2014).

Assessing reductions in socioeconomic inequality in health remains a critical aspect of the SDGs. Traditional assessments of changes in socioeconomic inequalities in ANC coverage, for instance, tended to focus on how the poorer populations benefit relative to the rich (for example, Abekah-Nkrumah, 2019; Adeyanju et al., 2017) or understanding the social determining factors associated with changes in socioeconomic inequalities in health (Wagstaff et al., 2003). These assessments do not reveal whether worsening or improving inequalities are mainly due to inequalities between- or within-socioeconomic groups, an essential consideration for policy in many countries. Although each socioeconomic group, for instance, the top 20% of the population, is seen as externally homogeneous, they are internally heterogenous as the poorest 20% of the population contains the most deprived individual and those who are relatively not as poor as the most deprived individual. So, focusing on between-group inequalities does not unpack the inherent heterogeneities within socioeconomic groupings. In the context of this paper, within-group inequalities recognise that women in each socioeconomic group do not have the same ANC service utilisation rates even though they have been categorised as such. The dynamics between and within groups of poorer or wealthier populations, which economists call between-group and within-group dynamics, remain essential because "the slope of the relationship between health and income, or 'the gradient,' depends on the ratio of between-to within-group inequality" (Deaton, 2001, p. 285).

Socioeconomic inequalities arising mainly from within-group inequality need policies prioritising individuals in similar socioeconomic classes. In contrast, socioeconomic inequalities attributed largely to disparities between socioeconomic groups require prioritising vulnerable socioeconomic groups. Thus, this study develops and uses a generalised framework to assess intertemporal socioeconomic inequalities in ANC service utilisation in selected SSA countries and uncover the relative contributions of between- and within-socioeconomic group inequalities to overall socioeconomic inequalities. This will contribute to the debate on closing health gaps between the poor and rich as contained in the SDGs.

2. Conceptual framework

Differences in health (e.g., morbidity, mortality, health status) between individuals or groups in a population constitute health inequality (Arcaya et al., 2015; Gakidou et al., 2000). The Black Report provided the basis for recent studies and scientific enquiry into health inequalities (Black et al., 1980). Although health inequalities may occur within or between countries (Arcaya et al., 2015), they may be absolute or relative, with two different classes of measures; one which compares a group's health or an individual's health with another group's health or the population's average health, and another that compares an individual's health with everyone's health (Arcaya et al., 2015; Gakidou et al., 2000). In the health economics literature, Wagstaff et al. (1991) summarized six widely used measures of health inequality, including the range, the health Lorenz curve and Gini coefficient, pseudo-Lorenz curves, the index of dissimilarity, the slope and relative indices of inequality, and the concentration index and curve. This paper omits the definition and explanation of each measure for brevity. Health inequality assessment can be univariate (i.e., focusing on the distribution of health in the population without comparing that with any other distribution) or bivariate (i.e., where the distribution of health in a population is compared with another distribution such as income or another measure of socioeconomic status) (Wolfson & Rowe, 2001). Because our interest is in the bivariate assessment that shows the socioeconomic dimension of health inequalities (Ataguba et al., 2011; Bleichrodt & van Doorslaer, 2006; Wagstaff et al., 1991), only the slope (and relative) indices of inequality and the concentration index (and curve), which will be introduced later, are recommended. This is because they reflect the experiences of the entire population and are sensitive to any change in the population distribution across socioeconomic groupings (Wagstaff et al., 1991).

Epidemiologists and social scientists have proposed theories to explain how health inequality may arise, most of which are originally contained in the Black Report (Black et al., 1980). The popular theories include the artefact theory, natural or health selection theory, behavioural or cultural theory, materialist or structural theory, psychosocial theory, and life-course epidemiology perspective (Bambra, 2011a, 2011b; Black et al., 1980; McCartney et al., 2013). A summary of these theories is contained in Box 1. The materialist or structural theory's acknowledgement of policies and services in shaping health inequalities makes it a promising theory to explain the inequalities presented in this paper. Based on this theory, reducing health inequalities requires addressing the causes, including policies.

As our interest is to reduce socioeconomic inequalities, it is important to highlight that reductions in socioeconomic inequalities in health may occur with widening inequalities among the poor. So, achieving reductions in socioeconomic inequalities, although necessary, may not be sufficient not to leave anyone behind. To build a framework for examining how countries have progressed in achieving reductions in socioeconomic inequalities in ANC coverage, we used the concentration index, a common index for assessing socioeconomic health inequalities (Ataguba, 2022; Kakwani et al., 1997; Wagstaff et al., 1991). In this case, the concentration index measures the joint distribution of socioeconomic status and ANC service coverage. It summarises how ANC coverage is distributed among socioeconomic or living standard groups.

Box 1
Summary of major health inequality theories

The artefact theory	This theory views the relationship between socioeconomic position and health, if any, as superficial or a statistical artefact.
The health selection theory	Here, health determines socioeconomic groups or classes rather than the other way around. Healthier individuals or groups are likelier to move up the social strata, while their unhealthy counterparts move downward and become concentrated in the lower socioeconomic classes.
The behavioural or cultural theory	This views socioeconomic inequalities as coming from how health-related behaviours vary between different socioeconomic groups.
The materialist or structural theory	This theory views socioeconomic inequalities as emanating from unequal access to income, material wealth, and power, which enables differential access to goods and services, including health services. It also acknowledges the role of public policy and services (e.g., schools, environment and transportation), often beyond an individual's control, in the social patterning of inequalities.
The psychosocial theory	This theory views socioeconomic inequality as resulting from the unequal distribution of psychosocial risk factors along social and economic lines because it focuses on how social inequality affects people's feelings, including any resulting biological and health consequences.
The life-course epidemiology approach	This approach acknowledges that multiple causal processes and mechanisms explain diseases' socioeconomic inequalities. It emphasises that socioeconomic inequality in health results from "inequalities in the accumulation of social, psychological and biological advantages and disadvantages over time" (Raphael, 2012, p. 742)

Sources: Black et al. (1980), McCartney et al. (2013), Bambra (2011a), Bambra (2011b).

It is essential to highlight the difficulty in decomposing this index into only between- and within-group inequalities due to an overlap factor caused by the distribution of living standards (Clarke et al., 2003). Generally, for any mutually exclusive groupings (e.g., region of residence, sex of household head, etc.), the concentration index (C) of socioeconomic inequalities can be decomposed into between-group inequalities (C_B), within-group inequalities (C_W), and the residual or overlap component (R) as shown in Equation (1) (Clarke et al., 2003).

$$C = C_W + C_B + R \tag{1}$$

For urban and rural groups, for instance, there will be an overlap in the socioeconomic distribution leading to a non-zero ($R \neq 0$) value of the residual because some urban and rural dwellers could share similar socioeconomic quantiles. Fortunately, because C is computed based on socioeconomic ranks (Kakwani et al., 1997), using quantiles of living standards as the groups makes the residual component to become zero, as there will be no overlap in the living standards distribution between socioeconomic quantiles that are mutually exclusive. Therefore, the concentration index can be decomposed conveniently using the living standards quantiles as $C = C_B + C_W$ because the overlap component is zero.

With at least two non-overlapping ($K \geq 2$) groups, the within-group component (C_W) can be computed as the weighted group-specific concentration indices (C_k) of the health variable:

$$C_W = \sum_{k=1}^{K} m_k p_k C_k \tag{2}$$

where m_k and p_k are weights representing group k's health share and population share, respectively.

The within-group component (C_W) can also be written as the sum of each group's component. For example, if $K = 3$ and C_{W_k} represents group k's (within) component such that $C_{W_k} = m_k p_k C_k$, then Equation (2) becomes

$$C_W = \sum_{k=1}^{3} C_{W_k} = C_{W_1} + C_{W_2} + C_{W_3} \tag{3}$$

The between-group component (C_B) will be non-zero if the mean of the health variable is different between groups, and it is obtained by computing the concentration index of a distribution where the value of the health variable for every individual in a group is replaced with the group's mean value to eliminate inequalities within groups. Because the residual component (R) is zero with no overlaps in quantiles of living standards, either C_W may be estimated and C_B computed as $C_B = C - C_W$ or C_B estimated and C_W computed as $C_W = C - C_B$. The results are equivalent to computing C_B and C_W individually.

Using quantiles of socioeconomic status, if C^t and C^{t-1} represent the health concentration index at time t (recent period) and $t-1$ (previous period), respectively, because $R \rightarrow 0$, changes in the socioeconomic inequalities in health (ΔC) between the two time periods can be written as:

$$\underbrace{\Delta C}_{C^t - C^{t-1}} = \underbrace{\Delta C_B}_{C_B^t - C_B^{t-1}} + \underbrace{\Delta C_W}_{C_W^t - C_W^{t-1}} \tag{4}$$

where C_B^t and C_B^{t-1} represent the between-group concentration indices at the most recent period (t) and previous period ($t-1$), respectively. Also, C_W^t and C_W^{t-1} are the within-group inequalities for the most recent period (t) and previous period ($t-1$), respectively. The possible values for the components of Equation (4) are summarized in Table 1.

3. Application to data from 19 countries in sub-Saharan Africa

3.1. Data

The framework in Table 1 is applied to data from two rounds of the Demographic and Health Survey (DHS) dataset of 19 countries in SSA, with a recent DHS round and a previous round conducted about ten years apart. The ten-year time interval was chosen for a few reasons. As reported in global statistics, the maternal mortality ratio declined marginally over the past 20 years (World Health Organization, 2023), meaning substantial changes occur slowly, and a sizeable time interval is needed to assess changes. Considering 2000 as our starting point to coincide with the beginning of the MDG era and knowing that DHS data are typically collected every five years per country, we included countries with a sufficient time gap to capture changes over time. Ideally, major policy changes within countries should determine the time gap. However, because this is a multi-country analysis, using different time gaps per country was challenging. The 19 countries with a recent DHS and another conducted about ten years prior are the Republic of Benin

Table 1
Characterising intertemporal socioeconomic health inequality, decomposed into between- and within-group components.

	Negative or pro-poor shift	Positive or pro-rich shift	Zero or no change
Changes in the between-group component (ΔC_B)	A pro-poor shift in the between-group component ($\Delta C_B < 0$) occurs when changes in between-group inequality "favour" poorer socioeconomic groups (i.e., between-group inequality is becoming more pro-poor or less pro-rich over time).	A pro-rich shift in the between-group component ($\Delta C_B > 0$) occurs when changes in between-group inequality "favour" wealthier socioeconomic groups (i.e., between-group inequality is becoming more pro-rich or less pro-poor over time).	No changes in socioeconomic health inequality between groups between t and $t-1$.
Changes in the within-group component (ΔC_W)	A pro-poor shift in the within-group component ($\Delta C_W < 0$) occurs when changes in within-group inequality "favour" poorer socioeconomic groups (i.e., inequality within groups is becoming more pro-poor or less pro-rich over time).	A pro-rich shift in the within-group component ($\Delta C_W > 0$) occurs when changes in inequality within-group "favour" wealthier groups (i.e., within-group inequality is becoming more pro-rich or less pro-poor over time).	No changes in socioeconomic health inequality within groups between t and $t-1$.
Changes in the health concentration index (ΔC)	A pro-poor shift in the concentration index ($\Delta C < 0$) occurs when a previously pro-poor concentration index ($C < 0$) becomes even more pro-poor or a previously pro-rich concentration index ($C > 0$) becomes less pro-rich or becomes pro-poor between t and $t-1$.	A pro-rich shift in the concentration index ($\Delta C > 0$) occurs when a previously pro-rich concentration index ($C > 0$) becomes even more pro-rich, and a previously pro-poor concentration index ($C < 0$) becomes less pro-poor or becomes pro-rich between t and $t-1$.	This occurs when there is no change in the concentration indices between periods.

Notes: $\Delta C = C^t - C^{t-1}$; $\Delta C_B = C_B^t - C_B^{t-1}$; $\Delta C_W = C_W^t - C_W^{t-1}$. Here, superscript t represents the most recent survey period, while superscript $t-1$ stands for the earlier survey period. For example, C^t is the concentration index for the most recent time period.

(2006 and 2017/18), Burundi (2010 and 2016/17), Cameroon (2011 and 2018), Chad (2004 and 2014/15), Ethiopia (2005 and 2016), The Gambia (2013 and 2019/20), Ghana (2003 and 2014), Kenya (2003 and 2014), Lesotho (2004 and 2014), Liberia (2007 and 2019), Malawi (2004 and 2015/16), Mali (2006 and 2018), Nigeria (2008 and 2018), Rwanda (2010 and 2019/20), Sierra-Leone (2008 and 2019), Tanzania (2004 and 2015), Uganda (2006 and 2016), Zambia (2007 and 2018), and Zimbabwe (2005 and 2015) (Demographic And Health Survey, 2022). DHS uses a uniform approach across countries, is nationally and sub-nationally representative, and is implemented using a stratified two-stage cluster sampling design. Enumeration areas (EAs) and households are selected in the first and second stages, respectively, using the Population and Housing Censuses of respective countries as sampling frames (Croft et al., 2018). The Individual Recode dataset, containing data on women aged 15–49, is used for all countries.

The key health variable of interest is ANC visits reported by women aged 15–49 for their most recent live birth. Two ANC measures are computed: (i) *ANC4+*, which is a dummy variable for women with at least four ANC visits and (ii) *ANC intensity*, which is a count variable for the total number of ANC visits per woman. Wealth indices are used as a measure of living standards (O'Donnell et al., 2008; Rutstein & Rojas, 2006). The wealth indices in the DHS are constructed using ownership of various household items and assets and access to amenities and facilities, including drinking water sources and materials for housing (Rutsein & Johnson, 2004).

3.2. Analytical methods

The concentration indices for *ANC4+* and *ANC intensity* are computed using the convenient regression approach (Kakwani et al., 1997) via the *-conindex-* user-written Stata command (O'Donnell et al., 2016). Normalising the concentration index is proposed for dummy variables like *ANC4+* (Erreygers, 2009; Wagstaff, 2005). However, in some instances, such normalisation may produce counterintuitive results for policy (Ataguba, 2022); hence the standard concentration indices are used for the decomposition shown in Equation (4). A user-friendly Stata Ado file was written to generate the following estimates for each country: C^t, C^{t-1}, C_B^t, C_B^{t-1}, C_W^t, C_W^{t-1}, ΔC_B, ΔC_W and ΔC. In the absence of analytic standard errors, bootstrapped standard errors for ΔC_B, ΔC_W and ΔC are computed with 1000 replications (Efron, 1987; Efron & Tibshirani, 1986), accounting for sampling design. The relative contributions of ΔC_B and ΔC_W to ΔC are computed as $\left(\frac{\Delta C_B}{\Delta C}\right)\%$ and $\left(\frac{\Delta C_W}{\Delta C}\right)\%$, respectively.

4. Results

4.1. Descriptive statistics

Almost all countries, except the Benin Republic, Malawi, and Tanzania, made significant progress in increasing the proportion of women aged 15–49 who had live births, with a minimum of 4 ANC visits. Similarly, except for six countries (Benin Republic, Kenya, Lesotho, Malawi, Nigeria, and Tanzania), the average number of ANC visits increased or remained the same over time (Table 2). Comparatively, Burundi, Chad, Ethiopia, Mali and Rwanda had less than 50% of women with at least 4 ANC visits. In contrast, the Gambia, Ghana, Lesotho, Liberia, Sierra Leone, and Zimbabwe had between 68% and 89% of women with at least 4 ANC visits (Table 2).

4.2. Intertemporal inequalities

The concentration indices for ANC4+ are positive for almost all the countries for both periods, indicating that women from wealthier households are more likely to have at least 4 ANC visits than women from poorer backgrounds (Table 3). In Sierra Leone and Zambia, the concentration indices for ANC4+ changed from positive in the previous period to negative in a recent period, meaning that reductions in socioeconomic inequalities in ANC4+ benefit poorer populations more than wealthier populations. There is generally a pro-poor shift in socioeconomic inequalities in ANC4+ in SSA as $\Delta C < 0$ for most countries, based on the framework in Table 1. The pro-poor change, ΔC, was statistically significant at the 1% or 5% level in Chad ($\Delta C = -0.263$), Ethiopia (-0.237), Ghana (-0.055), Liberia (-0.074), Nigeria (-0.114), Sierra Leone (-0.072), Uganda (-0.029) and Zambia (-0.020) but marginally significant at the 10% level in Lesotho (-0.017), Malawi (-0.016) and the Gambia (-0.012). Pro-rich shifts in socioeconomic inequalities in ANC4+ ($\Delta C > 0$) occurred in a few countries, but only statistically significant in Benin Republic (0.014), Rwanda (0.042) and Tanzania (0.051).

The results for ANC intensity in Table 4 were similar to those in Table 3, as the concentration indices for ANC intensity are positive for both periods for all the countries. The positive concentration indices mean a positive gradient exists between socioeconomic status and the number of ANC visits women have; women from wealthier households have more ANC visits than their poorer counterparts. The pro-rich socioeconomic inequalities in ANC intensity decreased over time in most countries, except Burundi, Mali and Rwanda, where $\Delta C > 0$. It was only in Rwanda that the pro-rich shift in socioeconomic inequality in ANC intensity between 2010 and 2019/20 ($\Delta C = 0.020$) was statistically

Table 2
The proportion of women with at least four ANC visits and the average number of ANC visits for 19 countries in SSA, various years.

Country	Year	Observations	ANC4+ (%)	ANC intensity (mean)
Benin	2006	10453	61.4	4.4
	2017/18	8766	53.4	3.9
Burundi	2010	4902	33.5	3.2
	2016/17	8655	49.3	3.5
Cameroon	2011	7576	62.9	4.3
	2018	6395	65.5	4.3
Chad	2004	3462	18.0	1.5
	2014/15	10928	31.7	2.3
Ethiopia	2005	6542	12.2	1.0
	2016	7174	31.9	2.4
The Gambia	2013	5377	77.8	4.8
	2019/20	5747	79.0	4.8
Ghana	2003	2663	72.0	5.4
	2014	4272	87.7	6.5
Kenya	2003	3870	53.7	4.1
	2014	14898	57.8	4.0
Lesotho	2004	2843	72.3	5.2
	2014	2576	74.9	5.0
Liberia	2007	3525	74.3	5.6
	2019	4185	88.9	6.1
Malawi	2004	7256	57.4	4.0
	2015/16	13389	50.8	3.7
Mali	2006	8872	36.1	2.7
	2018	6246	44.3	3.1
Nigeria	2008	16664	49.4	5.0
	2018	21465	57.8	4.7
Rwanda	2010	6318	35.4	3.1
	2019/20	6166	47.2	3.2
Sierra Leone	2008	3260	68.1	5.4
	2019	6540	89.5	6.5
Tanzania	2004	5632	61.7	4.1
	2015	7019	50.9	3.7
Uganda	2006	4952	47.7	3.7
	2016	10219	60.2	3.8
Zambia	2007	4099	61.1	4.0
	2018	7305	64.1	4.0
Zimbabwe	2005	4023	71.9	4.8
	2015	4823	75.9	5.1

significant at the 1% level (Table 4).

While most countries have reduced socioeconomic inequalities in ANC service utilisation over time because $\Delta C < 0$, this decline was mainly due to a pro-poor shift or reductions in socioeconomic inequalities between groups. In countries like the Benin Republic, Burundi and Rwanda, where existing pro-rich socioeconomic inequalities increased ($\Delta C > 0$), between-group socioeconomic inequalities also dominate. In Tables 3 and 4, for instance, the contribution of between-group socioeconomic inequalities to overall inequalities, $\left(\frac{\Delta C_B}{\Delta C}\right)\%$, is consistently larger than $\left(\frac{\Delta C_W}{\Delta C}\right)\%$ for all countries. For ANC4+ in Table 3, the results for ΔC_B are not statistically significant in certain cases like Benin Republic, Burundi, Cameroon, Kenya, Lesotho and Zimbabwe. In Sierra Leone, for instance, the statistically significant reduction in socioeconomic inequalities in ANC4+ ($\Delta C = -0.072$) is mainly (92.1%) due to reductions or a pro-poor shift in socioeconomic inequalities between groups ($\Delta C_B = -0.066$) (Table 3). Similarly, 91.7% of the pro-poor shift in socioeconomic inequalities ($\Delta C = -0.123$) in ANC intensity (Table 4) in Sierra Leone is due to a decrease or a pro-poor shift in between-group socioeconomic inequality ($\Delta C_B = -0.113$). In Tanzania, however, although the results are not significant at the 5% level, there is an almost even split in the contributions of changes in between-group and within-group socioeconomic inequalities to the reduction in the pro-rich socioeconomic inequality in ANC intensity (Table 4), with the pro-poor shift in between-group socioeconomic inequalities ($\Delta C_B = -0.002$) accounting for 51% of the overall decline.

5. Discussion

ANC coverage increased in most countries in SSA included in the analysis, with the Gambia, Liberia, Sierra Leone, Ghana, and Zimbabwe recording over 75% coverage with ANC4+. However, the proportion of women receiving at least 4 ANC visits declined in a few countries like the Benin Republic, Malawi, and Tanzania, even though the proportions were initially below 60%, which is a cause for concern. Because the WHO recommends at least eight ANC contacts for the health of mothers and children (World Health Organization, 2016), countries, where the proportion of women attending at least four ANC declined over time are not on track to improve maternal health statistics. Generally, although the use of ANC services is concentrated among women from wealthier backgrounds, as shown in this paper and other previous studies (Asuman et al., 2021; Seidu et al., 2022), many countries in SSA witnessed significant reductions in socioeconomic inequalities in ANC coverage as the pro-rich inequalities in ANC4+ and ANC intensity are becoming less pro-rich, leading to a pro-poor shift. As ANC utilisation increases, many SSA countries' health systems are increasingly reaching out to more women from poorer backgrounds. Still, there is a long way to go to change the pro-rich to pro-poor inequalities, an issue we return to later. In the Benin Republic and Tanzania, where the proportion of women attending at least 4 ANC visits declined in the subsequent year, the significant pro-rich shift in ANC4+ arose from women in poorer socioeconomic backgrounds being left behind. Clearly, pro-rich changes in ANC4+ inequalities or widening disparities in ANC service coverage, as seen in the Benin Republic, Rwanda, and Tanzania, do not align with the goal of progressive realisation of service coverage, especially in closing the gap between women from poorer and wealthier backgrounds. Closing this gap in countries with a pro-rich shift in inequalities requires identifying key access barriers and policies prioritising women from poorer socioeconomic backgrounds in each country. Governments should focus on achieving shared goals of addressing critical access barriers and prioritising population groups being left behind with locally relevant policies.

Pregnancy and fertility rates are generally higher among women from poorer socioeconomic backgrounds (Jokela, 2012), including countries in SSA. This implies that the need for maternal health services, including ANC services, is higher among women from poorer socioeconomic groups than women from wealthier households. Although a significant pro-poor shift in socioeconomic inequality in ANC coverage occurred in many countries in SSA, there is considerable inequity in many countries' health systems, including countries in SSA (Cookson et al., 2021; Gwatkin et al., 2004) where people from poorer socioeconomic backgrounds, who need more services, receive fewer services than the need compared to their wealthier counterparts. This paper's findings show almost persistent pro-rich socioeconomic inequalities in the most recent ANC coverage statistics. Thus, while having a pro-poor shift in socioeconomic inequality in ANC service coverage is critical, as demonstrated in the framework in Table 1, it is vital to align the use of ANC services to the distribution of need to achieve equity in health service utilisation (Ataguba & Kabaniha, 2022; Cookson et al., 2021; McIntyre & Ataguba, 2011). Unfortunately, ANC service utilisation remains pro-rich in almost all countries, as women from wealthier households utilise more ANC services than their poorer counterparts.

The emerging result that changes in between-socioeconomic group inequalities accounted for most of the changes in ANC service coverage inequalities $\left(\frac{\Delta C_B}{\Delta C} > \frac{\Delta C_W}{\Delta C}\right)$, especially for countries with a pro-poor shift, is important for policy to address inequality in ANC service coverage in SSA. So, it is essential to identify women in different socioeconomic groups and reduce disparities between groups. Although maternal health services are free at primary-level public facilities in many SSA countries (Ansu-Mensah et al., 2020), there are a few examples of systems used in different countries in SSA to categorise populations into socioeconomic groups for prioritisation. Various approaches are

Table 3
Decomposing socioeconomic inequalities in ANC4+ between- and within-socioeconomic groups over time in selected countries in sub-Saharan Africa.

	C^{t-1}	C^t	ΔC	ΔC_B	ΔC_W	$\left(\frac{\Delta C_B}{\Delta C}\right)\%$	$\left(\frac{\Delta C_W}{\Delta C}\right)\%$
Benin	0.160	0.174	**0.014** (0.007)**	**0.011 (0.007)**	**0.003** (0.002)**	77.6%	22.4%
Burundi	0.002	0.016	**0.015 (0.014)**	**0.015 (0.014)**	**0.000 (0.003)**	100.7%	−0.7%
Cameroon	0.172	0.171	−0.001 (0.009)	−0.003 (0.009)	**0.002 (0.002)**	288.9%	−188.9%
Chad	0.418	0.154	−0.263*** (0.026)	−0.240*** (0.026)	−0.023*** (0.006)	91.2%	8.8%
Ethiopia	0.459	0.222	−0.237*** (0.025)	−0.202*** (0.025)	−0.036*** (0.006)	84.9%	15.1%
Ghana	0.105	0.050	−0.055*** (0.007)	−0.053*** (0.007)	−0.002 (0.002)	96.9%	3.1%
Kenya	0.113	0.115	**0.002 (0.011)**	**0.005 (0.011)**	−0.003 (0.002)	217.4%	−117.4%
Lesotho	0.075	0.058	−0.017* (0.010)	−0.016 (0.010)	−0.001 (0.002)	92.3%	7.7%
Liberia	0.093	0.019	−0.074*** (0.008)	−0.071*** (0.008)	−0.003 (0.002)	96.2%	3.6%
Malawi	0.057	0.041	−0.016* (0.009)	−0.015* (0.009)	−0.001 (0.002)	96.8%	3.2%
Mali	0.204	0.222	**0.019 (0.014)**	**0.023* (0.014)**	−0.004 (0.004)	121.3%	−21.8%
Nigeria	0.326	0.213	−0.114*** (0.006)	−0.112*** (0.006)	−0.001 (0.001)	98.8%	1.1%
Rwanda	0.038	0.080	**0.042*** (0.013)**	**0.042*** (0.013)**	**0.000 (0.003)**	100.5%	−0.5%
Sierra Leone	0.071	−0.001	−0.072*** (0.008)	−0.066*** (0.008)	−0.006*** (0.002)	92.1%	7.9%
Tanzania	0.069	0.121	**0.051*** (0.011)**	**0.052*** (0.010)**	−0.001 (0.002)	101.6%	−1.6%
The Gambia	0.017	0.005	−0.012* (0.007)	−0.013* (0.007)	**0.001 (0.002)**	105.9%	−5.9%
Uganda	0.075	0.046	−0.029*** (0.011)	−0.025** (0.010)	−0.004* (0.002)	86.2%	13.8%
Zambia	0.013	−0.008	−0.020** (0.010)	−0.022** (0.010)	**0.002 (0.002)**	108.3%	−8.3%
Zimbabwe	0.043	0.031	−0.012 (0.009)	−0.014 (0.008)	**0.002 (0.002)**	117.1%	−17.1%

Notes: Superscript t represents the most recent survey period, while superscript $t-1$ stands for the earlier survey period. For example, C^t is the concentration index for the most recent time period.
ANC4+ is the indicator of at least four antenatal care visits.
C_B and C_W represent inequality between and within socioeconomic groups, respectively.
$\Delta C = C^t - C^{t-1}\Delta C_B = C_B^t - C_B^{t-1}\Delta C_W = C_W^t - C_W^{t-1}$
For ΔC, ΔC_B and ΔC_W, the bold entries represent pro-rich shifts, while the unbolded entries are pro-poor shifts.
Bootstrapped standard errors in parentheses.
*, **, *** statistically significant at the 10%, 5% and 1% levels, respectively.

Table 4
Decomposing socioeconomic inequalities in ANC intensity between- and within-socioeconomic groups over time in selected countries in sub-Saharan Africa.

	C^{t-1}	C^t	ΔC	ΔC_B	ΔC_W	$\left(\frac{\Delta C_B}{\Delta C}\right)\%$	$\left(\frac{\Delta C_W}{\Delta C}\right)\%$
Benin	0.157	0.153	−0.004 (0.005)	−0.006 (0.005)	**0.002 (0.001)**	150.0%	−47.4%
Burundi	0.010	0.011	**0.001 (0.004)**	**0.001 (0.004)**	**0.000 (0.001)**	116.7%	−16.7%
Cameroon	0.174	0.162	−0.013* (0.007)	−0.013* (0.007)	**0.001 (0.001)**	105.6%	−5.6%
Chad	0.353	0.101	−0.252*** (0.015)	−0.235*** (0.016)	−0.017*** (0.004)	93.3%	6.7%
Ethiopia	0.409	0.182	−0.227*** (0.017)	−0.199*** (0.017)	−0.028*** (0.004)	87.8%	12.2%
Ghana	0.149	0.091	−0.058*** (0.008)	−0.053*** (0.008)	−0.004** (0.002)	92.7%	7.3%
Kenya	0.093	0.085	−0.008 (0.008)	−0.006 (0.008)	−0.002 (0.002)	72.0%	28.0%
Lesotho	0.095	0.074	−0.022** (0.011)	−0.021** (0.010)	**0.000 (0.002)**	98.1%	1.9%
Liberia	0.068	0.024	−0.043*** (0.010)	−0.041*** (0.010)	−0.002 (0.002)	95.6%	4.4%
Malawi	0.041	0.019	−0.022*** (0.005)	−0.020*** (0.005)	−0.002 (0.001)	93.1%	6.9%
Mali	0.162	0.166	**0.003 (0.009)**	**0.007 (0.009)**	−0.004* (0.002)	218.8%	−115.6%
Nigeria	0.386	0.264	−0.122*** (0.006)	−0.121*** (0.006)	−0.001 (0.001)	99.6%	0.5%
Rwanda	0.016	0.036	**0.020*** (0.004)**	**0.019*** (0.004)**	**0.001 (0.001)**	94.9%	4.6%
Sierra Leone	0.129	0.006	−0.123*** (0.009)	−0.113*** (0.009)	−0.010*** (0.002)	91.7%	8.3%
Tanzania	0.063	0.059	−0.004 (0.006)	−0.002 (0.006)	−0.002* (0.001)	51.2%	48.8%
The Gambia	0.017	0.006	−0.011** (0.005)	−0.010** (0.005)	−0.001 (0.001)	93.3%	7.6%
Uganda	0.054	0.039	−0.015** (0.006)	−0.012** (0.006)	−0.003** (0.001)	80.8%	18.5%
Zambia	0.027	0.003	−0.023*** (0.006)	−0.022*** (0.005)	−0.001 (0.001)	94.0%	6.0%
Zimbabwe	0.066	0.055	−0.011 (0.007)	−0.012* (0.007)	**0.001 (0.002)**	104.4%	−4.4%

Notes: Superscript t represents the most recent survey period, while superscript $t-1$ stands for the earlier survey period. For example, C^t is the concentration index for the most recent time period.
ANC means antenatal care.
C_B and C_W represent inequality between and within socioeconomic groups, respectively.
$\Delta C = C^t - C^{t-1}\Delta C_B = C_B^t - C_B^{t-1}\Delta C_W = C_W^t - C_W^{t-1}$
For ΔC, ΔC_B and ΔC_W, the bold entries represent pro-rich shifts, while the unbolded entries are pro-poor shifts.
Bootstrapped standard errors in parentheses.
*, **,*** statistically significant at the 10%, 5% and 1% levels, respectively.

adopted in countries because it is challenging to categorise women utilising health services into quintiles used in this paper. In South Africa, for instance, the Uniform Patient Fee Schedule (UPFS) (Matsoso & Fryatt, 2012) used to categorise public health service users for different levels of fee waivers could potentially help prioritise selected groups even though maternal health services are free at public primary health

care facilities in the country since 1996. Prioritising specific groups may help address existing access barriers beyond the availability of free services. Because the cost of transportation emerged as a significant barrier to accessing free health services in South Africa (Cleary et al., 2013), service users in the fully subsidised UPFS category could be refunded the cost of transportation or provided with services directly at their places of residence as means to reduce transport cost, among other barriers significantly. In Rwanda, socioeconomic groupings are also identified through the Ubudehe categorisation system (i.e., a wealth categorisation system) (Sabates-Wheeler et al., 2015). The Ubudehe categorisation system is used in Rwanda's health system to graduate insurance premiums and to fully subsidize premiums for those from poorer socioeconomic backgrounds. Although this may not be a perfect system for categorising households and families, it makes it easier to prioritise women from low socioeconomic backgrounds to increase ANC their service utilisation to reduce disparities in ANC coverage between socioeconomic groups. As in the case of South Africa, identifying the barriers to accessing ANC services in the country should inform country specific policies to address them. Ghana used means testing and, recently, eligibility for the Livelihood Empowerment Against Poverty (LEAP) programme to identify indigents for the National Health Insurance Scheme (NHIS) premium exemption (Akweongo et al., 2022). The LEAP programme could also identify women from poorer backgrounds to prioritise for ANC services to achieve pro-poor socioeconomic inequalities in ANC service coverage in Ghana.

The issue of access to quality ANC services, which is distinct from the utilisation of ANC services, although not directly analysed in this paper, remains critical for reducing the pro-rich inequalities in ANC service utilisation (Ansu-Mensah et al., 2020; Arroyave et al., 2021; Ataguba, 2018). This is mainly because wealthier households tend to have access to better quality health services than households from poorer backgrounds, what has often been termed the inverse care law (Hart, 1971). Thus, reducing socioeconomic inequalities between groups should be about increasing the number of ANC visits or contacts among disadvantaged groups and improving the quality and content of ANC service utilisation, especially among women from poorer households. An important country case study in SSA is Sierra Leone, where about 90% of women attended at least 4 ANC visits. Still, maternal health statistics remain poor, mainly due to poor quality services at health facilities (Koroma et al., 2017). So, access to quality health services remains an important consideration beyond ANC attendance or utilisation. Apart from the unavailability of quality services, many women, especially those from less wealthy backgrounds, face significant barriers to accessing health services, including the freely provided ANC services in many countries. Such barriers include paying for certain accompanying services that are not included in the "free" package, like drugs and ultrasound scans in Ghana (Dalinjong et al., 2018), the cost of transportation, long wait times, and incompatibility of facility hours with women's availability, among others (Cleary et al., 2013; Masiye et al., 2020; McIntyre et al., 2009; Tibebe et al., 2012). While not directly assessed in the paper, addressing these barriers to service utilisation is fundamental to improving access to ANC services, which can reduce between- and within-socioeconomic group inequalities.

As the end of the SDG timeframe approaches, it is critical to ascertain the success of policies to close health gaps between the rich and poor to leave no one behind, as enshrined in the SDGs, specifically SDG #3, focusing on maternal and child health (United Nations Development Programme, 2015). We argue that because policies needed to address between- and within-socioeconomic group inequalities may differ, the novel framework for characterising intertemporal socioeconomic inequalities (Table 1) developed and applied in this paper provides a valuable way to assess whether to prioritise between- or within-socioeconomic groups in implementing appropriate policies to reduce health inequalities and achieve health equity.

A critical strength of this paper's analysis is the use of the DHS datasets for 19 countries, given the similarities in how the data are collected. The same variables were used to measure living standards. A limitation of this paper is that intertemporal differences in socioeconomic inequalities, ΔC, for instance, are assumed to be monotonic between periods. For example, as shown in Table 3, the decline in the concentration index for ANC4+ in Ethiopia between 2005 and 2016 ($C^{t-1} = 0.459$; $C^{t} = 0.222$) was assumed to occur continuously between the time periods. While this may be so in many cases, it could be complex for others. However, the pattern of the results in many instances where countries have made significant progress (Table 2) may indicate the likelihood of monotonicity. This paper implements the between- and within-group decomposition using quantiles of socioeconomic status, but these components may be sensitive to the choice of the number of quantiles. However, the results are qualitatively similar for conventional quantiles, including tertiles, quartiles, and deciles. Another limitation is that the paper uses DHS data for different years because there was no common base or end year. Unfortunately, this was not easy to control as different countries have their DHS survey cycles. However, choosing two data points with about ten years intervals made it possible to capture reasonable changes as we considered this to be sufficiently long. Importantly, country-specific analysis is suggested to assess the impact of any policy change between time periods. For example, the results for Rwanda, where ANC coverage increased, benefiting the rich more, present a case that needs a specific country case study as countries are heterogeneous. Relatedly, a critical ingredient for policy addressing socioeconomic inequality in ANC service coverage, especially in the context of free maternal services in many countries in Africa, is understanding the underlying access barriers. Because this was beyond the scope of this paper, it was challenging to provide specific country policy options without understanding these access barriers. The content and quality of ANC service utilisation are critical beyond the count of visits (Arroyave et al., 2021; Ataguba, 2018). The importance of addressing the challenge of socioeconomic inequality and the quality of health services to achieve equitable access is highlighted in the paper. However, because of the paucity of data on the content and quality of ANC services in the DHS, only the count of ANC visits available in the DHS across countries is used. However, it is critical to note that the generalised framework developed in this paper is still useful to assess and decompose changes in socioeconomic inequalities in quality health service coverage over time, including quality ANC utilisation, into changes in between- and within-socioeconomic groups where sufficient data exist.

6. Conclusion

Socioeconomic inequalities exist in using ANC services in SSA as women from poorer households attend fewer ANC visits than their wealthier counterparts. While many countries in SSA have significantly reduced socioeconomic inequalities in ANC service utilisation over time, these achievements have yet to translate into pro-poor service utilisation. Like most health services, the need for ANC service utilisation is higher among women from poorer socioeconomic backgrounds than women from wealthier households. Unfortunately, ANC service utilisation continues to leave many women from low socioeconomic backgrounds out of the system. This paper applying a novel framework to decompose socioeconomic inequalities in ANC utilisation into changes in between- and within-group socioeconomic inequalities has shown that focusing on reducing between-socioeconomic groups inequalities is critical to mitigate overall inequalities and close the gap between the rich and the poor, a crucial objective for the SDGs. Researchers can use this paper's framework for assessing the progressive realisation of service coverage to identify whether changes in between- or within-group socioeconomic inequalities are more critical and for appropriate policies to address them.

Ethics approval and consent to participate

The study used data freely available at http://www.dhsprogram.com and does not contain any personally identifiable information.

Consent for publication

Not applicable.

Availability of data and materials

Data are available at http://www.dhsprogram.com.

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Authors' contributions

JEA: conceptualization, analysis, drafting the manuscript; CON: data curating, analysis, drafting manuscript. AGO: data curating, analysis, drafting manuscript. All authors read and approved the final manuscript.

Declaration of interest statement

The authors have no conflicts of interest to declare.

Data availability

Data are available at http://www.dhsprogram.com

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