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Delay in timing of first antenatal care utilisation among women of reproductive age in sub-Saharan Africa: a multilevel mixed effect analysis

Million Phiri[1,2*], Jason Mwanza[3], Angel Mwiche[4], Musonda Lemba[1] and Jacob R. S. Malungo[1]

Abstract

Background Several studies in sub-Saharan Africa and elsewhere have affirmed the importance of community-level factors in influencing maternal health seeking behaviour. However, literature shows no uniform pattern in terms of how contextual-level factors influence delay in seeking antenatal care service in different parts of the region. The association of contextual factors and timing of antenatal care is not well documented at regional level. Thus, this study was conducted to examine how community-level characteristics influence decision not to initiate antenatal care in the first trimester. Regional-level analyses of antenatal care utilisation in sub-Saharan Africa are important because they help identify geographic disparities in access and utilisation of the service. Thus, allowing for targeted interventions to improve maternal health outcomes.

Methods Data from the most recent Demographic and Health Surveys conducted between January 2010 and December 2021 were used in this study. A sample of 222,436 women aged 15–49 who gave birth in the last five years preceding each of the 33 country surveys in the region was used in the analysis. The association between individual and contextual-level factors and timing of antenatal care was assessed using multilevel binary logistic regression models. Stata software version 17 was used to perform statistical analysis taking into account the complex survey design. Multivariable results were presented using adjusted odds ratios at 95% confidence interval.

Results The prevalence of delay in utilisation of first antenatal care service in sub-Saharan Africa was 61.1% [95% CI, 60.6, 61.5]. Mozambique had the highest prevalence of 85.5% [95% CI, [84.2, 86.7] while Liberia had the lowest prevalence at 27.8% [95% CI, [25.6, 30.1]. Women in the age groups 25–34 [aOR = 0.79, 95%CI = 0.76–0.82] or 35–49 [aOR = 0.66, 95%CI = 0.63–0.69], those with secondary or tertiary education [aOR = 0.97, 95%CI = 0.93–1.01] and [aOR = 0.71, 95%CI = 0.66–0.77], belonging to rich households [aOR = 0.91, 95%CI = 0.88–0.95], and those who experienced a pregnancy loss [aOR = 0.84, 95%CI = 0.81–0.87] were less likely to delay first ANC utilisation. Conversely, women living in rural areas [aOR = 1.18, 95%CI = 1.13–1.23], communities with a high proportion of women who experienced unwanted births [aOR = 1.08, 95%CI = 1.02–1.14] were more likely to delay first antenatal care visit.

Conclusion Both individual and community-level factors influenced women's delay in seeking antenatal care service in sub-Saharan Africa. Integrating community level factors when designing maternal health promotion interventions would be key to improve early utilisation of antenatal care services. There is need to strengthen maternal health

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promotion initiatives such as Community Health Worker Outreach, Mobile Messaging Campaigns, Male Involvement Initiatives and, School and Youth Friendly Health Programmes targeting women in marginalised communities such as rural settings.

Keywords Women of reproductive age, Antenatal care, Reproductive health, Multilevel analysis, Sub-Saharan Africa

Introduction

A reduction in maternal and newborn deaths is strongly associated with antenatal care (ANC) utilisation, which is generally acknowledged to be one of the most significant drivers of pregnancy outcomes [5, 48, 55]. Even though ANC services are offered in public health facilities for free, access to these services is frequently difficult in underdeveloped countries. Even in those countries where services are available, the prevalence of women who present themselves early during first ANC is still low [9, 12]. According to previous studies, among other factors that contribute to delayed uptake of ANC include the education level of a woman and her partner, their marital status, their household's financial situation, their employment status, parity, and cultural norms and beliefs surrounding pregnancy care [13, 44, 48, 50].

Studies also show that a number of these determinants differ according to the socioeconomic and cultural setting of the regions and countries [3, 13, 34, 35, 44, 55]. As a result, it is appropriate that research which is context-specific is conducted to inform design of interventions to address the problem.

Lack or delay in accessing prenatal care has been linked to an increased risk of maternal morbidity and mortality by several studies [1, 58, 59]. This has a bearing on the general health of the women, especially during their reproductive period. Since insufficient ANC is linked to lower pregnancy outcomes. It is crucial for health officials to understand the variables affecting appropriate and prompt ANC utilisation. The World Health Organization (WHO) advises that pregnant women have their first contact within the first 12 weeks of gestation, followed by contacts at 20, 26, 30, 34, 36, 38, and 40 weeks [59].

The World Health Organization (WHO) proposed, the newly focused antenatal care (FANC) which requires that a pregnant women should make eight ANC visits [59]. Ideally, women should initiate the first ANC visit in the first trimester but not after 16 weeks of gestation [1, 59]. Early first ANC visit allows health care providers to counsel pregnant women to deliver in the health facility [59] and to treat pregnancy-related complications for better maternal and neonatal health outcome [6, 8]. Furthermore, delay in initiating first ANC among pregnant women can lead to late treatment of maternal mortality risk factors such as malaria and low hemoglobin concentration [29].

Previous studies conducted in different parts of sub-Saharan Africa (SSA) have revealed that various factors such as place of residence, education of mother, parity, employment status, distance to health facility, experience of unplanned pregnancy and exposure to radio and television are associated with timing of ANC service utilisation [3, 40, 43]. However, there is no evidence of studies conducted at regional level to examine the influence of both individual and contextual-level factors on delay of first ANC among women of childbearing age. This is a critical research gap because without regional-level analyses, policymakers may overlook important contextual barriers and inequalities, thus limiting the effectiveness of interventions aimed at improving timely antenatal care access. Examining both individual and contextual-level factors at the regional level is essential to understand how community, health system, and socioeconomic conditions influence delays in the first antenatal care visit among women of childbearing age. This approach can help design more effective, region-specific interventions that address structural barriers and improve timely access to maternal healthcare. Therefore, study sought to examine the drivers of delayed first ANC utilisation across 33 countries in SSA. The findings of this study could are useful to health policy makers to implement interventions aimed at improving early utilisation of ANC services in the region.

Theoretical framework

Theoretically, early ANC utilisation can be understood within the theoretical underpinnings of the Three Delay Model. The Three Delay Model contributes valuable insights to understanding the complex factors that explain early ANC utilisation among women of reproductive age. The Three Delay Model was initially proposed by Serene Thaddeus and Deborah Maine in 1994. This theory identifies three important phases that can affect a woman's access to care. The three phases include: delay in decision to seek care, delay in identifying and reaching the health facility, and delay in receiving appropriate treatment at the facility [37, 56]. The factors in these phases include: socio-economic status of the woman, knowledge of pregnancy danger signs and

previous experience with the health system (first phase); distance and availability and means of transport (second phase) and; inadequate facilities, medical supplies and shortage of trained healthcare providers (phase three) [37, 42, 56]. The Three Delay Model remains valuable in understanding maternal health care in low and middle-income countries (LMICs), including maternal health-care-seeking behaviours which have a significant impact on reducing maternal and child mortality [7]. The model highlights that the socioeconomic factors (education/knowledge and transport costs), accessibility of facilities (distance) and quality of care factors (facility conditions) are key in influencing early ANC visits among women of reproductive age [37, 42, 45]. Women who have low levels of education and low socioeconomic opportunities may be more likely to experience low levels of early ANC visits [7, 42].

Furthermore, distance to health facilities, particularly in rural areas may present women with less access to ANC services, which poses a risk to maternal and child health. Employment status may also limit women's decision-making power to make informed choice about their health, hence contributing to low levels of early ANC visits [7]. Based on the theoretical model used in this study, it is expected that women who belong to vulnerable groups such as those with low levels of education, reside in rural areas, the poorest, have long distance to healthcare facilities and those with poor or no previous experience with health facilities are more likely to have low levels of early ANC visits [37, 42, 45]. Therefore, identification of the risk factors linked to experience of low early ANC visits and understanding of the model through which these factors operate, as well identifying which groups of women are at risk of experiencing low early ANC visits in SSA countries, is critical. This information is crucial for designing reproductive interventions aimed at promoting maternal healthcare utilisation among women of reproductive age in the region.

Methods and data

Data source

Data used in this study was obtained from the most recent DHS's conducted between January, 1st 2010 and 31st December 2021 across 33 countries in SSA. The DHS program was designed to collect and provide data on various demographic and health related indicators such as fertility, contraceptive use, maternal health, child health and maternal mortality in low and middle income countries [19]. The details of the methodology employed in the DHS are documented elsewhere [16]. In this study, only women who ever gave birth in the past five years preceding the country most recent DHS and had information on the use of ANC service, were considered in the analysis ($N = 222,436$). Table 1 provides a complete description of the countries, survey years, total women interviewed, and the country sample size used in this study. The datasets for each

Table 1 Description of the countries survey years and samples used in the study (N = 222,436)

Country	Survey year	Women interviewed	Sample (N)	Region
Angola	2015	14,379	6,965	Southern Africa
Benin	2015	15,928	7,795	West Africa
Burkina Faso	2010	17,087	9,885	West Africa
Burundi	2016–17	17,269	8,569	East Africa
Cameroon	2018	14,677	5,602	West Africa
Chad	2014–15	17,719	6,503	Central Africa
Comoros	2012	5329	1,820	East Africa
Congo	2011–12	10,819	5,830	Central Africa
Congo Democratic Republic	2013–14	18,827	9,823	Central Africa
Cote d'Ivoire	2011–12	10,060	4,903	West Africa
Ethiopia	2016	15,683	4,680	East Africa
Gabon	2012	8422	3,786	Central Africa
Gambia	2019	11,865	5,734	West Africa
Ghana	2014	9396	4,161	West Africa
Guinea	2018	10,874	4,680	West Africa
Kenya	2014	31,079	13,976	East Africa
Liberia	2019–20	8965	4,132	West Africa
Madagascar	2021	18,869	8,213	Southern Africa
Malawi	2015–16	24,562	13,183	Southern Africa
Mali	2018	10,519	4,850	West Africa
Mauritania	2019–20	15,714	6,548	West Africa
Mozambique	2011	13,745	7,033	Southern Africa
Namibia	2013	10,018	3,777	Southern Africa
Nigeria	2018	41,821	16,385	West Africa
Rwanda	2019–20	14,634	6,023	East Africa
Senegal	2019	8649	4,083	West Africa
Sierra Leone	2019	15,574	7,245	West Africa
South Africa	2016	8614	2,833	Southern Africa
Tanzania	2015–16	13,266	6,913	East Africa
Togo	2013–14	9480	4,645	West Africa
Uganda	2016	18,506	10,042	East Africa
Zambia	2018	13,683	7,268	Southern Africa
Zimbabwe	2015	9955	4,551	Southern Africa

country's DHS used in this study are available at http://dhsprogram.com/data/.

Study measures

Outcome variable

The outcome variable for this study was timing of first ANC utilisation. All eligible women were asked a question "How many months pregnant were you when you first received ANC for the last pregnancy?" The outcome variable in the DHS was classified using numeric responses ranging from one month to nine months. The description of the number of antennal care visits attended by each women is described in detail in DHS guide to statistics [16]. A binary outcome was then created from this initial variable with the classification "0" representing utilising ANC in the first 3 months "first trimester" and "1" representing women who initiated ANC between 4 and 9 months "second or third trimester".

Independent correlates

Based on exiting literature [5, 6, 11, 35, 47], the following explanatory variables were selected: age of a woman,education level; household wealth status; place of residence; employment status; marital status; parity; distance to health facility; experience of pregnancy loss; experience of unplanned birth; exposure to media family planning messages; exposure of radio/television; and exposure to reading newspaper. These variables were categorised at individual and contextual-levels.

Individual-level factors

Individual level factors included age categorized as (15–24 years, 25–34 years and 35–49 years); education level (no education, primary, secondary and tertiary); household wealth status (poor, moderate, rich); employment status (working, not working); parity (one, two–three, four–five, six or more); marital status (never married, married, formerly married); distance to health facility (a big problem, not a big problem); experienced pregnancy loss (yes/no); experienced unplanned birth (yes/no); exposure to radio/television (yes/no); exposure to reading newspaper (yes/no); and exposure to mass-media FP messages (no, yes).

Community-level factors

Community-level variables are contextual factors that capture shared characteristics of a population within a defined geographic area, such as healthcare accessibility or socioeconomic conditions [15, 39]. Community-level variables are crucial for understanding individual-level outcomes in social science research. In this study the community level variables were chosen based on their significance in influencing maternal health outcomes as documented in previous research [5, 12, 48]. Using DHS data, the aggregation of socioeconomic characteristics (education, wealth status), reproductive factor (unwanted birth), access factor (exposure to radio/television) and geographic (distance to health facility) from individual-level to contextual-level was done to study variables at the community level. The DHS uses the primary sampling unit (i.e., cluster) to define a community. The proportion of women inside the cluster was determined by their residence, wealth status, women's education, distance to health facility, experience of unwanted birth; and exposure to listening or watching television. Percentiles were categorised into three levels for simple interpretation (low, middle, and high). Contextual-level variables were categorised as place of residence (rural, urban); community wealth status (low, medium, high); community education (low, medium, high); community distance to health facility (low, medium, high); community experience of unwanted birth (low, medium, high); and community media exposure (low, medium, high). In this study media exposure was defined as the extent to which women were reached by information through television or radio. A composite variable was then generated by combining the two media access variables. Thus, the variable media exposure was constructed as a binary variable with (yes/no) response category.

Statistical analysis

Data analysis was done at three levels. Descriptive, bivariate, and multi-level logistic regression. All statistical analyses were performed using Stata version 17 software, with 5% level of significance. At descriptive level, percent distributions of outcome indicators were presented. At bivariate level, cross-tabulations with chi-square tests were used to analyse the association between delayed first ANC utilisation and the selected independent variables. To assess the effects of several individual and community level factors on delay in first ANC utilisation in SSA, a two-level multi-level binary logistic regression model was applied on pooled data for all the 33 countries included in the study. A sample weight equalisation process was performed to give equal weight to each survey, such that if one survey had a large sample, it did not predominate the pooled results.

The use of a multilevel modelling technique was acceptable for this investigation since it was able to account for the DHS data's hierarchical structure. Individuals are nested in households (level 2), while households are layered in communities (level 3) [24, 27]. As a result, members of the same group are more likely to exhibit similar behaviours [39], such as delay in first ANC utilisation. Researchers can also use multilevel modelling to see how much variance in the outcome variable, which

in this case is delayed first ANC utilisation, is explained by factors at each level [20].

Adjusted odds ratios (aOR) with corresponding 95% confidence intervals (CI) were reported in the presentation of results. Four multilevel logistic models were estimated. Model 0 only included the intercept and the outcome variable. Model 1 included the individual level variables and model 2 included only community level variables, while Model 3 had both the individual and community level variables. In the multivariable logistic regression analysis, only covariates from the bivariate analyses with a significance level of 0.4 were considered. The multilevel model assesses the probability p_{ij} of a woman or women i in a community j having delayed first ANC. This analysis is represented as [36, 38]:

$$logit(p_{ij}) = \beta_0 + \beta X_{ij} + uj + \upsilon$$

where X_{ij} is a vector of independent variables at individual and community levels and uj is normally distributed with variance σ_u^2; υ is normally distributed with varianceσ_u^2. [20, 39]

In terms of variances used to understand the variations of relationships between communities and the relative effect of community-level variables, the intraclass correlation coefficient (ICC) was used. The ICC provides information on the share of variance at each level. The latent method was used to calculate the ICC at each level. It assumes a threshold model, approximating the level 1 variance by $\pi^2/3(\approx 3.29)$ [38]. The community level variance is calculated as follows [20, 39]:

$$ICC_{Community} = \frac{\sigma_u^2}{\sigma_u^2 + \pi^2/3}$$

To explain the heterogeneity in the probabilities of delayed first ANC utilisation, the Proportional Change in Variance (PCV) was computed for each model in comparison to the empty model [20, 24, 39]. The PCV provided information on the share of variance at each level. The PVC is calculated as follows [39];

$$PCV = \frac{\sigma^2_{u[Model\ 2]} - \sigma^2_{u[Model\ 3]}}{\sigma^2_{u[Model\ 2]}}$$

The model with the lower Aikake Information Criteria (AIC) was considered to be a better fit for the data. This was used to determine the models' goodness of fit. The AIC values were used to compare models and measure the goodness of fit for each model [24, 39]. To assess multicollinearity among independent factors, the variance inflation factor (VIF) was used. There were no concerns with multicollinearity in any of the variables (all VIF < 5) (Supplementary file: Table 1).

Ethical approval

The data analysed in this study is available in the public domain at (https://dhsprogram.com/) Permission to the data was obtained from the DHS program. The original DHS Biomarker and survey protocols for each DHS were approved by each country's Ethics Review Body and the Research Ethics Review Board of the Centers for Disease Control and Prevention (CDC) Atlanta. All data used in this study did not contain any personal identifying information.

Results

Description of sample characteristics

The background characteristics of the study sample are summarized in Table 2. Forty-six percent of the study sample were in the age range 25–34 years while 30 percent were within 15–24 years old. Most (36 percent) of the respondents in the study sample had primary school education while only 4 percent had attained tertiary level education. About 40 percent and 20 percent of them were from rich and middle households, respectively. The majority (84 percent) of the respondents were married or living with a partner and (8.1 percent) were never married. The study sample was also made up of majority (71.4 percent) women who were in employment. The largest proportion (36 percent) of the study sample had two or three children at the time of the survey and more than half (63.5%) of them were living in rural areas. Majority of women were not exposed to mass-media family planning messages (60.1 percent).

Prevalence of delay in first ANC utilisation among women of reproductive age

The prevalence of delay in timing of utilising ANC among women of childbearing age in SSA is presented in Fig. 1. The overall prevalence of delay in accessing ANC for the 33 SSA countries was 61.0% (95% CI: 60.6, 61.5). In terms of country-based analysis Mozambique had the highest prevalence of delay in accessing first ANC at 85.5% (95% CI: 84.2, 86.7) while Liberia had the lowest prevalence at 27.8% (95% CI: 25.6, 30.1).

Distribution of first ANC timing among women of reproductive age

Table 3 shows the distribution of results of timing of ANC utilisation across different individual and contextual-level factors. With regard to the individual-level factors, the highest prevalence of delay in utilisation of first ANC was found among young women aged 15–24 (62.8%), those with primary education (65.1%), or no education (62.6%), working women (60.8%), formerly married women (62.4%) and those from poor households (65.2%). Furthermore, high rates of delay in utilisation of first ANC

Table 2 Distribution of women (15–49 years) who ever gave birth in the last 5 years preceding DHS survey in sub-Saharan Africa countries

Background characteristics	(N = 222,436)	
	Number	Percent
Age		
15–24	67,086	30.2
25–34	102,122	46.0
35–49	53,031	23.9
Residence		
Urban	81,197	36.5
Rural	141,041	63.5
Education level		
None	69,433	31.2
Primary	79,746	35.9
Secondary	63,569	28.6
Higher	9,476	4.3
Wealth status		
Poor	88,477	39.8
Middle	45,017	20.3
Rich	88,744	39.9
Marital status		
Never married	18,056	8.1
Married	186,574	84.0
Formerly married	17,608	7.9
Employment status		
Not working	59,233	28.6
Working	148,109	71.4
Age at first birth		
Less than 15 years	11,308	5.1
15–19 years	117,347	52.8
20 + years	93,445	42.1
Children ever born		
One	49,497	22.3
Two–Three	79,992	36.0
Four-Five	49,683	22.4
Six or more	43,066	19.4
Media exposure to FP messages		
No	133,560	60.1
Yes	88,678	39.9

was found among women who were not exposed to radio or television (65.6%), those with no exposure to reading newspapers (62.4%) and those not exposed to media FP messages (63.3%) delayed in attendance their first ANC. Women with six or more births (66.5%), those who perceived distance to health facility as a big problem (63.3%), and those who experienced unplanned birth (64.0%) also had higher reports of delay in attending first ANC.

In terms of contextual-level factors, the highest prevalence of delay in attending first ANC was found among women in rural areas (64.5%), those in communities with low education (61.7%), those in communities with a high proportion of women who considered distance to health facility as a big problem (61.9%) and those in communities with high unwanted births (62.5%). The chi-square test of independence results revealed that apart from community wealth, all the independent correlates were statistically associated with timing of utilising first ANC service among women of childbearing age.

Determinants of delay in first ANC utilisation

The study found statistically significant associations between individual and community-level factors associated with delay in attendance of first ANC. Specifically, older women in the age groups 25–34 [aOR = 0.79, 95% CI = 0.76–0.82] and 35–49 years [aOR = 0.66, 95% CI = 0.63–0.69] were less likely to delay first ANC utilisation compared to young women aged 15–24 years (Table 3). Women with tertiary education [aOR = 0.71, 95% CI = 0.66–0.77] had lower odds of delaying first ANC attendance compared to those with no formal education (Table 4).

Results further show that women had ever given birth to 4 to 5 children [aOR = 1.43, 95% CI = 1.37–1.50] or those who ever gave birth to 6 or more children [aOR = 1.76, 95% CI = 1.67–1.86] had a higher likelihood of delaying first ANC utilisation compared to those ever gave birth to only 1 child. Women who experienced a pregnancy loss before [aOR = 0.84, 95% CI = 0.81–0.87] or those who were exposed to radio/television [aOR = 0.89, 95% CI = 0.86–0.91] had lower odds of delay in first ANC utilisation. Conversely, those who experienced an unplanned birth [aOR = 1.22, 95% CI = 1.19–1.26] were more likely to delay first ANC utilisation compared to their counterparts who had never experienced an unplanned birth.

Regarding to the influence of the community-level factors on delay in first ANC utilisation, the findings indicate that women who lived in rural areas [aOR = 1.18, 95% CI = 1.13–1.23] were more likely to start their first ANC late compared to their counterparts living in urban areas. Communities that had a high percentage of women who experienced unwanted births equally had higher odds aOR = 1.08, 95% CI = 1.02–1.14] of delay in first ANC utilisation compared to their defined counterparts. Surprisingly, women from communities that had high access to radio/television [aOR = 1.17, 95% CI = 1.09–1.25] were more likely to delay first ANC attendance (Table 4).

Table 4 also presents adjusted odds ratios (aOR) and random effects for modelling delay on first ANC utilisation using a two-level multilevel analysis. The effect of

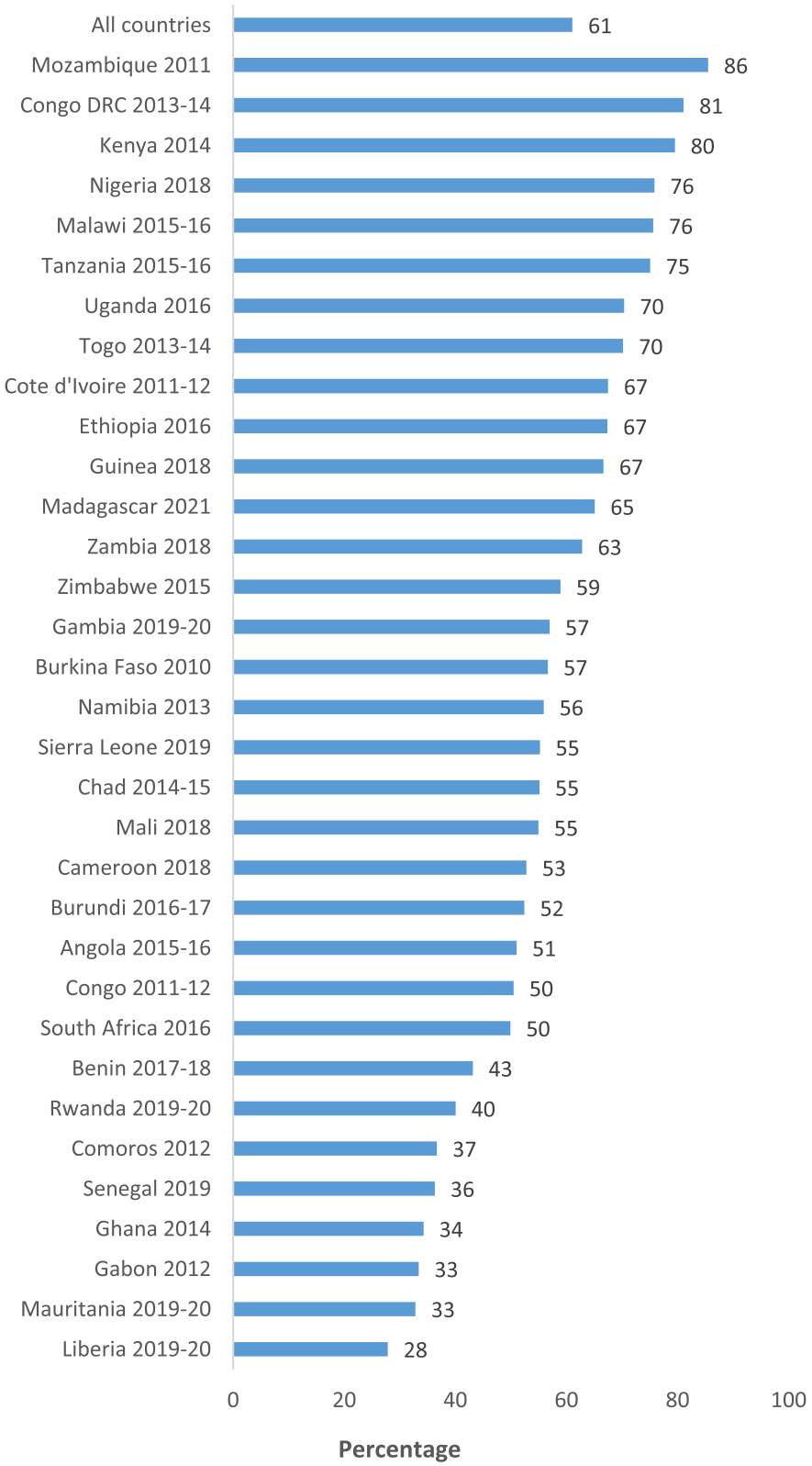


Fig. 1 Prevalence of delayed first ANC utilisation among women of childbearing age

Table 3 Percent distribution of women (15–49 years) by timing of antenatal care in sub-Saharan Africa, DHS (N = 222,436)

Background characteristics	Initiated ANC in the first trimester		Initiated ANC in the second or third trimester		*p*-value
	Number	Percent	Number	Percent	
Age					0.000***
15–24	24,944	37.2	42,142	62.8	
25–34	40,880	40.0	61,242	60.0	
35–49	20,686	39.0	32,345	61.0	
Education level					0.000***
None	25,986	37.4	43,447	62.6	
Primary	27,850	34.9	51,897	65.1	
Secondary	27,429	43.1	36,140	56.9	
Higher	5237	55.3	4239	44.7	
Marital status					0.002**
Never married	7235	40.1	10,821	59.9	
Married	72,652	38.9	113,922	61.1	
Formally married	6622	37.6	10,986	62.4	
Wealth status					0.000***
Poor	30,773	34.8	57,705	65.2	
Middle	16,438	36.5	28,579	63.4	
Rich	39,299	44.3	49,445	55.7	
Employment status					0.000***
Not working	24,925	42.1	34,309	57.9	
Working	58,065	39.2	90,044	60.8	
Age at first birth					0.000***
Less than 15 years	4086	36.1	7221	63.9	
15–19 years	42,168	35.9	75,179	64.1	
20 + years	40,186	43.0	53,259	57.0	
Children ever born					0.000***
One	20,859	42.1	28,639	57.9	
Two–Three	32,651	40.8	47,341	59.2	
Four–Five	18,590	37.4	31,093	62.6	
Six or more	14,410	33.5	28,657	66.5	
Distance to health facility					0.000***
A big problem	29,256	36.7	50,472	63.3	
Not a big problem	52,952	41.0	76,254	59.0	
Experienced pregnancy loss					0.000***
No	70,851	38.8	111,785	61.2	
Yes	14,210	43.9	18,169	56.1	
Experienced unplanned birth					0.000***
No	63,212	40.9	911,179	59.1	
Yes	21,827	36.0	38,751	64.0	
Exposure to radio/television					0.000***
No	25,113	34.4	47,951	65.6	
Yes	61,397	41.2	87,778	58.8	
Exposure to reading newspaper					0.000***
No	68,710	37.6	114,036	62.4	
Yes	17,743	45.1	21,627	54.9	
Exposure to media FP messages					0.000***
No	49,059	36.7	84,501	63.3	
Yes	37,451	42.2	51,278	57.8	

Table 3 (continued)

Background characteristics	Initiated ANC in the first trimester		Initiated ANC in the second or third trimester		*p*-value
	Number	Percent	Number	Percent	
Place of residence					0.000***
Urban	36,391	44.8	44,806	55.2	
Rural	50,119	35.5	90,923	64.5	
Community education					0.007*
Low	41,352	38.3	66,693	61.7	
Moderate	22,810	40.1	34,113	59.9	
High	22,348	39.0	34,923	61.0	
Community wealth status					0.361 ns
Low	41,695	38.8	65,855	61.2	
Moderate	22,735	39.5	34,847	60.5	
High	22,080	38.7	35,026	61.3	
Community distance problem to health facility					0.044*
Low	43,422	38.9	68,107	61.1	
Moderate	22,301	39.7	33,845	60.3	
High	20,784	38.1	33,776	61.9	
Community experience of unwanted births					0.002**
Low	43,532	39.3	67,151	60.7	
Moderate	22,175	39.5	33,947	60.5	
High	20,801	37.5	34,630	62.5	
Community exposure to media					0.000***
Low	41,555	38.4	66,716	61.6	
Moderate	23,078	40.7	33,611	59.3	
High	21,877	38.2	35,402	61.8	
Total	86,510	38.9	135,729	61.1	

***$p < 0.001$; **$p < 0.01$; *$p < 0.05$

individual and contextual-level variables on delay in first ANC utilisation were determined using four models. In the null model, the clustering of the primary sampling units (PSUs) accounted for substantial variations in the odds of using modern ANC utilisation ($\sigma 2 = 0.15$, 95% CI 0.13–0.17). Model 0 showed that 4.4% of the total variation in delay in first ANC utilisation was attributed to the variance between clusters (ICC = 0.044). The between-cluster variance showed a decrease from 4.4% to 3.2% from Model 0 to Model 1 (individual level factors only). The ICC further reduced to 3.7% in Model I to 2.9% in the full model (Model III), where all the independent correlates and community-level factors were considered. This indicates that differences in the clustering of the communities (primary sampling units) accounted for the variations in delay of first ANC utilisation among women of childbearing age in SSA.

Additionally, 33.3% of the variance in the odds of delay in first ANC attendance across communities were explained by both individual and community-level factors, as indicated by the PCV. Furthermore, the median odds ratio (MOR) reduced from 1.45 (Model 0) to 1.35 (Model III), signifying significant difference between communities in the delay in first ANC utilisation. This suggests that the full model still had some unexplained community variability. Finally, Model III of the data analysis was considered as model of best fit. (Log-likelihood = − 3983.7 and AIC = 8045.4).

Discussion

This study sought to analyse the influence of individual and community-level factors that explain the delay in first ANC utilisation among women of childbearing age in SSA. The study applied a two-level multilevel logistic regression models on the most recent Demographic and Health Survey data of 33 countries in SSA. Disparities in delay of first ANC utilisation have been observed across different socio-economic and demographic strata. Thus, a comprehensive understanding of these factors has significant implication on strengthening maternal health promotion policies and programmes aimed at improving maternal health in the region.

Table 4 Mixed effects results of individual and contextual factors associated with delay in first antenatal care utilisation among women aged (15–49) in sub-Saharan African countries

Delay in ANC utilisation				
Variables	**Model 0**	**Model I**	**Model II**	**Model III**
		AOR (95%CI)	**AOR (95%CI)**	**AOR (95%CI)**
Individual factors				
Age				
15–24		1		1
25–34		0.82*** [0.79, 0.85]		0.79*** [0.76, 0.82]
35–49		0.70*** [0.67, 0.74]		0.66*** [0.63, 0.69]
Education level				
None		1		1
Primary		1.13*** [1.09, 1.17]		1.13** [1.76, 0.82]
Secondary		0.95* [0.92, 1.17]		0.97* [0.93, 1.01]
Higher		0.71*** [0.66, 0.77]		0.71*** [0.66, 0.77]
Wealth status				
Poor		1		1
Middle		1.00 [0.97, 1.03]		1.02 [0.99, 1.05]
Rich		0.85*** [0.82, 0.88]		0.91*** [0.88, 0.95]
Employment status				
Not working		1		1
Working		1.11*** [1.08, 1.15]		1.10*** [1.06, 1.13]
Marital status				
Never married		1		1
Married		0.97 [0.92, 1.02]		0.95* [0.90, 0.99]
Formerly married		1.01 [0.95, 1.07]		1.10 [0.94, 1.06]
Children ever born				
One		1		1
Two–Three		1.15*** [1.11, 1.19]		1.18*** [1.13, 1.22]
Four–Five		1.38*** [1.32, 1.44]		1.43*** [1.37, 1.50]
Six or more		1.67*** [1.58, 1.77]		1.76*** [1.67, 1.86]
Distance to health facility				
A big problem		1		1
Not a big problem		0.92*** [0.89, 0.95]		0.93*** [0.90, 0.96]
Experienced pregnancy loss				
No		1		1
Yes		0.83*** [0.80, 0.86]		0.84*** [0.81, 0.87]
Experienced unplanned birth				
No		1		1
Yes		1.22*** [1.19, 1.25]		1.22*** [1.19, 1.26]
Exposure to radio/television				
No		1		1
Yes		0.88*** [0.85, 0.90]		089*** [0.86, 0.91]
Exposure to reading newspaper				
No		1		1
Yes		0.93*** [0.90, 0.97]		0.94** [0.90, 0.97]
Exposure to media FP messages				
No		1		1
Yes		0.97* [0.94, 1.00]		0.96** [0.93, 0.99]
Contextual factors				
Place of residence				

Table 4 (continued)

Delay in ANC utilisation				
Variables	**Model 0**	**Model I**	**Model II**	**Model III**
		AOR (95%CI)	**AOR (95%CI)**	**AOR (95%CI)**
Urban			1	1
Rural			1.49*** [1.43, 1.55]	1.18*** [1.13, 1.23]
Community education				
Low			1	1
Moderate			0.91** [0.87, 1.54]	0.94* [0.89, 0.99]
High			1.02 [0.96, 1.09]	1.04 [0.97, 1.11]
Community wealth status				
Low			1	1
Moderate			0.96 [0.91, 1.02]	1.01 [0.96, 1.06]
High			0.97 [0..90, 1.03]	1.03 [0.96, 1.10]
Community distance problem to health facility				
Low			1	1
Moderate			0.91*** [0.86, 0.96]	0.94* [0.89, 0.99]
High			0.99 [0.94, 1.06]	1.00 [0.95, 1.06]
Community experience of unwanted births				
Low			1	1
Moderate			098 [0.93, 0.04]	0.97 [0.92, 1.02]
High			1.14*** [1.08, 1.20]	1.08* [1.02, 1.14]
Community exposure to radio/television				
Low			1	1
Moderate			0.94* [0.89, 0.99]	0.95* [0.90, 0.99]
High			1.14*** [1.08, 1.20]	1.17*** [1.09, 1.25]
Random effects				
Variance (CI)	0.15 [0.13–0.17]	0.11 [0.09–0.14]	0.12 [0.10–0.15]	0.10 [0.08–0.12]
ICC (%)	4.4	3.2	3.7	2.9
VPC (%)	Ref	26.7	20.0	33.3
Wald chi-square	Ref	2055.52***	565.45***	2235.73***
MOR	1.45	1.37	1.40	1.35
Model fitness				
Log-likelihood	− 147,521.0	132,175.2	− 146,573.8	− 132,025.0
AIC	295,046.0	264,392.3	293,173.6	264,114.0
BIC	295,066.6	264,606.8	293,307.6	264,440.8
N	222,436	222,436	222,436	222,436

*** $p < 0.001$; ** $= p < 0.01$; * $= p < 0.05$; 1 = Reference Category; Model 0 contains no explanatory variables; Model I includes individual-level factors only; Model II includes community-level factors only; Model III includes both individual-level and community-level factors; aOR adjusted odds ratio, CI confidence internal, ICC intraclass correlation coefficient, PVC Proportional variance change, AIC Akaike information criterion, BIC Bayesian Information Criterion

Our study reveals that the overall proportion of women who delayed first ANC utilisation in SSA was 61.1%. The highest prevalence was recorded in Mozambique at 85.5% while Liberia had the lowest prevalence of 27.8%. These results of our study could be attributed to differentials in socioeconomic and cultural factors that influence acceptance and access to maternal health services in SSA [11, 25, 36]. Our study has established that individual factors (age of a women, level of education, wealth status, distance to health facility, experience of pregnancy loss, exposure to radio/television, exposure to reading newspaper and exposure to media FP messages) were associated with reduced probability of delay in first ANC utilisation. Community factors (rural residence, experience of unwanted births and exposure to radio or television were associated with increased chance of delay in first ANC utilisation in SSA.

The finding which showed that communities with higher access to media reported higher odds of delay in first ANC utilisation was not expected noting that

studies have shown that access to media is likely to improve maternal health care seeking behaviour [4, 28]. One possible explanation for why communities with higher access to media report higher odds of delay in first ANC utilization in the SSA region is the influence of conflicting health information which affect quality of messaging. While media can promote awareness of maternal health, it may also spread misinformation or prioritize other health concerns over early ANC visits. Further, there is a possibility that this issue could also be a limitation of the conceptual definition of a community based on the demographic and health survey design.

Early detection of underlying pregnancy problems is required for several of the critical ANC services. The initial ANC visit should occur as early in pregnancy as possible [57, 59]. The high prevalence of women who delay first ANC visit remains a public health and social concerns to achievement of sustainable development goals targets on improving maternal and child health in SSA. These results suggest urgent attention for strengthening access to health facilities especially for populations living in marginalised communities such as rural areas. Rural–urban variations could be explained by limited transportation options, especially in rural areas, make it difficult for women to reach healthcare facilities on time [18]. Weak healthcare infrastructure, including a shortage of trained providers and essential medical supplies, further discourages early visits. Additionally, cultural norms and gender dynamics often influence decision-making, with some women needing spousal or family approval before seeking care [18, 49]. Addressing these barriers is crucial for improving timely access to maternal health services in the region.

Furthermore, there is need to enhance a number of strategies like, promotion of media based-maternal health messages, community health outreach sensitisations and facility health talks in order to sensitise women on the benefits of early ANC utilisation. Many studies conducted in different parts of SSA, Ethiopia [21, 55], Nigeria [10, 52], Rwanda [49], Zambia [51], Burkina Faso [53], Kenya [40], Uganda [33] and the Democratic Republic of Congo [26] also reported that a high proportion of women initiated their first ANC in the second trimester. One explanation for this findings is that women who delay ANC utilisation could be lacking exposure to maternal health information relating to appropriate timing of ANC initiation [21].

In this analysis, there were significant differences in the proportions of women who delayed first ANC by level of education. Women with secondary or higher level of education in SSA were less likely to delay their initial ANC utilisation compared to those without formal education. The finding is in support of what was reported in earlier studies conducted in Congo DR [61], Zambia [14], Nigeria, [22], South Sudan [41] and Ethiopia [54] which also reported education as a predictor of maternal health seeking behaviour. The reason for our observed finding could be due to the fact that women who have moderate or higher level of education have better access to maternal health information [31, 32] which enhances their positive health decision making behaviour. This finding has a significant implication for strengthening education policies to enhance access to universal education for girls, especially in rural communities. Furthermore, our study found that women from rich households were less likely to initiate first ANC late. This suggests that implementing strategies that support economic empowerment of poor households has the potential to improve maternal health and child health in the region.

Another important finding of this study is that the number of the children ever born to a woman was associated with a higher chance of delaying first ANC attendance among women. Women who had high parity were more likely to initiate first ANC in the second or third trimester. This finding could suggest that increasing parity may be associated with higher risk of experiencing maternal health complications among women. This finding supports what has been reported by earlier studies about the significance of parity in determining utilisation of maternal health services [30]. The delay in first ANC utilisation among women with high parity could explained by lack of sufficient knowledge of the benefits of early maternal health seeking behaviour. Furthermore, the study by Jinga and colleagues [29] found that women with prior births pressured to know how to manage pregnancy care [29] hence did not see the importance of initiating ANC early. Additionally, women who experienced unplanned births were equally more likely to delay first ANC utilisation compared to their defined reference group. This could be attributed to a possibility that these women were less emotionally and financially prepared for the responsibilities of pregnancy and childbirth, in addition to the delay in identifying a pregnancy [2].

Studies have shown evidence that mass-media has the potential role to influence maternal health seeking behaviour by raising awareness about benefits of utilising maternal and general health services due its ability to reach a wider population coverage [4, 28, 46, 60]. This study confirms the conclusion of earlier studies. Our study found that exposure to listening to radio or watching television, reading of newspapers as well as being exposed to media FP messages was associated with less chance to delay first ANC initiation among women. This implies that access and exposure to mass-media has the potential to help women make informed sexual reproductive health decisions regarding early ANC utilisation.

Community and public radio, and television stations may be fostered to broadcast messages on importance early ANC.

The effects of community characteristics on delay in initiating first ANC among women of childbearing age have been well-documented at country level in parts of SSA but not at regional level [13, 14, 34, 44, 55]. Findings from the current analysis revealed rural areas had higher proportions of women who delayed in initiating their first ANC. The probable reason for this findings is due to the fact that access to health facilities is usually a challenge in rural settings. Furthermore, access to mass-media is also limited. Media exposure can reduce the likelihood of delays in ANC utilisation among women by increasing awareness about the importance of early antenatal care, addressing misconceptions, and promoting positive health-seeking behaviours. Additionally, targeted health campaigns can empower women with knowledge, influence social norms, and encourage supportive family and community attitudes toward early ANC visits [17, 23]. Future research should conduct a decomposition analysis to examine drivers of increasing trends in early utilisation of ANC among women in most SSA countries.

Communities with a high proportion of women who experienced unwanted births were more likely to delay initiating of first ANC and this finding relates to previous studies [2, 21, 29]. These results have a significant implication for improving family planning access and utilisation especially among marginalised populations. This could therefore, reduce the prevalence of delay in first ANC utilisation.

The study observed the association of both individual and contextual-level factors with delay of first ANC attendance among women in the reproductive age in SSA. This could suggest a need for contextually targeted maternal health interventions aimed at encouraging women to initiate ANC early. There were still unobserved or unmeasured community factors that could potentially influence maternal health seeking behaviour. This may suggest that there could be factors operating at the community-level, which were not analysed by the current analysis. These may include but are not limited to socio-cultural differences between communities. There is therefore need for strengthening safe motherhood action community structures that promote maternal health programmes at community level. Interventions such as mobile health clinic for rural areas should be promoted to enhance access to maternal health services. Furthermore, culturally tailored media campaigns can play a crucial role in addressing delays in ANC utilisation in SSA by promoting awareness, dispelling misconceptions, and encouraging early care-seeking behaviors in a way that resonates with local beliefs and practices.

Although the study has provided a comprehensive picture of the prevalence of delay in utilising first ANC in SSA, there are limitations to the study. Because of the cross-sectional nature of the DHS data, causality cannot be inferred in this study. The data collected on the outcome of interest may be subject to errors due the possibility of recall bias since the respondents were asked to report events that happened in the past. Self-reported variables in the DHS, such as the timing of antenatal care utilization, are subject to recall bias, where respondents misremember or misreport the exact timing of their visits, thus introducing measurement error. Additionally, social desirability bias can lead to over reporting of health maternal behaviours, potentially distorting the accuracy of the data. Another key limitation of this study is the potential for unmeasured confounding, as DHS data may lack some critical variables influencing the delay in first ANC utilisation in SSA, such as cultural beliefs or health system factors.

Despite the limitation, this study comprised nationally representative samples of women who ever gave birth during the last five years preceding each of the country's DHS. Thus, the current study findings can be applied to the entire population of women of childbearing age in all the countries in SSA where this study was conducted. The hierarchical nature of the DHS dataset allowed for exploration of community effects which may have an influence on women's reproductive behavior in SSA. A wide range of factors were assessed in this study to strengthen the associations observed between individual and contextual correlates and timing of ANC utilisation.

The study has provided useful findings to inform the strengthening of maternal, new-born and child health and reproductive policies and programming targeting at enhancing early utilisation of ANC services among women in SSA. However, designing of appropriate interventions to effectively address the problem may require use of qualitative approaches to have an in-depth understanding of socio-cultural context and other community level factors that could be contributing to the observed delay in maternal health seeking behaviour. This also requires engagement of all stakeholders in the health sector.

Conclusion

The study has established that the proportion of women who delay initial ANC utilisation in SSA is high. As evidenced, slightly more than 6 out of 10 women delayed first utilisation of first ANC. Age of a woman, level of education, household wealth status, parity, experience of a pregnancy loss and exposure to media were identified as individual-level factors associated with delay in timing of first ANC utilisation among women in SSA countries.

At community level, place of residence, distance to health facilities, experience of unwanted birth and education were associated with delay in timing of first ANC. Therefore, Governments of SSA countries and stakeholders, through policymakers and programmes implementers of maternal health initiatives should intensify mass community health promotion campaigns such as Community Health Worker Outreach, Mobile Messaging Campaigns, Male Involvement Initiatives and School and Youth Friendly Health Programmes to educate women about benefits of early ANC utilisation. Such maternal health education campaigns should be done, taking into consideration country-tailored interventions based on local contextual factors at the individual, community, and country levels. This is because of unique socioeconomic, cultural, and health system barriers that vary across the region. Furthermore, strengthening health facility access through the use of mobile clinics or transport subsidies should be encouraged especially among marginalised communities living in rural areas.

Abbreviations

CI	Confidence interval
DHS	Demographic and health survey
EA	Enumeration area
FP	Family planning
SDG	Sustainable development goal
SRH	Sexual reproductive health
SSA	Sub-Saharan Africa
UNFPA	United Nations population fund
UNICEF	United Nations children fund
USAID	United States aid for international development
WHO	World Health Organisation

Supplementary Information

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Supplementary file 1.

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Author contributions
MP developed the concept for this study. MP prepared background section and methods. ML and MP performed statistical analysis. MP and JM wrote the interpretation text for the manuscript. MP wrote the discussion section. AM, JRSM and JM performed overall review for intellectual content. All authors read, revised and approved the final version of this manuscript.

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Availability of data and materials
Data used in our study is publicly available at DHS program website (https://dhsprogram.com/).

Declarations

Ethical approval and consent to participate
Because the data used in the analysis came from secondary sources that are already in the public domain, our study did not require approval from an ethics body. However, all necessary procedures and guidelines were followed to access the DHS datasets from the DHS program. Furthermore, The DHS protocols ensured that all ethical processes were followed before the commencement of data collection processes in Zambia. All participants older than 18 years who were enrolled in the DHS were required to give their consent during enumeration. Additionally, parents or guardians of all participants aged 15 to 17 years gave consent before the legal minors were asked for their assent. In the DHS, parental or guardian consent is obtained for participants under 18 by first informing the parent or guardian about the purpose, procedures, and voluntary nature of the survey. Only after obtaining their informed consent can the minor be approached for assent, ensuring ethical compliance and protection of participants' rights. Thus, all data collection methods were carried out in accordance with relevant ethical guidelines and regulations.

Consent for publication
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Competing interests
The authors declare no competing interests.

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