

BMJ Open Magnitude of antenatal care service uptake and associated factors among pregnant women: analysis of the 2016 Ethiopia Demographic and Health Survey

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To cite: Fenta SM, Ayenew GM, Getahun BE. Magnitude of antenatal care service uptake and associated factors among pregnant women: analysis of the 2016 Ethiopia Demographic and Health Survey. *BMJ Open* 2021;**11**:e043904. doi:10.1136/bmjopen-2020-043904

► Prepublication history for this paper is available online. To view these files, please visit the journal online (<http://dx.doi.org/10.1136/bmjopen-2020-043904>).

Received 17 August 2020
Revised 29 March 2021
Accepted 29 March 2021



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ABSTRACT

Objective Antenatal and postnatal cares are crucial for the survival and well-being of both the mother and the child. WHO recommends a minimum of four antenatal care (ANC) visits during a pregnancy. In Ethiopia, only 38% of women in the reproductive age make a minimum of first ANC visits. This value is far below the typical rates of least developed countries. This study aimed to calculate the magnitude and identify associated factors of ANC service utilisation among pregnant women in Ethiopia.

Design Cross-sectional study design.

Setting Ethiopia.

Participants A total of 7913 pregnant women participated in the study.

Primary outcome measures Antenatal care service uptake among pregnant women.

Result Only 35.5% of the pregnant mothers have used ANC services at least four times and 64.5% of the pregnant mothers have used less than three times during their periods of pregnancy. The study showed that rich women (PR=1.077, 95% CI: 1.029 to 1.127), having access to mass media (PR=1.086, 95% CI: 1.045 to 1.128), having pregnancy complications (PR=1.203, 95% CI: 1.165 to 1.242), secondary education and above (PR=1.112, 95% CI: 1.052 to 1.176), husbands' having secondary education and above (PR=1.085, 95% CI: 1.031 to 1.142) and married (PR=1.187; 95% CI: 1.087 to 1.296), rural women (PR=0.884, 95% CI: 0.846 to 0.924) and women >30 years of age (PR=1.067, 95% CI: 1.024 to 1.111) significantly associated with the ANC service uptake.

Conclusion The magnitude of ANC service uptake was low. This low magnitude of ANC service utilisation calls for a need to improve community awareness about maternal health. More importantly, intensive health education is required for pregnant women to have better ANC service uptake and follow-up adherence.

INTRODUCTION

Maternal mortality is one of the most significant health problems in low-income and middle-income countries.^{1 2} Worldwide, about 295 000 maternal deaths, 2.4 million newborns and 2 million stillbirths occur each

Strengths and limitations of this study

- The study provides a timely evidence for policy-makers to reduce maternal and infant mortality.
- The study gives solid information to the scientific community about how to use overdispersed and excess zeroes data.
- Large sample size and high-quality data reduced the risk of sampling and measurement bias.
- It was not possible to measure the causal effects and know whether the data are time dependent or not.
- Ethiopian Demographic and Health Survey did not include information on distance to a health facility and the quality of healthcare that could affect the uptake of antenatal care service.

year and most causes of these deaths were found to be not only preventable but also associated with pregnancy and childbirth. Around 99% of these deaths occurred in developing countries including Ethiopia. About 85% of the total global maternal deaths occurred in sub-Saharan Africa and Southern Asia, two-thirds of it were from sub-Saharan Africa.³⁻⁵ The maternal mortality rate in developing countries in the year 2015 was 239 per 100 000 live births and 12 per 100 000 live births.^{6 7} In Ethiopia, the maternal mortality rate is 412 deaths per 100 000 live births. This indicates that in Ethiopia a woman's lifetime hazard of maternal death is 1 in 243.^{7 8}

Antenatal and postnatal cares are crucial to salvage the mother and the child. Antenatal care (ANC) helps women prepare for childbirth and contemplate the warning signs during pregnancy and birth.⁹ The WHO suggested encouraging the positive experience of ANC pregnancy and increasing the recommended number of ANC visits from four to eight by 2018. However, it revealed

that only 64% of women worldwide had ≥ 4 ANC visits.^{9,10} In Ethiopia, about 62% of women did not attend a minimum of four ANC visits throughout their pregnancy.⁸ Health Sector Transformation Plan of the Ethiopian Federal Ministry of Health addresses troubles associated with having targeted ANC with a minimal of four visits consistent with pregnancy as mainstream in the least provider delivery levels with a target to grow the proportion from 68% to 95% at the highest by 2020.¹¹ But, according to the 2016 Ethiopia Demography and Health Survey (EDHS), the ANC service utilisation with a minimum of four visits is merely 32%.⁸ This indicated that in Ethiopia, ANC went immobile underneath any suitable standard.

Previous research in Ethiopia covered small geographical regions and there is no sufficient study nationwide to the best knowledge of the authors.^{12–17} The studies investigated the associated factor of ANC service utilisation through binary logistic. Binary logistic regression undercounts the total number of ANC visits. Thus, multiple service utilisation is collapsed into a single unit to fulfil the requirements of binary logistic regression as it provides sufficient information for studying the pattern of multiple service utilisation. Since the zero-inflated Poisson regression (ZIPR) model provides a way of modelling the excessive proportion of zero values by allowing overdispersion, in this study, the ZIPR model is the preferred model for analysis. It provides a good fit than Poisson or negative binomial model,¹⁸ when the number of zeros is large. This study therefore aimed to calculate the magnitude and identify associated factors of ANC service uptake for the country at large.

METHOD

Patient and public involvement

This study used a publicly available data set (2016 EDHS). Therefore, there were no patients or members of the public involved.

Data source

The data used for this study were taken from the 2016 EDHS. This survey is the fourth comprehensive survey designed to provide estimates for the health and demographic variables of interest for the whole urban and rural areas of Ethiopia as a domain. Women who had 9 months of pregnancy during the survey interview were included in the analysis. The study includes 7193 cases of the reproductive age group within the country.

Sampling design

The 2016 EDHS employed a stratified two-stage cluster sampling procedure designed to provide a representative sample for multiple health and population indicators at national and subnational levels (nine regions and two city administrations). Initially, 645 enumeration areas (EAs) (202 in urban areas and 443 in rural areas) were drawn using probability proportional to size sampling approach from a whole list of 84915 EAs defined within the recent

2007 population census. Then, in every selected EA, an exhaustive listing of households was made and 28 households were selected using a systematic sampling approach. Within the chosen households, enumeration of the entire members was made and information about the ANC service utilisation among all household members was collected primarily from the women.¹⁹

Study variables

The outcome variable of interest in this study was a count response of the number of ANC visits during their last pregnancy. The independent variables of this study were selected by reviewing related work of the literature.^{12–17, 20–25} Women's educational level (no education, primary, secondary and higher), husband's occupation (not working, working), wealth index (poor, middle, rich), marital status (living alone, married, divorced/widowed), women occupation (housewife, employed), age of women (15–24, 25–29 and ≥ 30 years), husband's educational level (no education, primary, secondary and higher), planned pregnancy (yes, no), access to mass media (yes, no), pregnancy complications (yes, no), the desire of pregnancy (yes, no), a history of terminated pregnancy ever in her life (yes, no) and residence (urban, rural) were considered to be independent variables within the study.

Data management and analysis

The cleaned and recoded data were analysed using R software V.3.5.3. Frequencies and percentages were used to describe the categorical variables. Data were presented using tables. ZIPR model was conducted to identify factors associated with ANC service utilisation among the pregnant women. In recent years, the ZIPR model has gained popularity for modelling count data with excess zeroes.¹⁸ The ZIPR model can be viewed as a finite mixture model with a degenerative distribution where its mass is concentrated at zero. Excess zeroes arise when the event of interest is not experienced by many of the subjects.²⁶ In this study, the ZIPR model was employed to identify the determinant factors of ANC service uptake among pregnant women. Suppose Y_i is the number of ANC service uptake among the pregnant. Thus, the probability mass function of ZIPR is given by^{18, 27, 28}

$$P(Y_i = y_i) = \begin{cases} \pi_i + (1 - \pi_i) \exp(-\mu_i), & \text{if } y_i = 0 \\ (1 - \pi_i) \frac{\exp(-\mu_i) \mu_i^{y_i}}{y_i!}, & \text{if } y_i = 1, 2, 3, \dots \end{cases} \quad 0 \leq \pi_i \leq 1.$$

The parameters μ_i and π_i depend on the covariates x_i and z_i , respectively. The mean and the variance of ZIPR model, respectively, are

$E(y_i) = (1 - \pi_i) \mu_i$ and $Var(y_i) = \mu_i (1 - \pi_i) (1 + \pi_i \mu_i)$. To apply the ZIPR model in practical modelling situations, Lambert, Afifi *et al* and Agarwal *et al*^{18, 27, 28} suggested the following joint models for μ and π :

$\ln(\mu) = X^T \beta$ and $\ln\left(\frac{\pi}{1-\pi}\right) = Z^T \gamma$ where X and Z are covariate matrices and β and γ are $(p+1) \times 1$ and $(q+1) \times 1$ vectors of unknown parameters, respectively.

Table 1 The number of women who experienced antenatal care visits

Number of visits	Count	Per cent
0	2545	35.4
1	342	4.8
2	563	7.8
3	1187	16.5
4	1136	15.8
5	621	8.6
6	402	5.6
7	187	2.6
8+	108	2.9
Total	7193	100.0
Mean	2.53	
Variance	5.614	

The two sets of covariates may or may not coincide. Finally, the OR and prevalence ratios (PR) with a 95% CI were used to assess the strength of associations between the outcome and the independent variables using Poisson and Bernoulli regression models' assumptions. P values of ≤ 0.05 were considered for statistically significant.

RESULTS

From a total of 7913 pregnant women, 64.6% of the pregnant women have used the service, 35.4% of the pregnant women did not receive any ANC service and 35.5% of the pregnant women have received at least four ANC visits. The mean and variance of observation are 2.53 and 5.614, respectively. The variance to mean ratio is 2.22, which indicates some overdispersion (table 1).

Test of overdispersion

The Pearson residual χ^2 statistic for Poisson and ZIPR model was summarised in table 2. The Pearson dispersion value of the Poisson model is 1.829 ($p < 0.001$), which clearly shows the existence of overdispersion in the data and the Poisson model is overdispersed. It follows that the options for modelling and analysing such overdispersed and excess zero ANC count response data should be considered. Then fit ZIP and 1.001 is the Pearson dispersion value. This indicates that the ZIP has modelled and captured the overdispersion in the data set very well because the dispersion value is very close to 1. For this

Table 2 Test of overdispersion based on Pearson residual χ^2 statistic

Model	Dispersion test (ratio statistic and p value)
Poisson	1.829 (0.001)
Zero-inflated Poisson	1.001 (0.004)

reason, ZIPR model is used for the analysis to identify the associated factors of ANC service uptake (table 2).

Sociodemographic characteristics of study participants

The majority of the study respondents were from rural residences (79%). Most of the respondents were housewives (70%) and 30% of the respondents were employed. About 60.6% of mothers did not attend primary school and only 12.4% of the mothers attended secondary and above level education. The majority (69.4%) of the respondents had no pregnancy complications and 64.4% had no access to mass media. About 91.5% of women were married, 3.2% were living alone and 5.3% were divorced and widowed. The majority (79.8%) of the pregnancies were planned, while 9% of the pregnancies were terminated. 31.7% of the husbands had no formal education, while 30% of husbands attended primary education. About half (50.7%) of women had poor wealth index, 35.0% were rich and others had middle wealth index (14.3%). Regarding mother's age, the majority (46.2%) of them were under the age group of 30 years (table 3).

Magnitude of ANC services uptake by sociodemographic characteristics of study participants

The mean and median numbers of ANC visits by sociodemographic characteristics of study participants are shown in table 3. The mean numbers of ANC visits for urban women (4.26) were higher than for rural women (2.07). Among poor women, the lowest mean numbers of ANC visits were recorded (1.71). The lowest mean numbers of ANC visits were observed for uneducated husbands (1.93), while the highest mean numbers of ANC visits were observed for husbands with secondary education and above (3.83). Women exposed to the media had the highest mean numbers of ANC visits (3.65), while the mean numbers of ANC visits for women not exposed to the media were low (1.92). The lowest mean numbers of ANC visits occurred among uneducated women (1.88), while the highest mean numbers of ANC visits have been recorded for women with secondary education and above (4.36). Compared with women who had no symptoms of pregnancy problems (1.78), women who had seen signs of pregnancy complications had a higher mean number of ANC visits (4.28) (table 3).

Factors associated with ANC service uptake, application of ZIPR models

As shown in table 4, the Poisson component shows the PR of ANC visits. This study revealed that women's and husbands' levels of education are a significant factor in ANC service uptake. Compared with women with no formal education, the expected number of ANC service uptake for women with primary education is 1.06 (PR=1.06; 95% CI: 1.02 to 1.10) times higher. Further, compared with women with no formal education, the expected number of ANC service uptake for women with secondary and above education was 1.11 (PR=1.11; 95% CI: 1.05 to 1.18) times higher. The expected number

**Table 3** Magnitude of antenatal care services uptake by sociodemographic characteristics of study participants

Characteristics		Frequency (%)	Mean	Median
Residence	Urban	1512 (21.0)	4.26	4
	Rural	5681 (79.0)	2.07	2
Occupation of women	Housewife	5033 (70.0)	2.37	2
	Employed	2160 (30.0)	2.92	3
Planned pregnancy	No	1452 (20.2)	2.53	3
	Yes	5741 (79.8)	2.54	3
Terminated pregnancy	No	6556 (91.1)	2.51	3
	Yes	637 (8.9)	2.79	3
Wealth index	Low	3607 (50.7)	1.71	1
	Medium	1028 (14.3)	2.47	3
	Rich	2558 (35.0)	3.71	4
Marital status	Never married	230 (3.2)	2.52	3
	Married	6579 (91.5)	3.26	4
	Divorced/widowed	384 (5.3)	2.56	3
Age of women in a year	15–24	1852 (25.1)	2.60	3
	25–29	2015 (28.1)	2.73	3
	30 and above	3326 (46.2)	2.38	3
Husband's education	No education	3719 (51.7)	1.93	1
	Primary	2160 (30.0)	2.79	3
	Secondary and above	1314 (18.3)	3.83	4
Woman's education	No education	4359 (60.6)	1.88	1
	Primary	1942 (27.0)	3.15	3
	Secondary and above	892 (12.4)	4.36	4
Access to mass media	No	4646 (64.6)	1.92	1
	Yes	2547 (35.4)	3.65	4
Pregnancy complications	No	5015 (69.7)	1.78	1
	Yes	2178 (30.3)	4.28	4
Husband's occupation	Not working	1285 (17.9)	2.19	2
	Working	5908 (82.1)	2.61	3

of ANC service uptake for husbands with primary education was 1.05 (PR=1.05; 95% CI: 1.01 to 1.10) times higher compared with husbands with no formal education. Similarly, compared with husbands with no formal education, ANC service uptake for husbands with secondary and above education increased by 9% (PR=1.09; 95% CI: 1.03 to 1.14). The expected number of ANC service uptake of the rural women was 0.88 (PR=0.88; 95% CI: 1.85 to 1.92) times lower compared with urban women. The expected number of ANC service uptake for women with a rich wealth index was 1.08 (PR=1.08; 95% CI: 1.03 to 1.13) times higher compared with those having poor wealth index. Moreover, compared with women living alone, the expected number of ANC service uptake for married women was 1.19 (PR=1.19; 95% CI: 1.09 to 1.30) times higher. The expected number of ANC service uptake for women who had seen signs of pregnancy complications was 1.20 (PR=1.20; 95% CI: 1.17 to 1.24) times higher compared with those women who had no signs of pregnancy complication. Furthermore, compared with

women who do not use mass media, the expected number of ANC service uptake for women using mass media was 1.09 (PR=1.09; 95% CI: 1.05 to 1.13) times higher. The expected number of ANC service uptake for mothers in the age group of 25–29 was 1.06 (PR=1.06; 95% CI: 1.02 to 1.10) times higher compared with the age group of 15–24 years. The expected number of ANC service uptake for mothers of age 30 and above was 1.07 (PR=1.07; 95% CI: 1.02 to 1.11) times higher compared with the age group of 15–24 years (table 4).

The Bernoulli part also indicated that the estimated odds that the number of ANC service uptake becomes zero with who is living in the rural area was 2.25 (OR=2.25; 95% CI: 1.78 to 2.86) times that of the urban women. The estimated odds the number of ANC service uptake which was zero with women who attend primary education was 0.45 (OR=0.45; 95% CI: 0.39 to 0.53) times that of the non-educated women. Similarly, the estimated odds by which the number of ANC service uptake becomes zero with husbands who have primary education was 0.63

Table 4 Factors associated with ANC service uptake, application of zero-inflated Poisson regression models

Characteristics		Poisson part	Bernoulli part
		PR (95% CI of PR)	AOR (95% CI of AOR)
Residence	Urban	1	1
	Rural	0.884 (0.846 to 0.924)*	2.254 (1.780 to 2.855)*
Access to mass media	No	1	1
	Yes	1.086 (1.045 to 1.128)*	0.612 (0.525 to 0.713)*
Planned pregnancy	No	1	1
	Yes	1.028 (0.989 to 1.069)	0.794 (0.685 to 0.920)*
Husband's occupation	Not working	1	1
	Working	1.017 (0.959 to 1.077)	0.761 (0.655 to 0.884)*
Wealth index	Low	1	1
	Medium	1.039 (0.989 to 1.093)	0.594 (0.501 to 0.704)*
	Rich	1.077 (1.029 to 1.127)*	0.568 (0.479 to 0.672)*
Women's education	No education	1	1
	Primary	1.057 (1.015 to 1.101)*	0.454 (0.388 to 0.531)*
	Secondary and above	1.112 (1.052 to 1.176)*	0.389 (0.286 to 0.530)*
Husband's education	No education	1	1
	Primary	1.052 (1.010 to 1.096)*	0.625 (0.542 to 0.721)*
	Secondary and above	1.085 (1.031 to 1.142)*	0.666 (0.532 to 0.836)*
Age of women (years)	15–24	1	1
	25–29	1.060 (1.016 to 1.104)*	0.991 (0.830 to 1.184)
	30 and above	1.067 (1.024 to 1.111)*	0.827 (0.656 to 1.042)
Marital status	Living alone	1	1
	Married	1.187 (1.087 to 1.296)*	0.865 (0.576 to 1.301)
	Divorced/widowed	1.083 (0.990 to 1.184)	0.639 (0.460 to 0.888)*
Pregnancy complications	No	1	1
	Yes	1.203 (1.165 to 1.242)*	0.859 (0.569 to 1.297)
Occupation of women	Housewife	1	1
	Working	0.982 (0.950 to 1.016)	0.937 (0.809 to 1.085)
Terminated pregnancy	No	1	1
	Yes	1.039 (0.986 to 1.094)	0.817 (0.649 to 1.027)

1=reference category of the categorical variable.

*Significant at 5% level of significance.

ANC, antenatal care; AOR, adjusted OR; PR, prevalence ratios.

(OR=0.63; 95% CI: 0.54 to 0.72) times that of the non-educated husbands. The estimated odds by which the number of ANC service uptake becomes zero with rich women was 0.57 (OR=0.57; 95% CI: 0.48 to 0.67) times that of the poor wealth index. The odds of the number that the ANC service uptake becomes zero with husbands who work is 0.76 (OR=0.76; 95% CI: 0.66 to 0.88) times that of husbands without work. The estimated odds at which the number of ANC service uptake becomes zero with women who have used mass media was 0.61 (adjusted OR (AOR)=0.61; 95% CI: 0.53 to 0.71) times that of women who did not use any mass media (table 4).

DISCUSSION

ANC during pregnancy is important for the health of the mother and the development of the fetus. Therefore, this

study sought to determine the magnitude and associated factors of ANC service uptake among pregnant women in Ethiopia. The results of this study showed that about 64.6% of the pregnant women have used the service and 35.4% have not received ANC services during their pregnancy which is less than the figure reported from 2016 EDHS for urban Ethiopia.¹⁹ This percentage figure is also less than those reported from the studies conducted in different parts of Ethiopia.^{12 29 30}

The findings of this study revealed that education had a positive relationship with ANC service uptake, that is, the amount of ANC service uptake increased with the rise in woman's and husband's education level. This study shows a result similar with other studies,^{15 20 25 31–35} which revealed that uneducated women and husbands were fewer ANC attendants than those who were educated. The



justification could be that educated women took more ANC because they had more awareness about regular ANC uptake benefits such as reduced risks of pregnancy and safe childbirth. Educated husbands may have better communication with their wives and be able to explore the importance of ANC uptake and other maternal health services³⁶ which could in turn provide their wives with more freedom.³⁷

The uptake of ANC services among married women was higher compared with women living alone. This finding is consistent with the studies conducted in Ethiopia,¹⁵ Kenya,³² Rwanda³⁸ and Bangladesh.³⁵ The higher ANC uptake could be attributed to the psychological and economic support obtained from their husbands, plannedness and desirability of their pregnancy, and the societal acceptability and support of their pregnancy state when compared with their unmarried women.

Wealth index correlated negatively with the use of ANC services. Relative to the richest wealth quintile, women belonging to the lowest wealth quintiles were less likely to uptake ANC services. Studies elsewhere have also documented a positive relationship between economic status and ANC service uptake.^{17 21 22 31 35 39} The justification for this might be that rich women may obtain more ANC information from mass media and had greater access to healthcare. In addition, this may be attributed to the indirect cost of ANC, such as transport cost when travelling to distant health facilities.⁴⁰

Compared with rural women, women living in urban areas were more likely to use ANC service. This finding is supported by the studies conducted by Wilunda *et al*, Workie and Lakew, Tekelab *et al* and Saaka and Akuamoah-Boateng.^{16 17 33 41} The reason could be that urban women had a better education, access to health services and are more informed about the importance of ANC service uptake. The exposure of mass media positively associated with ANC services. Women exposed to media had more ANC service uptake than women not exposed to media. This finding is in line with reports of other previous studies.^{17 23 33 35} Compared with housewives, the number of ANC uptake was higher among employed women. This finding is similar to a study in Kenya⁴² and 31 sub-Saharan Africa countries⁴³ which showed that the odds of ANC utilisation were higher among working women than non-working.⁴³ This may be because employed women, especially those in the formal sector, get benefit from a pregnancy care health insurance system. The finding indicated that women with pregnancy complications tend to uptake ANC service than those who did not develop pregnancy complications. This finding is in line with findings of studies in Ethiopia,⁴⁴ Northern Jordan,²⁴ Tanzanian²⁵ and Pakistan.²⁵

Relative to unplanned/unwanted pregnancies, women whose pregnancies were planned and desired were more likely to use ANC services. These findings are consistent with findings of previous studies.^{22-24 32} The study results also showed that the number of ANC visits increased significantly as the age of women increased. Previous

studies supported that women's age plays a significant role in the utilisation of maternal health care.^{12 20}

Strengths and limitation

This study used EDHS data having a larger sample size and higher quality, which substantially reduces the risk of sampling bias and measurement bias. The study results also provide a timely evidence for policy-makers and health sectors with respect to reducing levels of maternal and infant mortality which highly depend on increased use of reproductive and maternal health services. The study provides other researchers with information about how to use overdispersed excess zeroes and ZIPR model. Due to the cross-sectional study design, causal effects are not measured and it is impossible to know whether the data are time dependent or not. The other limitation was that the EDHS did not include information on distance to a health facility and the quality of healthcare which could affect the uptake of ANC service.

CONCLUSION

About 64.6% of the pregnant women have used the service and only 35.5% of the pregnant women have received at least four ANC visits. Compared with the minimum requirement of ANC service uptake recommended by WHO, ANC service uptake in Ethiopia is extremely low and below average. This study revealed that rural women, poor women, lower maternal and paternal education, mothers not having access to mass media, women living alone and mothers without pregnancy complication significantly associated with less number of ANC service utilisation. The low ANC service utilisation calls for a need to improve community awareness about maternal health. More importantly, pregnant women need intensive health education so as to boost their ANC service uptake and follow-up adherence.

Correction notice This article has been corrected since it was published. Middle name was missing for Girum Meseret Ayenew.

Acknowledgements The authors would like to thank the Central Statistical Agency of Ethiopia, for making the data freely available for research purposes.

Contributors SMF drafted the proposal, did the analysis, wrote the results and prepared the manuscript. GMA revised and critically reviewed the manuscript. BEG revised, edited and proof read the manuscript. All the three authors read and approved the final manuscript.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient consent for publication Not required.

Ethics approval Publicly available 2016 Ethiopian Demography and Health Survey data were used for this study. Informed consent was taken from each participant, and all identifiers were removed.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available in a public, open access repository. The data for this study were sourced from Demographic and Health Surveys and are available at <http://www.dhsprogram.com/data/available-datasets.cfm>.

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