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Determinants of Antenatal care use in nine sub-Saharan African countries: Evidence from population Demographic and Health Surveys

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4 **Determinants of Antenatal care use in nine sub-Saharan African countries:**
5 **Evidence from population Demographic and Health Surveys**
6

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31
32 **Abstract:**
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35 **Objective:** To examine the factors associated with four or more antenatal care
36 attendance in nine sub-Saharan African countries.
37

38
39 **Participants:** 56002 women who had given birth three years prior to the survey.
40

41
42 **Methods.** Data sets were drawn from the most recent Demographic health surveys
43 (DHS) of women 15-49-year-old questionnaire. Chi-square tests, Univariate, and
44 multivariable logistic regression models were performed to explore the associated
45 factors.
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50 **Outcomes:** Four or more antenatal visits
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53 **Results:** Only 55.52% (95% CI; 55.11 to 55.93) of all women had four or more
54 antenatal care visits. Multivariable analysis shows that all sociodemographic
55 variables were significantly associated with four or more antenatal care visits
56 (p<0.001). Four or more antenatal care visits vary widely across the studied
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3 countries. The highest visits were in Ghana (85.6%) and Namibia (78.9%), and the
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5 lowest was in Rwanda (44.5%) and Senegal (45.3%). In country-specific analysis,
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7 the odds of lower uptake of four or more antenatal care attendance was significant
8
9 among women from a rural residence in Kenya, Malawi, and Senegal: no schooling
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11 in Kenya, Malawi, Rwanda, and Zambia; un-employed in Ghana and Uganda;
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13 poorest households in Ghana, Kenya, Malawi, Senegal, Tanzania and Uganda; and
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15 lack of access to media in all the studied countries except in Malawi, Rwanda,
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17 Senegal, and Zambia. Overall, women from low socioeconomic status (rural place of
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19 residence, no schooling, unemployed, poor household, and no media access) were
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21 less likely to uptake the required antenatal care visits.
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26 **Conclusion:** The overall antenatal care visits is not adequate, with substantial
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28 variation among the studied countries. Program priority for women of low economic
29
30 status and poor social development on antenatal care must be implemented.
31
32 Integrated interventions addressing multiple factors and the whole region is needed.
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34

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36 **Keywords:** Four or more antenatal care, Determinants, sub-Saharan Africa,
37
38 Demographic health survey, and health service utilization.
39
40

41 **Strengths and limitations of this study**

- 42
43 ➤ To the best of our knowledge, no prior study has analyzed the determinants of
44
45 antenatal care use in segregated and pooled data forms in a single study
- 46
47 ➤ The study used national representative samples from nine sub-Saharan Africa
48
49 countries which have been linked to enhance the generatability of the study
- 50
51 ➤ This analysis included women who have birth three years before the survey,
52
53 which could minimize the recall bias of self-report at a single point in time
- 54
55 ➤ The survey was cross-sectional design. Therefore, it cannot affirm any causal
56
57 inference or direction of the association.
- 58
59 ➤ Since the data sets were obtained from countries DHS in a different time,
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awareness of participants may be varied due to time heterogeneity

Introduction

Maternal and neonatal mortality which remains unacceptably high is a significant public health issues that reflect the overall status of a country's healthcare system and socioeconomic development¹. The world health organization (WHO) estimates that approximately 830 maternal deaths/day from preventable causes relate to pregnancy and childbirth, and 99% of these deaths occur in low-income countries². Sub-Saharan Africa (SSA) remains the region with the highest maternal and under-five mortality³⁻⁵. Almost half of the under-five deaths occur among new-born babies whose deaths could be prevented by reaching a high coverage of quality antenatal care, skilled care at birth, postnatal care for mother and baby, and care of small and sick new-born^{3 4}. Several review studies on intervention for maternal and new-born life have demonstrated that the provision of adequate antenatal care (ANC) brings with it a positive impact on pregnancy outcomes through early diagnosis and appropriate management and this has a 39% reduced risk of neonatal mortality in sub-Saharan countries⁶⁻⁹.

On top of the WHO advise every pregnant woman with a normal pregnancy in middle-and low-income countries to attend at least four ANC's¹, several studies have attempted to identify factors associated with the underutilization of ANC's^{10 11}. Age¹¹⁻¹⁵, women's education^{8 11-23}, husbands' education^{17 21 22}, socioeconomic status^{13-22 24}, women's employment¹⁷, birth order^{10 11 17}, frequency of listening to the radio/watching TV/reading newspaper/ magazines^{8 10 17 22 23}, and place of residence^{11 12 15-18 21 23 24} are among the factors associated with underutilization of ANC. Many studies have concluded that the factors attributed to inadequate ANC follow-ups are quite substantial across regions and countries^{10 15 22 25 26}.

Meeting SDGs to ensure healthy lives and well-being for all ages by 2030 requires transnational organizations' efforts and the ability to collaborate in

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2
3 partnership. Interestingly the means of implementing and revitalizing capacity
4 development and the information exchange of multinational cooperation have been
5 emphasized in the SDGs ²⁷. However, despite the available evidence on ANC's key
6 role in reducing maternal and neonatal mortality, millions of women in developing
7 countries do not receive it and there remains a high variability (32%-91%) of four or
8 more ANC (4⁺ANC) visits between countries ^{20 21 23 28}. Lessons on coverage of
9 crucial ANCs from neighboring areas would aid in precise allocations of resources
10 and interventions where they are most needed. Therefore, new research projects on
11 mutual benefit and knowledge sharing at every level must be implemented to attain
12 global health development goals.
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26 We conducted secondary data analysis using recent standard population and
27 Demographic Health Surveys conducted in nine sub-Saharan Africa countries (Ghana,
28 Kenya, Malawi, Namibia, Senegal, Rwanda, Tanzania, Uganda, and Zambia). The
29 objective of the study was to understand the factors associated with 4⁺ANC
30 attendance.
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39 **Materials and Methods**

40 **Study design**

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42 We used data from the Demographic and Health Survey (DHS). DHS is a
43 five-year periodic national representative cross-sectional study using a stratified
44 two-stage cluster sampling design. Details of the DHS protocol are published
45 elsewhere ²⁹ [[http:// www.dhsprogram.com/data/data-collection.cfm](http://www.dhsprogram.com/data/data-collection.cfm)]. Information
46 from ever-married women aged 15-49 years in nine sub-Sahara Africa countries on
47 demographic characteristics and reproductive history were collected (Figure-1).
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Participants

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3 Women who had one or more births three years before the survey were included
4
5 as study participants. Selection of study participants was as shown in (Figure-2)
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7

8 **Outcome variables**

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10 Our study's primary outcome was dichotomized as 4+ANC visits (yes/no). We
11
12 calculated minimum of 4+ANC visits during their last pregnancy. ANC is defined as
13
14 a health care service provided to mother and fetus during pregnancy by skilled health
15
16 personnel. ANC provided by non-health professionals such as traditional birth
17
18 attendants were excluded.
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22 **Explanatory variables**

23
24 A set of sociodemographic variables related to the utilization of ANC such as
25
26 women's age in years, women and husbands education and occupation, birth order
27
28 (parity), frequency of listening to radio/ watching TV/ reading magazines, household
29
30 wealth quantile, and place of residence were identified from the survey data as
31
32 predictors of ANC follow-ups. Numerical values like age, ANC visits, and years of
33
34 education attended were grouped into categories. Women's age in years was
35
36 tabulated into groups (15-19-year, 20-24-year, 25-29-year, 30-34 year, 35 and above),
37
38 women's and husbands' education were classified as 'no schooling', 'primary',
39
40 'secondary', and 'higher' education. Women's and husband's occupation were
41
42 classified as 'not working outside home', 'professional/skilled work', 'agriculture',
43
44 and 'unskilled'. Frequency of listening to radio/ watching TV/ reading magazines (not
45
46 at all, less than once a week, and at least once a week) was included to gauge the
47
48 women's exposure to promotion messages on the benefits of ANC attendance. The
49
50 household wealth index was constructed using a principal component analysis method
51
52 from items related to possession of durable assets, access to utilities and
53
54 infrastructure, and housing characteristics to assess the mothers' economic status.
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3 Each woman was ranked into five categories (poorest, poorer, middle, richer, and
4 richest) based on a household asset score, comprising 20% of the population^{10 30}.
5
6 Place of residence/ ecological status assessed the difference in the availability and
7
8 accessibility of services among urban and rural and were identified from the survey
9
10 data as predictors of ANC follow-ups. Data sets were segregated according to the nine
11
12 countries in the SSA region. There is merit in segregating data, for it allows us to
13
14 focus on aspects of ANC visits that may remain hidden in intra-national/national level
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16 indicators.
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22 **Data sources/ measurements**

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25 Data sets were collected through household interviews using a structured
26
27 questionnaire. Women were interviewed about the number of ANC visits. Trained
28
29 interviewers obtained informed consent from all eligible households and women
30
31 before conducting the interview using pencil and paper questionnaires. The surveys
32
33 are weighted for over or under-sampling and non-response. Thus, the design and
34
35 standardized core modules allow for regional and transnational comparison of the
36
37 data. Field supervisors and data clerks checked all forms before entering them into
38
39 databases. Data for this analysis was taken from the latest household survey of the
40
41 studied countries. This study's survey years ranged from 2013 to 2018, and the sample
42
43 size ranges from 2,286 in Namibia to 10,981 in Kenya.
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48 Multiple responses for ANC visits were addressed by limiting the study looking
49
50 at the service given to a woman by qualified health care professionals during their
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52 most recent pregnancy preceding the study period.
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56 **Data analysis**

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59 Data analysis was performed using STATA software version 14.0. Descriptive
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analysis was conducted on combined and separate forms for the studied country.

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3 Chi-square tests were used to analyze the potential factors affecting ANC use during
4 their last pregnancy. Bivariate and multivariable regressions were used to study the
5 statistical association between the explanatory variables and 4+ANC. A multilevel
6 analysis was used in which the level of coefficients was modeled as a function of
7 predictors considering the average log odds of 4+ ANC across the studied countries.
8 Women's age at childbirth and husband's occupation were excluded from the
9 multilevel analysis due to collinearity effects with a variance inflation factor value
10 (VIF>4) on the collinearity diagnosis test. A two-sided P-value <0.05 was considered
11 statistically significant in this study.
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23 **Patient and public involvement**

24 The study used public available secondary data from DHS(<https://dhsprogram.com/>).
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26 Patients and public were not involved in the design and conducted of this research
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31 **Results**

32 **Baseline characteristics of the study population**

33 Overall, 56,002 women with complete details from nine SSA countries were
34 included in this study (Table1-supplementary). The distribution of study participants
35 was presented in flowchart Figure 2. Data for late 2013-2018 show that 55.52% (95%
36 CI; 55.11 to 55.93) of the women in the nine SSA countries had at least four ANC
37 visits with a skilled provider during pregnancy. Thirty-five percent of the participated
38 women started their first ANC visit in the 1st trimester and 57% in the 2nd trimester of
39 pregnancy. Before pregnancy, 82.2% of women in this study had received a tetanus
40 injection. There were 1,808 (3.23%) new-born deaths from all births in the three years
41 preceding the survey.
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55 The highest proportion of 4+ANC visits among the studied countries was from
56 Ghana (85.61%) followed by Namibia (78.92%), and the lowest proportion was from
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3 Rwanda, Senegal, and Tanzania, in which the proportion of 4+ANC attendance was
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5 below 50% (Figure 3).
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8 Pooled data (Figure 4) indicated that the highest proportion of 4+ ANC visits was
9
10 among mothers aged 25-29 (57.3%). Mothers from an urban place of residence
11
12 account for 64.3% of 4+ ANC visits. A similar higher proportion of ANC visits was
13
14 reported among mothers and husbands with higher education, among the richest
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16 families, primigravidae, and women with access to media.
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18

19 20 **Determinants of four or more antenatal care visits** 21

22
23 Women aged 25-29 years attended more ANC than all the other age groups
24
25 across all the studied countries except in Zambia ($p=0.361$), and the difference was
26
27 statistically significant ($p<0.005$). Similarly, women from an urban place of residence
28
29 have meaningful higher ANC visits than women from a rural area of living, and the
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31 difference was significant ($p<0.001$) except in Rwanda ($p=0.788$). Table 2 shows that
32
33 as women's and husbands' education level increased, women utilization of ANC
34
35 increased across all nine countries in the regions ($p<0.001$). The highest ANC
36
37 attendance was among women and husband highest educational levels from Ghana,
38
39 99.2% and 96.4% respectively, and the lowest was among women of no schooling in
40
41 Rwanda (37.6%) and Tanzania (38.6%), and husband's no schooling in Tanzania
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43 (36.3%).
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48 Both women and husband occupations were associated ($p<0.001$) with women's
49
50 ANC attendance across all regions except in Rwanda ($p=0.493$) and Zambia
51
52 ($p=0.062$) where husband's occupation is not significantly associated with women
53
54 4+ANC visits. Husband's employment in Rwanda has a negative relationship with
55
56 women 4+ANC visits.
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59 In this study, difference in household wealth status has a significant positive
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association ($p<0.001$) with 4+ANC visits in all the studied countries except in

1
2
3 Rwanda ($p=0.234$). Women's birth order is associated with 4+ANC visits, except in
4
5 Malawi. The frequency of women's listening to radio/ watching TV/ reading
6
7 newspapers or magazine is related to 4+ANC attendance in the studied countries,
8
9 except in Rwanda and Zambia ($p>0.05$).
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Table 2. Sociodemographic characteristics influencing 4+ ANC visits in nine sub-Saharan countries.

Variables	Ghana (3,224)	Kenya (10,981)	Malawi (9,541)	Namibia (2,286)	Rwanda (4,416)	Senegal				
						(6,552)	Tanzania (5,536)	Uganda (7,979)	Zambia (5,487)	
Age group										
15-19	140(79.1)	399(47.11)	470(43.93)	153(66.81)	59(40.14)	232(40.00)	252(47.10)	475(58.93)	430(62.05)	
20-24	519(84.12)	1547(54.05)	1461(48.62)	487(78.30)	427(45.77)	743(47.08)	718(49.42)	1466(62.30)	989(65.63)	
25-29	722(87.73)	1782(55.02)	1115(52.01)	463(81.66)	597(47.76)	791(46.67)	659(50.89)	1213(62.78)	779(63.70)	
30-34	636(86.53)	1080(52.81)	902(52.78)	334(82.47)	483(43.59)	595(46.09)	491(48.76)	924(61.52)	656(65.74)	
35 and above	743(85.21)	982(49.40)	840(52.08)	367(79.27)	399(40.80)	609(43.25)	544(43.66)	753(54.33)	668(62.90)	
p-value	0.029	< 0.001	< 0.001	< 0.001	0.012	0.014	0.004	< 0.001	0.361	
Place of residence										
Urban	1207(91.72)	2228(61.28)	892(57.92)	853(82.66)	442(44.87)	1188(60.00)	816(60.53)	1009(67.90)	1028(60.44)	
Rural	1553(81.39)	3562(48.50)	3896(48.69)	951(75.84)	1523(44.39)	1782(38.98)	1848(44.13)	3822(58.86)	2494(65.87)	
p-value	< 0.001	< 0.001	< 0.001	< 0.001	0.788	< 0.001	< 0.001	< 0.001	< 0.001	
Mother's education										
No schooling	846(79.21)	916(40.75)	494(45.78)	106(58.56)	228(37.62)	1982(41.28)	421(38.62)	535(55.15)	325(59.52)	
Primary	544(82.42)	2884(50.67)	3124(49.15)	367(71.40)	1397(44.53)	677(54.51)	1557(46.91)	2872(58.18)	1807(64.15)	
Secondary	1242(90.86)	1380(60.50)	1038(53.73)	1229(82.82)	257(45.73)	291(60.00)	643(59.76)	1072(66.46)	1206(63.37)	
Higher	128(99.22)	610(80.26)	132(75.86)	102(95.33)	83(74.77)	20(83.33)	43(84.31)	352(76.52)	184(83.26)	
p-value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	
Husband's education										
No schooling	699(79.16)	344(40.23)	348(48.07)	123(65.78)	248(40.52)	1900(40.85)	234(36.34)	324(58.70)	161(61.92)	
Primary	292(83.67)	1172(51.38)	2068(48.72)	174(73.73)	1267(45.66)	362(55.69)	1341(45.66)	2057(57.54)	1008(64.24)	

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Secondary	1245(88.61)	727(60.43)	1314(52.86)	522(82.08)	172(44.33)	273(62.19)	521(59.68)	1114(65.38)	1174(64.01)
Higher	267(96.39)	347(73.83)	252(67.56)	83(96.51)	95(62.91)	84(68.29)	75(69.44)	508(73.62)	272(78.61)
p-value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001

Mother's occupation

Not working O/H	519(81.99)	1012(50.40)	1457(48.47)	969(74.65)	130(40.12)	1654(45.23)	543(52.92)	760(56.55)	1560(61.81)
Professional/Skilled work	1375(91.18)	305(70.28)	579(55.94)	558(84.67)	336(49.19)	656(52.27)	261(65.91)	1468(64.84)	668(67.61)
Agriculture	786(78.52)	632(49.11)	2031(49.61)	40(86.96)	1428(44.47)	377(33.87)	1247(41.58)	2099(57.90)	965(66.69)
Unskilled	73(97.33)	859(56.03)	721(51.28)	233(83.51)	71(36.04)	279(53.55)	613(54.98)	498(67.30)	328(62.36)
p-value	< 0.001	< 0.001	< 0.001	< 0.001	0.003	< 0.001	< 0.001	< 0.001	0.001

Husband's occupation

Not working O/H	-	44(51.76)	380(49.74)	8(88.89)	12(50.00)	82(49.70)	16(38.10)	134(59.03)	267(62.38)
Professional/Skilled work	1024(92.42)	777(62.26)	1241(53.84)	459(83.91)	516(45.03)	1412(51.22)	600(57.58)	2091(65.53)	905(65.72)
Agriculture	1065(78.54)	556(44.91)	1446(49.25)	117(68.02)	1082(46.16)	726(34.00)	1096(41.66)	1327(55.36)	1033(66.09)
Unskilled	433(91.54)	1199(54.01)	920(49.78)	180(81.45)	180(42.35)	445(48.74)	467(54.75)	521(62.40)	488(61.69)
p-value	< 0.001	0.006	< 0.001	< 0.001	0.493	< 0.001	< 0.001	< 0.001	0.062

Wealth quintile

Poorest	817(78.78)	1532(41.79)	1002(46.32)	369(73.51)	444(41.73)	634(31.51)	457(37.71)	1152(54.78)	1003(65.13)
Poorer	577(81.96)	1130(49.71)	1022(48.83)	351(74.05)	409(45.14)	706(40.88)	450(40.50)	1020(58.42)	842(66.09)
Middle	495(86.09)	1011(55.10)	888(48.05)	388(79.51)	377(46.60)	660(49.14)	481(44.87)	893(60.13)	692(62.62)
Richer	474(94.23)	1007(60.55)	887(50.63)	401(82.51)	355(45.87)	561(61.58)	666(55.64)	863(64.26)	473(57.47)
Richest	397(98.02)	1110(71.15)	989(58.69)	295(87.80)	380(44.03)	409(73.17)	610(64.62)	903(69.35)	512(68.72)
p-value	< 0.001	< 0.001	< 0.001	< 0.001	0.234	< 0.001	< 0.001	< 0.001	< 0.001

Birth order

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First	636(87.60)	1471(59.80)	1267(51.23)	594(79.41)	613(50.16)	718(52.33)	766(56.70)	1077(63.73)	918(65.95)
Second	584(89.30)	1345(57.45)	941(48.26)	469(81.42)	502(46.83)	585(50.39)	538(51.88)	953(63.87)	684(65.14)
Third	470(85.77)	1019(54.40)	798(50.41)	309(84.43)	322(45.61)	448(45.16)	395(48.59)	762(62.56)	523(63.16)
Fourth	382(88.22)	710(50.25)	621(50.74)	180(79.92)	193(38.14)	367(44.48)	299(46.00)	583(61.50)	446(66.77)
Fifth & above	688(79.72)	1245(43.02)	1161(50.24)	252(69.61)	335(36.81)	852(38.69)	666(39.53)	1456(55.34)	951(61.39)
p-value	< 0.001	< 0.001	0.383	< 0.001	0.001	< 0.001	< 0.001	< 0.001	0.043
Frequency of listening to radio/ watching TV/ reading newspaper or magazine									
Not at all	288(70.07)	1044(39.77)	2127(47.85)	178(62.24)	298(42.63)	308(34.00)	394(37.60)	1051(53.54)	1640(63.25)
Less than once a week	646(81.46)	671(51.14)	829(49.11)	355(76.84)	481(42.87)	442(37.91)	836(44.83)	724(59.69)	352(62.52)
At least once a week	1826(90.40)	4074(57.84)	1832(53.76)	1271(82.75)	1184(45.75)	2220(49.55)	1434(54.67)	3056(63.63)	473(66.25)
p-value	< 0.001	< 0.001	< 0.001	< 0.001	0.147	< 0.001	< 0.001	< 0.001	0.264

Univariate analysis magnitude (ORs and 95% CI) of sociodemographic characteristics for 4+ANC visits

As shown on Table 3, adequate ANC visit was lower among young women (15-19 years) in all countries than young adults and adult women (except in Tanzania and Uganda). This difference was significant in Ghana, Kenya, Malawi, Senegal, and Namibia. Four or more ANC use was lower by 2%-60% among rural residents compared to urban across all countries except in Zambia, in which women from rural places were 26% more to attend 4+ANC compared to their counterparts, and the difference was significant in all countries except in Rwanda.

Women’s and husband’s higher educational level of secondary and above has a significant positive association with 4+ ANC visits across all countries in this study.

Table 3. Univariate analysis of sociodemographic factors influencing 4+ ANC visits in nine sub-Saharan countries.

	Ghana	Kenya	Malawi	Namibia	Rwanda	Senegal	Tanzania	Uganda	Zambia	Total
Variables	(3,224)	(10,981)	(9,541)	(2,286)	(4,416)	(6,552)	(5,536)	(7,979)	(5,487)	(56,002)
Age (grouped)										
15-19	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]
20-24	1.40(0.92,2.13)	1.32(1.13,1.54)	1.21(1.05,1.39)	1.79(1.28,2.50)	1.26(0.88,1.79)	1.34(1.10,1.62)	1.10(0.90,1.34)	1.15(0.98,1.36)	1.17(0.97,1.41)	1.21(1.13,1.29)
25-29	1.89(1.24,2.87)	1.37(1.18,1.60)	1.38(1.19,1.60)	2.21(1.56,3.13)	1.36(0.96,1.93)	1.31(1.08,1.59)	1.16(0.95,1.42)	1.18(0.99,1.39)	1.07(0.89,1.30)	1.27(1.19,1.36)
30-34	1.70(1.12,2.58)	1.26(1.07,1.48)	1.43(1.22,1.66)	2.34(1.61,3.40)	1.15(0.81,1.64)	1.28(1.05,1.57)	1.07(0.87,1.32)	1.11(0.94,1.33)	1.16(0.95,1.42)	1.23(1.15,1.32)
35 and above	1.52(1.01,2.29)	1.10(0.93,1.29)	1.39(1.19,1.62)	1.90(1.33,2.71)	1.03(0.72,1.46)	1.14(0.94,1.39)	0.87(0.71,1.07)	0.83(0.70,0.99)	1.04(0.85,1.26)	1.10(1.02,1.17)
Place of residence										
Urban	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]
Rural	0.40(0.32,0.50)	0.60(0.55,0.65)	0.69(0.62,0.77)	0.66(0.54,0.81)	0.98(0.85,1.13)	0.43(0.38,0.47)	0.52(0.45,0.58)	0.68(0.60,0.76)	1.26(1.12,1.42)	0.61(0.59,0.63)
Mother's education										
No schooling	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]
Primary	1.23(0.96,1.58)	1.49(1.35,1.65)	1.15(1.01,1.30)	1.77(1.24,2.51)	1.33(1.11,1.59)	1.70(1.50,1.93)	1.40(1.22,1.62)	1.13(0.99,1.30)	1.22(1.01,1.47)	1.30(1.25,1.36)
Secondary	2.61(2.06,3.30)	2.23(1.98,2.51)	1.38(1.18,1.60)	3.41(2.46,4.72)	1.40(1.11,1.77)	2.13(1.76,2.58)	2.36(1.99,2.80)	1.61(1.37,1.90)	1.18(0.97,1.43)	2.21(2.10,2.33)
Higher	33.59(4.7,241.59)	5.91(4.85,7.20)	3.72(2.58,5.37)	14.43(5.6,37.14)	4.91(3.11,7.78)	7.11(2.43,20.8)	8.54(3.98,18.35)	2.65(2.06,3.40)	3.38(2.28,5.01)	4.97(4.42,5.58)
Husband's education										
No schooling	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]
Primary	1.35(0.97,1.87)	1.57(1.34,1.84)	1.03(0.88,1.20)	1.46(0.96,2.22)	1.23(1.03,1.47)	1.82(1.54,2.15)	1.47(1.23,1.76)	0.95(0.80,1.14)	1.11(0.84,1.45)	1.25(1.19,1.31)
Secondary	2.05(1.63,2.58)	2.27(1.90,2.71)	1.21(1.03,1.43)	2.38(1.66,3.43)	1.17(0.90,1.51)	2.38(1.95,2.91)	2.59(2.10,3.20)	1.33(1.09,1.62)	1.09(0.84,1.43)	2.06(1.95,2.18)
Higher	7.03(3.66,13.49)	4.19(3.27,5.37)	2.25(1.73,2.92)	14.40(4.38,47.36)	2.49(1.72,3.60)	3.12(2.12,4.58)	3.98(2.57,6.18)	1.96(1.55,2.50)	2.26(1.58,3.24)	3.52(3.19,3.88)
Mother's occupation										

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3											
4											
5	Not working O/H	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]
6	Professional/Skilled work	2.27(1.73,2.97)	2.33(1.86,2.91)	1.35(1.17,1.56)	1.88(1.47,2.40)	1.45(1.11,1.89)	1.33(1.17,1.51)	1.72(1.35,2.19)	1.42(1.23,1.63)	1.29(1.10,1.51)	1.73(1.64,1.82)
7	Agriculture	0.80(0.62,1.03)	0.95(0.83,1.09)	1.05(0.95,1.15)	2.26(0.95,5.39)	1.20(0.95,1.51)	0.62(0.54,0.71)	0.63(0.55,0.73)	1.06(0.93,1.20)	1.24(1.08,1.42)	0.87(0.84,0.91)
8	Unskilled	8.02(1.94,33.15)	1.25(1.10,1.43)	1.12(0.99,1.27)	1.72(1.22,2.42)	0.84(0.58,1.21)	1.40(1.16,1.68)	1.09(0.92,1.29)	1.58(1.31,1.91)	1.02(0.84,1.24)	1.13(1.07,1.20)
9	Husband's occupation										
10											
11	Not working O/H		1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]
12	Professional/Skilled work	1.00[Ref]	1.54(0.99,2.39)	1.18(1.00,1.39)	0.65(0.08,5.28)	0.82(0.37,1.84)	1.06(0.78,1.46)	2.21(1.17,4.16)	1.32(1.00,1.74)	1.16(0.92,1.45)	1.35(1.22,1.49)
13	Agriculture	0.30(0.23,0.39)	0.76(0.49,1.18)	0.98(0.84,1.15)	0.27(0.03,2.18)	0.86(0.38,1.92)	0.52(0.38,0.72)	1.16(0.62,2.17)	0.86(0.65,1.14)	1.21(0.97,1.51)	0.86(0.78,0.95)
14	Unskilled	0.89(0.60,1.32)	1.09(0.71,1.69)	1.00(0.85,1.19)	0.55(0.07,4.51)	0.74(0.32,1.67)	0.96(0.69,1.34)	1.97(1.04,3.72)	1.15(0.85,1.55)	0.97(0.76,1.24)	1.10(0.99,1.22)
15	Wealth quintile										
16											
17	Poorest	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]
18	Poorer	1.22(0.96,1.56)	1.37(1.23,1.52)	1.11(0.98,1.25)	1.03(0.77,1.37)	1.15(0.96,1.37)	1.50(1.31,1.72)	1.13(0.95,1.33)	1.16(1.02,1.32)	1.04(0.89,1.22)	1.19(1.14,1.25)
19	Middle	1.67(1.26,2.20)	1.70(1.52,1.90)	1.07(0.95,1.21)	1.40(1.04,1.88)	1.22(1.01,1.47)	2.10(1.82,2.42)	1.35(1.14,1.59)	1.25(1.09,1.43)	0.90(0.76,1.05)	1.34(1.27,1.41)
20	Richer	4.40(2.94,6.59)	2.12(1.89,2.39)	1.19(1.05,1.35)	1.70(1.25,2.31)	1.18(0.98,1.43)	3.48(2.96,4.10)	2.07(1.76,2.44)	1.48(1.29,1.71)	0.72(0.61,0.86)	1.60(1.52,1.69)
21	Richest	13.36(6.53,27.33)	3.41(3.00,3.88)	1.65(1.45,1.87)	2.59(1.77,3.80)	1.10(0.92,1.32)	5.93(4.81,7.31)	3.02(2.53,3.60)	1.87(1.62,2.16)	1.18(0.98,1.42)	2.13(2.02,2.25)
22	Birth order										
23											
24	First	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]
25	Second	1.18(0.85,1.65)	0.91(0.81,1.02)	0.89(0.79,1.00)	1.14(0.86,1.50)	0.88(0.74,1.03)	0.93(0.79,1.08)	0.82(0.70,0.97)	1.01(0.87,1.16)	0.97(0.82,1.14)	0.93(0.88,0.98)
26	Third	0.85(0.62,1.18)	0.80(0.71,0.91)	0.97(0.85,1.10)	1.41(1.01,1.96)	0.83(0.69,1.00)	0.75(0.64,0.88)	0.72(0.61,0.86)	0.95(0.82,1.11)	0.89(0.74,1.06)	0.87(0.82,0.92)
27	Fourth	1.06(0.74,1.53)	0.68(0.60,0.78)	0.98(0.86,1.12)	0.86(0.61,1.23)	0.61(0.50,0.76)	0.73(0.61,0.87)	0.65(0.54,0.79)	0.91(0.77,1.07)	1.04(0.85,1.26)	0.81(0.76,0.86)
28	Fifth & above	0.56(0.42,0.73)	0.51(0.46,0.57)	0.96(0.86,1.08)	0.59(0.45,0.79)	0.58(0.49,0.69)	0.58(0.50,0.66)	0.50(0.43,0.58)	0.71(0.62,0.80)	0.82(0.71,0.96)	0.65(0.62,0.68)
29	Frequency of listening to radio/ watching TV/ reading newspaper or magazine										
30											
31	Not at all	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]
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Less than once a week	1.88(1.42,2.48)	1.59(1.39,1.81)	1.05(0.94,1.18)	2.01(1.46,2.78)	1.01(0.83,1.22)	1.19(0.99,1.42)	1.35(1.16,1.57)	1.29(1.11,1.49)	0.97(0.80,1.17)	1.15(1.09,1.21)
At least once a week	4.02(3.11,5.20)	2.08(1.90,2.28)	1.27(1.16,1.39)	2.91(2.21,3.83)	1.14(0.96,1.34)	1.91(1.64,2.22)	2.00(1.73,2.32)	1.52(1.37,1.69)	1.14(0.96,1.36)	1.53(1.47,1.59)

Bold font indicates a significant difference from reference at p<0.05. O/H: outside home.

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3 Women of the professional work category were significantly higher on 4+ANC
4 visits than women who do not work outside the home, and this difference was
5 consistent across all countries. The strength of the association of women's
6 socioeconomic status and 4+ANC visits showed considerable variation. For example,
7 the magnitude of ORs for 4+ANC among the richest women varies from 1.10(0.92,
8 1.32) in Rwanda to 13.36(6.53, 27.33) in Ghana.
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17 The 4+ANC utilization pattern shows an inverse relationship with the mother's
18 previous pregnancy experience, and the difference was significant. The magnitude of
19 ORs of 4+ANC was lower from 4%-50% among fifth and above birth women than
20 among first births. Listening to radio/ watching TV/ reading newspaper or magazine
21 has a significant positive association with 4+ANC attendance across all countries
22 except in Rwanda and Zambia (Table 3).
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32 **Multivariable findings**

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34 Table 4 summarizes data analysis results adjusted by sociodemographic variables
35 and the overall adjusted by cluster (country).
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39 Overall, the 4+ ANC visits were 14% lower among women from the rural area
40 than from urban, and the difference was significant (AOR, 0.86; 95% CI: 0.81,0.91).
41 Multivariable logistic regression analysis exploring the relationship between 4+ ANC
42 visits and place of residence was significant in four countries (Kenya, Malawi,
43 Senegal and Zambia). While in Ghana, Namibia, Rwanda, Tanzania, and Uganda;
44 4+ANC visit and women place of residence has no association. Unlike all countries,
45 in Zambia, the proportion of 4+ANC visits was significantly higher among women
46 from rural areas than from urban.
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57 Findings of selected sociodemographic predictors related to ANC visit after
58 adjusted for cluster (country) variations indicated that the use of ANC service increase
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3 from 14% (AOR=1.14, 95%CI 1.07-1.21, $p<0.001$) to 96% (AOR=1.96, 95% CI
4 1.65-2.33, $p<0.001$) with an increase in mother's educational level compared to
5 mothers who have not attended any education. The odds of 4+ANC visits were higher
6 among women with higher educational levels than women who have not schooled in
7 all countries, but the difference was only significant in Kenya, Malawi, Rwanda, and
8 Zambia. Husband's higher academic level was significantly associated with 12%-48%
9 higher odds of women 4+ANC visit ($p<0.001$). Even though the husband's education
10 is related to 4+ANC visits across all the studied countries, the association is
11 meaningful after adjusting only in three countries; Kenya, Malawi, and Zambia.
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24 Women in the wealthiest group were found to be highly likely to receive more
25 4+ANC visits. After adjusting for the cluster (country), ANC service utilization
26 increased consistently from 12%, 18%, 32%, and 41% for every 20% variation on the
27 wealth category compared to the most deficient level, and the difference was
28 significant ($p<0.001$) (Table 4). Across the studied countries, household's economic
29 status has a positive association with higher 4+ANC visits except in Rwanda. The
30 proportions of 4+ANC visits were 4% (AOR=0.96, 95% CI; 0.78-1.19 and 14%
31 (AOR=0.86, 95% CI; 0.64-1.16) lower among middle and richer economic status in
32 Zambia after adjusted for the other variables, and the difference was none significant
33 ($p>0.05$).
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47 Overall, women's occupation has a positive association with 4+ANC visits. The
48 variation on 4+ANC visits was 19%, 7%, and 13% more among women working as
49 Professional/Skilled, Agriculture, and Unskilled labour. Employed women on an
50 unskilled level in Ghana were more than fifteen times (AOR, 15.54, 95%CI; 2.1,
51 114.9) more to attend 4+ANC visits than women who have no work outside the home.
52 Another similar group, women in Uganda, were 62% more to attend 4+ANC (AOR,
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3 1.62, 95%CI; 1.28, 2.05), and the difference was significant. Women employed in
4 agriculture in Kenya, Senegal, and Tanzania and unskilled worker in Rwanda,
5 Tanzania, and Zambia, were on lower uptake of 4+ANC, and the association was not
6 significant.
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12 Women with previous experience on birth have a disadvantage in ANC
13 utilization. Four or more ANC use's odds were lower by 16%, 21%, 23%, and 32%
14 for second, third, fourth, and fifth and above than the first birth women. All this
15 difference was significant ($p < 0.001$) (Table 4). Country wise analysis shows, the
16 difference in birth order and 4+ANC visits were significant in Kenya, Rwanda,
17 Senegal, Tanzania, Uganda, and Zambia.
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26 Women who have access to media at least once a week relates with the use of
27 4+ANC up-to 22% higher than women who have not at all (AOR, 1.22, 95%CI;
28 1.15,1.29). This association was significant in all countries except in Malawi,
29 Rwanda, Senegal, and Zambia.
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Table 4. Adjusted multivariable analysis of sociodemographic factors influencing 4+ ANC visits in nine sub-Saharan countries.

Variables	Ghana	Kenya	Malawi	Namibia	Rwanda	Senegal	Tanzania	Uganda	Zambia	Overall *
Place of residence										
Urban	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]
Rural	0.84(0.61,1.15)	0.83(0.72,0.9)	0.83(0.71,0.96)	0.83(0.57,1.21)	0.95(0.77,1.18)	0.73(0.62,0.84)	0.83(0.69,1.01)	0.86(0.72,1.01)	1.48(1.2,1.82)	0.86(0.81,0.91)
Mother's education										
No schooling	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]
Primary	1.06(0.78,1.43)	1.12(0.90,1.39)	1.09(0.94,1.27)	1.34(0.83,2.16)	1.20(0.99,1.46)	1.06(0.91,1.23)	1.04(0.88,1.22)	1.03(0.87,1.22)	1.12(0.90,1.41)	1.14(1.07,1.21)
Secondary	1.47(1.05,2.05)	1.23(0.94,1.60)	1.11(0.91,1.35)	1.78(1.04,3.05)	1.28(0.95,1.74)	1.08(0.84,1.4)	1.00(0.79,1.28)	1.19(0.96,1.47)	1.05(0.81,1.38)	1.17(1.08,1.21)
Higher	4.82(0.6,37.23)	2.17(1.42,3.32)	2.26(1.42,3.60)	2.13(0.51,8.93)	3.82(2.17,6.73)	1.78(0.58,5.47)	2.19(0.91,5.30)	1.30(0.92,1.83)	2.06(1.20,3.55)	1.96(1.65,2.33)
Husband's education										
No schooling	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]
Primary	1.04(0.73,1.48)	1.08(0.87,1.36)	0.97(0.83,1.15)	1.11(0.71,1.75)	1.10(0.91,1.33)	1.35(1.13,1.61)	1.18(0.98,1.42)	0.86(0.70,1.05)	1.07(0.81,1.42)	1.12(1.05,1.20)
Secondary	0.97(0.72,1.33)	1.20(0.93,1.56)	1.06(0.88,1.27)	1.21(0.77,1.88)	0.93(0.69,1.24)	1.36(1.09,1.71)	1.35(1.05,1.72)	1.01(0.80,1.26)	1.15(0.86,1.54)	1.17(1.09,1.27)
Higher	1.42(0.69,2.93)	1.41(1.00,1.97)	1.42(1.03,1.95)	3.57(0.9,14.17)	1.42(0.88,2.27)	1.32(0.86,2.02)	1.38(0.84,2.27)	1.22(0.91,1.63)	1.91(1.23,2.96)	1.48(1.31,1.69)
Mother's occupation										
Not working O/H	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]
Professional/Skilled work	1.99(1.46,2.27)	1.19(0.91,1.56)	0.97(0.81,1.15)	1.64(1.11,2.44)	1.23(0.91,1.66)	1.09(0.94,1.26)	1.24(0.93,1.65)	1.38(1.18,1.62)	1.24(1.01,1.50)	1.19(1.11,1.27)
Agriculture	1.44(1.06,1.97)	0.98(0.83,1.15)	1.08(0.96,1.19)	2.25(0.75,6.72)	1.16(0.87,1.53)	0.89(0.76,1.04)	0.89(0.75,1.07)	1.26(1.09,1.46)	1.14(0.96,1.35)	1.07(1.01,1.13)
Unskilled	15.54(2.1,114.9)	1.06(0.91,1.24)	1.07(0.92,1.22)	1.58(0.85,2.97)	0.79(0.52,1.21)	1.09(0.87,1.35)	0.95(0.78,1.16)	1.62(1.28,2.05)	0.96(0.76,1.23)	1.13(1.05,1.21)
Wealth quintile										
Poorest	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]
Poorer	0.93(0.70,1.23)	1.09(0.91,1.32)	1.07(0.94,1.23)	0.74(0.48,1.13)	1.06(0.87,1.28)	1.37(1.19,1.58)	1.05(0.87,1.26)	1.18(1.02,1.37)	1.09(0.91,1.32)	1.12(1.06,1.19)

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Middle	0.93(0.64,1.36)	1.18(0.96,1.45)	1.09(0.94,1.26)	0.85(0.53,1.36)	1.12(0.91,1.37)	1.56(1.32,1.86)	1.15(0.95,1.40)	1.19(1.01,1.40)	0.96(0.78,1.19)	1.18(1.11,1.26)
Richer	1.88(1.09,3.23)	1.21(0.97,1.51)	1.07(0.92,1.25)	0.79(0.45,1.40)	1.04(0.84,1.30)	2.26(1.83,2.79)	1.62(1.31,2.00)	1.29(1.08,1.5)	0.86(0.64,1.16)	1.32(1.23,1.42)
Richest	4.74(1.9,11.95)	1.55(1.19,2.04)	1.23(1.02,1.50)	1.31(0.57,3.00)	0.77(0.57,1.02)	3.62(2.78,4.72)	1.69(1.27,2.24)	1.27(1.02,1.60)	1.17(0.81,1.69)	1.41,1.29,1.55)
Birth order										
First	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]
Second	1.08(0.72,1.63)	0.71(0.58,0.87)	0.83(0.72,0.95)	1.22(0.74,1.99)	0.72(0.60,0.87)	0.88(0.74,1.06)	0.82(0.68,1.00)	0.95(0.80,1.13)	0.87(0.70,1.08)	0.84(0.79,0.90)
Third	0.77(0.52,1.15)	0.62(0.51,0.76)	0.91(0.79,1.05)	1.06(0.64,1.76)	0.68(0.55,0.83)	0.78(0.65,0.94)	0.72(0.59,0.89)	0.97(0.81,1.16)	0.76(0.61,0.96)	0.79(0.74,0.85)
Fourth	1.06(0.69,1.64)	0.56(0.45,0.70)	0.95(0.82,1.11)	1.12(0.65,1.94)	0.52(0.42,0.66)	0.76(0.62,0.92)	0.71(0.57,0.88)	0.88(0.73,1.07)	0.91(0.71,1.17)	0.77(0.72,0.83)
Fifth & above	0.75(0.52,1.08)	0.50(0.41,0.61)	0.98(0.85,1.12)	0.79(0.49,1.26)	0.50(0.41,0.61)	0.68(0.58,0.80)	0.61(0.51,0.73)	0.77(0.65,0.90)	0.73(0.59,0.90)	0.68(0.64,0.73)
Frequency of listening to the radio/reading newspaper/magazines										
Not at all	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]
Less than once a week	1.47(1.08, 2.00)	1.35(1.08,1.68)	1.05(0.94,1.20)	1.94(1.22,3.07)	0.95(0.78,1.17)	1.06(0.87,1.29)	1.11(0.93,1.33)	1.13(0.96,1.34)	1.01(0.80,1.28)	1.08(1.01,1.15)
At least once a week	2.62(1.96,3.50)	1.21(1.02,1.44)	1.09(0.98,1.22)	2.31(1.51,3.53)	1.07(0.88,1.30)	1.14(0.96,1.35)	1.34(1.12,1.60)	1.24(1.09,1.41)	1.05(0.85,1.30)	1.22(1.15,1.29)

All are adjusted for sociodemographic factors and media exposure. * adjusted for sociodemographic factors, media exposure, and country. **bold font** indicates a significant difference from reference at p<0.05, O/H:

outside home

Discussion

In an era of envision for every pregnant woman to receive quality care throughout her pregnancy, only 55.52% women in nine sub-Saharan Africa countries have received four or more uptake of ANC on average. This low proportion is comparable to the researches from Nigeria (53.3%)²³ and India (51.7%)²². Therefore, there is an urgent need on intervention towards maximizing the utilization of ANC in low income countries.

Pooled data adjusted by countries has shown that all sociodemographic variables (Rural place of residence, no women and husband's schooling, no maternal employment, poorest household economic status, lack of access to media and a history of previous births) were significantly associated with lower utilization of 4+ANC (Table 5). This is in line with previous studies^{6 10 14 17 20 22}. Efforts focused on reaching adequate ANC by all women in sub-Saharan countries must be strengthened through community and regional marginalization. Programs on monitoring adequate ANC attendance and maternal health for disadvantaged women (Table-4) should be implemented. The roadmap for the integrative approach towards sustainable development goal 3 (SDG-3) achievement must be fully exercised within countries despite the projection on missing the SDG targets in the region⁴.

Country-level data showed that women's socioeconomic status is significantly associated with the likelihood of having 4+ANC visits. This is consistent with previous studies in developing countries^{7 8 20 24}, and women in predominantly poor communities have lower odds of ANC visits^{10 17 20 22}. Inequalities in wealth are baseline risks and critical determinants of poor maternal health, particularly in sub-Saharan countries⁴. Efforts are needed to address these disparities within

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3 countries since new-born infants from poorer households often have worse health
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5 outcomes than from wealthy households.
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8 The overall progress made on 4+ANC visits was comparable with the 1990-2001
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10 study across all the studied countries. Women from rural places made better
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12 improvements than the urban residents except in Tanzania and Zambia⁶. Overall, the
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14 odds of 4+ANC visits were lower by 5%-27% among rural women in eight of the
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16 studied countries, and this was significant in Kenya, Malawi, and Senegal. However,
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18 one data (Zambia) indicated a 48% more uptake of 4+ANCs by rural residents [Table
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20 4]. This finding in Zambia is contrary to other studies ²¹⁻²³. For many conditions,
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22 particularly in low-income SSA countries, premature illness and deaths can be averted
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24 by removing barriers to accessing health service utilization for ANC. These can be
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26 economical, as well as physical barriers ^{11 24}. To address the inequalities in the
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28 utilization of ANC services, strategies that encompass intervention on regional
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30 disparities to reach women living in rural areas with limited resources are essential.
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32 Such programs should include a holistic approach to women education, income, free
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34 or subsidized care, and transport interventions, similar to lessons from other studies in
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36 the sub-Saharan countries ^{8 20 26}.
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42 Our findings revealed that women of first birth three years preceding the survey
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44 were more likely to receive 4+ANC than older adults of second and above births
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46 except in Namibia. Women of fifth and above births in Kenya and Rwanda were 50%
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48 lower to attend 4+ANC than first birth women and the difference was significant in
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50 Kenya, Rwanda, Senegal, Tanzania, Uganda, and Zambia, similar to previous
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52 research studies ^{17 31}. Consistent to our findings in Namibia, research in Nigeria
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54 suggested that adolescents are less likely to attend ANC services ²⁸.
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Listening to radio/ watching TV/ reading newspapers or magazines at least once a week has a positive association with the uptake of 4+ANC across all the studied countries. In two countries (Ghana and Namibia), women who have access to media were more than twice more likely to attend 4+ANC than women who have not at all, and the difference was significant. Although previous studies highlighted media plays a significant role in utilizing facility service for 4+ANC ^{8 10 17 22}, no association was detected in Rwanda, Senegal, Malawi, and Zambia. Therefore, further actions should be strengthened to increase the reach of ANC information among the studied countries.

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At the individual level, we found that women with secondary and higher education levels were the most likely to use 4+ANC visits than women with no schooling, in line with previous research studies ^{6 8 10 17 22}. This was consistent after adjustment, and the difference was significant in Kenya, Malawi, Rwanda, and Zambia. Similarly, husband's higher education level has a positive influence on women's 4+ANC visits across all the studied countries (Table 4). This difference was significant in Kenya, Malawi, and Zambia. Therefore, higher educational status women are at a lower risk of the ANC visit lost opportunities consistent with other research studies ^{6 10 22}.

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Differences in service use for 4+ANC and women employment were not consistent in this study. In two countries Ghana and Uganda, employment outside the home during pregnancy was significantly associated with 4+ANC visits in support of the existing literature ¹⁷. This could be due to overcoming the financial challenges similar to a study from India ²². In this study, Tanzanian women employed in agriculture or as unskilled labor had lower 4+ANC visits than housewives /unemployed, similar to a lesson in Indonesia ¹⁰.

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Despite the global efforts towards attaining the new commitment of SDG-3 on maternal and newborn health, countries in SSA like Rwanda, Senegal, Tanzania, Malawi, and Kenya are far below the required 4+ANC visits, similar to studies from other countries^{22 23}. Although not all 100%, we need to look at the factors affecting ANC attendance inadequate coverage. Therefore, governments can share the best lessons from neighboring countries on ecological and socioeconomic factors and progress towards maternal health. In this study, Ghana and Namibia have shown 85.6% and 78.9% of 4+ANC visits across all reproductive age groups. Ghana's present finding is in line to the 2013 cross-sectional study conducted in three sites of Ghana, where 86% of women reported attending 4+ANC visits, which is probably due to the health insurance service in Ghana²⁰. Very poor use of 4+ANC in Rwanda, Senegal, and Tanzania may have multiple and complex social, economic and demographic determinants deterring the required attendance of ANCs. Therefore, lessons on implementation of applauded interventions on ANC attendance from neighboring countries must be contextualized to maintain national and regional adequate ANC visits.

Conclusion and recommendation

Four or more ANC service utilization is very low among women of the studied countries. Women from low economic class or region were less likely to attend the required 4+ANC visits. Sociodemographic factors (living in rural, no educational level, low-income family, and lack of access to media) have significant negative effect on the use of 4+ANC services. There is also heterogeneity between and within countries and the community. Regional and country-specific interventions are required to address the barriers to adequate ANC visits. Furthermore, exploring effective ways of increasing ANC service utilization must be enhanced among the

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3 whole population in the region and particularly to young women, no schooled,
4 low-income level, and multipara women. More caution is required to evaluate the gain
5 of 4+ANC use among the better-off rather than the poor for the SDG achievement.
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10 **Author Contributions:** Conceptualization, methodology, literature review, formal
11 analysis, and writing original draft, AKA. Writing—review and editing, AKA.; LXZ.;
12 ZZH.; MEM. and QQ. Supervision, LXZ. All authors read and approved the final
13 manuscript.
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27 sites on the map.
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32 **Competing interests:** None declared.
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36
37 **Patients consent for publication:** Not required.
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41 **Ethics approval:** This study was exempt from review by the ethics committee as
42 publicly available data sets were used and no identifying participant information was
43 obtained. The authorization for using the data in the current analysis was granted from
44 the DHS program: DHS, ICF international, Rockville, Maryland, USA office upon
45 presenting the research protocol and research plan aims.
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50 **Data availability statement:** Data sets used in the analysis are publicly available and
51 can be accessed online through application to MEASURE DHS. Analysis syntaxes
52 and outputs generated for the study can be made available upon request to the
53 corresponding author.
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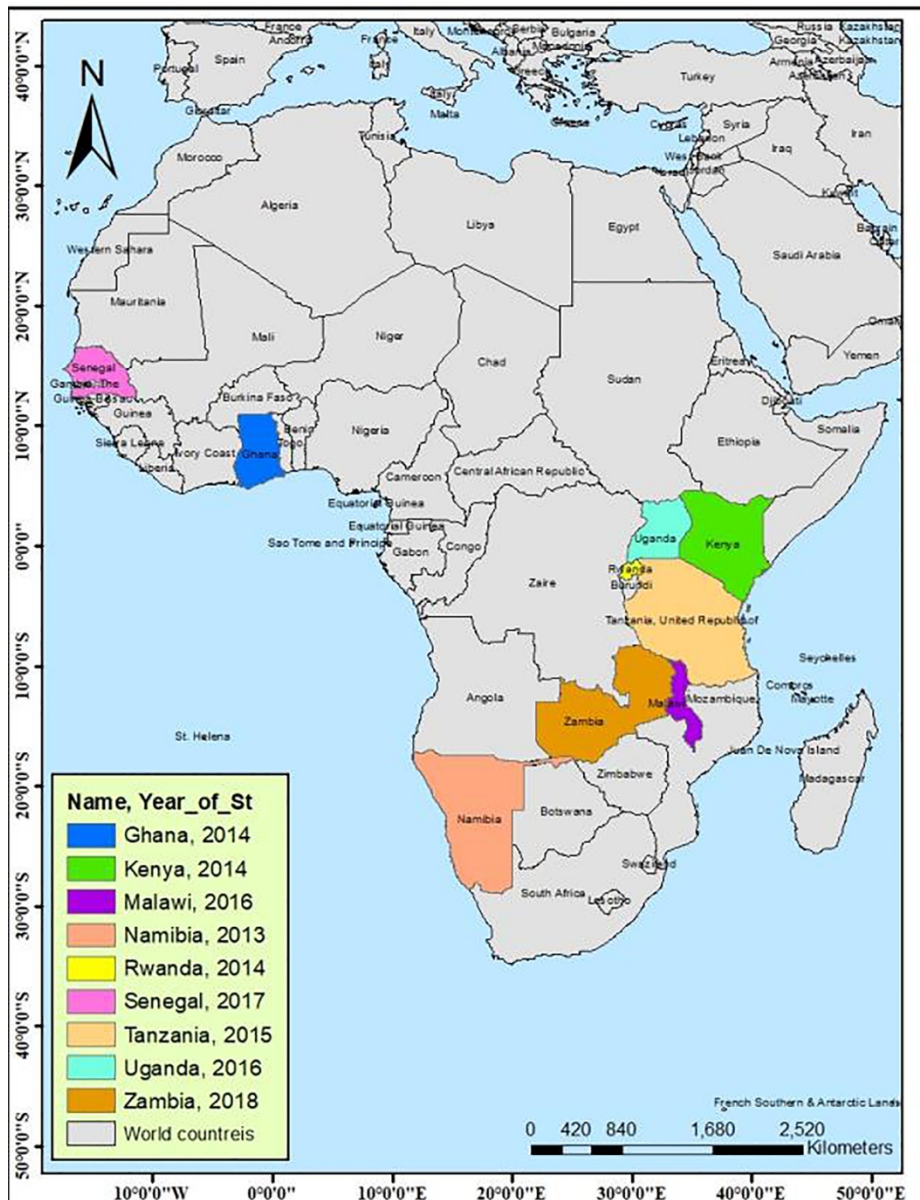


Figure 1. Map of African countries showing the geographical location of the study sites (source: Geographic Coordinate System: GCS_WGS_1984, Datum: D_WGS_1984, Prime Meridian: Greenwich, Angular Unite: Degree)

163x211mm (300 x 300 DPI)

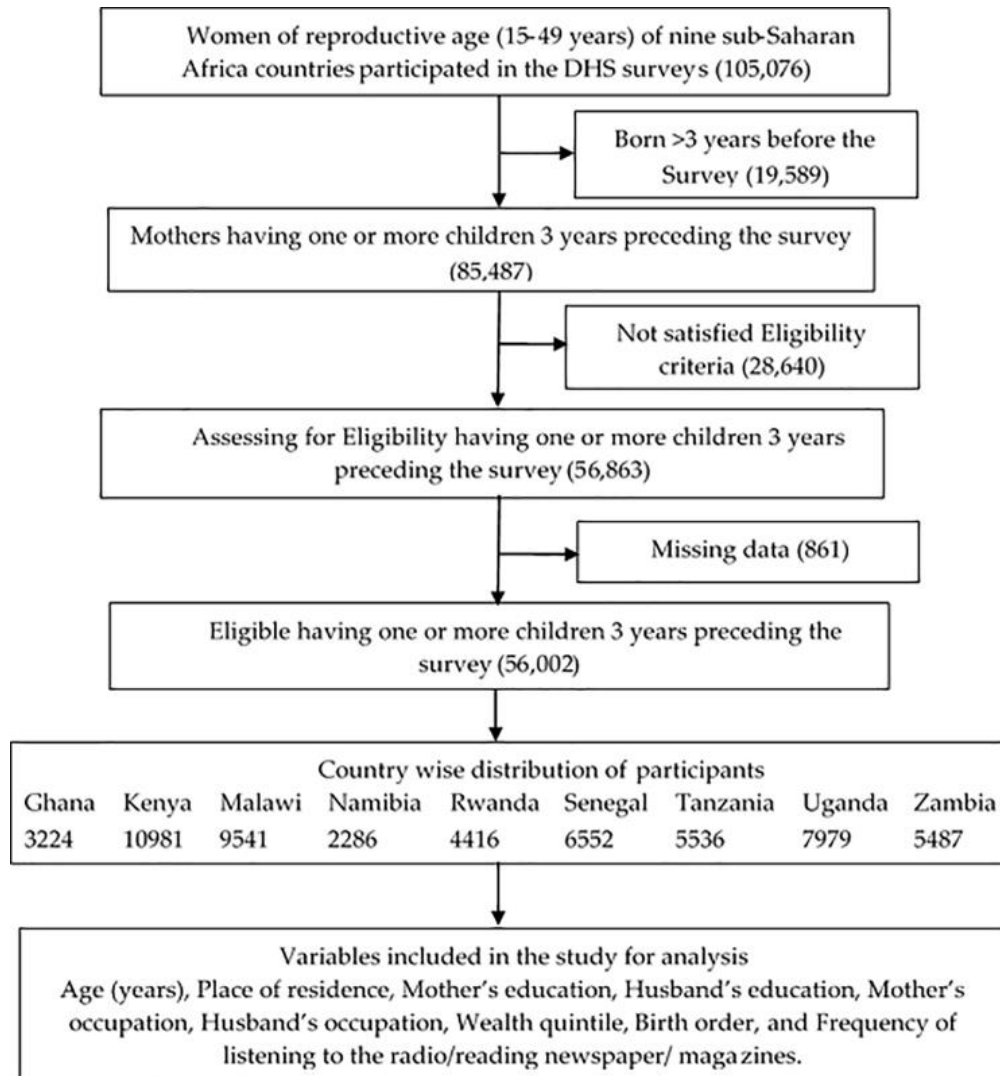


Figure 2: Flow chart of the process of selection of women for analysis of 4+ANC

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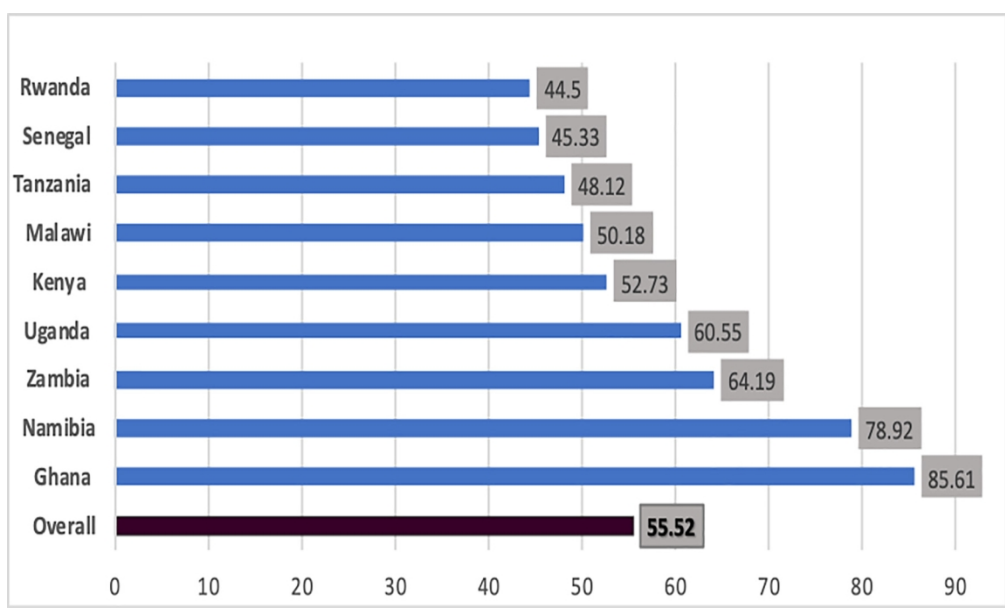


Figure 3. Percentage distribution of 4+Antenatal care visits among women in nine sub-Saharan countries

151x90mm (300 x 300 DPI)

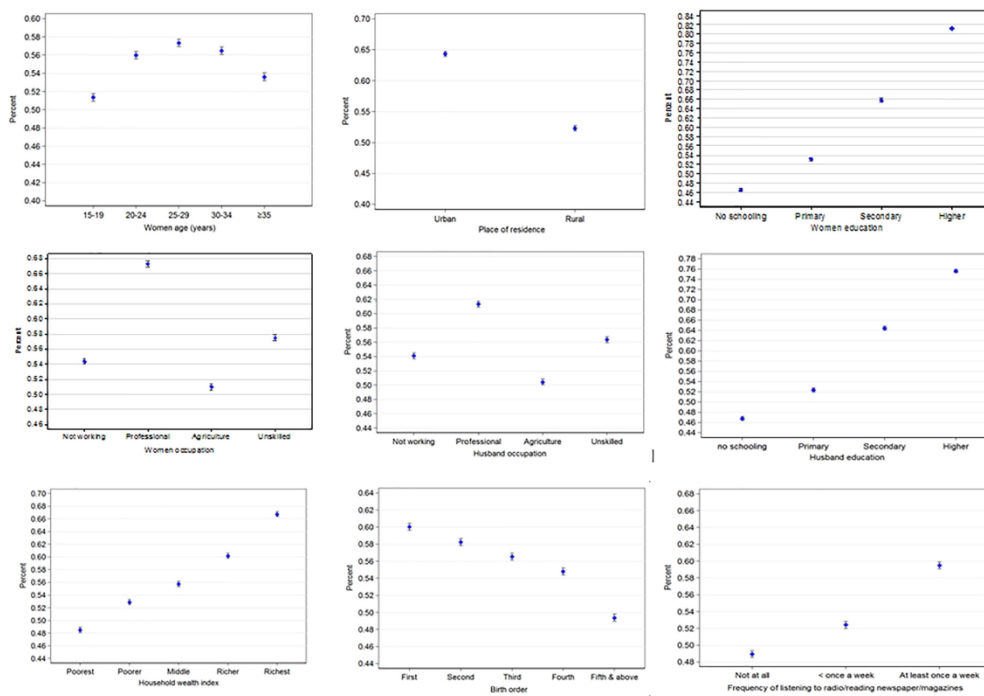


Figure 4. Distribution of 4+ANC visits of study participants, by sociodemographic factors, with 95% confidence interval

251x174mm (300 x 300 DPI)

Table1. Distribution of study participants for ANC visit by sociodemographic factors

Variables	N	Percent (%)
Age group		
15-19	5084	9.08
20-24	14930	26.66
25-29	14168	25.30
30-34	10804	19.29
35 and above	11016	19.67
Place of residence		
Urban	15024	26.83
Rural	40978	73.17
Women education		
No schooling	12589	22.48
Primary	28673	51.20
Secondary	12703	22.68
Higher	2037	3.64
Husband education		
no schooling	9368	22.53
Primary	18617	44.78
Secondary	10968	26.38
Higher	2624	6.31
Women occupation		
Not working outside home	15820	31.48
Professional/Skilled work	9222	18.35
Agriculture	18823	37.45
Unskilled	6392	12.72
Husband occupation		
Not working outside the home	1744	4.17
Professional/Skilled work	14721	35.22
Agriculture	16758	40.09
Unskilled	8579	20.52
Wealth quintile		
Poorest	15283	27.29
Poorer	12308	21.98
Middle	10560	18.86
Richer	9452	16.88
Richest	8399	15.00
Birth order		
First	13434	23.99
Second	11333	20.24
Third	8927	15.94
Fourth	6901	12.32
Fifth & above	15407	27.51
Frequency of listening to the radio/reading newspaper/magazines		
Not at all	14976	27.54
Less than once a week	10184	18.73
At least once a week	29213	53.73

BMJ Open

Determinants of Antenatal care use in nine sub-Saharan Africa countries: evidence from cross-sectional study of Demographic and Health Surveys

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3 **Determinants of Antenatal care use in nine sub-Saharan Africa countries:**
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5 **evidence from cross-sectional study of Demographic and Health Surveys**
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33 **Abstract:**

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36 **Objective:** Literature on determinants of antenatal care visits in sub-Saharan Africa
37 remains limited. The aim of this study is to explore the factors associated with
38 antenatal care visits.
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41 **Design:** A secondary data analysis from cross-sectional studies was conducted.

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43 **Setting:** Sub-Saharan Africa (SSA)

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45 **Participants:** 56002 women aged 15-49 years who gave birth three years preceding
46 the survey (2013-2019) from Ghana, Kenya, Malawi, Namibia, Rwanda, Senegal,
47 Tanzania, Uganda, and Zambia were analyzed.
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49
50 **Outcomes:** Four or more antenatal care (4+ANC) visits

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52 **Results:** Overall 55.52% (95% CI: 55.11 to 55.93) of women had 4+ANC visits.
53 The highest and lowest 4+ANC visits were from Ghana (85.6%) and Rwanda
54 (44.5%). Women 15-19 years from Ghana, Kenya, Malawi, Senegal, and Namibia
55 had lower 4+ANC visits. Multivariable analysis showed that the odds of 4+ANC
56 visits were 14% lower among rural women (AOR:0.86;95% CI: 0.81 to 0.91) and
57 this difference was significant in Kenya, Malawi, and Senegal. Unlike other
58 countries, this was 48% higher (AOR:1.48;95% CI: 1.2 to 1.82) among rural women
59 in Zambia. Women with higher educational levels had more than two-fold higher
60

odds of 4+ANC visits in seven countries, and it was significant in Kenya, Malawi, Rwanda, and Zambia. Compared to the poorest households, odds of 4+ANC visits increased by 12 % (AOR:1.12;95% CI: 1.06 to 1.19), 18% (AOR:1.18; 95% CI: 1.11 to 1.26), 32% (AOR:1.32; 95% CI: 1.23 to 1.42), and 41% (AOR:1.41,95% CI 1.29 to 1.55) for every 20% variation on the wealth quantile. First-time pregnancy and access to media at least once a week were associated with 4+ANC visits.

Conclusion: Despite its importance, ANC service utilization was low among women of the SSA countries. Therefore, regional and country-specific maternal health programs focused on women of rural resident, no schooled, no outside-home occupation, low-economic status, non-first-time pregnancy, and no access to media are required.

Keywords: Four or more antenatal care, Determinants, sub-Saharan Africa, Demographic health survey, and health service utilization.

Strengths and limitations of this study

- The analytical approach both as pooled data support the outcome to be valid and the merit in segregating data allows to focus on aspects of ANC visits that may remain hidden in intra-national/national level indicators
- The study used national representative samples from nine sub-Saharan Africa countries which have been linked to enhance the generalizability of the study
- This analysis included women who have birth three years before the survey, which could minimize the recall bias of self-report at a single point in time
- The cross-sectional nature of the study design cannot affirm the cause-effect or direction of association of the predictors.
- Since the data sets were obtained from countries DHS in a different time, awareness of participants may be varied due to time heterogeneity

Introduction

Maternal and neonatal mortality which remains unacceptably high is a significant public health issues that reflect the overall status of a country's healthcare system and socioeconomic development¹. The world health organization (WHO) estimates that approximately 830 maternal deaths/day from preventable causes relate to pregnancy and childbirth, and 99% of these deaths occur in low-income countries ². Sub-Saharan Africa (SSA) remains the region with the highest maternal and under-five mortality ³⁻⁵. Almost half of the under-five deaths occur among new-born babies whose deaths could be prevented by reaching a high coverage of quality antenatal care, skilled care

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3 at birth, postnatal care for mother and baby, and care of small and sick new-born ^{3 4}.
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5 Several review studies on intervention for maternal and new-born life have
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7 demonstrated that the provision of adequate antenatal care (ANC) brings with it a
8
9 positive impact on pregnancy outcomes through early diagnosis and appropriate
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11 management and this has a 39% reduced risk of neonatal mortality in sub-Saharan
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13 countries ⁶⁻⁹.
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17 The WHO advises every pregnant woman with a normal pregnancy in middle-
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19 and low-income countries to attend at least four ANCs ¹. However, many women in
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21 low income countries particularly in SSA have limited access ¹⁰. Several studies have
22
23 attempted to identify factors associated with the underutilization of ANC's ^{11 12}. Age
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25 12-16, women's education ^{8 12-24}, husbands' education ^{18 22 23}, socioeconomic status ¹⁴⁻²³
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27 ²⁵, women's employment ¹⁸, birth order ^{11 12 18}, frequency of listening to the
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29 radio/watching TV/reading newspaper/ magazines ^{8 11 18 23 24}, and place of residence ¹²
30
31 ^{13 16-19 22 24 25} are among the most identified factors associated with underutilization of
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33 ANC. Evidence shows that the factors attributed to inadequate ANC follow-ups are
34
35 quite substantial across regions and countries ^{11 16 23 26 27}.
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40 Meeting SDGs to ensure healthy lives and well-being for all ages by 2030
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42 requires transnational organizations' efforts and the ability to collaborate in
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44 partnership. Interestingly the means of implementing and revitalizing capacity
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46 development and the information exchange of multinational cooperation have been
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48 emphasized in the SDGs ²⁸. Despite the available evidence on ANC's key role in
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50 reducing maternal and neonatal mortality, millions of women in developing countries
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52 do not receive it and there remains a high variability (32%-91%) of four or more
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54 ANC (4+ANC) visits between countries ^{21 22 24 29}. Lessons on coverage of crucial
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56 ANCs from neighboring areas would aid in precise allocations of resources and
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3 interventions where they are most needed. Therefore, new research projects on mutual
4 benefit and knowledge sharing at every level must be implemented to attain global
5 health development goals.
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10 We conducted secondary data analysis using the latest (2013-2019) standard
11 Demographic health survey conducted in nine sub-Saharan Africa countries (Ghana,
12 Kenya, Malawi, Namibia, Senegal, Rwanda, Tanzania, Uganda, and Zambia). The
13 objective of the study was to understand the factors associated with 4⁺ANC
14 attendance.
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22 **Materials and Methods**

23 **Study design**

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26 We used data from the Demographic and Health Survey (DHS). DHS is a five-
27 year periodic national representative cross-sectional study using a stratified two-stage
28 cluster sampling design. Details of the DHS protocol are published elsewhere ³⁰.
29 Information from ever-married women aged 15-49 years in nine sub-Sahara Africa
30 countries on demographic characteristics and reproductive history were collected.
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40 The nine countries included in this analysis and their year of survey are; Ghana
41 (DHS 2014), Kenya (DHS 2014) Malawi (DHS 2015/2016), Namibia (DHS 2013),
42 Rwanda (DHS 2014/2015) Senegal (DHS 2017), Tanzania (DHS 2015/2016), Uganda
43 (DHS 2016) and Zambia (DHS 2018/2019). Countries were selected based on the
44 availability of recent standard DHS data after 2010 and representing the four different
45 sub-regions of the Sub-Saharan Africa, i.e. Western, Central, Southern, and Eastern
46 Africa.
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57 **Data sources/ measurements**

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3 Data sets were collected through household interviews using a structured
4 questionnaire. Women were interviewed about the number of ANC visits. Trained
5 interviewers obtained informed consent from all eligible women in selected
6 households before conducting the interview using pencil and paper questionnaires.
7
8 The surveys are weighted for over or under-sampling and non-response. Thus, the
9 design and standardized core modules allow for regional and transnational
10 comparison of the data. Field supervisors and data clerks checked all forms before
11 entering them into databases. Data for this analysis was taken from the latest
12 household survey of the studied countries. This study's survey years ranged from 2013
13 to 2019, and the sample size ranges from 2,286 in Namibia to 10,981 in Kenya.
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27 **Participants**

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30 Women who had one or more births three years before the survey were included
31 as study participants. Selection criteria of study participants was as shown in (Figure-
32 1). In the DHS survey, information about antenatal care is only collected for the
33 youngest child under-five years. Therefore, to minimize the degree of error due to
34 recall bias we have limited our analysis to those births happened three years before
35 the survey. Overall and country wise contribution of study participants is presented in
36 Figure 1.
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46 **Exclusion criteria**

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48 ANC provided by non-health professionals such as traditional birth attendants
49 were excluded from the present analysis.
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53 **Outcome variable**

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55 We used antenatal care visits as our primary outcome. We categorized this
56 variable in to binary as 4⁺ANC visits (yes= if the mother had at least four ANC visits)
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3 and (no= if the mother had less than four ANC visits) during the last pregnancy three
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5 years before the survey.
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8 **Explanatory variables**

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10 A set of sociodemographic variables related to the utilization of ANC such as
11 women's age in years, women and husbands education and occupation, birth order
12 (parity), frequency of listening to radio/ watching TV/ reading magazines, household
13 wealth quantile, and place of residence were identified from the survey data as
14 predictors of ANC follow-ups. Numerical values like age, ANC visits, and years of
15 education attended were grouped into categories. Women's age in years was
16 tabulated into groups (15-19-year, 20-24-year, 25-29-year, 30-34 year, 35 and above),
17 women's and husbands' education were classified as 'no schooling', 'primary',
18 'secondary', and 'higher' education. Women's and husband's occupation were
19 classified as 'not working outside home', 'professional/skilled work', 'agriculture',
20 and 'unskilled'. Frequency of listening to radio/ watching TV/ reading magazines (not
21 at all, less than once a week, and at least once a week) was included to gauge the
22 women's exposure to promotion messages on the benefits of ANC attendance. The
23 household wealth index was constructed using a principal component analysis method
24 from items related to possession of durable assets, access to utilities and
25 infrastructure, and housing characteristics to assess the women's economic status.
26 Each woman was ranked into five categories (poorest, poorer, middle, richer, and
27 richest) based on a household asset score, comprising 20% of the population ^{11 31}.
28 Place of residence/ ecological status assessed the difference in the availability and
29 accessibility of services among urban and rural and were identified from the survey
30 data as predictors of ANC follow-ups.
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Data analysis

Data analysis was performed using STATA software version 14.0. Descriptive analysis was conducted on combined and separate forms for the studied country using weight, clustering, and stratification variables provided by the DHS, using the svyset command, to account for the study design. Chi-square tests were used to analyze the potential factors affecting ANC use during their last pregnancy three years before the survey. Bivariate and multivariable regressions were used to study the statistical association between the explanatory variables and 4⁺ANC. A multilevel analysis was used in which the level of coefficients was modeled as a function of predictors considering the average log odds of 4⁺ANC across the studied countries. Women's age at childbirth and husband's occupation were excluded from the multilevel analysis due to collinearity effects with a variance inflation factor value (VIF>4) on the collinearity diagnosis test. A two-sided P-value <0.05 was considered statistically significant in this study.

Patient and public involvement

The study used publicly available secondary data from DHS. Patients and public were not involved in the design and conduct of this research

Results

Baseline characteristics of the study population

A total of 56,002 women with complete details from nine SSA countries were included in this study. The distribution of study participants was presented in flowchart Figure 1. Sixty one percent of the participant women were less than 30 years old and about three-fourth (73.2%) of the total participant were from rural place of residence. Rate of illiteracy in the studied countries was high with more than one-fifth (22.5%) of all women and husband had not attended any schooling. More women

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3 (51.2%) had primary level of education than husbands (44.8%), while women
4 unemployment status (no working outside home) was higher than husband's (31.5%
5 vs 4.2%). More than one-fourth (27.3%) of all the studied households were in the
6 lowest (poorest) wealth quantiles and 24% of the participant women were first birth
7 order (primigravidae) (Table 1).
8
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10 Overall, 55.52% (95% CI; 55.11 to 55.93) of the women in the nine SSA
11 countries had at least four ANC visits with skilled health provider during pregnancy.
12 Thirty-five percent of the participated women started their first ANC visit in the 1st
13 trimester and 57% in the 2nd trimester of pregnancy. Before pregnancy, 82.2% of
14 women in this study had received a tetanus injection. There were 1,808 deaths (32.3
15 deaths/ 1000 live births) among new-born three years preceding the survey.
16
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18 The highest proportion of 4⁺ANC visits among the studied countries was from
19 Ghana (85.61%) followed by Namibia (78.92%), and Zambia (64.2%), and the lowest
20 proportion was from Rwanda (44.5%), Senegal (45.3%), and Tanzania (48.1%)
21 (Figure 2 online).
22
23

24 Pooled data (Figure 3) illustrates that the highest proportion (57.3%) of 4⁺ANC
25 visits was among 25-29 years old women. Women from an urban place of residence
26 account for 64.3% of 4⁺ANC visits. There was an increased proportion of 4⁺ANC
27 visits with an increasing women educational level, husbands educational level,
28 household wealth status, and access to radio listening / watching TV/ reading
29 newspapers or magazine. Proportion of 4⁺ANC visits decreased with an increase in
30 birth order. There was no clear pattern in the association of 4⁺ANC visits on women
31 and husband occupation levels, albeit professional in both groups were higher.
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34 **Determinants of four or more antenatal care visits**

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3 Table 1 describes that women aged 25-29 years attended more ANC across all the
4 studied countries and the difference was statistically significant ($p < 0.005$) except in
5 Zambia ($p = 0.361$). Similarly, women from an urban place of residence had
6 meaningful ($p < 0.001$) higher ANC visits than women from rural place of residence
7 except in Rwanda ($p = 0.788$). In Zambia women from rural place of residence had
8 higher 4+ANC visits ($p < 0.001$). Table 1 shows that higher women's and husbands'
9 education level significantly ($p < 0.001$) increased women utilization of ANC across all
10 the studied countries. The highest 4+ANC attendance was among women and
11 husbands with highest educational level in Ghana, 99.2% and 96.4% respectively, and
12 the lowest was among women of no schooling in Rwanda (37.6%) and Tanzania
13 (38.6%), and husbands no schooling in Tanzania (36.3%).

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Occupational status of women and husband was associated ($p < 0.001$) with
women's 4+ANC attendance across all countries except in Rwanda ($p = 0.493$) and
Zambia ($p = 0.062$) where husband's occupation had no association with women's
4+ANC visits.

In this study, household wealth status (wealth quantile) had a significant
association ($p < 0.001$) with 4+ANC visits. As the household wealth status increases,
the usage of 4+ANC visits increase across all countries except in Rwanda ($p = 0.234$).
Most women of first pregnancy had received more ANCs, and the difference was
significant ($p < 0.001$) except in Malawi ($p = 0.383$).

More than one in four (27.54) of the participant women had no access to radio
listening / watching TV/ reading newspapers or magazine and 53% had access at least
once a week. However, women who had access to radio listening / watching TV/
reading newspapers or magazine had significant higher 4+ANC attendance in the
studied countries ($p < 0.001$), except in Rwanda ($p = 0.147$) and Zambia ($p = 0.264$).

Table 1. Sociodemographic characteristics influencing 4⁺ANC visits in nine sub-Saharan Africa countries.

Variables	N (%)	Ghana	Kenya	Malawi	Namibia	Rwanda	Senegal	Tanzania	Uganda	Zambia
		3,224	10,981	9,541	2,286	4,416	6,552	5,536	7,979	5,487
Age group										
15-19	5084(9.08)	140(79.1)	399(47.11)	470(43.93)	153(66.81)	59(40.14)	232(40.00)	252(47.10)	475(58.93)	430(62.05)
20-24	14930(26.66)	519(84.12)	1547(54.05)	1461(48.62)	487(78.30)	427(45.77)	743(47.08)	718(49.42)	1466(62.30)	989(65.63)
25-29	14168(25.30)	722(87.73)	1782(55.02)	1115(52.01)	463(81.66)	597(47.76)	791(46.67)	659(50.89)	1213(62.78)	779(63.70)
30-34	10804(19.29)	636(86.53)	1080(52.81)	902(52.78)	334(82.47)	483(43.59)	595(46.09)	491(48.76)	924(61.52)	656(65.74)
35 and above	11016(19.67)	743(85.21)	982(49.40)	840(52.08)	367(79.27)	399(40.80)	609(43.25)	544(43.66)	753(54.33)	668(62.90)
p-value		0.029	< 0.001	< 0.001	< 0.001	0.012	0.014	0.004	< 0.001	0.361
Place of residence										
Urban	15024(26.83)	1207(91.72)	2228(61.28)	892(57.92)	853(82.66)	442(44.87)	1188(60.00)	816(60.53)	1009(67.90)	1028(60.44)
Rural	40978(73.17)	1553(81.39)	3562(48.50)	3896(48.69)	951(75.84)	1523(44.39)	1782(38.98)	1848(44.13)	3822(58.86)	2494(65.87)
p-value		< 0.001	< 0.001	< 0.001	< 0.001	0.788	< 0.001	< 0.001	< 0.001	< 0.001
Women's education										
No schooling	12589(22.48)	846(79.21)	916(40.75)	494(45.78)	106(58.56)	228(37.62)	1982(41.28)	421(38.62)	535(55.15)	325(59.52)
Primary	28673(51.20)	544(82.42)	2884(50.67)	3124(49.15)	367(71.40)	1397(44.53)	677(54.51)	1557(46.91)	2872(58.18)	1807(64.15)
Secondary	12703(22.68)	1242(90.86)	1380(60.50)	1038(53.73)	1229(82.82)	257(45.73)	291(60.00)	643(59.76)	1072(66.46)	1206(63.37)
Higher	2037(3.64)	128(99.22)	610(80.26)	132(75.86)	102(95.33)	83(74.77)	20(83.33)	43(84.31)	352(76.52)	184(83.26)
p-value		< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Husband's education										
No schooling	9368(22.53)	699(79.16)	344(40.23)	348(48.07)	123(65.78)	248(40.52)	1900(40.85)	234(36.34)	324(58.70)	161(61.92)
Primary	18618(44.78)	292(83.67)	1172(51.38)	2068(48.72)	174(73.73)	1267(45.66)	362(55.69)	1341(45.66)	2057(57.54)	1008(64.24)
Secondary	10968(26.38)	1245(88.61)	727(60.43)	1314(52.86)	522(82.08)	172(44.33)	273(62.19)	521(59.68)	1114(65.38)	1174(64.01)
Higher	2624(6.31)	267(96.39)	347(73.83)	252(67.56)	83(96.51)	95(62.91)	84(68.29)	75(69.44)	508(73.62)	272(78.61)
p-value		< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Women's occupation										
Not working O/H	15820(31.48)	519(81.99)	1012(50.40)	1457(48.47)	969(74.65)	130(40.12)	1654(45.23)	543(52.92)	760(56.55)	1560(61.81)
Professional/Skilled work	9222(18.35)	1375(91.18)	305(70.28)	579(55.94)	558(84.67)	336(49.19)	656(52.27)	261(65.91)	1468(64.84)	668(67.61)
Agriculture	18823(37.45)	786(78.52)	632(49.11)	2031(49.61)	40(86.96)	1428(44.47)	377(33.87)	1247(41.58)	2099(57.90)	965(66.69)
Unskilled	6392(12.72)	73(97.33)	859(56.03)	721(51.28)	233(83.51)	71(36.04)	279(53.55)	613(54.98)	498(67.30)	328(62.36)
p-value		< 0.001	< 0.001	< 0.001	< 0.001	0.003	< 0.001	< 0.001	< 0.001	0.001
Husband's occupation										
Not working O/H	1744(4.17)	-	44(51.76)	380(49.74)	8(88.89)	12(50.00)	82(49.70)	16(38.10)	134(59.03)	267(62.38)
Professional/Skilled work	14721(35.22)	1024(92.42)	777(62.26)	1241(53.84)	459(83.91)	516(45.03)	1412(51.22)	600(57.58)	2091(65.53)	905(65.72)
Agriculture	16758(40.09)	1065(78.54)	556(44.91)	1446(49.25)	117(68.02)	1082(46.16)	726(34.00)	1096(41.66)	1327(55.36)	1033(66.09)
Unskilled	8579(20.52)	433(91.54)	1199(54.01)	920(49.78)	180(81.45)	180(42.35)	445(48.74)	467(54.75)	521(62.40)	488(61.69)
p-value		< 0.001	0.006	< 0.001	< 0.001	0.493	< 0.001	< 0.001	< 0.001	0.062
Wealth quintile										
Poorest	15283(27.29)	817(78.78)	1532(41.79)	1002(46.32)	369(73.51)	444(41.73)	634(31.51)	457(37.71)	1152(54.78)	1003(65.13)
Poorer	12308(21.98)	577(81.96)	1130(49.71)	1022(48.83)	351(74.05)	409(45.14)	706(40.88)	450(40.50)	1020(58.42)	842(66.09)
Middle	10560(18.86)	495(86.09)	1011(55.10)	888(48.05)	388(79.51)	377(46.60)	660(49.14)	481(44.87)	893(60.13)	692(62.62)

	Richer	9452(16.88)	474(94.23)	1007(60.55)	887(50.63)	401(82.51)	355(45.87)	561(61.58)	666(55.64)	863(64.26)	473(57.47)
	Richest	8399(15.00)	397(98.02)	1110(71.15)	989(58.69)	295(87.80)	380(44.03)	409(73.17)	610(64.62)	903(69.35)	512(68.72)
	p-value		< 0.001	< 0.001	< 0.001	< 0.001	0.234	< 0.001	< 0.001	< 0.001	< 0.001
Birth order	First	13434(23.99)	636(87.60)	1471(59.80)	1267(51.23)	594(79.41)	613(50.16)	718(52.33)	766(56.70)	1077(63.73)	918(65.95)
	Second	11333(20.24)	584(89.30)	1345(57.45)	941(48.26)	469(81.42)	502(46.83)	585(50.39)	538(51.88)	95363.87)	684(65.14)
	Third	8927(15.94)	470(85.77)	1019(54.40)	798(50.41)	309(84.43)	322(45.61)	448(45.16)	395(48.59)	762(62.56)	523(63.16)
	Fourth	6901(12.32)	382(88.22)	710(50.25)	621(50.74)	180(79.92)	193(38.14)	367(44.48)	299(46.00)	583(61.50)	446(66.77)
	Fifth & above	15407(27.51)	688(79.72)	1245(43.02)	1161(50.24)	252(69.61)	335(36.81)	852(38.69)	666(39.53)	1456(55.34)	951(61.39)
	p-value		< 0.001	< 0.001	0.383	< 0.001	0.001	< 0.001	< 0.001	< 0.001	0.043
Frequency of listening to radio/ watching TV/ reading newspaper or magazine	Not at all	14976(27.54)	288(70.07)	1044(39.77)	2127(47.85)	178(62.24)	298(42.63)	308(34.00)	394(37.60)	1051(53.54)	1640(63.25)
	Less than once a week	10184(18.73)	646(81.46)	671(51.14)	829(49.11)	355(76.84)	481(42.87)	442(37.91)	836(44.83)	724(59.69)	352(62.52)
	At least once a week	29213(53.73)	1826(90.40)	4074(57.84)	1832(53.76)	1271(82.75)	1184(45.75)	2220(49.55)	1434(54.67)	3056(63.63)	473(66.25)
	p-value		< 0.001	< 0.001	< 0.001	< 0.001	0.147	< 0.001	< 0.001	< 0.001	0.264

Univariate analysis magnitude (*ORs and 95% CI*) of sociodemographic characteristics for 4⁺ANC visits

Table 2 presents the results of univariate analysis of 4⁺ANC visits by sociodemographic characteristics across the nine countries. Adequate ANC visit was lower among young women (15-19 years) in seven of the nine countries and the difference was significant in Ghana, Kenya, Malawi, Senegal, and Namibia. The odds of 4⁺ANC visit was lower by 2%-60% among rural residents compared to urban across all countries except in Zambia, in which women from rural places were 26% more to attend 4⁺ANCs, and the difference was significant ($p < 0.001$) in all countries except in Rwanda ($p = 0.283$).

Four or more ANC visits had positive association with increasing educational level. Women and husbands with secondary and above educational level had significantly higher odds of 4⁺ANC visits across all the studied countries ($p < 0.05$).

Table 2. Univariate analysis of sociodemographic factors influencing 4+ANC visits in nine sub-Saharan Africa countries.

Variables	Ghana 3,224	Kenya 10,981	Malawi 9,541	Namibia 2,286	Rwanda 4,416	Senegal 6,552	Tanzania 5,536	Uganda 7,979	Zambia 5,487	Total 56,002
Age (grouped)										
15-19	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]
20-24	1.40(0.92,2.13)	1.32(1.13,1.54)	1.21(1.05,1.39)	1.79(1.28,2.50)	1.26(0.88,1.79)	1.34(1.10,1.62)	1.10(0.90,1.34)	1.15(0.98,1.36)	1.17(0.97,1.41)	1.21(1.13,1.29)
25-29	1.89(1.24,2.87)	1.37(1.18,1.60)	1.38(1.19,1.60)	2.21(1.56,3.13)	1.36(0.96,1.93)	1.31(1.08,1.59)	1.16(0.95,1.42)	1.18(0.99,1.39)	1.07(0.89,1.30)	1.27(1.19,1.36)
30-34	1.70(1.12,2.58)	1.26(1.07,1.48)	1.43(1.22,1.66)	2.34(1.61,3.40)	1.15(0.81,1.64)	1.28(1.05,1.57)	1.07(0.87,1.32)	1.11(0.94,1.33)	1.16(0.95,1.42)	1.23(1.15,1.32)
35 and above	1.52(1.01,2.29)	1.10(0.93,1.29)	1.39(1.19,1.62)	1.90(1.33,2.71)	1.03(0.72,1.46)	1.14(0.94,1.39)	0.87(0.71,1.07)	0.83(0.70,0.99)	1.04(0.85,1.26)	1.10(1.02,1.17)
Place of residence										
Urban	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]
Rural	0.40(0.32,0.50)	0.60(0.55,0.65)	0.69(0.62,0.77)	0.66(0.54,0.81)	0.98(0.85,1.13)	0.43(0.38,0.47)	0.52(0.45,0.58)	0.68(0.60,0.76)	1.26(1.12,1.42)	0.61(0.59,0.63)
Women's education										
No schooling	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]
Primary	1.23(0.96,1.58)	1.49(1.35,1.65)	1.15(1.01,1.30)	1.77(1.24,2.51)	1.33(1.11,1.59)	1.70(1.50,1.93)	1.40(1.22,1.62)	1.13(0.99,1.30)	1.22(1.01,1.47)	1.30(1.25,1.36)
Secondary	2.61(2.06,3.30)	2.23(1.98,2.51)	1.38(1.18,1.60)	3.41(2.46,4.72)	1.40(1.11,1.77)	2.13(1.76,2.58)	2.36(1.99,2.80)	1.61(1.37,1.90)	1.18(0.97,1.43)	2.21(2.10,2.33)
Higher	3.51(2.86, 4.17)	5.91(4.85,7.20)	3.72(2.58,5.37)	14.43(5.6,37.14)	4.91(3.11,7.78)	7.11(2.43,20.8)	8.54(3.98,18.35)	2.65(2.06,3.40)	3.38(2.28,5.01)	4.97(4.42,5.58)
Husband's education										
No schooling	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]
Primary	1.35(0.97,1.87)	1.57(1.34,1.84)	1.03(0.88,1.20)	1.46(0.96,2.22)	1.23(1.03,1.47)	1.82(1.54,2.15)	1.47(1.23,1.76)	0.95(0.80,1.14)	1.11(0.84,1.45)	1.25(1.19,1.31)
Secondary	2.05(1.63,2.58)	2.27(1.90,2.71)	1.21(1.03,1.43)	2.38(1.66,3.43)	1.17(0.90,1.51)	2.38(1.95,2.91)	2.59(2.10,3.20)	1.33(1.09,1.62)	1.09(0.84,1.43)	2.06(1.95,2.18)
Higher	7.03(3.66,13.49)	4.19(3.27,5.37)	2.25(1.73,2.92)	14.40(4.38,47.36)	2.49(1.72,3.60)	3.12(2.12,4.58)	3.98(2.57,6.18)	1.96(1.55,2.50)	2.26(1.58,3.24)	3.52(3.19,3.88)
Women's occupation										
Not working O/H	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]
Professional/Skilled										
work	2.27(1.73,2.97)	2.33(1.86,2.91)	1.35(1.17,1.56)	1.88(1.47,2.40)	1.45(1.11,1.89)	1.33(1.17,1.51)	1.72(1.35,2.19)	1.42(1.23,1.63)	1.29(1.10,1.51)	1.73(1.64,1.82)
Agriculture	0.80(0.62,1.03)	0.95(0.83,1.09)	1.05(0.95,1.15)	2.26(0.95,5.39)	1.20(0.95,1.51)	0.62(0.54,0.71)	0.63(0.55,0.73)	1.06(0.93,1.20)	1.24(1.08,1.42)	0.87(0.84,0.91)
Unskilled	8.02(1.94,33.15)	1.25(1.10,1.43)	1.12(0.99,1.27)	1.72(1.22,2.42)	0.84(0.58,1.21)	1.40(1.16,1.68)	1.09(0.92,1.29)	1.58(1.31,1.91)	1.02(0.84,1.24)	1.13(1.07,1.20)
Husband's occupation										
Not working O/H		1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]
Professional/Skilled										
work	1.00[Ref]	1.54(0.99,2.39)	1.18(1.00,1.39)	0.65(0.08,5.28)	0.82(0.37,1.84)	1.06(0.78,1.46)	2.21(1.17,4.16)	1.32(1.00,1.74)	1.16(0.92,1.45)	1.35(1.22,1.49)
Agriculture	0.30(0.23,0.39)	0.76(0.49,1.18)	0.98(0.84,1.15)	0.27(0.03,2.18)	0.86(0.38,1.92)	0.52(0.38,0.72)	1.16(0.62,2.17)	0.86(0.65,1.14)	1.21(0.97,1.51)	0.86(0.78,0.95)
Unskilled	0.89(0.60,1.32)	1.09(0.71,1.69)	1.00(0.85,1.19)	0.55(0.07,4.51)	0.74(0.32,1.67)	0.96(0.69,1.34)	1.97(1.04,3.72)	1.15(0.85,1.55)	0.97(0.76,1.24)	1.10(0.99,1.22)
Wealth quintile										
Poorest	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]
Poorer	1.22(0.96,1.56)	1.37(1.23,1.52)	1.11(0.98,1.25)	1.03(0.77,1.37)	1.15(0.96,1.37)	1.50(1.31,1.72)	1.13(0.95,1.33)	1.16(1.02,1.32)	1.04(0.89,1.22)	1.19(1.14,1.25)
Middle	1.67(1.26,2.20)	1.70(1.52,1.90)	1.07(0.95,1.21)	1.40(1.04,1.88)	1.22(1.01,1.47)	2.10(1.82,2.42)	1.35(1.14,1.59)	1.25(1.09,1.43)	0.90(0.76,1.05)	1.34(1.27,1.41)
Richer	4.40(2.94,6.59)	2.12(1.89,2.39)	1.19(1.05,1.35)	1.70(1.25,2.31)	1.18(0.98,1.43)	3.48(2.96,4.10)	2.07(1.76,2.44)	1.48(1.29,1.71)	0.72(0.61,0.86)	1.60(1.52,1.69)
Richest	13.36(6.53,27.33)	3.41(3.00,3.88)	1.65(1.45,1.87)	2.59(1.77,3.80)	1.10(0.92,1.32)	5.93(4.81,7.31)	3.02(2.53,3.60)	1.87(1.62,2.16)	1.18(0.98,1.42)	2.13(2.02,2.25)
Birth order										
First	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]

Second	1.18(0.85,1.65)	0.91(0.81,1.02)	0.89(0.79,1.00)	1.14(0.86,1.50)	0.88(0.74,1.03)	0.93(0.79,1.08)	0.82(0.70,0.97)	1.01(0.87,1.16)	0.97(0.82,1.14)	0.93(0.88,0.98)
Third	0.85(0.62,1.18)	0.80(0.71,0.91)	0.97(0.85,1.10)	1.41(1.01,1.96)	0.83(0.69,1.00)	0.75(0.64,0.88)	0.72(0.61,0.86)	0.95(0.82,1.11)	0.89(0.74,1.06)	0.87(0.82,0.92)
Fourth	1.06(0.74,1.53)	0.68(0.60,0.78)	0.98(0.86,1.12)	0.86(0.61,1.23)	0.61(0.50,0.76)	0.73(0.61,0.87)	0.65(0.54,0.79)	0.91(0.77,1.07)	1.04(0.85,1.26)	0.81(0.76,0.86)
Fifth & above	0.56(0.42,0.73)	0.51(0.46,0.57)	0.96(0.86,1.08)	0.59(0.45,0.79)	0.58(0.49,0.69)	0.58(0.50,0.66)	0.50(0.43,0.58)	0.71(0.62,0.80)	0.82(0.71,0.96)	0.65(0.62,0.68)
Frequency of listening to radio/ watching TV/ reading newspaper or magazine										
Not at all	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]
Less than once a week	1.88(1.42,2.48)	1.59(1.39,1.81)	1.05(0.94,1.18)	2.01(1.46,2.78)	1.01(0.83,1.22)	1.19(0.99,1.42)	1.35(1.16,1.57)	1.29(1.11,1.49)	0.97(0.80,1.17)	1.15(1.09,1.21)
At least once a week	4.02(3.11,5.20)	2.08(1.90,2.28)	1.27(1.16,1.39)	2.91(2.21,3.83)	1.14(0.96,1.34)	1.91(1.64,2.22)	2.00(1.73,2.32)	1.52(1.37,1.69)	1.14(0.96,1.36)	1.53(1.47,1.59)

Bold font indicates a significant difference from reference at p<0.05. O/H: outside home.

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3 Compared to women who had not work outside home, the odds of 4⁺ANC visits
4 were significantly higher among professional women. Odds of 4⁺ANC visit in relation
5 to household wealth status had considerable variation among the countries ranging
6 from 1.10(95% CI: 0.92 to 1.32) in Rwanda to 13.36(95% CI: 6.53 to 27.33) in
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The pattern of 4⁺ANC utilization shows an inverse relationship with birth order. Women of fifth and above birth order had significant lower ANC attendance than first birth order. Listening to radio/ watching TV/ reading newspaper or magazine had a significant positive association with 4⁺ANC attendance across all countries except in Rwanda and Zambia (Table 2).

Multivariable findings

Table 3 summarizes data analysis results adjusted by sociodemographic variables and the overall adjusted by cluster (country).

Overall, the 4⁺ANC visits were 14% lower among women from the rural area than from urban, and the difference was significant (AOR: 0.86; 95% CI: 0.81 to 0.91). Multivariable logistic regression analysis exploring the relationship between 4⁺ANC visits and place of residence was significant in four countries (Kenya, Malawi, Senegal and Zambia). While in Ghana, Namibia, Rwanda, Tanzania, and Uganda; 4⁺ANC visit had no association with place of residence. Unlike all countries, in Zambia, the odds of 4⁺ANC visits was 48% higher (AOR: 1.48; 95% CI: 1.2 to 1.82) among rural women than urban.

Findings of selected sociodemographic predictors related to ANC visit after adjusted for cluster (country) variations indicated that the odds of 4⁺ANC visits increased from 14% (AOR:1.14; 95% CI: 1.07to 1.21, p<0.001) to 96% (AOR:1.96; 95% CI: 1.65to 2.33, p<0.001) with an increase in women's educational level.

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3 Women with higher educational levels had more than two-fold higher odds of 4⁺ANC
4 visits in seven of the nine countries, and the difference was significant in four (Kenya,
5 Malawi, Rwanda, and Zambia). Husband's higher educational level had significant
6 association with 12% (AOR: 1.12; 95% CI: 1.05 to 1.20) to 48% (AOR: 1.48; 95% CI:
7 1.31 to 1.69) higher odds 4⁺ANC visits of women ($p < 0.001$). Country wise this
8 association was significant in Kenya, Malawi, and Zambia.
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12 Overall, women's occupation had a positive association with 4⁺ANC visits. The
13 variation on 4⁺ANC visits was 19% (AOR: 1.19; 95% CI: 1.11 to 1.27), 7% (AOR:
14 1.07; 95% CI: 1.01 to 1.13), and 13% (AOR: 1.13; 95% CI: 1.05 to 1.21) more among
15 women working as Professional/Skilled, Agriculture, and Unskilled labour
16 respectively compared to women not working outside home. In Ghana, the odds of
17 4⁺ANC visits was fifteen times (AOR: 15.54; 95%CI: 2.1 to 114.9) higher among
18 employed women than women who had no work outside home. Another similar group,
19 women in Uganda, were 62% more to attend 4⁺ANC (AOR: 1.62; 95%CI: 1.28 to
20 2.05). Agriculture employed women in Kenya, Senegal, and Tanzania and unskilled
21 worker in Rwanda, Tanzania, and Zambia had non-significant lower uptake of
22 4⁺ANCs.
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27 Women in the wealthiest group were highly likely to receive more 4⁺ANC visits.
28 After adjusting for cluster (country), ANC service utilization increased by 12 %
29 (AOR:1.12; 95% CI: 1.06 to 1.19), 18% (AOR:1.18; 95% CI: 1.11 to 1.26), 32%
30 (AOR:1.32; 95% CI: 1.23 to 1.42), and 41% (AOR:1.41; 95% CI: 1.29 to 1.55) for
31 every 20% variation on the wealth category compared to the poorest level, and the
32 difference was significant ($p < 0.001$) (Table 3). This association was uniform across
33 the studied countries except in Rwanda where women in the highest wealth quantiles
34 were 23% lower (AOR: 0.77; 95% CI: 0.57 to 1.02) to up-take 4⁺ANC than the
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3 poorest group. The odds of 4⁺ANC visits were 4% (AOR: 0.96; 95% CI: 0.78 to 1.19)
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5 and 14% (AOR: 0.86; 95% CI: 0.64 to 1.16) lower among middle and richer
6
7 economic status in Zambia.
8
9

10 Women with previous birth experience had significant ($p<0.001$) lower uptake of
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12 ANC services than first birth order. Odds of 4⁺ANC visits were lower by 16% (AOR:
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14 0.84; 95% CI: 0.79 to 0.90), 21% (AOR: 0.79; 95% CI: 0.74 to 0.85), 23% (AOR:
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16 0.77; 95% CI: 0.72 to 0.83), and 32% (AOR: 0.68; 95% CI: 0.64 to 0.73) for second,
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18 third, fourth, and fifth and above birth orders than first birth order (Table 3). Country
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20 wise analysis shows, the birth order difference on 4⁺ANC visits were significant in
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22 Kenya, Rwanda, Senegal, Tanzania, Uganda, and Zambia.
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26 Women who had access to media at least once a week had 22% higher odds of
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28 4⁺ANC visit than women who have not at all (AOR: 1.22; 95%CI: 1.15 to 1.29). This
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30 association was significant in all countries except in Malawi, Rwanda, Senegal, and
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Table 3. Adjusted multivariable analysis of sociodemographic factors influencing 4⁺ANC visits in nine sub-Saharan countries.

Variables	Ghana	Kenya	Malawi	Namibia	Rwanda	Senegal	Tanzania	Uganda	Zambia	Overall *
Place of residence										
Urban	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]
Rural	0.84(0.61,1.15)	0.83(0.72,0.9)	0.83(0.71,0.96)	0.83(0.57,1.21)	0.95(0.77,1.18)	0.73(0.62,0.84)	0.83(0.69,1.01)	0.86(0.72,1.01)	1.48(1.2,1.82)	0.86(0.81,0.91)
Women's education										
No schooling	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]
Primary	1.06(0.78,1.43)	1.12(0.90,1.39)	1.09(0.94,1.27)	1.34(0.83,2.16)	1.20(0.99,1.46)	1.06(0.91,1.23)	1.04(0.88,1.22)	1.03(0.87,1.22)	1.12(0.90,1.41)	1.14(1.07,1.21)
Secondary	1.47(1.05,2.05)	1.23(0.94,1.60)	1.11(0.91,1.35)	1.78(1.04,3.05)	1.28(0.95,1.74)	1.08(0.84,1.4)	1.00(0.79,1.28)	1.19(0.96,1.47)	1.05(0.81,1.38)	1.17(1.08,1.21)
Higher	4.82(0.6,37.23)	2.17(1.42,3.32)	2.26(1.42,3.60)	2.13(0.51,8.93)	3.82(2.17,6.73)	1.78(0.58,5.47)	2.19(0.91,5.30)	1.30(0.92,1.83)	2.06(1.20,355)	1.96(1.65,2.33)
Husband's education										
No schooling	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]
Primary	1.04(0.73,1.48)	1.08(0.87,1.36)	0.97(0.83,1.15)	1.11(0.71,1.75)	1.10(0.91,1.33)	1.35(1.13,1.61)	1.18(0.98,1.42)	0.86(0.70,1.05)	1.07(0.81,1.42)	1.12(1.05,1.20)
Secondary	0.97(0.72,1.33)	1.20(0.93,1.56)	1.06(0.88,1.27)	1.21(0.77,1.88)	0.93(0.69,1.24)	1.36(1.09,1.71)	1.35(1.05,1.72)	1.01(0.80,1.26)	1.15(0.86,1.54)	1.17(1.09,1.27)
Higher	1.42(0.69,2.93)	1.41(1.00,1.97)	1.42(1.03,1.95)	3.57(0.9,14.17)	1.42(0.88,2.27)	1.32(0.86,2.02)	1.38(0.84,2.27)	1.22(0.91,1.63)	1.91(1.23,2.96)	1.48(1.31,1.69)
Mother's occupation										
Not working O/H	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]
Professional/Skilled work	1.99(1.46,2.27)	1.19(0.91,1.56)	0.97(0.81,1.15)	1.64(1.11,2.44)	1.23(0.91,1.66)	1.09(0.94,1.26)	1.24(0.93,1.65)	1.38(1.18,1.62)	1.24(1.01,1.50)	1.19(1.11,1.27)
Agriculture	1.44(1.06,1.97)	0.98(0.83,1.15)	1.08(0.96,1.19)	2.25(0.75,6.72)	1.16(0.87,1.53)	0.89(0.76,1.04)	0.89(0.75,1.07)	1.26(1.09,1.46)	1.14(0.96,1.35)	1.07(1.01,1.13)
Unskilled	15.54(2.1,114.9)	1.06(0.91,1.24)	1.07(0.92,1.22)	1.58(0.85,2.97)	0.79(0.52,1.21)	1.09(0.87,1.35)	0.95(0.78,1.16)	1.62(1.28,2.05)	0.96(0.76,1.23)	1.13(1.05,1.21)
Wealth quintile										
Poorest	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]
Poorer	0.93(0.70,1.23)	1.09(0.91,1.32)	1.07(0.94,1.23)	0.74(0.48,1.13)	1.06(0.87,1.28)	1.37(1.19,1.58)	1.05(0.87,1.26)	1.18(1.02,1.37)	1.09(0.91,1.32)	1.12(1.06,1.19)
Middle	0.93(0.64,1.36)	1.18(0.96,1.45)	1.09(0.94,1.26)	0.85(0.53,1.36)	1.12(0.91,1.37)	1.56(1.32,1.86)	1.15(0.95,1.40)	1.19(1.01,1.40)	0.96(0.78,1.19)	1.18(1.11,1.26)
Richer	1.88(1.09,3.23)	1.21(0.97,1.51)	1.07(0.92,1.25)	0.79(0.45,1.40)	1.04(0.84,1.30)	2.26(1.83,2.79)	1.62(1.31,2.00)	1.29(1.08,1.5)	0.86(0.64,1.16)	1.32(1.23,1.42)
Richest	4.74(1.9,11.95)	1.55(1.19,2.04)	1.23(1.02,1.50)	1.31(0.57,3.00)	0.77(0.57,1.02)	3.62(2.78,4.72)	1.69(1.27,2.24)	1.27(1.02,1.60)	1.17(0.81,1.69)	1.41(1.29,1.55)
Birth order										
First	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]
Second	1.08(0.72,1.63)	0.71(0.58,0.87)	0.83(0.72,0.95)	1.22(0.74,1.99)	0.72(0.60,0.87)	0.88(0.74,1.06)	0.82(0.68,1.00)	0.95(0.80,1.13)	0.87(0.70,1.08)	0.84(0.79,0.90)
Third	0.77(0.52,1.15)	0.62(0.51,0.76)	0.91(0.79,1.05)	1.06(0.64,1.76)	0.68(0.55,0.83)	0.78(0.65,0.94)	0.72(0.59,0.89)	0.97(0.81,1.16)	0.76(0.61,0.96)	0.79(0.74,0.85)
Fourth	1.06(0.69,1.64)	0.56(0.45,0.70)	0.95(0.82,1.11)	1.12(0.65,1.94)	0.52(0.42,0.66)	0.76(0.62,0.92)	0.71(0.57,0.88)	0.88(0.73,1.07)	0.91(0.71,1.17)	0.77(0.72,0.83)
Fifth & above	0.75(0.52,1.08)	0.50(0.41,0.61)	0.98(0.85,1.12)	0.79(0.49,1.26)	0.50(0.41,0.61)	0.68(0.58,0.80)	0.61(0.51,0.73)	0.77(0.65,0.90)	0.73(0.59,0.90)	0.68(0.64,0.73)
Frequency of listening to radio/reading newspaper/magazines										
Not at all	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]
Less than once a week	1.47(1.08, 2.00)	1.35(1.08,1.68)	1.05(0.94,1.20)	1.94(1.22,3.07)	0.95(0.78,1.17)	1.06(0.87,1.29)	1.11(0.93,1.33)	1.13(0.96,1.34)	1.01(0.80,1.28)	1.08(1.01,1.15)
At least once a week	2.62(1.96,3.50)	1.21(1.02,1.44)	1.09(0.98,1.22)	2.31(1.51,3.53)	1.07(0.88,1.30)	1.14(0.96,1.35)	1.34(1.12,1.60)	1.24(1.09,1.41)	1.05(0.85,1.30)	1.22(1.15,1.29)

All are adjusted for sociodemographic factors and media exposure. * adjusted for sociodemographic factors, media exposure, and country. **bold font** indicates a significant difference from reference at p<0.05, O/H: outside home

Discussion

In an era of envision for every pregnant woman to receive quality care throughout her pregnancy, only 55.52% (95% CI: 55.11 to 55.93) women in nine sub-Saharan Africa countries have received 4⁺ANC on average three years before the survey. Our result indicated that there were disparities among the countries on 4⁺ANC with the highest in Ghana (85.61%) followed by Namibia (78.92%), and Zambia (64.2%), and the lowest proportion was from Rwanda (44.5%), Senegal (45.3%), and Tanzania (48.1%).

We have shown that women's demographic and socioeconomic factors including place of residence, women and husband educational level, women and husband occupational status, household wealth quantiles, birth order, and access listening to radio/reading newspaper/magazines were significant determinants of 4⁺ANC attendance. Therefore, there is an urgent need on intervention towards maximizing the utilization of ANC in the SSA countries.

The strength of this analysis is use of nationally-representative data from nine sub-Saharan Africa countries which is assumed to have a very minimum sampling (random or systemic) and instrumental errors through the use of an appropriate multistage stratified cluster sampling strategies, having a large sample size of 56,002 respondents, and weighted data analysis with reliable test of instrumentations. The analytical approach as pooled data support the outcome to be valid and the merit in segregating data allows to focus on aspects of ANC visits that may remain hidden in intra-national/national level indicators. Recall biases of self-report data and the cross-sectional nature of the studies limits for the cause-effect association of potential predictors. Since the data were obtained from countries DHS in a different time, awareness of participants may be varied due to time heterogeneity. Moreover, the data

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2
3 in the present analysis did not consider the quality of care provided to pregnant
4 women during ANC visit which could be a potential predictor for ANC attendance.
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8 Pooled data adjusted by countries has shown that rural place of residence, no
9 women and husband schooling, no maternal employment, poor household economic
10 status, second and above birth orders, and lack of access listening to radio/reading
11 newspaper/magazines were significantly associated with lower utilization of 4⁺ANC
12 (Table 3). This is in line with previous studies from low and middle income countries
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Country-level data showed that; Ghana and Namibia had the highest attendance
of 4⁺ANC visits across all reproductive age groups. Ghana's present finding was in
line to the 2013 cross-sectional study where 86% of Ghanaian women reported
attending 4⁺ANC visits ²¹. Consistent with the finding on other studies in India and
Nigeria, this report also showed that 4⁺ANC visits was very low in Rwanda, Senegal,
Tanzania, Malawi, and Kenya ^{23 24}.

Women from rural place of residence had 5%-27% lower odds of 4⁺ANC visits in
eight of the nine studied countries, and the difference was significant in Kenya,
Malawi, and Senegal. However, one data (Zambia) indicated a 48% more uptake of
4⁺ANCs by rural residents (Table 3). This finding in Zambia is contrary to other
studies ²²⁻²⁴.

Multivariable analysis proved that women and husband higher education were
significant predictors of 4⁺ANC visits ^{6 8 11 18 23}. Women with higher educational
levels had more than two-fold higher odds of 4⁺ANC visits and this difference was
significant in Kenya, Malawi, Rwanda, and Zambia. Similarly, husband's higher
educational level had significant association with 4⁺ANC visits of women in Kenya,
Malawi, and Zambia ³².

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3 Women's occupation had non-uniform association with 4+ANC visits across
4 countries. Women from Ghana and Uganda working as Professional/Skilled,
5 Agriculture, and Unskilled labour had attended more ANC visits than women who do not
6 work outside home similar to other study¹⁸. However, this association was
7 insignificant or lower in seven of the nine countries (Kenya, Malawi, Namibia,
8 Rwanda, Senegal, Tanzania, and Zambia)¹¹.
9

10 Both univariate and multivariable analysis showed that difference in wealth
11 quantiles had association with the uptake of 4+ANCs^{7 8 21 25}. Women from the highest
12 wealth category had more access to 4+ANC visits than those at the lowest category
13 and the difference was significant in Ghana, Kenya, Malawi, Senegal, Tanzania, and
14 Uganda. This result in Rwanda was different after adjustment in which women in the
15 richest wealth quantiles had 23% lower (AOR: 0.77; 95% CI: 0.57 to 1.02) 4+ANC
16 visits than the poorest group, which is different from the existing literature^{11 18 21 23}.
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18 Our findings revealed that women of first pregnancy were more likely to receive
19 4+ANC than second and above except in Namibia. This might be due to they are more
20 careful about the pregnancy experiences³³. This difference was significant in Kenya,
21 Rwanda, Senegal, Tanzania, Uganda, and Zambia, similar to previous research studies
22^{10 18}. Consistent to our findings in Namibia, research from Nigeria suggested that
23 adolescents are less likely to attend ANC services²⁹.
24

25 Listening to radio/ watching TV/ reading newspapers or magazines at least once a
26 week had a positive association with the uptake of 4+ANC across all the studied
27 countries. The odds of 4+ANC visit among women who had access to media at least
28 once a week was more than two-folds higher in Ghana (AOR:2.62; 95% CI: 1.96 to
29 3.50) and Namibia (AOR:2.31; 95% CI: 1.51 to 3.53). This association was not
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4 significant in Rwanda, Senegal, Malawi, and Zambia despite the previous evidences⁸
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9 In summary, despite the importance of attending the WHO recommended level of
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11 at least 4+ANC visits for a normal pregnancy¹, our analysis demonstrated that many
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13 women in SSA have limited access. The result of this study indicate that, disparities
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15 on 4+ANC visits were related to women economic as well as physical barriers^{12 25}.
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17 Therefore, interventions on addressing the inequalities on ANC services use among
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19 women from rural areas and limited resources are crucial. Although not all 100%, the
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21 lesson from neighboring countries like Ghana which could be due to community
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23 based health insurance and other countries in the sub-Saharan countries^{8 21 27} are ideal
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25 examples for country based policy evaluation towards ANC use optimization.
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27 Furthermore, governments commitment on community insurance is crucial to avoid
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29 the challenges like in Rwanda which was functional 1999-2012³⁴, but in this analysis
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31 DHS 2014/2015 it is the lowest.
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36 Moreover, awareness raising programs and access to health information should
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38 be improved. The possible justification for women and husband with higher education
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40 had more uptake of 4+ANC could be educated women and husbands knew the
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42 importance of adequate ANC attendance.
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45 **Conclusion and recommendation**

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47 Four or more ANC service utilization is low among women of the SSA countries.
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49 Countries had varied practices of 4+ANC visits despite its importance. Therefore,
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51 regional and country-specific maternal health program interventions are required to
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53 address the barriers of adequate ANC visits. Moreover, health program should target
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55 particularly to women of rural resident, had no schooling, no outside home occupation,
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57 from low-household economic status, non-first-time pregnancy, and had no access to
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3 listening radio/ watching TV/ reading newspapers or magazines. Furthermore, ANC
4 use barriers at individual and community level and health services need to be
5 investigated.
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11 conducted the literature review, formal analysis, and wrote original draft. AKA, LXZ,
12 ZZH, MEM, and QQ revised the document and LXZ supervision the study. All
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27
28
29

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31
32

33 **Patients consent for publication:** Not required.
34
35

36 **Ethics approval:** This study was exempt from review by the ethics committee as
37 publicly available data sets were used and no identifying participant information was
38 obtained. The authorization for using the data in the current analysis was granted from
39 the DHS program: DHS, ICF international, Rockville, Maryland, USA office upon
40 presenting the research protocol and research plan aims.
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48 **Data availability statement:** Data sets used in the analysis are publicly available and
49 can be accessed online through application to MEASURE DHS. Analysis syntaxes
50 and outputs generated for the study can be made available upon request to the
51 corresponding author.
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57 Figure captions
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Figure 1: Flow chart of the process of selection of women for analysis of 4⁺ANC visits

Figure 2. Proportion of women attending 4⁺ANC visits three years before the DHS survey (online).

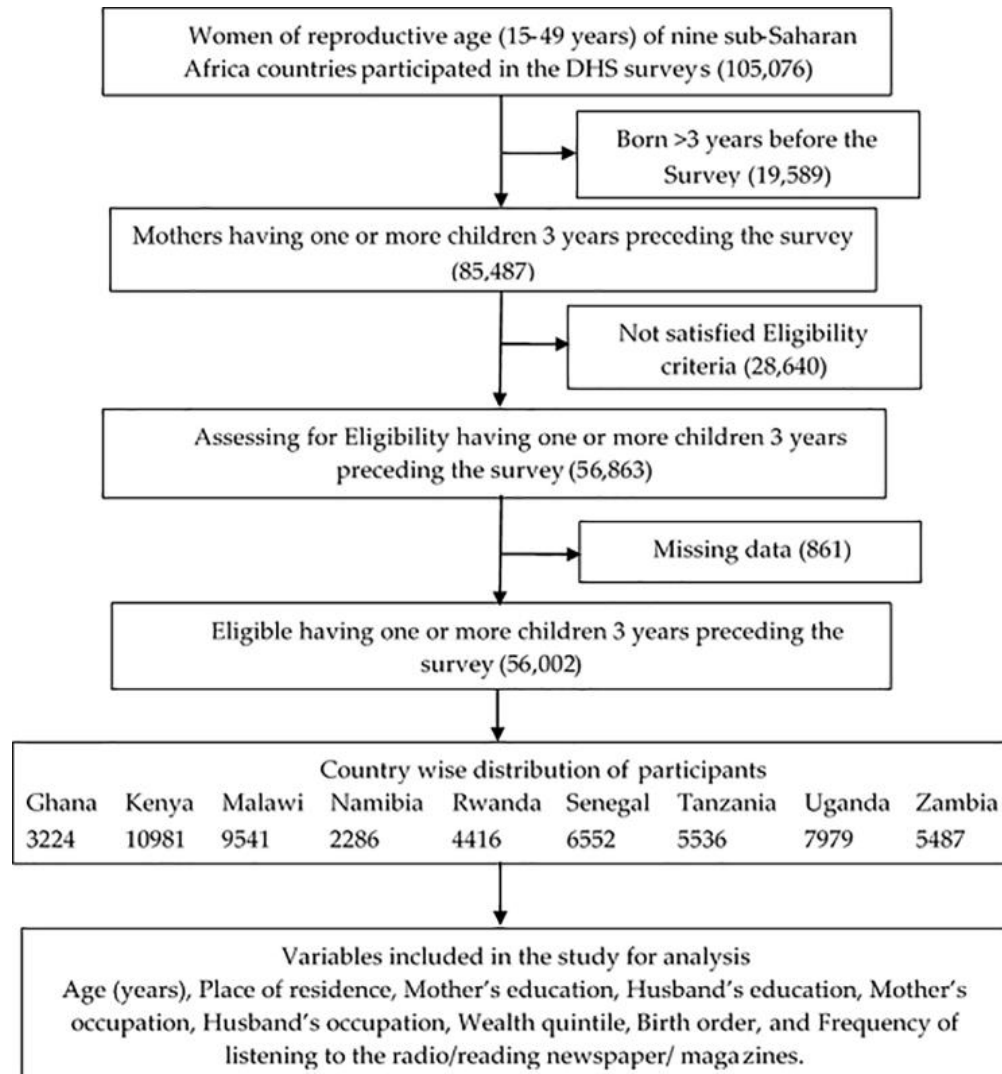
Figure 3. Distribution of 4⁺ANC visits of women by sociodemographic factors, with 95% confidence interval

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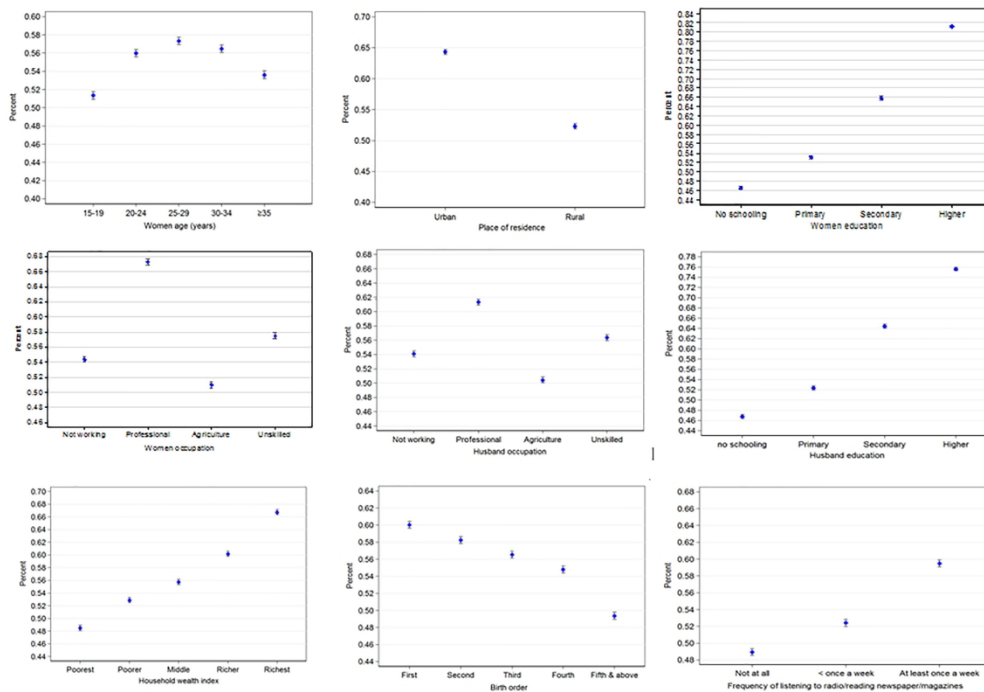
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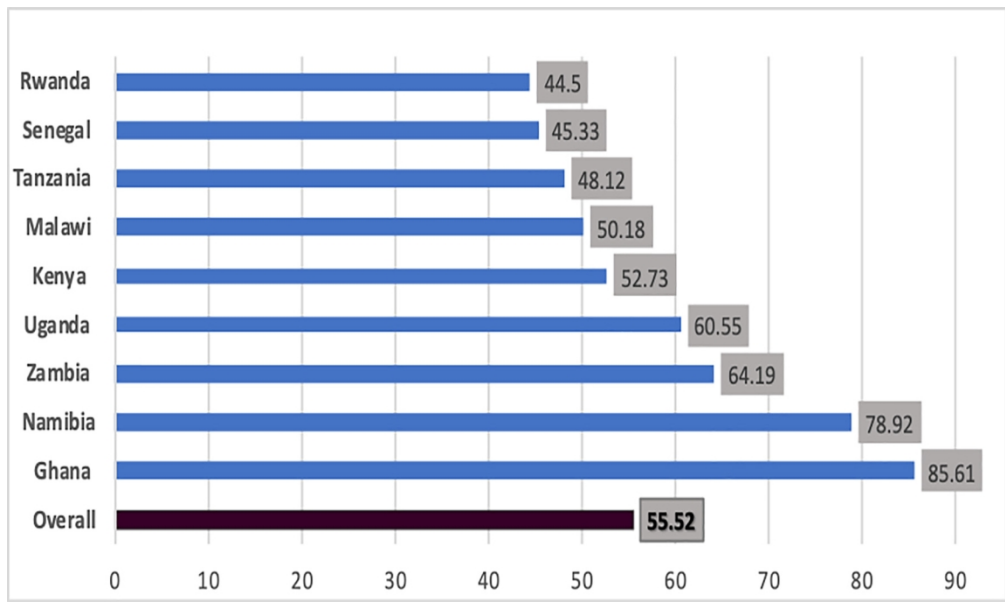


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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3-4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	-
Bias	9	Describe any efforts to address potential sources of bias	6
Study size	10	Explain how the study size was arrived at	5-6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	7-8
		(b) Describe any methods used to examine subgroups and interactions	7-8
		(c) Explain how missing data were addressed	6
		(d) If applicable, describe analytical methods taking account of sampling strategy	7
		(e) Describe any sensitivity analyses	-

Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	-
		(b) Give reasons for non-participation at each stage	-
		(c) Consider use of a flow diagram	6
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8-9
		(b) Indicate number of participants with missing data for each variable of interest	11-13
Outcome data	15*	Report numbers of outcome events or summary measures	13
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	13- 21
		(b) Report category boundaries when continuous variables were categorized	11-14
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	-
Discussion			
Key results	18	Summarise key results with reference to study objectives	22
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	22-23
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	23-25
Generalisability	21	Discuss the generalisability (external validity) of the study results	22-23
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	NA

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Determinants of Antenatal care use in nine sub-Saharan Africa countries: A statistical analysis of cross-sectional data from Demographic and Health Surveys

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3 **Determinants of Antenatal care use in nine sub-Saharan Africa countries: A**
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5 **statistical analysis of cross-sectional data from Demographic and Health Surveys**
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33 **Abstract:**

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35 **Objective:** To explore the factors associated with antenatal care visits.

36 **Design:** A secondary data analysis from cross-sectional studies was conducted.

37 **Setting:** Sub-Saharan Africa

38 **Participants:** 56002 women aged 15-49 years; Ghana(3224), Kenya(10981),
39 Malawi(9541), Namibia(2286), Rwanda(4416), Senegal(6552), Tanzania(5536),
40 Uganda(7979), and Zambia(5487) were analyzed.

41 **Outcomes:** 4⁺ANC visits

42 **Results:** Overall 55.52% (95% CI; 55.11, 55.93) of women made 4⁺ANC visits. The
43 highest 4⁺ANC visits were in Ghana (85.6%) and Namibia (78.9%), and the lowest
44 were in Senegal (45.3%) and Rwanda (44.5%). Young women 15-19 years had the
45 lowest uptake of 4⁺ANCs. Multivariable analysis indicated that, the odds of 4⁺ANC
46 visits were 14% lower among women from rural areas compared to those living in
47 towns (AOR, 0.86; 95% CI: 0.81, 0.91). This difference was significant in Kenya,
48 Malawi, Senegal and Zambia. However, in Zambia the odds of 4⁺ANC visits was
49 48% higher (AOR, 1.48; 95% CI: 1.2, 1.82) among women from rural compared to
50 urban areas. Women with higher educational level had more than two-fold higher
51 odds of 4⁺ANC visits in seven of the nine countries, and was significant in Kenya,
52 Malawi, Rwanda, and Zambia. Compared to the poorest household wealth category,
53 odds of 4⁺ANC visits increased by 12 %, 18%, 32%, and 41% for every 20%
54 variation on the wealth quantile. Women in their first-time pregnancy had higher odds
55 of 4⁺ANC visits compared to others across all countries and women who had access
56 to media at least once-a-week had a 22% higher probability of 4⁺ANC visits than
57 women who had no access to media (AOR, 1.22, 95%CI; 1.15,1.29).
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3 **Conclusion:** The number of ANC visits was considered to be inadequate with
4 substantial variation among the studied countries. Comprehensive interventions on
5 scaling up-take of ANC is needed among the low performing countries. Particular
6 attention should be given to women of low economic status, and rural residents.
7

8
9 **Keywords:** Four or more antenatal care, Determinants, sub-Saharan Africa,
10
11 Demographic health survey, and health service utilization.
12

13 **Strengths and limitations of this study**

- 14
15 The analytical approach both as pooled data support the outcome to be valid
16 and the merit in segregating data allows to focus on aspects of ANC visits that
17 may remain hidden in intra-national/national level indicators
- 18
19 The study used national representative samples from nine sub-Saharan Africa
20 countries which have been linked to enhance the generalizability of the study
- 21
22 This analysis included women who have birth three years before the survey,
23 which could minimize the recall bias of self-report at a single point in time
- 24
25 The cross-sectional nature of the study design cannot affirm the cause-effect
26 or direction of association of the predictors.
- 27
28 Since the data sets were obtained from countries DHS in a different time,
29 awareness of participants may be varied due to time heterogeneity
30
31

32 **Introduction**

33
34
35 Maternal and neonatal mortality is a significant public health issue that reflects
36 the overall status of a country's healthcare system and socioeconomic development¹.
37
38 The World Health Organization (WHO) estimates that approximately 830 maternal
39 deaths/day from preventable causes are related to pregnancy and childbirth. Almost
40 all (99%) of these deaths occur in low-income countries ². Sub-Saharan Africa (SSA)
41 remains the region with the highest maternal and under-five mortality ³⁻⁵. Almost half
42 of the under-five deaths occur among new-born babies whose deaths could be
43 prevented by reaching a high coverage of quality antenatal care, skilled care at birth,
44 postnatal care for mother and baby, and care of small and sick new-borns ^{3 4}. Several
45 review studies on interventions for maternal and new-born babies have demonstrated
46 that the provision of adequate antenatal care (ANC) brings with it a positive impact on
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3 pregnancy outcomes, through early diagnosis and appropriate management. ANC has
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5 a 39% reduced risk of neonatal mortality in sub-Saharan countries ⁶⁻⁹.

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8 The WHO advises every pregnant woman with a normal pregnancy in middle-
9
10 and low-income countries to attend at least four ANC's ¹. However, many women in
11
12 low income countries particularly in SSA have limited access to health providers ¹⁰.
13
14 Several studies have attempted to identify the factors associated with the under-
15
16 utilization of ANC's ^{11 12}. Age ¹²⁻¹⁶, women's education ^{8 12-24}, husbands' education ¹⁸
17
18 ^{22 23}, socioeconomic status ^{14-23 25}, women's employment ¹⁸, birth order ^{11 12 18},
19
20 frequency of listening to the radio/watching TV/reading newspaper/ magazines ^{8 11 18}
21
22 ^{23 24}, and place of residence ^{12 13 16-19 22 24 25} are among the factors associated with
23
24 under-utilization of ANC. The factors attributed to inadequate ANC follow-ups are
25
26 quite substantial across regions and countries ^{11 16 23 26 27}.

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30 Meeting Sustainable Development Goals (SDGs) to ensure healthy lives and
31
32 well-being for all ages by 2030 requires transnational organizations' efforts and the
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34 ability to collaborate in partnership. Interestingly, the means of implementing and
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36 revitalizing capacity development and the information exchange of multinational co-
37
38 operation have been emphasized in the SDGs ²⁸. Despite the available evidence on
39
40 ANC's key role in reducing maternal and neonatal mortality, millions of women in
41
42 developing countries do not receive it and there remains a high variability (32%-91%)
43
44 of four or more ANC (4+ANC) visits between countries ^{21 22 24 29}. Lessons on
45
46 coverage of crucial ANC's from neighboring areas would aid in precise allocations of
47
48 resources and interventions where they are most needed. Therefore, new research
49
50 projects on mutual benefit and knowledge sharing at every level must be implemented
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52 to attain global health development goals.

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55 We conducted secondary data analysis using the latest (2013-2019) Standard
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57 Demographic Health Surveys conducted in nine sub-Saharan Africa countries (Ghana,
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3 Kenya, Malawi, Namibia, Senegal, Rwanda, Tanzania, Uganda, and Zambia). The
4
5 objective of the study was to understand the factors associated with 4⁺ANC
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7 attendance.
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10 **Materials and Methods**

11 **Study design**

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17 We used data from the Demographic and Health Survey (DHS). DHS is a five-
18
19 year periodic national representative cross-sectional study using a stratified two-stage
20
21 cluster sampling design. Details of the DHS protocol are published elsewhere ³⁰.
22
23 Information from ever-married women aged 15-49 years in nine sub-Saharan Africa
24
25 countries on demographic characteristics and reproductive history were collected.
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29 **Data sources/ measurements**

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31
32 Data sets were collected through household interviews using a structured
33
34 questionnaire. Women were interviewed about the number of ANC visits. Trained
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36 interviewers obtained informed consent from all eligible women in selected
37
38 households before conducting the interview using pencil and paper questionnaires.
39
40 The surveys are weighted for over or under-sampling and non-response. Thus, the
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42 design and standardized core modules allow for regional and transnational
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44 comparison of the data. Field supervisors and data clerks checked all forms before
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46 entering them into databases. Data for this analysis was taken from the latest
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48 household survey of the studied countries. This study's survey years ranged from 2013
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51 to 2019, and the sample size ranges from 2,286 in Namibia to 10,981 in Kenya.
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58 Countries were selected based on the availability of recent standard DHS data
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60 after 2010 and representing the four different sub-regions of the Sub-Saharan Africa,
i.e. Western, Central, Southern, and Eastern Africa. The nine countries included in

1
2
3 this analysis and their year of survey are; Ghana (DHS 2014), Kenya (DHS 2014)
4
5 Malawi (DHS 2015/2016), Namibia (DHS 2013), Rwanda (DHS 2014/2015) Senegal
6
7 (DHS 2017), Tanzania (DHS 2015/2016), Uganda (DHS 2016) and Zambia (DHS
8
9 2018/2019).

13 **Participants**

16 Women who had one or more births three years before the survey were included
17
18 as study participants. Selection criteria of study participants was as shown in (Figure-
19
20 1). In the DHS survey, information about antenatal care is only collected for the
21
22 youngest child under-five years. Therefore, to minimize the degree of error due to
23
24 recall bias (because in some countries information about ANC visits are subjective
25
26 from the mother while others check an ANC card), we have limited our analysis to
27
28 those births that occurred three years before the survey. The contribution of study
29
30 participants is presented in Figure 1.

34 **Exclusion criteria**

37 ANC provided by non-health professionals such as traditional birth attendants
38
39 were excluded from the present analysis.

41 **Outcome variable**

44 We used antenatal care visits as our primary outcome. We categorized this
45
46 variable into a binary variable as 4+ANC visits 'yes' =if the mother had at least four
47
48 ANC visits and 'no' = if the mother had less than four ANC visits during her last
49
50 pregnancy.
51

54 **Explanatory variables**

57 A set of sociodemographic variables related to the utilization of ANC such as
58
59 women's age in years, women and husbands education and occupation, birth order
60
(parity), frequency of listening to radio/ watching TV/ reading magazines, household

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3 wealth quantile, and place of residence were identified from the survey data as
4
5 predictors of ANC follow-ups.
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7
8 We adapted Anderson's behavioral model framework on factors associated with
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10 utilization of medical care service in developing countries which has been applied in
11
12 similar studies ¹⁷. Variables with missing values (>10%) on enabling and need factors
13
14 were excluded from the analysis due to limited representativeness.
15

16
17 Numerical values like age, ANC visits, and years of education attended were
18
19 grouped into categories. Women's age in years was tabulated into groups (15-19-
20
21 year, 20-24-year, 25-29-year, 30-34 year, 35 and above), women's and husbands'
22
23 education were classified as 'no schooling', 'primary', 'secondary', and 'higher'
24
25 education. Women's and husband's occupation were classified as 'not working
26
27 outside home', 'professional/skilled work', 'agriculture', and 'unskilled'. Frequency
28
29 of listening to radio/ watching TV/ reading magazines (not at all, less than once a
30
31 week, and at least once a week) was included to gauge the women's exposure to
32
33 promotion messages on the benefits of ANC attendance. The household wealth index
34
35 was constructed using principal component analysis from items related to possession
36
37 of durable assets, access to utilities and infrastructure, and housing characteristics.
38
39 Each woman was ranked into five categories (poorest, poorer, middle, richer, and
40
41 richest) based on a household asset score, comprising 20% of the population ^{11 31}.
42
43 Place of residence/ ecological status identified from the survey assessed the difference
44
45 in the availability and accessibility of services among urban and rural areas and were
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47 used as predictors of ANC follow-up.
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53 54 55 **Data analysis**

56
57 Data analysis was performed using STATA software version 14.0. Descriptive
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59 analysis was conducted on combined and separate forms for the studied country. Chi-
60
square tests were used to analyze the potential factors affecting ANC use during a

womans last pregnancy three years before the survey. Bivariate and multivariable regression was used to study the statistical association between the explanatory variables and 4+ANC. A multi-level analysis was used in which the level of coefficients was modeled as a function of predictors considering the average log odds of 4+ANC across the studied countries. Women's age at childbirth and husband's occupation were excluded from the multilevel analysis due to collinearity effects with a variance inflation factor value ($VIF > 4$) on the collinearity diagnosis test. A two-sided P-value < 0.05 was considered statistically significant in this study.

Patient and public involvement

The study used publicly available secondary data from DHS (<https://dhsprogram.com/>). Patients and public were not involved in the design and conduct of this research.

Results

Baseline characteristics of the study population

A total of 56,002 women with complete details from nine SSA countries were available. The distribution of study participants is presented in Figure 1. Sixty one percent of the participant women were less than 30 years old and about three-fourths (73.2%) of the total were from rural places of residence. Rates of illiteracy in the studied countries was high. More than one-fifth (22.5%) of all women or their husbands had no schooling. More women (51.2%) had a primary level of education than their husbands (44.8%); whilst women's unemployment status (no working outside home) was higher than their husband's (31.5% vs 4.2%). More than a quarter (27.3%) of all households were in the lowest (poorest) wealth quantile and 24% of the women were having their first child (primigravidae) (Table 1).

Overall, 55.52% (95% CI; 55.11,55.93) of the women had at least four ANC visits with a skilled health provider during pregnancy. Thirty-five percent of the

1
2
3 women started their first ANC visit in the 1st trimester and 57% in the 2nd trimester of
4 pregnancy. Before pregnancy, 82.2% of women in this study had received a tetanus
5 injection. There were 1,808 deaths (32.3 deaths/ 1000 live births) among new-borns in
6 the three years preceding the survey.
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11
12 The highest proportion of 4⁺ANC visits among the studied countries was from
13 Ghana (85.61%) followed by Namibia (78.92%), and Zambia (64.2%), and the lowest
14 proportion was from Rwanda (44.5%), Senegal (45.3%), and Tanzania (48.1%)
15 (Figure 2 online).
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21 Pooled data (Figure 3) illustrates that the highest proportion (57.3%) of 4⁺ANC
22 visits was among 25-29 years old women. Women from an urban place of residence
23 accounted for 64.3% of 4⁺ANC visits. There was an increased proportion of 4⁺ANC
24 visits with an increase in women's educational level, husbands educational level,
25 household wealth status, and access to radio listening/watching TV/reading
26 newspapers or magazines. The proportion of 4⁺ANC visits decreased with an increase
27 in birth order. There was no clear pattern in the association of 4⁺ANC visits on
28 women and husband occupation levels, albeit professionals in both groups were
29 higher.
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43 **Determinants of four or more antenatal care visits**

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46 Table 1 indicates that women aged 25-29 years attended more ANC across all the
47 studied countries ($p < 0.005$), except in Zambia ($p = 0.361$). Similarly, women from an
48 urban place of residence had a higher number of ANC visits than women from rural
49 areas ($p < 0.001$), except in Rwanda ($p = 0.788$). In Zambia women from rural areas had
50 higher 4⁺ANC visits ($p < 0.001$). Table 1 shows that women's and husbands' education
51 level significantly ($p < 0.001$) increased women utilization of ANC across all the
52 studied countries. The highest 4⁺ANC attendance was among women and husbands
53 with highest educational level in Ghana, (99.2% and 96.4% respectively), and the
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3 lowest was among women of no schooling in Rwanda (37.6%) and Tanzania (38.6%),
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5 and husbands with no schooling in Tanzania (36.3%).
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8 Occupational status of women and their husbands was associated ($p<0.001$) with
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10 women's 4⁺ANC attendance across all countries except in Rwanda ($p=0.493$) and
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12 Zambia ($p=0.062$) where the husband's occupation had no association with women's
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14 4⁺ANC visits.
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17 Household wealth status (wealth quantile) was significantly associated with
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19 4⁺ANC visits ($p<0.001$). As the household wealth status increased, the usage of
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21 4⁺ANC visits increased across all countries except in Rwanda ($p=0.234$). With the
22
23 exception of Malawi ($p=0.383$) most primigravidae women undertook more ANC
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25 visits than multi-parous women ($p<0.001$).
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28 More than one in four (27.54%) of the participant women had no access to
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30 radio/TV/newspapers or magazine whilst 53% had access to these media at least once
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32 a week. Increasing access to media was significantly associated with 4⁺ANC
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34 attendance ($p<0.001$), although in Rwanda and Zambia the association was not
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36 significant ($p=0.147$ and $p=0.264$ respectively).
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Table 1. Sociodemographic characteristics influencing 4+ANC visits in nine sub-Saharan countries.

Variables		Ghana	Kenya	Malawi	Namibia	Rwanda	Senegal	Tanzania	Uganda	Zambia
N (%)		3,224	10,981	9,541	2,286	4,416	6,552	5,536	7,979	5,487
Age group										
	15-19	5084(9.08)	140(79.1)	399(47.11)	470(43.93)	153(66.81)	59(40.14)	232(40.00)	252(47.10)	430(62.05)
	20-24	14930(26.66)	519(84.12)	1547(54.05)	1461(48.62)	487(78.30)	427(45.77)	743(47.08)	718(49.42)	989(65.63)
	25-29	14168(25.30)	722(87.73)	1782(55.02)	1115(52.01)	463(81.66)	597(47.76)	791(46.67)	659(50.89)	1213(62.78)
	30-34	10804(19.29)	636(86.53)	1080(52.81)	902(52.78)	334(82.47)	483(43.59)	595(46.09)	491(48.76)	924(61.52)
	35 and above	11016(19.67)	743(85.21)	982(49.40)	840(52.08)	367(79.27)	399(40.80)	609(43.25)	544(43.66)	753(54.33)
	p-value		0.029	< 0.001	< 0.001	< 0.001	0.012	0.014	0.004	< 0.001
Place of residence										
	Urban	15024(26.83)	1207(91.72)	2228(61.28)	892(57.92)	853(82.66)	442(44.87)	1188(60.00)	816(60.53)	1009(67.90)
	Rural	40978(73.17)	1553(81.39)	3562(48.50)	3896(48.69)	951(75.84)	1523(44.39)	1782(38.98)	1848(44.13)	3822(58.86)
	p-value		< 0.001	< 0.001	< 0.001	< 0.001	0.788	< 0.001	< 0.001	< 0.001
Women's education										
	No schooling	12589(22.48)	846(79.21)	916(40.75)	494(45.78)	106(58.56)	228(37.62)	1982(41.28)	421(38.62)	535(55.15)
	Primary	28673(51.20)	544(82.42)	2884(50.67)	3124(49.15)	367(71.40)	1397(44.53)	677(54.51)	1557(46.91)	2872(58.18)
	Secondary	12703(22.68)	1242(90.86)	1380(60.50)	1038(53.73)	1229(82.82)	257(45.73)	291(60.00)	643(59.76)	1072(66.46)
	Higher	2037(3.64)	128(99.22)	610(80.26)	132(75.86)	102(95.33)	83(74.77)	20(83.33)	43(84.31)	352(76.52)
	p-value		< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Husband's education										
	No schooling	9368(22.53)	699(79.16)	344(40.23)	348(48.07)	123(65.78)	248(40.52)	1900(40.85)	234(36.34)	324(58.70)
	Primary	18618(44.78)	292(83.67)	1172(51.38)	2068(48.72)	174(73.73)	1267(45.66)	362(55.69)	1341(45.66)	2057(57.54)
	Secondary	10968(26.38)	1245(88.61)	727(60.43)	1314(52.86)	522(82.08)	172(44.33)	273(62.19)	521(59.68)	1114(65.38)
	Higher	2624(6.31)	267(96.39)	347(73.83)	252(67.56)	83(96.51)	95(62.91)	84(68.29)	75(69.44)	508(73.62)
	p-value		< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Women's occupation										
	Not working O/H	15820(31.48)	519(81.99)	1012(50.40)	1457(48.47)	969(74.65)	130(40.12)	1654(45.23)	543(52.92)	760(56.55)
	Professional/Skilled work	9222(18.35)	1375(91.18)	305(70.28)	579(55.94)	558(84.67)	336(49.19)	656(52.27)	261(65.91)	1468(64.84)
	Agriculture	18823(37.45)	786(78.52)	632(49.11)	2031(49.61)	40(86.96)	1428(44.47)	377(33.87)	1247(41.58)	2099(57.90)
	Unskilled	6392(12.72)	73(97.33)	859(56.03)	721(51.28)	233(83.51)	71(36.04)	279(53.55)	613(54.98)	498(67.30)
	p-value		< 0.001	< 0.001	< 0.001	< 0.001	0.003	< 0.001	< 0.001	0.001
Husband's occupation										
	Not working O/H	1744(4.17)	-	44(51.76)	380(49.74)	8(88.89)	12(50.00)	82(49.70)	16(38.10)	134(59.03)
	Professional/Skilled work	14721(35.22)	1024(92.42)	777(62.26)	1241(53.84)	459(83.91)	516(45.03)	1412(51.22)	600(57.58)	2091(65.53)
	Agriculture	16758(40.09)	1065(78.54)	556(44.91)	1446(49.25)	117(68.02)	1082(46.16)	726(34.00)	1096(41.66)	1327(55.36)
	Unskilled	8579(20.52)	433(91.54)	1199(54.01)	920(49.78)	180(81.45)	180(42.35)	445(48.74)	467(54.75)	521(62.40)
	p-value		< 0.001	0.006	< 0.001	< 0.001	0.493	< 0.001	< 0.001	0.062
Wealth quintile										

	Poorest	15283(27.29)	817(78.78)	1532(41.79)	1002(46.32)	369(73.51)	444(41.73)	634(31.51)	457(37.71)	1152(54.78)	1003(65.13)
	Poorer	12308(21.98)	577(81.96)	1130(49.71)	1022(48.83)	351(74.05)	409(45.14)	706(40.88)	450(40.50)	1020(58.42)	842(66.09)
	Middle	10560(18.86)	495(86.09)	1011(55.10)	888(48.05)	388(79.51)	377(46.60)	660(49.14)	481(44.87)	893(60.13)	692(62.62)
	Richer	9452(16.88)	474(94.23)	1007(60.55)	887(50.63)	401(82.51)	355(45.87)	561(61.58)	666(55.64)	863(64.26)	473(57.47)
	Richest	8399(15.00)	397(98.02)	1110(71.15)	989(58.69)	295(87.80)	380(44.03)	409(73.17)	610(64.62)	903(69.35)	512(68.72)
	p-value		< 0.001	< 0.001	< 0.001	< 0.001	0.234	< 0.001	< 0.001	< 0.001	< 0.001
Birth order	First	13434(23.99)	636(87.60)	1471(59.80)	1267(51.23)	594(79.41)	613(50.16)	718(52.33)	766(56.70)	1077(63.73)	918(65.95)
	Second	11333(20.24)	584(89.30)	1345(57.45)	941(48.26)	469(81.42)	502(46.83)	585(50.39)	538(51.88)	953(63.87)	684(65.14)
	Third	8927(15.94)	470(85.77)	1019(54.40)	798(50.41)	309(84.43)	322(45.61)	448(45.16)	395(48.59)	762(62.56)	523(63.16)
	Fourth	6901(12.32)	382(88.22)	710(50.25)	621(50.74)	180(79.92)	193(38.14)	367(44.48)	299(46.00)	583(61.50)	446(66.77)
	Fifth & above	15407(27.51)	688(79.72)	1245(43.02)	1161(50.24)	252(69.61)	335(36.81)	852(38.69)	666(39.53)	1456(55.34)	951(61.39)
	p-value		< 0.001	< 0.001	0.383	< 0.001	0.001	< 0.001	< 0.001	< 0.001	0.043
Frequency of listening to radio/ watching TV/ reading newspaper or magazine	Not at all	14976(27.54)	288(70.07)	1044(39.77)	2127(47.85)	178(62.24)	298(42.63)	308(34.00)	394(37.60)	1051(53.54)	1640(63.25)
	Less than once a week	10184(18.73)	646(81.46)	671(51.14)	829(49.11)	355(76.84)	481(42.87)	442(37.91)	836(44.83)	724(59.69)	352(62.52)
	At least once a week	29213(53.73)	1826(90.40)	4074(57.84)	1832(53.76)	1271(82.75)	1184(45.75)	2220(49.55)	1434(54.67)	3056(63.63)	473(66.25)
	p-value		< 0.001	< 0.001	< 0.001	< 0.001	0.147	< 0.001	< 0.001	< 0.001	0.264

Univariate analysis magnitude (*ORs and 95% CI*) of sociodemographic characteristics for 4⁺ANC visits

Table 2 presents the results of univariate analysis of 4⁺ANC visits by sociodemographic characteristics across the nine countries in SSA. As shown in Table 2, adequate ANC visits were lower among young women (15-19 years) in seven of the nine countries. The difference was significant in Ghana, Kenya, Malawi, Senegal, and Namibia. The odds of 4⁺ANC visit was lower by 2%-60% among rural residents compared to urban residents across all countries ($p < 0.001$) except in Zambia, in which women from rural places were 26% more likely to attend 4⁺ANCs. The difference was significant in all countries except Rwanda ($p = 0.283$).

Four or more ANC visits had a positive association with increasing educational level. Women and husbands with secondary and higher education had significantly higher odds of 4⁺ANC visits across all the studied countries ($p < 0.05$).

Table 2. Univariate analysis of sociodemographic factors influencing 4+ANC visits in nine sub-Saharan Africa countries.

Variables	Ghana	Kenya	Malawi	Namibia	Rwanda	Senegal	Tanzania	Uganda	Zambia	Total
	(3,224)	(10,981)	(9,541)	(2,286)	(4,416)	(6,552)	(5,536)	(7,979)	(5,487)	(56,002)
Age (grouped)										
15-19	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]
20-24	1.40(0.92,2.13)	1.32(1.13,1.54)	1.21(1.05,1.39)	1.79(1.28,2.50)	1.26(0.88,1.79)	1.34(1.10,1.62)	1.10(0.90,1.34)	1.15(0.98,1.36)	1.17(0.97,1.41)	1.21(1.13,1.29)
25-29	1.89(1.24,2.87)	1.37(1.18,1.60)	1.38(1.19,1.60)	2.21(1.56,3.13)	1.36(0.96,1.93)	1.31(1.08,1.59)	1.16(0.95,1.42)	1.18(0.99,1.39)	1.07(0.89,1.30)	1.27(1.19,1.36)
30-34	1.70(1.12,2.58)	1.26(1.07,1.48)	1.43(1.22,1.66)	2.34(1.61,3.40)	1.15(0.81,1.64)	1.28(1.05,1.57)	1.07(0.87,1.32)	1.11(0.94,1.33)	1.16(0.95,1.42)	1.23(1.15,1.32)
35 and above	1.52(1.01,2.29)	1.10(0.93,1.29)	1.39(1.19,1.62)	1.90(1.33,2.71)	1.03(0.72,1.46)	1.14(0.94,1.39)	0.87(0.71,1.07)	0.83(0.70,0.99)	1.04(0.85,1.26)	1.10(1.02,1.17)
Place of residence										
Urban	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]
Rural	0.40(0.32,0.50)	0.60(0.55,0.65)	0.69(0.62,0.77)	0.66(0.54,0.81)	0.98(0.85,1.13)	0.43(0.38,0.47)	0.52(0.45,0.58)	0.68(0.60,0.76)	1.26(1.12,1.42)	0.61(0.59,0.63)
Women's education										
No schooling	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]
Primary	1.23(0.96,1.58)	1.49(1.35,1.65)	1.15(1.01,1.30)	1.77(1.24,2.51)	1.33(1.11,1.59)	1.70(1.50,1.93)	1.40(1.22,1.62)	1.13(0.99,1.30)	1.22(1.01,1.47)	1.30(1.25,1.36)
Secondary	2.61(2.06,3.30)	2.23(1.98,2.51)	1.38(1.18,1.60)	3.41(2.46,4.72)	1.40(1.11,1.77)	2.13(1.76,2.58)	2.36(1.99,2.80)	1.61(1.37,1.90)	1.18(0.97,1.43)	2.21(2.10,2.33)
Higher	3.51(2.86, 4.17)	5.91(4.85,7.20)	3.72(2.58,5.37)	14.43(5.6,37.14)	4.91(3.11,7.78)	7.11(2.43,20.8)	8.54(3.98,18.35)	2.65(2.06,3.40)	3.38(2.28,5.01)	4.97(4.42,5.58)
Husband's education										
No schooling	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]
Primary	1.35(0.97,1.87)	1.57(1.34,1.84)	1.03(0.88,1.20)	1.46(0.96,2.22)	1.23(1.03,1.47)	1.82(1.54,2.15)	1.47(1.23,1.76)	0.95(0.80,1.14)	1.11(0.84,1.45)	1.25(1.19,1.31)
Secondary	2.05(1.63,2.58)	2.27(1.90,2.71)	1.21(1.03,1.43)	2.38(1.66,3.43)	1.17(0.90,1.51)	2.38(1.95,2.91)	2.59(2.10,3.20)	1.33(1.09,1.62)	1.09(0.84,1.43)	2.06(1.95,2.18)
Higher	7.03(3.66,13.49)	4.19(3.27,5.37)	2.25(1.73,2.92)	14.40(4.38,47.36)	2.49(1.72,3.60)	3.12(2.12,4.58)	3.98(2.57,6.18)	1.96(1.55,2.50)	2.26(1.58,3.24)	3.52(3.19,3.88)
Women's occupation										
Not working O/H	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]
Professional/Skilled work	2.27(1.73,2.97)	2.33(1.86,2.91)	1.35(1.17,1.56)	1.88(1.47,2.40)	1.45(1.11,1.89)	1.33(1.17,1.51)	1.72(1.35,2.19)	1.42(1.23,1.63)	1.29(1.10,1.51)	1.73(1.64,1.82)
Agriculture Unskilled	0.80(0.62,1.03)	0.95(0.83,1.09)	1.05(0.95,1.15)	2.26(0.95,5.39)	1.20(0.95,1.51)	0.62(0.54,0.71)	0.63(0.55,0.73)	1.06(0.93,1.20)	1.24(1.08,1.42)	0.87(0.84,0.91)
Husband's occupation										
Not working O/H	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]
Professional/Skilled work	1.00[Ref]	1.54(0.99,2.39)	1.18(1.00,1.39)	0.65(0.08,5.28)	0.82(0.37,1.84)	1.06(0.78,1.46)	2.21(1.17,4.16)	1.32(1.00,1.74)	1.16(0.92,1.45)	1.35(1.22,1.49)
Agriculture Unskilled	0.30(0.23,0.39)	0.76(0.49,1.18)	0.98(0.84,1.15)	0.27(0.03,2.18)	0.86(0.38,1.92)	0.52(0.38,0.72)	1.16(0.62,2.17)	0.86(0.65,1.14)	1.21(0.97,1.51)	0.86(0.78,0.95)
Wealth quintile										
Poorest	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]
Poorer	1.22(0.96,1.56)	1.37(1.23,1.52)	1.11(0.98,1.25)	1.03(0.77,1.37)	1.15(0.96,1.37)	1.50(1.31,1.72)	1.13(0.95,1.33)	1.16(1.02,1.32)	1.04(0.89,1.22)	1.19(1.14,1.25)
Middle	1.67(1.26,2.20)	1.70(1.52,1.90)	1.07(0.95,1.21)	1.40(1.04,1.88)	1.22(1.01,1.47)	2.10(1.82,2.42)	1.35(1.14,1.59)	1.25(1.09,1.43)	0.90(0.76,1.05)	1.34(1.27,1.41)
Richer	4.40(2.94,6.59)	2.12(1.89,2.39)	1.19(1.05,1.35)	1.70(1.25,2.31)	1.18(0.98,1.43)	3.48(2.96,4.10)	2.07(1.76,2.44)	1.48(1.29,1.71)	0.72(0.61,0.86)	1.60(1.52,1.69)
Richest	13.36(6.53,27.33)	3.41(3.00,3.88)	1.65(1.45,1.87)	2.59(1.77,3.80)	1.10(0.92,1.32)	5.93(4.81,7.31)	3.02(2.53,3.60)	1.87(1.62,2.16)	1.18(0.98,1.42)	2.13(2.02,2.25)

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2											
3											
4											
5	Birth order										
6	First	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]
7	Second	1.18(0.85,1.65)	0.91(0.81,1.02)	0.89(0.79,1.00)	1.14(0.86,1.50)	0.88(0.74,1.03)	0.93(0.79,1.08)	0.82(0.70,0.97)	1.01(0.87,1.16)	0.97(0.82,1.14)	0.93(0.88,0.98)
8	Third	0.85(0.62,1.18)	0.80(0.71,0.91)	0.97(0.85,1.10)	1.41(1.01,1.96)	0.83(0.69,1.00)	0.75(0.64,0.88)	0.72(0.61,0.86)	0.95(0.82,1.11)	0.89(0.74,1.06)	0.87(0.82,0.92)
9	Fourth	1.06(0.74,1.53)	0.68(0.60,0.78)	0.98(0.86,1.12)	0.86(0.61,1.23)	0.61(0.50,0.76)	0.73(0.61,0.87)	0.65(0.54,0.79)	0.91(0.77,1.07)	1.04(0.85,1.26)	0.81(0.76,0.86)
10	Fifth & above	0.56(0.42,0.73)	0.51(0.46,0.57)	0.96(0.86,1.08)	0.59(0.45,0.79)	0.58(0.49,0.69)	0.58(0.50,0.66)	0.50(0.43,0.58)	0.71(0.62,0.80)	0.82(0.71,0.96)	0.65(0.62,0.68)
11	Frequency of listening to radio/ watching TV/ reading newspaper or magazine										
12	Not at all	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]
13	Less than once a week	1.88(1.42,2.48)	1.59(1.39,1.81)	1.05(0.94,1.18)	2.01(1.46,2.78)	1.01(0.83,1.22)	1.19(0.99,1.42)	1.35(1.16,1.57)	1.29(1.11,1.49)	0.97(0.80,1.17)	1.15(1.09,1.21)
14	At least once a week	4.02(3.11,5.20)	2.08(1.90,2.28)	1.27(1.16,1.39)	2.91(2.21,3.83)	1.14(0.96,1.34)	1.91(1.64,2.22)	2.00(1.73,2.32)	1.52(1.37,1.69)	1.14(0.96,1.36)	1.53(1.47,1.59)

Bold font indicates a significant difference from reference at p<0.05. O/H: outside home.

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3 Compared to women who did not work outside home, the odds of 4⁺ANC visits
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5 were significantly higher among professional women. Odds of 4⁺ANC visits in
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7 relation to household wealth status showed considerable variation among the
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9 countries ranging from 1.10 (95% CI, 0.92, 1.32) in Rwanda to 13.36 (95% CI, 6.53,
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11 27.33) in Ghana.
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15 The pattern of 4⁺ANC utilization showed an inverse relationship with birth order.
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17 Women of fifth and above birth order had significantly lower ANC attendance than
18
19 first birth order. Listening to radio/watching TV/ reading newspaper or magazine had
20
21 a significant positive association with 4⁺ANC attendance across all countries except
22
23 in Rwanda and Zambia (Table 2).
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26 27 **Multivariable findings**

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30 Table 3 summarizes data analysis results adjusted by sociodemographic variables
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32 and adjusted by country.
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35 Overall, the likelihood of 4⁺ANC visits were 14% lower among women from
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37 rural areas than from towns (AOR, 0.86; 95% CI: 0.81,0.91). Multivariable logistic
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39 regression analysis exploring the relationship between 4⁺ANC visits and place of
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41 residence was significant in four countries (Kenya, Malawi, Senegal and Zambia).
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43 While in Ghana, Namibia, Rwanda, Tanzania, and Uganda; 4⁺ANC visit had no
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45 association with place of residence. In Zambia, the odds of 4⁺ANC visits was 48%
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47 higher (AOR, 1.48; 95% CI: 1.2, 1.82) among rural women than urban.
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51 Findings of selected socio-demographic predictors related to ANC visit after
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53 adjustment for country variations indicated that the odds of 4⁺ANC visits increased
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55 from 14% (AOR=1.14, 95% CI 1.07,1.21, p<0.001) to 96% (AOR=1.96, 95% CI
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57 1.65,2.33, p<0.001) with an increase in women's educational level. Women with
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59 higher educational levels had more than two-fold higher odds of 4⁺ANC visits in
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3 seven of the nine countries, and the difference was significant in four (Kenya,
4 Malawi, Rwanda, and Zambia). Husband's higher educational level had significant
5 association with 12% (AOR=1.12, 95% CI 1.05, 1.20) to 48% (AOR=1.48, 95% CI
6 1.31, 1.69) higher odds 4⁺ANC visits of women (p<0.001). Association of husband's
7 education and 4⁺ANC visits of women was significant only in Kenya, Malawi, and
8 Zambia.
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17 Overall, women's occupation had a positive association with 4⁺ANC visits. The
18 variation on 4⁺ANC visits was 19% (AOR, 1.19, 95% CI; 1.11, 1.27), 7% (AOR,
19 1.07, 95% CI; 1.01, 1.13), and 13% (AOR, 1.13, 95% CI; 1.05, 1.21) greater among
20 working Professional/Skilled women, Agriculture, and Unskilled labour respectively
21 compared to women not working outside home. In Ghana, the odds of 4⁺ANC visits
22 was more than fifteen times (AOR, 15.54, 95%CI; 2.1, 114.9) higher among
23 employed women than women who had no work outside the home. Women in
24 Uganda, were 62% more to attend 4⁺ANC (AOR, 1.62, 95%CI; 1.28, 2.05).
25 Agriculture employed women in Kenya, Senegal, and Tanzania and unskilled workers
26 in Rwanda, Tanzania, and Zambia had non-significant lower uptake of 4⁺ANCs.
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40 Women in the wealthiest group were highly likely to undertake 4⁺ANC visits.
41 After adjusting for country, ANC service utilization increased by 12 % (AOR=1.12,
42 95% CI 1.06, 1.19), 18% (AOR=1.18, 95% CI 1.11, 1.26), 32% (AOR=1.32, 95% CI
43 1.23, 1.42), and 41% (AOR=1.41, 95% CI 1.29, 1.55) for every 20% variation on the
44 wealth category compared to the poorest level (p<0.001) (Table 3). This association
45 was uniform across the studied countries except in Rwanda where women in the
46 highest wealth quantile were 23% lower (AOR=0.77, 95% CI 0.57, 1.02) to make
47 4⁺ANC than the poorest group. The odds of 4⁺ANC visits were 4% (AOR=0.96, 95%
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3 CI; 0.78-1.19 and 14% (AOR=0.86, 95% CI; 0.64-1.16) lower among middle and
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5 richer economic status in Zambia.
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8 Women with previous birth experience had a significantly lower uptake of ANC
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10 services than first birth order ($p<0.001$). Odds of 4⁺ANC were lower by 16%
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12 (AOR=0.84, 95% CI 0.79, 0.90), 21% (AOR=0.79, 95% CI 0.74, 0.85), 23%
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14 (AOR=0.77, 95% CI 0.72, 0.83), and 32% (AOR=0.68, 95% CI 0.64, 0.73) for
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16 second, third, fourth, and fifth and above birth orders than first birth women (Table 3).
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18 Birth order difference on 4⁺ANC visits were significant in Kenya, Rwanda, Senegal,
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20 Tanzania, Uganda, and Zambia.
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23 Women who had access to media at least once a week had 22% higher odds of
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25 4⁺ANC visit than women who had no access (AOR, 1.22, 95%CI; 1.15,1.29). This
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27 association was significant in all countries except in Malawi, Rwanda, Senegal, and
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29 Zambia.
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Table 3. Adjusted multivariable analysis of sociodemographic factors influencing 4+ANC visits in nine sub-Saharan countries.

Variables	Ghana	Kenya	Malawi	Namibia	Rwanda	Senegal	Tanzania	Uganda	Zambia	Overall *
Place of residence										
Urban	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]
Rural	0.84(0.61,1.15)	0.83(0.72,0.9)	0.83(0.71,0.96)	0.83(0.57,1.21)	0.95(0.77,1.18)	0.73(0.62,0.84)	0.83(0.69,1.01)	0.86(0.72,1.01)	1.48(1.2,1.82)	0.86(0.81,0.91)
Women's education										
No schooling	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]
Primary	1.06(0.78,1.43)	1.12(0.90,1.39)	1.09(0.94,1.27)	1.34(0.83,2.16)	1.20(0.99,1.46)	1.06(0.91,1.23)	1.04(0.88,1.22)	1.03(0.87,1.22)	1.12(0.90,1.41)	1.14(1.07,1.21)
Secondary	1.47(1.05,2.05)	1.23(0.94,1.60)	1.11(0.91,1.35)	1.78(1.04,3.05)	1.28(0.95,1.74)	1.08(0.84,1.4)	1.00(0.79,1.28)	1.19(0.96,1.47)	1.05(0.81,1.38)	1.17(1.08,1.21)
Higher	4.82(0.6,37.23)	2.17(1.42,3.32)	2.26(1.42,3.60)	2.13(0.51,8.93)	3.82(2.17,6.73)	1.78(0.58,5.47)	2.19(0.91,5.30)	1.30(0.92,1.83)	2.06(1.20,355)	1.96(1.65,2.33)
Husband's education										
No schooling	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]
Primary	1.04(0.73,1.43)	1.08(0.87,1.36)	0.97(0.83,1.15)	1.11(0.71,1.75)	1.10(0.91,1.33)	1.35(1.13,1.61)	1.18(0.98,1.42)	0.86(0.70,1.05)	1.07(0.81,1.42)	1.12(1.05,1.20)
Secondary	0.97(0.72,1.33)	1.20(0.93,1.56)	1.06(0.88,1.27)	1.21(0.77,1.88)	0.93(0.69,1.24)	1.36(1.09,1.71)	1.35(1.05,1.72)	1.01(0.80,1.26)	1.15(0.86,1.54)	1.17(1.09,1.27)
Higher	1.42(0.69,2.93)	1.41(1.00,1.97)	1.42(1.03,1.95)	3.57(0.9,14.17)	1.42(0.88,2.27)	1.32(0.86,2.02)	1.38(0.84,2.27)	1.22(0.91,1.63)	1.91(1.23,2.96)	1.48(1.31,1.69)
Mother's occupation										
Not working O/H	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]
Professional/Skilled work	1.99(1.46,2.27)	1.19(0.91,1.56)	0.97(0.81,1.15)	1.64(1.11,2.44)	1.23(0.91,1.66)	1.09(0.94,1.26)	1.24(0.93,1.65)	1.38(1.18,1.62)	1.24(1.01,1.50)	1.19(1.11,1.27)
Agriculture	1.44(1.06,1.97)	0.98(0.83,1.15)	1.08(0.96,1.19)	2.25(0.75,6.72)	1.16(0.87,1.53)	0.89(0.76,1.04)	0.89(0.75,1.07)	1.26(1.09,1.46)	1.14(0.96,1.35)	1.07(1.01,1.13)
Unskilled	15.54(2.1,114.9)	1.06(0.91,1.24)	1.07(0.92,1.22)	1.58(0.85,2.97)	0.79(0.52,1.21)	1.09(0.87,1.35)	0.95(0.78,1.16)	1.62(1.28,2.05)	0.96(0.76,1.23)	1.13(1.05,1.21)
Wealth quintile										
Poorest	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]
Poorer	0.93(0.70,1.23)	1.09(0.91,1.32)	1.07(0.94,1.23)	0.74(0.48,1.13)	1.06(0.87,1.28)	1.37(1.19,1.58)	1.05(0.87,1.26)	1.18(1.02,1.37)	1.09(0.91,1.32)	1.12(1.06,1.19)
Middle	0.93(0.64,1.36)	1.18(0.96,1.45)	1.09(0.94,1.26)	0.85(0.53,1.36)	1.12(0.91,1.37)	1.56(1.32,1.86)	1.15(0.95,1.40)	1.19(1.01,1.40)	0.96(0.78,1.19)	1.18(1.11,1.26)
Richer	1.88(1.09,3.23)	1.21(0.97,1.51)	1.07(0.92,1.25)	0.79(0.45,1.40)	1.04(0.84,1.30)	2.26(1.83,2.79)	1.62(1.31,2.00)	1.29(1.08,1.5)	0.86(0.64,1.16)	1.32(1.23,1.42)
Richest	4.74(1.9,11.95)	1.55(1.19,2.04)	1.23(1.02,1.50)	1.31(0.57,3.00)	0.77(0.57,1.02)	3.62(2.78,4.72)	1.69(1.27,2.24)	1.27(1.02,1.60)	1.17(0.81,1.69)	1.41(1.29,1.55)
Birth order										
First	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]
Second	1.08(0.72,1.63)	0.71(0.58,0.87)	0.83(0.72,0.95)	1.22(0.74,1.99)	0.72(0.60,0.87)	0.88(0.74,1.06)	0.82(0.68,1.00)	0.95(0.80,1.13)	0.87(0.70,1.08)	0.84(0.79,0.90)
Third	0.77(0.52,1.15)	0.62(0.51,0.76)	0.91(0.79,1.05)	1.06(0.64,1.76)	0.68(0.55,0.83)	0.78(0.65,0.94)	0.72(0.59,0.89)	0.97(0.81,1.16)	0.76(0.61,0.96)	0.79(0.74,0.85)
Fourth	1.06(0.69,1.64)	0.56(0.45,0.70)	0.95(0.82,1.11)	1.12(0.65,1.94)	0.52(0.42,0.66)	0.76(0.62,0.92)	0.71(0.57,0.88)	0.88(0.73,1.07)	0.91(0.71,1.17)	0.77(0.72,0.83)
Fifth & above	0.75(0.52,1.08)	0.50(0.41,0.61)	0.98(0.85,1.12)	0.79(0.49,1.26)	0.50(0.41,0.61)	0.68(0.58,0.80)	0.61(0.51,0.73)	0.77(0.65,0.90)	0.73(0.59,0.90)	0.68(0.64,0.73)
Frequency of listening to radio/reading newspaper/magazines										
Not at all	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]	1.00[Ref]
Less than once a week	1.47(1.08, 2.00)	1.35(1.08,1.68)	1.05(0.94,1.20)	1.94(1.22,3.07)	0.95(0.78,1.17)	1.06(0.87,1.29)	1.11(0.93,1.33)	1.13(0.96,1.34)	1.01(0.80,1.28)	1.08(1.01,1.15)
At least once a week	2.62(1.96,3.50)	1.21(1.02,1.44)	1.09(0.98,1.22)	2.31(1.51,3.53)	1.07(0.88,1.30)	1.14(0.96,1.35)	1.34(1.12,1.60)	1.24(1.09,1.41)	1.05(0.85,1.30)	1.22(1.15,1.29)

All are adjusted for sociodemographic factors and media exposure. * adjusted for sociodemographic factors, media exposure, and country. **bold font** indicates a significant difference from reference at $p < 0.05$, O/H: outside home

Discussion

Every pregnant woman should receive quality care throughout her pregnancy. However, in the nine sub-Saharan Africa countries examined in this study only 55.52% (95% CI; 55.11, 55.93) attended 4⁺ANC. There were disparities between the countries in the proportion of women attending 4⁺ANC, with the highest in Ghana (85.61%) followed by Namibia (78.92%), and Zambia (64.2%), and the lowest proportion from Rwanda (44.5%), Senegal (45.3%), and Tanzania (48.1%).

Demographic and socioeconomic factors, including place of residence, women and husbands educational level, women and husbands occupational status, household wealth quantiles, birth order, and access to media were significant determinants of 4⁺ANC attendance. Therefore, there is an urgent need on interventions directed towards maximizing the utilization of ANC in the SSA.

The strength of this analysis is that we used nationally-representative data, from nine sub-Saharan Africa countries, assumed to have minimum sampling (random or systemic) or instrumental errors through the use of appropriate multistage stratified cluster sampling strategies, having a large sample size of 56,002 respondents, and weighted data analysis with reliable test of instrumentations. The analytical approach as pooled data support the outcome to be valid and the merit in segregating data allowed a focus on aspects of ANC visits that may remain hidden in intra-national/national level indicators. Recall biases of self-reported data and the cross-sectional nature of the studies limits the cause-effect association of potential predictors. Since the data were obtained from countries DHS at different times, awareness of participants may differ. Moreover, the data in the present analysis did not consider the quality of care provided to pregnant women during ANC visits which could be a potential predictor for ANC attendance.

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6 Pooled data, adjusted by country, showed that a rural place of residence, no
7 schooling, of either the wife or husband, no maternal employment, low household
8 economic status, second and higher birth order, and lack of access to media were
9 significantly associated with lower utilization of 4⁺ANC (Table 3). This is in line with
10 previous studies from low and middle income countries ^{6 11 15 18 21 23}.

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17 Country-level data showed that Ghana and Namibia had the highest attendance of
18 4⁺ANC visits across all reproductive age groups. The finding from Ghana was in line
19 with the 2013 cross-sectional study where 86% of Ghanaian women reported
20 attending 4⁺ANC visits ²¹. Consistent with the finding from other studies, in India and
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Nigeria, this report also showed that 4⁺ANC visits was very low in Rwanda, Senegal,
Tanzania, Malawi, and Kenya ^{23 24}.

Women from rural areas had 5%-27% lower odds of 4⁺ANC visits in eight of the
nine studied countries, and was significant in Kenya, Malawi, and Senegal. However,
contrary to other studies there was a 48% greater uptake of 4⁺ANCs by rural residents
from Zambia (Table 3)²²⁻²⁴.

Multivariable analysis indicated that higher education among both women and
men was a significant predictor of 4⁺ANC visits ^{6 8 11 18 23}. Women with higher
educational levels had more than two-fold higher odds of 4⁺ANC visits. This
difference was significant in Kenya, Malawi, Rwanda, and Zambia. Similarly, having
a husband with a higher educational level was significantly associated with 4⁺ANC
visits among women from Kenya, Malawi, and Zambia ³².

Women's occupation had non-uniform association with 4⁺ANC visits across
countries. Women from Ghana and Uganda working as Professional/Skilled,
Agriculture, and Unskilled labour attended more ANC visits than women who did not

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3 work outside the home, a finding similar to other studies¹⁸. However, this association
4 was not significant in seven of the nine countries (Kenya, Malawi, Namibia, Rwanda,
5 Senegal, Tanzania, and Zambia)¹¹.
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10 Both univariate and multivariable analysis indicated that difference in wealth
11 quantiles was associated with attendance at 4+ANCs^{7 8 21 25}. Women from the highest
12 wealth category had significantly greater access to 4+ANC visits than those in the
13 lowest category. This was significant in Ghana, Kenya, Malawi, Senegal, Tanzania,
14 and Uganda. In Rwanda women in the richest wealth quantile had 23% lower
15 (AOR=0.77, 95% CI 0.57, 1.02) 4+ANC visits than the poorest group, which is
16 different from the existing literature^{11 18 21 23}.
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26 Our findings revealed that women in their first pregnancy were more likely to
27 attend 4+ANC than second pregnancies and above, except in Namibia. This might be
28 due to them being more careful about pregnancy³³. This difference was significant in
29 Kenya, Rwanda, Senegal, Tanzania, Uganda, and Zambia, and was similar to previous
30 studies^{10 18}. Consistent with our findings in Namibia, research from Nigeria suggested
31 that adolescents are less likely to attend ANC services²⁹.
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40 Listening to radio/ watching TV/ reading newspapers or magazines at least once a
41 week was positively associated with the uptake of 4+ANC across all the studied
42 countries. The odds of 4+ANC visit among women who had access to media at least
43 once a week was more than two-fold higher in Ghana (AOR=2.62, 95% CI 1.96, 3.50)
44 and Namibia (AOR=2.31, 95% CI 1.51, 3.53). This association was not significant in
45 Rwanda, Senegal, Malawi, and Zambia^{8 11 18 23}.
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54 In summary, despite the importance of attending the WHO recommended level of
55 at least 4+ANC visits for a normal pregnancy¹, many women in SSA have limited
56 access. The result of this study indicate that, disparities on 4+ANC visits were related
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3 to womens economic situation as well as physical barriers ^{12 25}. Therefore,
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5 interventions on addressing the inequalities on ANC services use among women from
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7 rural areas and with limited resources are crucial. The relatively high utilization of
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9 ANC in Ghana could be due to community based health insurance ^{8 21 27}. Furthermore,
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11 governments committed to community insurance are crucial to avoid the challenges
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13 faced in countries like Rwanda, which was functional 1999-2012³⁴, but not in
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15 2014/2015.
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19 Women and husbands with higher education, exposed to outside home
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21 occupation, and who had exposure to media had positive results on the uptake of
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23 4+ANC. Educated women and their husbands as well as those in employment
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25 presumably knew the importance of adequate ANC attendance.
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28 **Conclusion and recommendation**

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30 Four or more ANC service utilization is low among women of the SSA countries.
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32 Despite its importance countries had varied practices of 4+ANC visits.
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36 Therefore, regional and country-specific maternal health program interventions
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38 are required to address the barriers of adequate ANC visits. Moreover, health
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40 programs should target women of rural resident, without schooling, no outside home
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42 occupation, from low-household economic status, non-first-time pregnancy, and had
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44 no access to media.
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47 **Author Contributions:** AKA conceptualization, design the study methodology,
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49 conduct the literature review, data acquisition, formal analysis, interpretation of data,
50
51 and write (original draft). AKA, LXZ, ZZH, MEM, and QQ write (review and
52
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55 authors read and approved the final manuscript
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10
11
12

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14
15

16 **Patients consent for publication:** Not required.
17
18

19 **Ethics approval:** This study was exempt from review by the ethics committee as
20 publicly available data sets were used and no identifying participant information was
21 obtained. The authorization for using the data in the current analysis was granted from
22 the DHS program: DHS, ICF international, Rockville, Maryland, USA office upon
23 presenting the research protocol and research plan aims.
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30 **Data availability statement:** Data sets used in the analysis are publicly available and
31 can be accessed online through application to MEASURE DHS. Analysis syntaxes
32 and outputs generated for the study can be made available upon request to the
33 corresponding author.
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40 Figure captions

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42 **Figure 1:** Flow chart of the process of selection of women for analysis of 4⁺ANC
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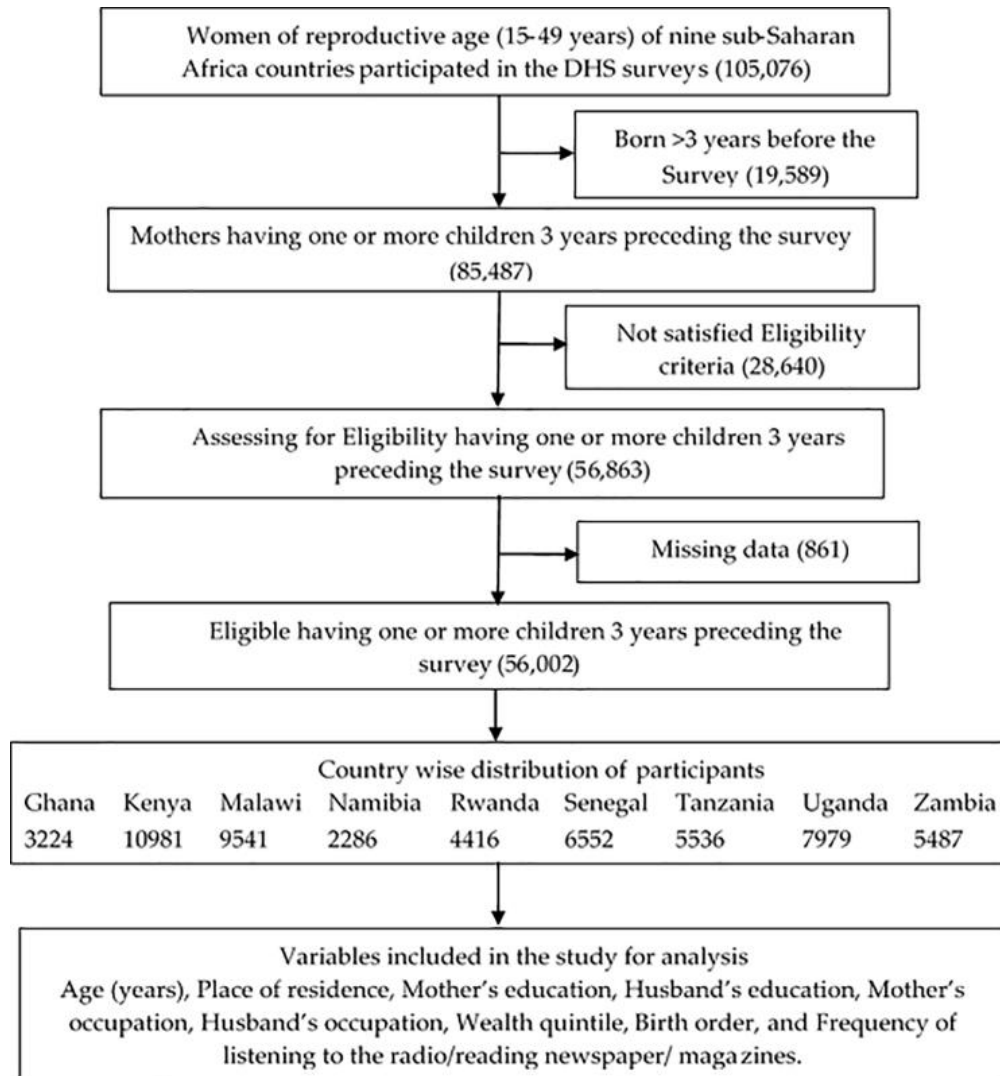
47 **Figure 2.** Proportion of 4⁺ANC visits of women in nine sub-Saharan Africa countries,
48 three years preceding the DHS survey of each country
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50 **Figure 3.** Proportion of 4⁺ANC visits of women in nine sub-Saharan Africa countries
51 and their socio-demographic factors, with 95% confidence interval
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58 **References**
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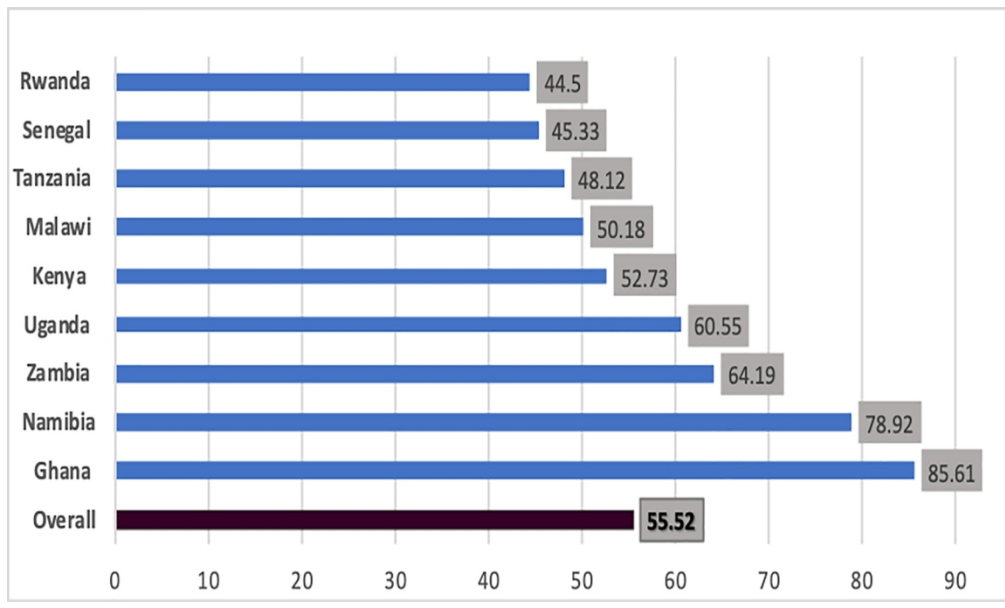
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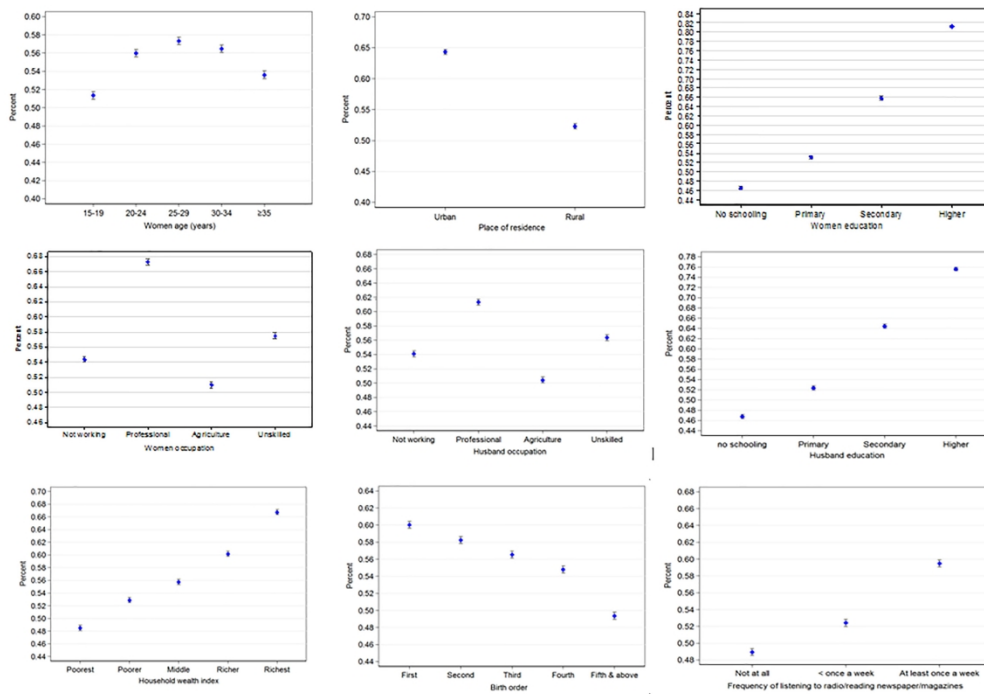


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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study’s design with a commonly used term in the title or the abstract	1
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3-4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	-
Bias	9	Describe any efforts to address potential sources of bias	6
Study size	10	Explain how the study size was arrived at	5-6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	7-8
		(b) Describe any methods used to examine subgroups and interactions	7-8
		(c) Explain how missing data were addressed	6
		(d) If applicable, describe analytical methods taking account of sampling strategy	7
		(e) Describe any sensitivity analyses	-

Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	-
		(b) Give reasons for non-participation at each stage	-
		(c) Consider use of a flow diagram	6
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8-9
		(b) Indicate number of participants with missing data for each variable of interest	11-13
Outcome data	15*	Report numbers of outcome events or summary measures	13
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	13- 21
		(b) Report category boundaries when continuous variables were categorized	11-14
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	-
Discussion			
Key results	18	Summarise key results with reference to study objectives	22
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	22-23
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	23-25
Generalisability	21	Discuss the generalisability (external validity) of the study results	22-23
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	NA

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.