Compliance with the 2016 WHO's antenatal care recommendation and its determinants among women in Sub-Saharan Africa: a multilevel-analysis of population survey data

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Abstract

Background Despite the positive impact of adhering to the new antenatal care model on pregnancy outcomes and maternal health service uptake, women in resource-limited settings exhibit low levels of compliance with this recommendation. Previous studies on women's adherence to the new antenatal care recommendation have been limited to individual countries, with no evidence available at Sub-Saharan Africa (SSA) level. Therefore, this study sought to investigate compliance with the 2016 WHO's recommendation of at least eight antenatal care contacts among women in SSA countries and identify its determinants.

Methods The study utilized a weighted sample of 101,983 women who had received antenatal care during their index pregnancy, drawn from recent DHS data of sixteen SSA countries. A multilevel mixed-effect analysis was conducted to identify factors that influence compliance with new antenatal care recommendations. Model comparison was performed using deviance and log-likelihood values, and statistical significance was determined at a *P*-value of less than 0.05.

Results The level of compliance with the recommended antenatal care contacts among women in SSA was 9.9% (95% CI: 9.7-10.1%), with the highest rate in Sierra Leone (26.1%) and lowest in Rwanda (< 1%). A multivariable logistic regression analysis showed that age, education, employment status, household wealth, healthcare decisions, the timing of antenatal contacts, consumption of nutritional supplements, residence, community-level women illiteracy, and media exposure were the significant determinants of compliance.

Conclusion Only one in ten pregnant women in SSA countries had attended the recommended number of antenatal contacts, with Sierra Leone having the highest compliance rate and Rwanda and Senegal having the lowest. Therefore, policymakers should focus on improving access to education, especially for women and their partners, and providing exempted services for pregnant women from low-income households. Interventions that target

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communities with low levels of literacy and media exposure could also be effective in improving the uptake of the services.

Keywords Recommended antenatal care, Pregnant women, Determinants, Sub-saharan Africa

Background

According to the 2023 estimate, about 287,000 mothers died due to pregnancy and childbirth complications and the majority (95%) of these deaths occurred in low- and middle-income countries, with sub-Saharan Africa (SSA) accounting for 70% of deaths [1]. Although evidence has underlined the significance of maternal health interventions in reducing maternal mortality and pregnancy and birth complications, only one-quarter of women in SSA optimally used these services [2]. A secondary analysis of demographic and health survey (DHS) data showed that utilization of antenatal, skilled childbirth, and postnatal care among young women in SSA was 55%, 79%, and 40%, respectively [3].

Quality antenatal care (ANC) during play a crucial role in significantly reducing the risk of morbidity and mortality for both the mother and the child [4]. In 2016, the World Health Organization (WHO) introduced an updated ANC model, covering five essential areas: routine antenatal nutrition, maternal and fetal assessment, preventive measures, interventions for managing common pregnancy-related symptoms, and health system-level strategies intended to enhance the accessibility and quality of ANC [5]. According to this recommendation, pregnant women should attend a minimum of eight contacts, with one, two, and five contacts scheduled during the three consecutive trimesters, respectively. The main rationale for increasing antenatal care contacts from four contacts to at least eight in 2016 was to improve prenatal outcomes and increase maternal satisfaction throughout the subsequent care [5, 6]

Studies conducted in different settings have examined women's compliance with WHO's new antenatal care recommendation. Accordingly, it was found that the level of compliance with the recommendation in Bangladesh [7] and Myanmar [8] was 6% and 18%, respectively. In Africa, the coverage varied from 31% [9] to 42% in Ghana [10], 28% in Cameroon [11] 25% in Sierra Leone [12], 2.5% in Ethiopia [13], and 17% in Nigeria [14]. Furthermore, studies have unveiled diverse factors that have been found to influence women's adherence to the updated WHO antenatal care contacts. These include age [12], enrollment in health insurance and women's education [12, 15], wealth index [7, 8, 16–18], educational attainment [12, 14, 16–18], parity [7, 12]), media exposure [7, 14, 16]), frequency of ANC contacts, place of residence, consultation with health care provider, and planned pregnancy [7], initiation month/time of ANC [8, 14]), quality of antenatal care and women's employment

status [17], and distance to health facilities and associated costs [16]. These variables have been documented as significant influencers impacting women's adherence to the newly recommended WHO antenatal care contacts.

Globally, efforts have been made to reduce maternal and child complications associated with pregnancy. These efforts include the implementation of the focused antenatal care model in 2002 [19] and the introduction of a newly recommended antenatal care model in 2016, which was endorsed by the World Health Organization [5]. The revised ANC model has been reported to be more effective in reducing infant morbidity and mortality [20–22], lowering perinatal death and stillbirth rates [23–25], facilitating early detection and prevention of adverse pregnancy-related outcomes [12, 23], and promoting institutional deliveries and the utilization of postnatal care services [26].

However, despite the positive outcomes of measures taken by the WHO [12, 20–26], evidence shows that women from developing countries still struggle to adhere to recommended ANC contacts due to cultural barriers, lack of knowledge, and limited accessibility and associated costs [7, 16]. Consequently, many women continue to experience pregnancy and childbirth complications leading to mortality [27, 28]. Furthermore, existing studies assessing women's adherence to newly recommended ANC contacts were either specific to a single country [8, 11, 13, 14, 18, 29] or included only a few countries [12]. Therefore, this study aims to examine women's compliance with the newly recommended WHO ANC model and its determinants in SSA countries.

Methods

Data source and participants

This study utilized data from the recent DHS conducted in 16 SSA between 2017 and 2022. The selection of these countries was based on the availability of a standardized and unrestricted DHS dataset that contained the outcome and necessary explanatory variables. DHS is a nationally representative survey conducted every five years to collect data on basic sociodemographic characteristics and various health indicators. The surveys in all countries utilized a standardized methodology and a two-stage stratified cluster sampling technique to select study participants. In the first stage, enumeration areas were randomly selected based on recent population data, and households were randomly selected in the second stage using the housing census as a sampling frame. For the final analysis, a total weighted sample of 101,983 women

of reproductive age who had attended antenatal care during their index pregnancy was considered. Further information regarding the countries and sample sizes included in the analysis is presented below (Table 1).

Variables

Dependent variable

This study defined the dependent variable as compliance with the WHO's updated antenatal care guidelines. This was assessed by determining the number of antenatal care contacts attended during the most recent pregnancy. Women who attended a minimum of eight contacts were classified as being compliant with the recommendation, while those who attended fewer than eight contacts were classified as non-compliant.

Independent variables

Individual-level variables were grouped into sociodemographic and obstetric variables. Socio-demographic variables included current age, marital status, woman's and partner's education, women's employment status, media exposure, household head, wealth index, coverage by health insurance, and family size. Obstetric variables were age at marriage, number of under-5 children, birth order, birth interval, timing of ANC, decision on health care, use of iron supplements, and history of pregnancy loss. While, residence, community-level media exposure, and community-level women illiteracy were the community-level variables.

Exposure to mass media was computed using three variables (frequency of watching television, listening to the radio, and reading newspapers) that have three response options (i.e. not at all, less than once a week,

and at least once a week). Thus, women who reported watching television, listening to the radio, or reading the newspaper at least once a week were considered as having media exposure and otherwise labeled as not having exposure to mass media.

Other community-level variables (i.e. community-level women illiteracy and media exposure) were generated by aggregating the individual-level observations at the cluster level and the aggregates were computed using the average values of the proportions of women in each category of a given variable and median values were used to categorize the aggregated variables into two groups (i.e. low and high).

Data management and statistical analysis

Stata software version 17 was used for data cleaning and analysis. Before analysis, the availability of the outcome variable in the DHS dataset of each country was confirmed and all variables considered in the study were checked for missing values. Then, the datasets of 16 SSA countries were appended and sample weight was applied to compensate for the non-representativeness of the sample and obtain reliable estimates and standard errors.

To account for the clustering effects, a multilevel logistic regression analysis was applied to determine the effects of independent variables on women's compliance with the recommended antenatal care contacts. Bivariable multilevel logistic regression analysis was done and all variables with a p-value of less than 0.25 in this analysis were considered for multivariable multilevel logistic regression analysis.

In our analysis, four models were fitted to select the model that best fits the data: model I (a model without independent variables to test random variability in the intercept), model II (a model with only community-level variables), model III (a model with individual-level variables), and model IV (a model with both individual and community-level predictor variables). Then, log-likelihood (LL) and deviance (i.e. -2*LL) values were used for model selection and the model with the lowest deviance and highest LL values was considered as a best-fitted model for the final analysis. The presence of multi-collinearity between explanatory variables was checked using generalized variance inflation factor values and this value was less than five for all variables, suggesting the non-existence of multi-collinearity. Finally, in the multivariable analysis, a p-value less than 0.05 and an adjusted odds ratio with the corresponding 95% confidence interval were used to identify the factors associated with compliance with antenatal care recommendations. Moreover, the random variability in the level of compliance across clusters was estimated by intra-class correlation coefficient (ICC), proportion change in variance (PCV), and median odds ratio (MOR).

Table 1 Countries included in the study and with their corresponding sample size

Country	Survey year	Unweighted sample	Weighted sample	Weight
Benin	2017-18	7,256	7,328	7.19
Cote d'Ivoire	2021	5,212	4,903	4.81
Cameroon	2018	5,415	5,550	5.44
Gambia	2019-20	5,283	4,841	4.75
Guinea	2018	4,495	4,479	4.39
Kenya	2022	9,992	9,266	9.09
Liberia	2019-20	3,890	3,727	3.65
Madagascar	2021	7,944	7,972	7.82
Mali	2018	4,576	4,939	4.84
Mauritania	2019-21	4,952	4,890	4.8
Nigeria	2018	15,862	15,963	15.65
Rwanda	2019-20	6,021	6,142	6.02
Sierra Leone	2019	6,293	6,172	6.05
Senegal	2019	3,832	3,592	3.52
Tanzania	2022	5,109	5,245	5.14
Zambia	2018	6,997	6,972	6.84
Total		103,129	101,983	

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Ethical approval

Data used in this study were obtained from a demographic and health survey, and permission to access it was granted through an online request process available at http://www.dhsprogram.com. The accessed data were solely utilized for this registered study and can be publicly accessed from the program's official database.

Results

Socio-demographic characteristics

Of the 101,982 women included in the study, 46,920 (46%) were between the ages of 25-35 years, 86,628 (84.9%) were married, and more than one-third (34.9%) had never attended formal schooling. Furthermore, over three-quarters (79.6%) of the participants were from male-head households, about half (50.1%) had exposure to the media, and 62,090 (60.9%) were living in rural areas.

Regarding compliance with at least eight ANC contacts across women's characteristics, the study found that women with higher education had a compliance rate of 16.2%, while women with no formal education had a compliance rate of 6.5%. Similarly, women from rich households and rural areas had a compliance rate of 15.2% and 15.5%, respectively (Table 2).

Obstetric and reproductive characteristics

Of the women included in the study, over half (57.4%) were married at the age of eighteen or older, and about three-quarters (74.2%) had 1 to 2 children under the age of five. Additionally, 30% of the participants had a preceding birth interval of less than 33 months. The study also found that 34% of women didn't have ANC in the first trimester, 50.7% took iron-folic acid supplements for at least 90 days, and about 33% collaborated with their partners to make healthcare decisions. The study also indicated that 12.8% of women with early ANC booking, 12.2% of women who received nutritional supplements for the recommended period, and 11.3% of women with a history of pregnancy termination had attended the recommended eight antenatal care contacts (Table 3).

Level of compliance with at least eight antenatal care contacts

The study found that the pooled level of compliance with the recommended antenatal care contacts among pregnant women in sub-Saharan African countries was 9.9% (95% CI: 9.7% - 10.1%). Sierra Leone had the highest compliance level, with 26.1% of women attending the recommended eight antenatal care contacts. In contrast, Rwanda and Senegal had the lowest compliance levels, with less than 1% of women attending the recommended eight antenatal care contacts. The analysis also showed that only three countries (Liberia (24.9%), Nigeria (25.5%), and Senegal (26.1%)) had relatively better performance in the implementation of the new antenatal care model (Fig. 1).

Random effect analysis

In this study, 101,982 pregnant women were nested within 1692 clusters across 16 countries. The result of the random effects analysis indicated that 30% (ICC values of model I) of the variation in the receipt of the recommended antenatal contacts was attributed to cluster-level differences, and 26% (ICC values of model IV) of the variation was accounted for by both individual and community-level aspects. The PCV value of the final model implies that the collective effect of individual and community-level variables accounted for 50% of the variation in maternal compliance with the recommended antenatal care contacts. Furthermore, the MOR of 1.94 in the empty model indicates the presence of heterogeneity in the receipt of at least eight antenatal care contacts between clusters. This implies that compared to women in the clusters with a low level of compliance to the recommended antenatal care contacts, women in the clusters with a higher compliance level had a 94% higher likelihood of attending the recommended contacts (Table 4).

Determinants of compliance with at least eight antenatal care contacts

The study found that both individual and community-level characteristics had a significant relationship with the receipt of the recommended ANC contacts in the multivariable multilevel binary logistic regression model. For instance, compared to younger women, women in the ages of 25-34 [AOR (95% CI): 1.11 (1.02, 1.21)] and 35-49 [AOR (95% CI):1.26 (1.12, 1.41)] had a higher likelihood of attending the recommended contacts. The odds of attending the recommended eight ANC contact was higher among women with higher education [AOR (95% CI): 1.28 (1.16, 1.42)], those whose husbands had attended higher education [AOR (95% CI):1.40 (1.26, 1.55)], working women [AOR (95% CI): 1.89 (1.75, 2.05)], those from middle-class [AOR (95% CI): 1.21 (1.10, 1.34)] and wealthy [AOR (95% CI): 1.37 (1.22, 1.54)] households. Furthermore, making joint healthcare decision [AOR (95% CI): 1.36 (1.22, 1.51), early initiation of ANC contacts [AOR (95% CI): 3.91 (3.56, 4.29)], taking of iron-folic acid supplement for at least 90 days [AOR (95% CI): 1.62 (1.49, 1.77)], residing in urban area [AOR (95% CI): 1.71 (1.52, 1.92)], living in a community with low women illiteracy [AOR (95% CI): 1.84 (1.64, 2.07)], and community with low non-exposure to media [AOR (95% CI): 1.33 (1.17, 1.52)] favored women's attendance of the recommended eight antenatal care contacts (Table 5).

Table 2 Socio-demographic characteristics of women who attended antenatal care in SSA countries (*n* = 101,982)

Characteristics	Frequency (Weighted %)	Compliance with 8 ANC contacts	
		Compliant	Non-Compliant
Age			
15-24	30,044 (29.5)	2,305 (7.7)	37,739 (92.3)
25-34	46,920 (46.0)	5,032 (10.7)	41,888 (89.3)
35-49	25,018 (24.5)	2,712 (10.8)	22,307 (89.1)
Marital status			
Never married	8,574 (8.4)	858 (10.0)	7,716 (90.0)
Currently married	86,628 (84.9)	8,699 (10.1)	77,929 (89.9)
Formerly married	6,780 (6.7)	492 (7.3)	6,289 (92.7)
Woman's education			
No formal education	35,592 (34.9)	2,308 (6.5)	33,284 (93.5)
Primary education	30,116 (29.5)	1,859 (6.2)	28,258 (93.8)
Higher education	36,274 (35.6)	5,882 (16.2)	30,392 (83.8)
Partner Education			
No formal education	30,210 (29.6)	1,811 (6.0)	28,399 (94.0)
Primary education	22,309 (21.9)	1,257 (5.6)	21,053 (94.4)
Higher education	49,463 (48.5)	6,981 (14.1)	42,481 (85.9)
Women's working status			
Non-working	36,866 (36.2)	2,562 (6.9)	34,303 (93.1)
Working	65,116 (63.8)	7,486 (11.5)	57,630 (88.5)
Media exposure			
No	50,970 (49.9)	4,294 (8.4)	46,676 (91.6)
Yes	51,012 (50.1)	5,755 (11.3)	45,257 (88.7)
Head of household			
Male	81,151 (79.6)	7,986 (9.8)	73,165 (90.2)
Female	20,831 (20.4)	2,063 (9.9)	18,768 (90.1)
Family size			
1-3	14,065 (13.8)	1,698 (12.1)	12,366 (87.9)
4-6	43,930 (43.1)	5,036 (11.5)	38,895 (88.5)
> 6	43,987 (43.1)	3,315 (7.5)	40,672 (92.5)
Household wealth			
Poor	40,273 (39.5)	2,122 (5.3)	38,151 (94.7)
Middle	20,716 (20.3)	1,699 (8.2)	19,017 (91.8)
Rich	40,993 (40.2)	6,228 (15.2)	34,765 (84.8)
Covered by health insurance			
No	81,242 (91.2)	9,114 (11.2)	72,127 (88.8)
Yes	7,883 (8.8)	529 (6.7)	7,354 (93.3)
Residence			
Urban	39,892 (39.1)	6,184 (15.5)	33,708 (84.5)
Rural	62,090 (60.9)	3,865 (6.2)	58,225 (93.8)
Community-level women illiteracy			
Low illiteracy	52,986 (52.0)	6,685 (12.6)	46,301 (87.4)
High illiteracy	48,996 (48.0)	3,364 (6.9)	45,632 (93.1)
Community-level non-exposure to media			
Low non-exposure	53,269 (52.2)	6,278 (11.8)	46,991 (88.2)
High non-exposure	48,713 (47.8)	3,770 (7.7)	44,9943 (9.3)

Discussion

This study aimed to assess compliance with the 2016 WHO's recommended eight antenatal care contacts and its determinants among pregnant women in SSA countries. Our finding showed that the level of compliance with the recommended antenatal care contacts was 9.9% (95% CI: 9.7%- 10.1%), which was higher than the rates reported in Southern Nigeria (2.2%) [16], Bangladesh (6%) [7], SSA countries (7.7%) [12], and Cameroon (8.9%) [11], but lower than those reported in Myanmar (18%) [8], Nigeria (17.5%-20%) [14, 18, 29], and Ghana (42%) [10]. The variation in compliance rates across studies

Table 3 Obstetric and reproductive characteristics of women who attended antenatal care in SSA countries (*n* = 101,982)

Characteristics	Frequency (Weighted %)	Compliance with 8 ANC contacts	
		Compliant	Non-Compliant
Age at marriage (*n*=93,409)			
< 18 year	39,813 (42.6)	2,746 (6.9)	37,067 (93.1)
> 18 year	53,596 (57.4)	6,445 (12.0)	47,151 (88.0)
Number of under-5 children			
0	4,841 (4.7)	674 (13.9)	4,166 (86.1)
1-2	75,628 (74.2)	7,935 (10.5)	67,693 (89.5)
> 2	21,513 (21.1)	1,439 (6.7)	20,074 (93.3)
Birth order			
1-3	60,660 (59.5)	6,545 (10.8)	54,115 (89.2)
> 3	41,322 (40.5)	3,504 (8.5)	37,819 (91.5)
Birth interval			
< 33 months	30,599 (30.0)	2,895 (9.5)	27,703 (90.5)
> 33 months	71,383 (70.0)	7,153 (10.0)	64,230 (90.0)
Decision on healthcare			
Women alone	15,236 (14.9)	1,511 (9.9)	13,725 (90.1)
Jointly with husband	33,470 (32.8)	4,100 (12.3)	29,369 (87.8)
Others*	53,276 (52.2)	4,437 (8.3)	48,839 (91.7)
Timing of ANC contact			
Early	67,263 (66.0)	8,583 (12.8)	58,681 (87.2)
Late	34,719 (34.0)	1,466 (4.2)	33,253 (95.8)
Given iron supplement during ANC contact			
No	8,703 (8.5)	900 (10.3)	7,803 (89.7)
Yes	93,279 (91.5)	9,149 (9.8)	84,130 (90.2)
Days iron supplement consumed (n= 86,858)			
< 90 days	42,858 (49.3)	2,862 (6.7)	39,997 (93.3)
> 90 days	44,000 (50.7)	5,373 (12.2)	38,627 (87.8)
Place of childbirth			
Home	25,163 (24.7)	1,554 (6.2)	23,609 (93.8)
Health facility	76,819 (75.3)	8,494 (11.1)	68,325 (88.9)
Ever terminated pregnancy			
No	87,302 (85.6)	8,395 (9.6)	78,908 (90.4)
Yes	14,680 (14.4)	1,654 (11.3)	13,025(88.7)

Others* = husband/partner alone, someone else, and other DHS categories

could be attributed to differences in participant characteristics and the countries included in the analysis. Notably, previous studies were mostly based on data from a single country, whereas our study used data from sixteen countries.

Consistent with the findings of a study in Nigeria [18], the current study found that women aged 25 years and above were more likely to attend the recommended antenatal contacts compared to those younger than 25 years. In addition, this finding is supported by the result of a study in SSA, which reported a reduced odds of non-compliance among older women [12]. This could be attributed to the possibility that younger women may

exhibit poor health-seeking behavior due to inadequate awareness regarding maternal healthcare services.

This study found a significant relationship between women's literacy both at the individual and community level and their partner's education with the completion of the recommended antenatal care contacts. In this regard, women with higher education had a 28% higher likelihood of attending optimal antenatal care contacts, while those whose partners had completed higher education had a 40% increased chance of attending these contacts. Furthermore, living in a community with low women's illiteracy was associated with a higher likelihood of attending adequate antenatal care contacts. This finding is consistent with the previous studies in SSA [12], Nigeria [16, 18], and Uganda [17]. The possible explanation for this finding is that educated women have a better understanding of the importance of frequent antenatal care and are therefore more likely to adhere to the recommendation than uneducated women.

In this study, women's employment status was also identified as a significant predictor for attending adequate antenatal care contacts. For instance, employed women were 1.89 times more likely to receive the recommended contacts compared to unemployed women. Consistent with this finding, a study in Uganda revealed that employed women had a 26% increased odds of attending antenatal care contacts as per the recommendation than their counterparts [17]. This might be because employed women tend to be financially empowered and more autonomous on decisions regarding health service utilization than non-working women and thus likely to receive the service optimally.

According to this study, women belonging to middle-class and wealthy households had a greater chance of receiving the recommended antenatal care contacts, with a 21% and 37% higher likelihood respectively than those from poor families. This result aligns with previous studies in Africa [12, 15–18] and Asia [7, 8], which consistently reported a positive association between socio-economic status and receiving adequate antenatal care contacts. This finding implies that women from economically disadvantaged households may have limited access to healthcare services and thus less likely to receive adequate care.

In addition, our study revealed that women who were involved in healthcare decision-making had a higher likelihood of attending at least eight antenatal care contacts. This finding is supported by a study conducted by Fagbamigbe and colleagues in Nigeria, which demonstrated that women who made healthcare decisions on their own were more likely to attend frequent antenatal care contacts [18]. This might be because women who are involved in healthcare decision-making may feel more empowered and in control of their health, leading to a
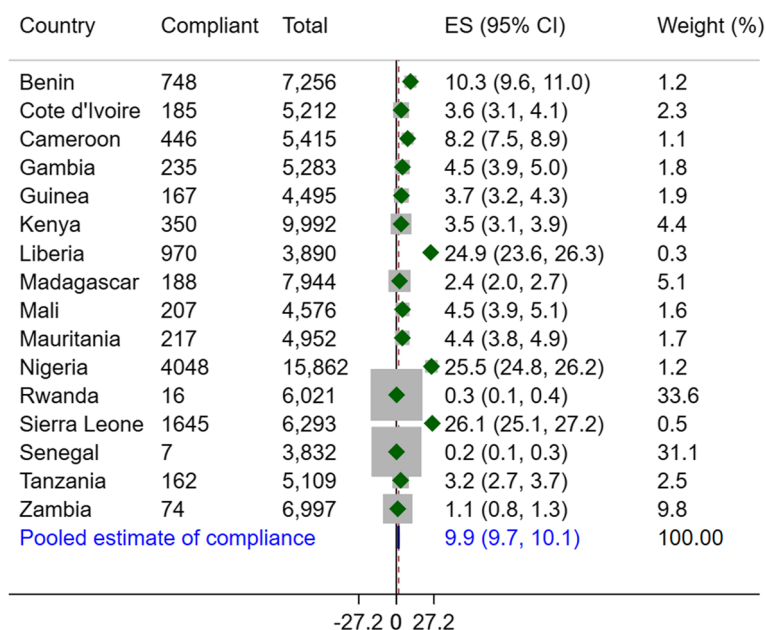
Country	Compliant	Total	ES (95% CI)	Weight (%)
Benin	748	7,256	10.3 (9.6, 11.0)	1.2
Cote d'Ivoire	185	5,212	3.6 (3.1, 4.1)	2.3
Cameroon	446	5,415	8.2 (7.5, 8.9)	1.1
Gambia	235	5,283	4.5 (3.9, 5.0)	1.8
Guinea	167	4,495	3.7 (3.2, 4.3)	1.9
Kenya	350	9,992	3.5 (3.1, 3.9)	4.4
Liberia	970	3,890	24.9 (23.6, 26.3)	0.3
Madagascar	188	7,944	2.4 (2.0, 2.7)	5.1
Mali	207	4,576	4.5 (3.9, 5.1)	1.6
Mauritania	217	4,952	4.4 (3.8, 4.9)	1.7
Nigeria	4048	15,862	25.5 (24.8, 26.2)	1.2
Rwanda	16	6,021	0.3 (0.1, 0.4)	33.6
Sierra Leone	1645	6,293	26.1 (25.1, 27.2)	0.5
Senegal	7	3,832	0.2 (0.1, 0.3)	31.1
Tanzania	162	5,109	3.2 (2.7, 3.7)	2.5
Zambia	74	6,997	1.1 (0.8, 1.3)	9.8
Pooled estimate of compliance			9.9 (9.7, 10.1)	100.00

-27.2 0 27.2

Fig. 1 Pooled and country-level estimates of compliance with newly recommended antenatal care contacts in sub-Saharan African Countries

Table 4 Measures of variations and model statistics summary for determinants of compliance with WHO's newly recommended antenatal care contacts among pregnant women in SSA countries

Measure of variation	Model 1	Model 2	Model 3	Model 4
Cluster-level variance	0.56 (0.45, 0.66)	0.44 (0.38, 0.49)	0.39 (0.28, 0.54)	0.28 (0.22, 0.39)
Intra-class correlation	0.30 (0.28, 0.32)	0.24 (0.22, 0.26)	0.28 (0.26, 0.31)	0.26 (0.23, 0.28)
Explained variance (PCV)	Reference	0.21 (0.16, 0.26)	0.30 (0.18, 0.37)	0.50 (0.41, 0.51)
Median odds ratio	1.94 (1.74, 2.10)	1.72 (1.60, 1.81)	1.62 (1.37, 1.90)	1.37 (1.21, 1.62)
Model statistics summary				
Akaike's information criteria	59969	58483	41689	41456
Bayesian information criteria	59988	58531	41847	41642
Log-likelihood	- 29983	- 29236	- 20827	-20708
Deviance	59966	58472	41654	41416

greater sense of responsibility and commitment to use maternal healthcare services [30].

The timing of the initial antenatal care contact was also identified as a significant factor influencing maternal attendance of frequent contacts. Women who booked early for antenatal care were 3.9 times more likely to attend the recommended contacts than those who sought care after the first trimester. In line with this finding, a study conducted in Nigeria also found a negative association between the timing and frequency of antenatal care contacts [14]. This might be because, with the first ANC contact happening later in pregnancy, there is less time for follow-up contacts. It also implies that women who book early for antenatal care are more likely to be aware of the importance of regular check-ups and may be more motivated to attend subsequent contacts.

According to our analysis, women who took iron-folic acid supplements for at least 90 days were more likely to attend the recommended eight antenatal care contacts compared to those who took the supplement for less than 90 days. This might be because women who receive high-quality antenatal care services are more inclined to adhere to the recommended and subsequent care [7, 17].

Compared to women who lived in rural settings, those who resided in urban areas were 1.7 times more likely to attend at least eight antenatal care contacts. This finding is consistent with the results of the previous studies [7, 8, 14, 18]. The possible reasons for this could be that women in urban areas have better access to healthcare facilities, compared to those in rural areas. Furthermore, geographic barriers in terms of limited transportation options, low health literacy, and socioeconomic status of the rural areas might have contributed to this disparity.

This study also identified community-level media exposure as a significant factor for compliance with the recommended antenatal care contacts. Women from communities with low non-exposure status to mass media were 33% more likely to attend the recommended contacts than those from communities with high non-exposure. This finding aligns with earlier studies that

Table 5 A multilevel fixed-effects analysis of determinants of compliance to WHO's newly recommended antenatal care contacts among pregnant women in SSA countries

Individual-level determinants	COR	AOR
Age		
15-24	1.00	1.00
25-34	1.31 (1.22, 1.40)	1.11 (1.02, 1.21)*
35-49	1.32 (1.21, 1.42)	1.26 (1.12, 1.41)*
Woman's education		
No formal education	1.00	1.00
Primary education	0.80 (0.73, 0.88)	0.97 (0.92, 1.14)
Higher education	2.01 (1.89, 2.23)	1.28 (1.16, 1.42)*
Partner Education		
No formal education	1.00	1.00
Primary education	0.81 (0.72, 0.90)	0.77 (0.64, 0.86)*
Higher education	2.00 (1.83, 2.21)	1.40 (1.26, 1.55)*
Women's working status		
Non-working	1.00	1.00
Working	1.76 (1..63, 1.89)	1.89 (1.75, 2.05)*
Household wealth		
Poor	1.00	1.00
Middle	1.56 (1.41, 1.72)	1.21 (1.10, 1.34)*
Rich	2.87 (1.58, 3.19)	1.37 (1.22, 1.54)*
Age at marriage (n=93,409)		
< 18 year	1.00	1.00
> 18 year	1.51 (1.41, 1.61)	1.06 (0.98, 1.14)
Birth order		
1-3	1.00	1.00
> 3	0.81 (0.76, 0.85)	0.99 (0.90, 1.06)
Decision on healthcare		
Women alone	1.00	1.00
Jointly with husband	1.37 (1.24, 1.51)	1.36 (1.22, 1.51)*
Others*	1.03 (0.94, 1.13)	1.13 (1.02, 1.26)*
Timing of ANC contact		
Late	1.00	1.00
Early	4.18 (3.83, 4.56)	3.91 (3.56, 4.29)*
Days iron supplements consumed		
< 90 days	1.00	1.00
≥ 90 days	2.00 (1.84, 2.18)	1.62 (1.49, 1.77)*
Community-level determinants		
Residence		
Rural	1.00	1.00
>Urban	2.57 (2.31, 2.85)	1.71 (1.52, 1.92)*
Community-level women illiteracy		
High illiteracy	1.00	1.00
Low illiteracy	2.38 (2.14, 2.66)	1.84 (1.64, 2.07)*
Community-level non-exposure to media		
High non-exposure	1.00	1.00
Low non-exposure	1.80 (1.59, 2.03)	1.33 (1.17, 1.52)*

*Statistically significant at *p*-value less than 0.05

demonstrated the positive effect of media exposure on the uptake of adequate prenatal contacts [7, 16, 18]. This could be because media exposure enhances women's understanding and perception of maternal healthcare,

which ultimately influences their healthcare-seeking behavior.

Strengths and limitations
This study has several notable strengths, including the utilization of a larger sample size, nationally representative data from sixteen countries, and advanced statistical methods. Nonetheless, the cross-sectional nature of the survey's design precludes establishing a causal relationship between the independent and dependent variables. Furthermore, there is a possibility of recall bias since women were required to recall events that happened two or five years before the survey. Additionally, differences in the survey years across countries may have either overestimated or underestimated the pooled estimate of the outcome variables.

Conclusion
The study found that the compliance rate to the recommended antenatal care contacts among pregnant women in sub-Saharan African countries was very low, with Sierra Leone having the highest compliance rate and Rwanda and Senegal having the lowest. It was also found women's and partner's literacy, wealth status, healthcare decision maker, timing of antenatal contacts, consumption of iron-folic acid supplements, residence, and communities-level women's illiteracy and media exposure were the determinants for the attendance of the recommended eight antenatal care contacts. Therefore, policymakers should focus on improving access to education, especially for women and their partners, and providing exempted services for pregnant women from low-income households. Interventions that target communities with low levels of literacy and media exposure could also be effective in improving the uptake of the services.

Authors' contributions
Conceptualization: Kusse Urmale Mare, Beminate Lemma Seifu, Kebede Gemeda Sabo, Yordanos Sisay Asgedom, Zufan Alamrie Asmare, Tsion Mulat Tebeje, Abdu Hailu Shibeshi, Afework Alemu Lombebo, Bezawit Melak Fente, Bizunesh Fantahun Kase, and Hiwot Altaye Asebe. Data curation: Kusse Urmale Mare, Beminate Lemma Seifu, Kebede Gemeda Sabo, Yordanos Sisay Asgedom, Zufan Alamrie Asmare, Tsion Mulat Tebeje, Abdu Hailu Shibeshi, Afework Alemu Lombebo, Bezawit Melak Fente, Bizunesh Fantahun Kase, and

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Availability of data and materials
The raw dataset used and analyzed in this study can be accessed from the DHS website (https://dhsprogram.com/data/dataset_admin/index.cfm).

Declarations

Ethics approval and consent to participate
Since we used secondary data, permission to access the data was granted from the Measure Demographic and Health Survey official Database via an online request at http://www.dhsprogram.com. The survey procedures were also approved by the Institutional Review Board of the host country and ICF International. Additionally, written informed consent was obtained from the study participants during the collection of the survey data.

Consent for publication
Not applicable

Competing interests
The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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