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Determinants of antenatal care utilization in sub-Saharan Africa from 2006 to 2018: Evidence from 36 sub-Sahara African Countries.

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Abstract

Objective: - Globally, the number of women who die each year from pregnancy-related complications and childbirth has declined. However, maternal deaths reduction shows a similar trend of decline, there is a large variation in terms of the absolute number of maternal deaths between developed and the developing nations. Particularly, improving maternal and newborn health remains a major challenge in sub-Saharan Africa. Thus, this study was carried out to estimate the pooled prevalence and determinants of ANC visit in sub-Saharan Africa.

Design Cross-sectional study

Setting Population based

Participants A recent Demographic and Health Surveys (DHS) data conducted in 36 sub-Saharan Africa countries from 2006 to 2018.

Methods: - A meta-analysis of DHS data of each sub-Saharan African countries was conducted to generate pooled magnitude and forest plot was used to present it. A multilevel logistic regression model was fitted to identify determinants of antenatal care utilization. The AOR (Adjusted Odds Ratio) with their 95% CI and p-value ≤ 0.05 were used to declare that determinates associated with postnatal care utilization.

Results: -The pooled prevalence of antenatal care utilization in sub-Saharan Africa countries were 95.57 % [95 % CI: 95.50, 95.65], with the highest ANC utilization Eastern Region of Africa (97.52 %) and the low ANC utilization in Southern Regions of Africa (91.05 %). In the multilevel logistic regression model; residence, maternal education, husband education, maternal occupation, wealth index, media exposure, contraceptive use, and wanted pregnancy were positively associated with ANC utilization while birth order was negatively associated with ANC utilization.

Conclusions: - This study revealed that there exists a wide gap between sub-Saharan African countries on antenatal care utilization ranges from 62% to 99%. Health education targeting mothers and their partner with no education are vital to increasing their awareness about the importance of postnatal care services.

Keywords: - Determinants, Antenatal care visit, sub-Saharan Africa, Demographic and Health Survey

ARTICLE SUMMARY

Strength and limitation of the study

- This study was done at the maternal health issue which was a low and less reached area.
- Since this study was conducted on 36 sub-Saharan Africa countries, the generalization of the result is possible.
- This study was based on cross-sectional data which implies that the direction of causal relationships cannot always be determined.

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BACKGROUND

Globally the number of women who die each year from pregnancy-related complications and childbirth has declined ^{1 2} from 342 deaths per 100, 000 live births in 2000 to 211 per 100,000 in 2017.² However, maternal deaths reduction shows a similar trend of decline (38 % reduction from 2000 to 2017 both the global and sub-Saharan Africa), there exists a large variation in terms of the absolute number of maternal deaths between developed and the developing nations. For instance, the maternal mortality reduction trend in sub-Saharan Africa shows as declined from 878 in 2000 to 542/100,000 in 2017.^{2 3}

In sub-Saharan Africa and Southern Asia accounted for about 86 percent of the total global maternal deaths in 2017 (254 000), with sub-Saharan Africa alone accounting for about 66 per cent (196 000), while Southern Asia accounted for almost 20 percent (58 000).^{2 4}

In developing nations, maternal mortality is 14 times higher than in high-income countries, with just half of the pregnant women receiving the required number of antenatal care visits in 2014. Nearly 4/5th of pregnant mothers in sub-Saharan Africa attended at least one antenatal care visit and half of the pregnant mothers got at least four antenatal care visits in 2016.⁵

However, World Health Organization (WHO) issued a new approach in 2016 which recommends eight ANC (Antenatal Care) contacts, focused antenatal care is still in practice in many African countries.^{6 7} Improving maternal and newborn health remains a major challenge in sub-Saharan Africa. Providing good maternal health care can manage most maternal and child pregnancy-related deaths through early detection of complications.⁸

Antenatal care is described as a dichotomous variable, with or without one or more visits to a skilled individual during pregnancy according to WHO. Antenatal care can reduce maternal morbidity and mortality right through the diagnosis and management of pregnancy-related illness.

ANC takes the lion share along with other maternal health services. Nonetheless, it is unusual to see pregnant women who deny ANC service.⁹ Successful ANC absorbs the mother and her family to the formal health care system, improves the likelihood of using skilled delivery service, and contributes to good health across the life cycle. A disappointing approach during this phase disrupts the continuity of care and affects both children's and women's health condition.¹⁰

Previous studies results show that the use of antenatal care is influenced by a variety of variables, such as the individual level, the household level or the interpersonal level and the access to health services. A recent study, in low-and middle-income countries, described the education of the mother and her husband as the most significant factor influencing the use of maternal health services.^{11 12}

The logistic regression model was used in previous studies, which cannot solve the problem of non-independence. However, we used the multilevel model, which can manage both individual and community-level variables in this study.

Furthermore, there are various individual and community-level variables that are likely to influence antenatal care service utilization. Identifying these determinants is a first step in discovering approaches to diminish maternal death.

To summarize as to our search, previous studies were concentrated on ANC service utilization with the scope of the country to sub country level. It may also make designing a harmonized maternal health service strategy difficult in the region.¹² Thus, it is important to have an insight into determinants and pooled prevalence of ANC service utilization in the region. Additionally, this information is essential for policy planners and program managers to identify gaps in the utilization of antenatal care and to plan strategies to increase the utilization of services.

Therefore, this analysis aimed at assessing the utilization of ANC care services during pregnancy, and its determinants in 36 sub-Saharan Africa countries using the DHS data from 2006 to 2018. This analysis is, therefore, necessary to obtain an overall picture of which determinants are important and how much of an impact they have on antenatal care use. This analysis aimed at systematically and quantitatively summarizing the factors affecting the utilization of antenatal care among women who were sub-Saharan Africa pregnant or had given birth at least once five years preceding the survey.

METHODS

Data Source

Data used in this study were the most recent Demographic and Health Surveys (DHS) data conducted in the following sub-Saharan Africa countries (Angola, Benin, Burkina-Faso, Burundi, Cameroon, Chad, Comoros, Congo, Cote d'Ivoire, Democratic Republic of Congo, Ethiopia, Gabon, Gambia, Ghana, Guinea, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mozambique, Namibia, Niger, Nigeria, Rwanda, Sao Tome & Principe, Senegal, Sierra Leone, Swaziland, Tanzania, Togo, Uganda, Zambia, Zimbabwe South Africa) from 2006 to 2018(**Table 1**). These datasets were appended together to determine the pooled prevalence and determinants of ANC utilization across the Sub-Saharan Africa countries. The DHS is a nationally representative survey that collects data on basic health indicators like mortality, morbidity, family planning service utilization, fertility, maternal and child health. The data were derived from the measure DHS program. Each country's survey consists of different datasets including men, women, children, birth, and household datasets, for this study IR file, was used.

The IR file contains all the data collected in the Woman's Questionnaire for de facto women plus some variables from the Household Questionnaire. Up to 20 births in the birth history, and up to 6 children under age 5, for whom pregnancy and postnatal care, as well as immunization, health and nutrition data, were collected, can be found as repeated variables in this file. This dataset is used for most woman-level analysis including marriage and sexual activity, fertility and fertility preferences, family planning, anthropometry and anaemia in women, malaria prevention for women, HIV/AIDS, women's empowerment, adult and maternal mortality, and domestic violence

The DHS used two stages stratified sampling technique to select the study participants. We pooled 36 DHS surveys done in the Sub-Saharan Africa countries and a total weighted sample of **300,575** reproductive-age women who gave at least one birth in the last five years preceding the survey was included in the study.

Measurements of variables

Outcome variable

The outcome variable for this study was whether a mother had at least one antenatal care visit or not. The variable is generated using the WHO-recommended antenatal care service. We coded "1" if women at least one antenatal care visit service and "0" otherwise.

Explanatory variables

Based on known facts and literature the explanatory variables included in this study were Region, residence, age group, maternal education, husband education, maternal occupational status, wealth index, media exposure, accessing health care, wanted pregnancy, contraceptive utilization, and birth order.

Data management and analysis

We pooled the data from the 36 sub-Saharan African countries together after extracting the variables based on literature. Before any statistical analysis, the data were weighted using sampling weight, primary sampling unit, and strata to restore the representativeness of the survey and take sampling design when calculating standard errors and reliable estimates. Cross tabulations and summary statistics were done using STATA version 14 software. The pooled prevalence of antenatal care utilization with 95% Confidence Interval (CI) was reported for sub- Saharan Africa Countries from 2006 to 2018.

Statistical Modeling

For the determinant factors, the DHS data had a hierarchical structure, this violates the independence of observations and equal variance assumption of the traditional logistic regression model. Hence women are nested within a cluster and we expect that women within the same cluster may be more similar to each other than women in the rest of the country. This implies that there is a need to take into account the between cluster variability by using advanced models. Four models were fitted null model (models without the explanatory variables), the model I (models include community-level variables, model II (models include individual-level variable)) and Model III (models include both individual and community level variables) were fitted to select the best fit model for the data using LLR and Deviance. Model III which includes both individual and community level variable was selected because of its highest LLR and Smallest deviance (**Table 3**)

Ethics consideration

Permission to get access to the data was obtained from the measure DHS program online request from <http://www.dhsprogram.com.website> and the data used were publicly available with no personal identifier.

Table 1: Pooled Demographic and Health Surveys (DHS) data from 36 sub-Saharan countries, 2006–2018.

Country	DHS year	Sample size (300,575)
Southern Region of Africa		11554
Lesotho	2014	2575
Namibia	2013	3813
Swaziland	2006/07	2130
South Africa	2016	3036
Central Region of Africa		88207
Angola	2015/16	14379
DR Congo	2013/14	18827
Congo	2011/12	10819
Cameroon	2011	15426
Gabon	2012	8422
Sao Tome & Principe	2008/09	2615
Chad	2014/15	19917
Eastern Region of Africa		98663
Burundi	2010	8940
Ethiopia	2016	7590
Kenya	2014	14141
Comoros	2012	2064
Madagascar	2008/09	8661
Malawi	2015/16	13515
Mozambique	2011	7874
Rwanda	2014/15	6059
Tanzania	2015/16	7078
Uganda	2011	10152
Zambia	2018	7324
Zimbabwe	2013/14	4987
Western Region of Africa		102151
Burkina-Faso	2010	10487
Benin	2017	9030
Cote d'Ivoire	2011	5229
Ghana	2014	4141
Gambia	2013	5293

Guinea	2018	5487
Liberia	2013	4769
Mali	2018	6622
Nigeria	2018	21911
Niger	2012	8002
Sierra Leone	2010/11	8647
Senegal	2010/11	7678
Togo	2013/14	4851

Patient and public involvement

There were no patients involved in this study.

RESULTS

A total of **300,575** women who gave at least one birth five years preceding the survey in 36 sub-Saharan Africa countries were included in this study. Of these, the largest study participants 102,151(33.99%) were from Western Africa Region and the smallest study participants 11,553(3.84%) were from Southern Regions of Africa. Majority of study participants 191,029(63.55%) were rural residents. The median age women included in his study was 28.8 (IQR=7.2) years in which 125,808(41.86%) of them under age category 25-34. Thirty-three percent of women and thirty-six percent of men had no formal education. More than one-third of women 121,842 (40.54%) were under poor wealth status (**Table 2**).

Table 2: - Distribution of postnatal service utilization in sub-Saharan Africa region

Variable	ANC utilization		Total (%)	X-square value	p-value
	Yes	No			
Africa Region					
Southern	10044	1509	11553(3.84)	54.23	<0.001*
Central	79304	8902	88207(29.35)		
Eastern	91782	6880	98663(32.82)		
Western	88165	13986	102151(33.99)		
Residence					
Rural	165566	25463	191029(63.55)	82.35	<0.001*

Urban	103730	5815	109546(36.45)		
Age group					
15-24	91025	8708	99733(33.18)	361.45	<0.001*
25-34	111984	13824	125,808(41.86)		
35-46	66287	8746	75,033(24.96)		
Maternal education					
No education	84928	20746	105657(36.16)	81.89	<0.001*
Primary education	92800	6620	99420(33.08)		
Secondary and above	91567	3912	95480(31.77)		
Husband education					
No education	72138	17711	89849(36.18)	196.83	<0.001*
Primary education	61978	5504	67482(27.55)		
Secondary and above	82953	5015	87608(35.77)		
Maternal Occupation					
Had occupation	192557	21407	86610(28.82)	286.55	<0.001*
Had no occupation	76739	9871	213964(71.18)		
Wealth Index					
Poor	102762	19080	121842(40.54)	120.51	<0.001*
Middle	53829	5654	59483(19.79)		
Rich	112705	6544	119249(39.67)		
Media Exposed					
Yes	189,649	13366	97537(32.45)	54.59	<0.001*
No	79630	17906	203016(67.55)		
Accessing health care					
Big problem	112299	11293	175471(58.67)	458.11	<0.001*
Not a big problem	155618	19852	123592(41.33)		
Wanted pregnancy					
Yes	207875	28706	17448(6.87)	1.56	0.211
No	15259	2188	236582(93.13)		
Contraceptive use					
Yes	79345	4210	83555(28.51)	84.39	<0.001*
No	182744	26730	209474(71.49)		
Birth Order					
1	53639	4608	582547(19.38)	537.22	<0.001*
2-4	117344	13447	130792(43.51)		
5+	98312	13223	111535(37.11)		

* = indicates a significant association between the ANC visit and independent variables

The pooled prevalence of antenatal care utilization

The pooled prevalence of antenatal care utilization in sub-Saharan Africa countries was 95.57 % [95 % CI: 95.50, 95.65], with the highest ANC utilization Eastern Region of Africa (97.52 %) and

the low ANC utilization in Southern Regions of Africa (91.05 %). The sub-group analysis result evidenced that in Southern regions of Africa highest ANC utilization 94.73% were recorded in Lesotho and the low ANC utilization 74.15 % were recorded in Namibia. In the Central Regions of Africa highest ANC utilization 95.99% were recorded in Congo and the low ANC utilization 76.52% were from Chad. In Eastern regions of Africa highest ANC utilization 99.27 % was recorded in Burundi and the low ANC utilization 62.67% were from Ethiopia. In the Western Regions of Africa, the highest ANC utilization 99.15 % were from Gambia and the low ANC utilization 74.01 % were from Nigeria (**Figure 1**).

Determinants of antenatal care utilization

The model fitted for this study was multilevel multivariable logistic regression. There are two parts of estimates in this model: The random-effects estimate and fixed estimate. The fixed and random effect estimates were observed by fitting four models (Null model, Model I, Model II, Model III). The empty model showed that there was significant variation in the likelihood of ANC utilization within sub-Saharan Africa Countries ($\sigma^2=0.46$, $p<0.001$). The ICC in the empty model implied that 12.49% of the total variation in ANC utilization was contributed to the difference between Countries. The cluster-level variance was expressed as ICC and MOR. Moreover, the MOR was 1.91 (95%CI:1.84,1.99) which implies that the odds of ANC utilization was 1.91 times more likely when women go from low ANC utilization to high ANC utilization Countries. In model III (full model adjusted for individual and community level factors) cluster level variance ($\sigma^2=0.65$, $p<0.001$) remained significant. A total of 39.87 % variability in ANC utilization that can be contributed to the country-level factors. The proportional change in variance (PCV) in this model was 39.87 % which indicated 39.87 % of the country variance observed in the empty model was explained by both Country and individual level variable (**Table 3**)

In the multilevel multivariable logistic regression model; Sub-Saharan Africa region, residence, maternal education, husband education, maternal occupation, wealth index, media exposure, contraceptive use, birth order and wanted pregnancy was statistically associated with ANC utilization in Sub-Saharan Africa.

The odds of ANC utilization among urban women were increased by 32% as compared to rural women (AOR=1.32, 95% CI: 1.27, 1.37). The odds of ANC utilization among women who had primary and secondary and above educational level were 2.19 (AOR=2.19, 95% CI: 2.11, 2.28) and 2.46 (AOR=2.46, 95% CI: 2.33, 2.60) times higher as compared to women who had no formal education. The odds of ANC utilization among women whose husband had primary and secondary and above educational level were 1.75 (AOR=1.75, 95% CI: 1.66, 1.80) and 1.71 (AOR=1.71, 95% CI: 1.64, 1.79) times higher as compared to women whose husband had no formal education. Women who had occupation were 1.26 (AOR=1.71, 95% CI: 1.64, 1.79) times more likely to utilize ANC than women who had no occupation. Women whose wealth status middle and rich were 1.32 (AOR=1.32, 95% CI: 1.28, 1.37) and 1.38 (AOR=1.38, 95% CI: 1.32, 1.43) times more likely to utilize ANC than poor women. The odds of ANC utilization among media exposed women were 1.97 times higher than women who do not expose to media (AOR=1.97, 95% CI: 1.91, 2.03). Women who reported accessing health care not a big problem were 1.08 (AOR=1.08, 95% CI: 1.05, 1.11) more likely to utilize ANC than women who reported accessing health care big problem. The odds of ANC utilization among women whose birth order 2-4 and 5+ were decreased by 15% (AOR=0.85, 95% CI: 0.81, 0.76) and 24 % (AOR=0.24, 95% CI: 0.72, 0.81) as compared to women who had first birth order. Women who had wanted pregnancy were 1.22 (AOR=1.22, 95% CI: 1.15, 1.30) times more likely to utilize ANC than its counterpart.

Women who use contraceptive were 1.89(AOR=1.22, 95% CI: 1.15, 1.30) times more likely to utilize ANC than its counterpart (Table 3).

Table 3: The multilevel logistic regression analysis result for ANC visit in SSA.

Variable	Null Model AOR (95%CI)	Model I AOR (95%CI)	Model II AOR (95%CI)	Model III AOR (95%CI)
Residence				
Rural		1		1
Urban		2.18(2.70,2.87)		1.32(1.27,1.37) *
Age group				
15-24			1	1
25-34			1.14(1.09,1.18)	1.09(0.98,1.13)
35-46			1.16(1.10,1.22)	1.07(0.97,1.11)
Maternal education				
No education			1	1
Primary education			2.02(1.95,2.10)	2.19(2.11,2.28) *
Secondary and above			2.11(2.00,2.22)	2.46(2.33,2.60) *
Husband education				
No education			1	1
Primary education			1.72(1.66,1.79)	1.73(1.66,1.80) *
Secondary and above			1.48(1.42,1.54)	1.71(1.64,1.79) *
Maternal Occupation				
Had no occupation			1	1
Had occupation			1.36(1.32,1.40)	1.26(1.23,1.30) *
Wealth Index				
Poor			1	1
Middle			1.35(1.30,1.40)	1.32(1.28,1.37) *
Rich			1.55(1.50,1.61)	1.38(1.32,1.43) *
Media Exposed				
No			1	1
Yes			2.26(2.20,2.32)	1.97(1.91,2.03) *
Accessing health care				
Big problem			1	1
Not a big problem			1.00(0.98,1.03)	1.08(1.05,1.11) *
Wanted pregnancy				

No			1	1
Yes			1.24(1.14,1.28)	1.22(1.15,1.30) *
Contraceptive use				
No			1	1
Yes			2.14(2.05,2.23)	1.89(1.81,1.97) *
Birth Order				
1			1	1
2-4			0.80(0.76,0.84)	0.85(0.81,0.89) *
5+			0.67(0.64,0.71)	0.76(0.72,0.81) *
Variance	0.469(0.416,0.529)	0.47(0.417,0.527)	0.487(0.426,0.555)	0.656(0.581,0.740)
ICC	12.49(11.22,13.87)	12.48(11.25,13.81)	12.89(11.48,14.45)	16.63(15.02,18.37)
PCV	1	0.106%	-3.85%	-39.87%
MOR	1.91(1.84,1.99)	1.91(1.84,1.99)	1.94(1.85,2.02)	2.15(2.06,2.26)
LL	-101995	-97879	-75286	-73353
Deviance	203990	195758	150572	146706
AIC	203994	195771	150607	146749
BIC	204016	195834	150782	146966

*=significant at p-value ≤ 0.05

DISCUSSION

This analysis carried out an assessment of the magnitude and factors influencing the use of antenatal care among women in sub-Saharan Africa. The pooled prevalence of antenatal care utilization in sub-Saharan Africa countries was 95.57 %. This finding is higher than a result reported by a systematic review and meta-analysis 63.77%,⁵ 2016 Ethiopian demographic and health survey 62.8%¹³ done in Ethiopia, 94.9%¹⁴ analysis of the Ugandan demographic and health survey data from 2007 to 2011. The possible explanation for this may be due to the accessibility of health care service and awareness on antenatal care service utilization increased as time elapsed due to different reasons.

In this analysis, we identified a range of determinants to the utilization of antenatal care services in Sub-Saharan Africa. The present analysis demonstrated that socio-demographic, economic and

reproductive characteristics and knowledge of the value of antenatal care services play an important role in the use of antenatal care in Sub-Saharan Africa.

The analysis showed that increased use of antenatal care services in Sub-Saharan Africa was positively correlated with urban residence, higher education among women, higher education among husbands/partners, contraceptive use among women, occupation among women, media exposure among women, improved economic status among women, and wanted pregnancy.

The odds of ANC utilization among urban women were increased by 32% as compared to rural women. This finding supported with studies elsewhere.^{5 15 16} It could be justified by the lack of access to health facilities and awareness is much easier for urban dwellers. The odds of ANC utilization among women who had primary and secondary and above educational level were 2.19 and 2.46 times higher as compared to women who had no formal education respectively. This finding is supported by other studies elsewhere.^{17 18} This can be driven by the fact that educated women tend to highlight the significance of using antenatal care services. Education increases the autonomy of women, the power of decision-making within the household and increases trust and the ability to decide about their safety.¹⁹⁻²¹ Likewise, women whose husband had primary and secondary and above educational level were 1.75 and 1.71 times higher as compared to women whose husband had no formal education respectively. This finding is consistent with other studies.^{16 22} The authors clarified that this could be due to more educated husbands who are more conscious of the value of antenatal care.²³ Women who had occupation were 1.26 times more likely to utilize ANC than women who had no occupation. This finding is similar to other studies elsewhere.²⁴ This might be the fact that women having occupation may have a decision-making power as well as well-paid which resolves financial barriers for antenatal care service. Women

whose wealth status middle and rich were 1.32 and 1.38 times more likely to utilize ANC than poor women respectively. The odds of ANC utilization among media exposed women were 1.97 times higher than women who did not expose to media. This finding is supported by other studies.¹⁷

²⁵ This finding may be because women who have access to the media may appear to be aware of the risks they may face when they do not have antenatal care. Women who reported accessing health care not a big problem were 1.08 more likely to utilize ANC than women who reported accessing health care big problem. This finding agrees with a systematic review done in developing countries.¹⁷ This can be explained by the fact that women who assumed that access to a health facility is not a major issue, which may enable them to have antenatal care. The odds of ANC utilization among women whose birth order 2-4 and 5+ were decreased by 15% and 24 % as compared to women who had first birth order respectively. This finding is similar to other studies elsewhere.^{17 26} This relationship might involve restricted access to resources and time constraints related to child care and household activities.²⁷ Women who had wanted pregnancy were 1.22 times more likely to utilize ANC than its counterpart. This finding is similar to two analyses done using a nationally representative Bangladesh demographic and health survey.^{28 29} This link may be because women who have desired pregnancy may have emotional readiness that emerges from favourable actions, either from their spouses, their close relatives etc. Women who use contraceptive were 1.89 times more likely to utilize ANC than its counterpart. This finding is supported by other studies conducted elsewhere.³⁰ This connection may be that women who use contraception may have a chance to be told about maternal health services. Besides, women who use contraceptives may have prior knowledge of maternal health services.

Strength and limitation of the study

Findings from the study are supported by large datasets covering 36 countries in SSA. The data were gathered following a common internationally acceptable methodological procedure. Due to the representative nature of the survey, the findings are representative of included countries and generalizable to women of reproductive age in SSA. Despite these strengths, the survey is cross-sectional and as such causal inference cannot be made.

Conclusions

This study reveals that there exists a wide gap between sub-Sahara African countries on postnatal care utilization ranges from 62% to 99%.; Residence, maternal education, husband education, maternal occupation, wealth index, media exposure, contraceptive use, and wanted pregnancy were positively associated with ANC utilization while birth order was negatively associated with ANC utilization. Special attention is required to improve health accessibility, utilization and quality of maternal health services to increase antenatal care service utilization in the region. Health education targeting mothers and their partner with no education are vital to increasing their awareness about the importance of postnatal care services.

Abbreviations

ANC; Antenatal Care, AOR; Adjusted Odds Ratio; CI; Confidence Interval, DHS; Demographic Health Survey, ICC; Intra-class Correlation Coefficient; LLR; log-likelihood Ratio, LR; Likelihood Ratio, MOR; Median Odds Ratio; SSA; Sub-Saharan Africa, WHO; World Health Organization

Declarations

Ethical Approval and Consent to participate

The study was based on secondary analysis of existing survey data with all identifying information removed. Permission for data access was obtained from measure demographic and health survey through an online request from <http://www.measuredhsprogram.com>.

Consent for publication

Not applicable since the study was a secondary data analysis

Availability of data and materials

Data is available online and you can access it from www.measuredhs.com

Competing interests

Authors declare that they have no conflict of interest

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Authors' contributions

ZTT, LY, and GAT conceived the study. ZTT, LY, and GAT analyzed the data, drafted the manuscript, and reviewed the article. ZTT, LY, and GAT extensively reviewed the article. All authors read and approved the final manuscript.

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Additional file

Figure 1 - Forest plot of ANC visit in SSA from 2006 to 2018.

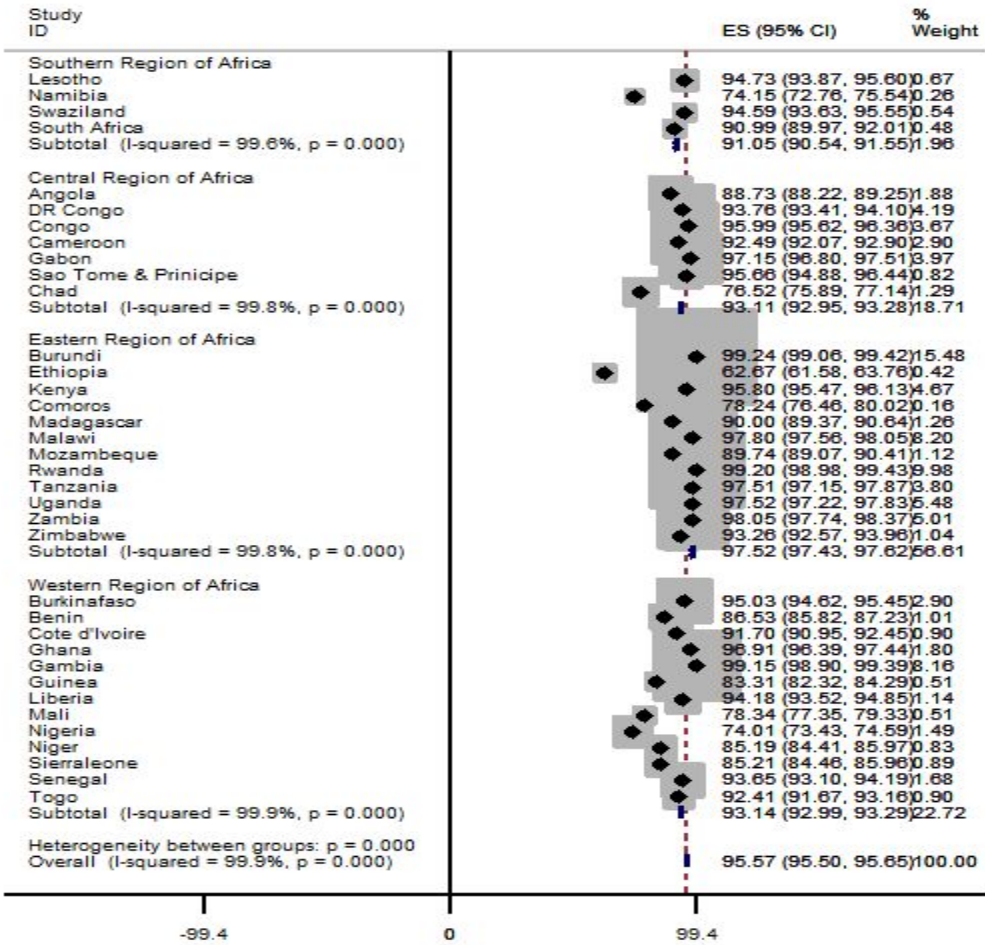


Figure 1: - Forest plot of ANC visit in SSA from 2006 to 2018.

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1 Individual and community-level factors associated with eight or more
2 antenatal care contacts in sub-Saharan Africa: Evidence from 36 sub-
3 Saharan Africa Countries.

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16 **Abstract**

17 **Objective:** - To reduce maternal mortality, the World Health Organization has been introducing
18 several antenatal care measures. Pregnancy-related preventable morbidity and mortality, on the
19 other hand, remained alarmingly high. This study was conducted to estimate the magnitude and
20 factors associated with eight or more ANC visits in sub-Saharan Africa.

21 **Design** A Population based, cross-sectional investigation was conducted.

22 **Setting** Sub-Saharan Africa countries

23 **Participants:** A total of **300,575** women from a recent Demographic and Health Surveys (DHS)
24 data conducted in 36 sub-Saharan Africa countries from 2006 to 2018 were included in this study.

25 **Methods:** - The data were sourced from sub-Saharan African countries' recent DHS dataset from
26 2006 to 2018. A multilevel logistic regression model was fitted to identify factors associated with
27 antenatal care use. The Adjusted Odds Ratio was employed to determine parameters linked to
28 ANC use, with a 95 percent confidence interval and a p-value of less than 0.05.

29 **Results:** -The pooled magnitude of eight or more ANC visit sub-Saharan Africa countries were
30 6.8 % [95 % CI: 6.7%, 6.9%], Residence, maternal education, husband education, maternal
31 occupation, wealth index, media exposure, contraceptive use, and desired pregnancy were all
32 positively associated with eight or more ANC utilization in the multilevel logistic regression
33 analysis, whereas birth order was negatively associated with eight or more ANC use.

34 **Conclusions:** - Compliance with WHO guidelines on the minimum number of ANC contacts in
35 sub-Saharan Africa is poor. We recommend that mother and child health programs review existing
36 policies and develop new policies to adopt, execute, and address the obstacles of maintaining the
37 WHO-recommended minimum of eight ANC interactions. Prioritize women's education,

economic position, media exposure, and improving family planning uptake. Therefore, urgent intervention is required to meet the minimum of eight ANC contacts in sub-Saharan Africa.

Keywords: - Associated factors, Antenatal care visit, sub-Saharan Africa, Demographic and Health Survey

ARTICLE SUMMARY

Strength and limitation of the study

- This study was done on the maternal health issue, which was a low and less reached area.
- Since this study was conducted in 36 sub-Saharan Africa countries, the generalization of the result is possible.
- This study was based on cross-sectional data, implying that causal relationship direction cannot always be determined.

51 **BACKGROUND**

52 In 2001, the World Health Organization (WHO) advised that low and middle-income nations
53 employ focused antenatal care (FANC) instead of the traditional antenatal care strategy (defined
54 by 7-16 visits). Travel times to and from clinics, waiting time, transportation costs where clinics
55 are located far away, loss of working hours, and care of other children at home were all expected
56 to be addressed by the FANC^{1 2}. A major challenge in the world including sub Saharan Africa
57 (SSA) is difficulty of enlightening maternal and child health status³. The SSA accounted for 66 %
58 of global maternal death according to a WHO report of 2017 ^{4 5}. A previous study also supported
59 this finding as in low and middle-income countries, maternal mortality is 14 times higher than in
60 high-income countries in 2014⁶.

61 Pregnancy-induced avoidable morbidity and mortality remained excessively high at introducing
62 the Sustainable Development Goals (SDGs) in 2016. Although significant progress has been
63 accomplished, countries need to integrate and enhance these advances and extend their priorities
64 beyond survival to boost the health and productivity of their citizens¹. As a result, in 2016, WHO
65 revised further its recommended minimum number of antenatal care (ANC) visits from four to
66 eight contacts⁷. The guidelines include a new approval that pregnant women have to eight contacts
67 to the health system during their pregnancy^{2 8}. The first contact be made up to 12 weeks after
68 conception, and the eighth contact up to 40 weeks after conception^{2 8}.

69 Providing good maternal health care can manage most maternal and child pregnancy-related deaths
70 through early detection of complications. Among the maternal and child, health services packages
71 to reduce preventable maternal and childhood mortalities is ANC ³. According to the WHO 2016
72 recommendation, a pregnant woman is considered as utilized ANC when she made eight and above
73 contacts to a skilled health care provider during pringancy⁷. ANC can reduce maternal morbidity

and mortality right through the diagnosis and management of pregnancy-related illness⁹. ANC takes the lion share along with other maternal health services⁷. Nonetheless, it is unusual to see pregnant women who deny ANC service¹⁰.

However, as per the new recommendation of WHO ANC contacts, a Demographic and Health Survey (DHS) data analysis showed only 17.4% of pregnant women in Nigeria made eight and above contacts with skilled health care provider¹¹. Whereas a previous study showed that nearly 80% and 40% of pregnant mothers in sub-Saharan Africa attended at least first and four antenatal care visit respectively, in 2016⁶. A disappointing approach during ANC counseling may disrupt the continuity of care and affects both children's and women's health conditions¹².

Studies conducted in different countries reported that maternal age, number of living children, educational status, place of residence, occupation, religion, socio-economic status, and previous obstetric history were factors significantly associated with antenatal care services^{7 13 14}. Similarly, in low-and middle-income countries, a recent study described women's level of education and her husband as the most considerable factor influencing health service utilization of pregnant women¹⁵¹⁶. All over SSA countries, however, little is known about the influence of routine ANC on early access, utilization, and quality of ANC services. This work aims to close this knowledge gap¹⁷. Therefore, this analysis aimed to estimate pooled prevalence and factors associated with ANC visits during pregnancy in SSA countries using the recent data of DHS. Moreover, the current information is essential for policy planners and program managers to design strategies to improve maternal and child health. This analysis aimed at summarizing the magnitude of ANC utilization and it's associated factors among pregnant women or had given birth a minimum of one incident five years earlier the survey in SSA.

METHODS

97 **Data Source**

98 The most recent Demographic and Health Surveys (DHS) data from 36 countries in SSA were
99 used in this study (Table 1). These statistics were combined to determine the prevalence of ANC
100 visits and the factors that influence them in SSA. The DHS is a national survey that collects
101 information on basic health indicators such as mortality, morbidity, family planning service use,
102 fertility, and mother and child health. The information came from the DHS measure program. Men,
103 women, children, birth, and household datasets are all included in each country's survey; for this
104 study, an IR file was employed.

105 The IR file contains all of the information obtained for de facto women in the Woman's
106 Questionnaire, as well as some variables from the Household Questionnaire. This file contains
107 repeated variables for up to 20 births in the birth history and up to 6 children under the age of 5,
108 for whom pregnancy and postnatal care, immunization, health, and nutrition data were gathered.
109 Most woman-level analyses, such as marriage and sexual activity, fertility and fertility choices,
110 family planning, anthropometry and anemia in women, malaria prevention in women, HIV/AIDS,
111 women's empowerment, adult and maternal mortality, and domestic violence, are conducted using
112 this dataset.

113 To choose research participants, the DHS employed a two-stage stratified selection procedure.
114 To begin, we combined data from 36 DHS surveys conducted in SSA countries, resulting in a
115 weighted sample of 300,575 reproductive-age women who had at least one child in the five years
116 prior to the survey.

117 **Measurements of variables**

118 **Outcome variable**

The "number of ANC visits" was the study's outcome variable. The percentage of women aged 15 to 49 who had a live birth in a specific time and got ANC services during pregnancy was used to calculate the number of ANC in this study. "How many times did you receive antenatal treatment throughout this pregnancy?" was the source of this variable. In SSA, the replies varied from 0 to 30. According to revised WHO standards, the number of ANC visits for pregnant women should be divided into two categories: 0 visit and 1 visit^{7 11}.

Explanatory variables

We evaluated both individual and household level factors/community level factors in our analysis based on theoretical and practical significance and the availability of the variables in the dataset. In addition, factors were chosen based on their prior studies' degree of correlation with the frequency of ANC visits^{7 11 13 14}.

Maternal current age (15-24, 25-34, 35 and above), maternal level of education (no education, primary, secondary & above), husband education level of education (no education, primary, secondary & above), and marital status were the individual-level factors (Currently Married, Cohabiting). Working status (working vs. not working), health care access (major problem vs. minor problem), media exposure (no, yes), desired pregnancy (yes vs. no), contraceptive use (yes vs. no), birth order (1,2-4, and 5+), and community-level factors include living region (East, West, Central, South), and residence (urban, rural).

Data management and analysis

After extracting the variables based on literature, we combined the data from the 36 SSA countries. To restore the representativeness of the survey and take sample design into account when generating standard errors and reliable estimates, the data were weighted using sampling weight,

primary sampling unit, and strata before any statistical analysis. STATA version 14 was used to perform cross tabulations and summary statistics. From 2006 to 2018, a 95 percent confidence interval (CI) was given for the pooled prevalence of prenatal care utilization in Sub-Saharan African countries.

Statistical Modeling

The DHS data has a hierarchical structure, which contradicts the classic logistic regression model's independence of observations and equal variance assumption. As a result, women are nested within a cluster based on the assumption that women in the same cluster are more similar. This means that advanced models should be used to account for between-cluster heterogeneity. A total of four models were fitted. Model I (community-level variables), Model II (individual-level variable), and Model III are examples of null models (models without explanatory variables) (both individual and community level variables). Model III was chosen because it has the highest LLR and the smallest deviation and contains both individual and community level variables.

Fixed and random effect estimates

The model's included variables, both individual and community-level variables, were used in the fixed effect analysis. Variations between clusters (EAs) were analyzed using the Intra-class correlation coefficient (ICC), a proportional change in variance (PCV), and the median odds ratio in the random effect analysis (MOR)¹⁸. The ICC is the proportion of variance explained by the population's grouping structure. It was calculated as follows: $ICC = \frac{\sigma_{\mu}^2}{\sigma_{\mu}^2 + \pi^2/3}$; Where the variance

of the standard logit distribution is $\pi^2/3$, σ_{μ}^2 indicates the cluster variance. Whereas PCV measures the total variation attributed by individual level and community level factors in the multilevel model as compared to the null model. It was computed as: $\frac{\text{variance of null model} - \text{variance of full model}}{\text{variance of null model}}$. When randomly selecting two clusters, MOR is defined as

the median value of the odds ratio between the cluster at high risk and the cluster at lower risk of recommended ANC usage (EAs). It was calculated as: $MOR = \exp(\sqrt{2 * \sigma_{\mu}^2 * 0.6745}) \sim MOR = \exp(0.95 * \sigma_{\mu})$

Ethics consideration

This study was not approved by an Ethics Committee(s) or Institutional Board(s). Because study participants are not involved in the study design, the data used were publicly available secondary data with no personal identifier. Permission to access the data was obtained through an online request to the measure DHS program at <http://www.dhsprogram.com.website>.

Patient and public involvement

This study did not include any patient.

RESULTS

This study comprised 300,575 women from 36 countries in Sub-Saharan Africa who had at least one child five years before to the survey. The most significant study participants, 102,151 (33.99%), were from Western Africa, while the smallest study participants, 11,553 (3.84%), came from Africa's Southern Regions. The majority of the participants in the research, 191,029 (63.55 percent), were from rural areas. The median age of the women in this study was 28.8 (IQR=7.2) years, with 125,808 (41.86 percent) being between the ages of 25 and 34. Thirty-three percent of women and 36 percent of males lacked a high school diploma. More than a third of the women, 121,842 (40.54 percent), lived in poverty (Table 2).

The prevalence of eight or more ANC contacts.

In SSA, the pooled prevalence of ANC use was 6.8% [95 % CI: 6.7, 6.9] (Table 3).

185 **Determinants of antenatal care utilization**

186 Multilevel multivariable logistic regression was used to fit the model for this study. The random-
187 effects estimate and the fixed estimate are the two types of estimations in this model. Fitting four
188 models revealed the fixed and random effect estimates (Null model, Model I, Model II, Model III).
189 Within SSA, the empty model revealed a substantial variance in the likelihood of ANC use
190 (2=0.46, p0.001). The ICC in the empty model implied that the difference across countries was
191 responsible for 12.49 percent of the entire variation in ANC use. ICC and MOR were used to
192 express cluster-level variance.

193 Furthermore, the MOR was 1.91 (95 percent CI:1.84,1.99), meaning that when women moved
194 from low to high ANC consumption countries, their chances of receiving ANC were 1.91 times
195 higher. Cluster level variance (2=0.65, p0.001) remained significant in model III (complete model
196 corrected for individual and community level covariates). The country-level factors are responsible
197 for 39.87 percent of the variation in ANC usage. The proportionate change in variance (PCV) in
198 this model was 39.87 percent, indicating that both country and individual-level variables explained
199 39.87 percent of the national variation seen in the empty model (Table 4).

200 Residence and media exposure were statistically significant community level factors in the
201 multilevel multivariable logistic regression model: SSA region. Individual level statistically
202 relevant predictors were maternal education, husband education, maternal occupation, wealth
203 index, contraception use, birth order, and desired pregnancy.

204 When compared to rural women, the likelihood of urban women receiving ANC amplified by 32%
205 (AOR=1.32, 95 percent CI: 1.27, 1.37). When compared to women with no formal education, the
206 odds of receiving ANC were 2.19 (AOR=2.19, 95 percent CI: 2.11, 2.28) and 2.46 (AOR=2.46,

95 percent CI: 2.33, 2.60) times higher for women with primary and secondary education. When compared to women whose husbands had no formal education, the odds of ANC use were 1.75 (AOR=1.75, 95 percent CI: 1.66, 1.80) and 1.71 (AOR=1.71, 95 percent CI: 1.64, 1.79) times higher for women whose husbands had primary and secondary and above educational levels. Women who had occupation were 1.26 (AOR=1.71, 95% CI: 1.64, 1.79) times more likely to utilize ANC than women who had no occupation. Women with a wealth status of middle and rich were 1.32 (AOR=1.32, 95 percent CI: 1.28, 1.37) and 1.38 (AOR=1.38, 95 percent CI: 1.32, 1.43) times more likely than poor women to use ANC. Those who were exposed to media were 1.97 times more likely to use ANC than women who were not (AOR=1.97, 95 percent CI: 1.91, 2.03). Women who said obtaining health care was not a large difficulty were 1.08 times more likely to use ANC than women who said accessing health care was a big problem (AOR=1.08, 95 percent CI: 1.05, 1.11). When compared to women with the first birth order, the odds of receiving ANC were 15 percent (AOR=0.85, 95 percent CI: 0.81, 0.76) and 24 percent (AOR=0.24, 95 percent CI: 0.72, 0.81) lower for women with birth orders 2-4 and 5+. Women who desired conception were 1.22 times more likely to use ANC than their counterparts (AOR=1.22, 95 percent CI: 1.15, 1.30). Contraceptive users were 1.89 times more probable to use ANC (AOR=1.22, 95 percent CI: 1.15, 1.30). (Table 4).

DISCUSSION

This analysis carried out an assessment of the magnitude and factors influencing the use ANC among women of SSA. As a result, the pooled magnitude of ANC utilization in SSA countries was 6.8 %. This finding is lower than a meta analysis reported elsewhere 63.77%⁶, 2016 Ethiopian demographic and health survey 62.8%¹⁹ done in Ethiopia, 94.9%²⁰ analysis of the Ugandan

demographic and health survey data from 2007 to 2011. The possible explanation for this may be due to the geographic coverage of this study is wider than all other studies.

In this analysis, we identified a range of determinants to the ANC use in SSA. The current analysis identified that socio-economic, reproductive and knowledge towards the value of ANC service as an important factor in influencing ANC use in SSA.

In this analysis urban residence and media exposure were a community level variable that were positively correlated with ANC utilization. Similarly, advanced level of women's education and advanced level of husband's education, contraceptive use among women, occupation among women, improved economic status among women, and wanted pregnancy were individual level variables that positively correlated with ANC utilization. Whereas, birth order was an individual level variable that negatively associated with ANC utilization in study area.

The likelihood of ANC use among urban women were amplified by 32% compared with their counterparts. This finding is supported by studies elsewhere^{6 21 22}. It could be justified by the lack of access to health facilities, and awareness is much easier for urban dwellers. The likelihood of ANC use among women who attended primary and secondary and above education levels were 2.19 and 2.46 times higher as compared to women had no formal education. , respectively. This result is supported by findings elsewhere^{23 24}. This can be driven by the fact that educated women tend to highlight the significance of antenatal care services. Education increases the autonomy of women, the power of decision-making within the household and increases trust and the ability to decide about their safety²⁵⁻²⁷. Likewise, women whose husbands had primary and secondary and above educational level were 1.73 and 1.71 times higher than women whose husbands had no formal education. This finding is consistent with other studies^{22 28}. The authors clarified that this

could be due to more educated husbands who are more conscious of the value of antenatal care²⁹. Women who had occupation were 1.26 folds more subject to use ANC as compared with their counterparts. This result is similar to other findings elsewhere³⁰. This might be because women having occupations may have decision-making power and be well-paid, which resolves financial barriers for antenatal care services. Women with middle and rich wealth status were 1.32 and 1.38 folds more subject to use ANC than poor women. The likelihood of women who were exposed to media were 1.97 folds more subject to use ANC as compared with their counterparts. This finding is supported by other studies^{23 31}. This finding may be because accessibility of media may make women aware of risks associated with missing ANC. Women who considered accessing health care as if it is not a big problem 1.08 times higher to utilize ANC as compared with their counterparts. This finding agrees with a systematic review done in developing countries²³. This might be due to the reason that women who assumed that accessibility of health care is not a major issue, enabling them to have antenatal care. The likelihood of utilization of ANC of women whose birth sequence two to four and five and more declined by 15% and 24 % than women who had first birth order, respectively. Our finding is similar to other studies elsewhere^{23 32}. This relationship might involve restricted access to resources and time constraints related to child care and household activities³³.

Women who had wanted pregnancy were 1.22 times more likely to utilize ANC than its counterpart. This finding is similar to two analyses done using a nationally representative Bangladesh demographic and health survey^{34 35}. This link may be because women who have desired pregnancy may have emotional readiness that emerges from favourable actions, either from their spouses, close relatives etc. Women who use contraceptives were 1.89 times more likely to utilize ANC than its counterpart. This finding is supported by other studies conducted elsewhere³⁶.

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2
3 274 This connection may be that women who use contraception may have a chance to be told about
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5 275 maternal health services. Besides, women who use contraceptives may have prior knowledge of
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8 276 health services for women.
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11 277 **Strength and limitation of the study**
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14 278 Findings from the study are supported by large datasets covering 36 countries in SSA. The data
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16 279 were gathered following a common internationally acceptable methodological procedure. Due to
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18 280 the representative nature of the survey, the findings are representative of included countries and
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20 281 generalizable to women of reproductive age in SSA. Despite these strengths, the survey is cross-
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23 282 sectional and as such causal inference cannot be made.
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26 283 **Conclusions**
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29 284 Compliance with WHO guidelines on the minimum number of ANC contacts in sub-Saharan
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31 285 Africa is poor. We recommend that mother and child health programs review existing policies and
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33 286 develop new policies to adopt, execute, and address the obstacles of maintaining the WHO-
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35 287 recommended minimum of eight ANC interactions. Prioritize women's education, economic
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38 288 position, media exposure, and improving family planning uptake. As a result, urgent intervention
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40 289 is required to meet the minimum of eight ANC contacts in SSA.
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42
43 290 **Abbreviations**
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45 291 ANC; Antenatal Care, FANC; Focused Antenatal Care, AOR; Adjusted Odds Ratio, CI;
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47 292 Confidence Interval, DHS; Demographic Health Survey, ICC; Intra-class Correlation
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50 293 Coefficient, LLR; log-likelihood Ratio, LR; Likelihood Ratio, MOR; Median Odds Ratio, WHO;
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52 294 World Health Organization
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54
55 295 **Declarations**
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Ethical Approval and Consent to Participate

The research was based on a secondary analysis of existing survey data that had been stripped of any identifying information. Through an online request to <http://www.measuredhsprogram.com>, permission for data access was gained from the measure demographic and health survey.

Consent for publication

Because this was a secondary data analysis, it was not applicable.

Availability of data and materials

Data is available online, and you can access it from www.measuredhs.com

Competing interests

Authors declare that they have no conflict of interest

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No funding was obtained for this study.

Authors' contributions

ZTT, GAT, and LY conceptualized the study. The data was examined, the paper was written, and the article was reviewed by ZTT, GAT, and LY. The article was thoroughly reviewed by ZTT, GAT, and LY. The final manuscript was read and approved by all writers.

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List of tables

Table 1: Pooled Demographic and Health Surveys (DHS) data from 36 sub-Saharan countries, 2006–2018.

Country	DHS year	Sample size (300,575)
Southern Region of Africa		11554
Lesotho	2014	2575
Namibia	2013	3813
Swaziland	2006/07	2130
South Africa	2016	3036
Central Region of Africa		88207
Angola	2015/16	14379
DR Congo	2013/14	18827
Congo	2011/12	10819
Cameroon	2011	15426
Gabon	2012	8422
Sao Tome & Principe	2008/09	2615
Chad	2014/15	19917
Eastern Region of Arica		98663
Burundi	2010	8940
Ethiopia	2016	7590
Kenya	2014	14141
Comoros	2012	2064
Madagascar	2008/09	8661
Malawi	2015/16	13515
Mozambique	2011	7874
Rwanda	2014/15	6059
Tanzania	2015/16	7078
Uganda	2011	10152
Zambia	2018	7324
Zimbabwe	2013/14	4987
Western Region of Africa		102151
Burkina-Faso	2010	10487
Benin	2017	9030
Cote d'Ivoire	2011	5229
Ghana	2014	4141

Gambia	2013	5293
Guinea	2018	5487
Liberia	2013	4769
Mali	2018	6622
Nigeria	2018	21911
Niger	2012	8002
Sierra Leone	2010/11	8647
Senegal	2010/11	7678
Togo	2013/14	4851

415 Table 2: - Distribution of postnatal service utilization in sub-Saharan Africa region

Variable	ANC utilization		Total (%)	X-square value	p-value
	Yes	No			
Africa Region					
Southern	10044	1509	11553(3.84)	54.23	<0.001*
Central	79304	8902	88207(29.35)		
Eastern	91782	6880	98663(32.82)		
Western	88165	13986	102151(33.99)		
Residence					
Rural	165566	25463	191029(63.55)	82.35	<0.001*
Urban	103730	5815	109546(36.45)		
Age group					
15-24	91025	8708	99733(33.18)	361.45	<0.001*
25-34	111984	13824	125,808(41.86)		
35-49	66287	8746	75,033(24.96)		
Maternal education					
No education	84928	20746	105657(36.16)	81.89	<0.001*
Primary education	92800	6620	99420(33.08)		
Secondary and above	91567	3912	95480(31.77)		
Husband education					
No education	72138	17711	89849(36.18)	196.83	<0.001*
Primary education	61978	5504	67482(27.55)		
Secondary and above	82953	5015	87608(35.77)		
Maternal Occupation					
Had occupation	192557	21407	86610(28.82)	286.55	<0.001*
Had no occupation	76739	9871	213964(71.18)		
Wealth Index					
Poor	102762	19080	121842(40.54)	120.51	<0.001*
Middle	53829	5654	59483(19.79)		
Rich	112705	6544	119249(39.67)		
Media Exposed					
Yes	189,649	13366	97537(32.45)	54.59	<0.001*
No	79630	17906	203016(67.55)		
Accessing health care					
Big problem	112299	11293	175471(58.67)	458.11	<0.001*

Not a big problem	155618	19852	123592(41.33)		
Wanted pregnancy					
Yes	207875	28706	17448(6.87)	1.56	0.211
No	15259	2188	236582(93.13)		
Contraceptive use					
Yes	79345	4210	83555(28.51)	84.39	<0.001 *
No	182744	26730	209474(71.49)		
Birth Order					
1	53639	4608	582547(19.38)	537.22	<0.001 *
2-4	117344	13447	130792(43.51)		
5+	98312	13223	111535(37.11)		

* = indicates a significant association between the ANC visit and independent variables

Table 3:- pooled prevalence of eight or more ANC contacts in SSA.

Utilization of eight or more ANC contacts	
< 8 visits	93.2%(95%CI 93.1% to 93.3%)
>=8 visits	6.8%(95%CI 6.7% to 6.9%)

Table 4: The multilevel logistic regression analysis result for ANC visit in SSA.

Variable	Null Model AOR (95%CI)	Model I AOR (95%CI)	Model II AOR (95%CI)	Model III AOR (95%CI)
Residence				
Rural		1		1
Urban		2.18(2.70,2.87)		1.32(1.27,1.37) *
Age group				
15-24			1	1
25-34			1.14(1.09,1.18)	1.09(0.98,1.13)
35-46			1.16(1.10,1.22)	1.07(0.97,1.11)
Maternal education				
No education			1	1
Primary education			2.02(1.95,2.10)	2.19(2.11,2.28) *
Secondary and above			2.11(2.00,2.22)	2.46(2.33,2.60) *
Husband education				
No education			1	1
Primary education			1.72(1.66,1.79)	1.73(1.66,1.80) *

Secondary and above			1.48(1.42,1.54)	1.71(1.64,1.79) *
Maternal Occupation				
Had no occupation			1	1
Had occupation			1.36(1.32,1.40)	1.26(1.23,1.30) *
Wealth Index				
Poor			1	1
Middle			1.35(1.30,1.40)	1.32(1.28,1.37) *
Rich			1.55(1.50,1.61)	1.38(1.32,1.43) *
Media Exposed				
No			1	1
Yes			2.26(2.20,2.32)	1.97(1.91,2.03) *
Accessing health care				
Big problem			1	1
Not a big problem			1.00(0.98,1.03)	1.08(1.05,1.11) *
Wanted pregnancy				
No			1	1
Yes			1.24(1.14,1.28)	1.22(1.15,1.30) *
Contraceptive use				
No			1	1
Yes			2.14(2.05,2.23)	1.89(1.81,1.97) *
Birth Order				
1			1	1
2-4			0.80(0.76,0.84)	0.85(0.81,0.89) *
5+			0.67(0.64,0.71)	0.76(0.72,0.81) *
Variance	0.469(0.416,0.529)	0.47(0.417,0.527)	0.487(0.426,0.555)	0.656(0.581,0.740)
ICC	12.49(11.22,13.87)	12.48(11.25,13.81)	12.89(11.48,14.45)	16.63(15.02,18.37)
PCV	1	0.106%	-3.85%	-39.87%
MOR	1.91(1.84,1.99)	1.91(1.84,1.99)	1.94(1.85,2.02)	2.15(2.06,2.26)
LL	-101995	-97879	-75286	-73353
Deviance	203990	195758	150572	146706
AIC	203994	195771	150607	146749
BIC	204016	195834	150782	146966

*=significant at p-value ≤ 0.05