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Home delivery among women with adequate antenatal care: insights from a multilevel analysis of the 2019 Ethiopian mini demographic and health survey

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Abstract

Background Despite Ethiopia's efforts to increase antenatal care (ANC) attendance, a significant number of women continue to deliver at home without skilled assistance, even after completing the recommended ANC visits. This study investigates the individual and community factors associated with home delivery among women who have received adequate ANC in Ethiopia.

Methods Data from 1643 women in the 2019 Ethiopian Mini Demographic and Health Survey were analyzed. The study focused on women who completed adequate ANC visits for their most recent birth. Multivariable multilevel logistic regression was used to identify factors influencing home delivery, with adjusted odds ratios (AOR) and 95% confidence intervals (CI) for association strength.

Results Home delivery prevalence among women with adequate ANC (≥ 4 visits) was 25.6% (95% CI: 23.55, 27.78). Community differences significantly contributed, as intra-cluster correlation dropped from 59 to 36.5% in the final model. Factors increasing the likelihood of home delivery included larger households (≥ 5 members) [AOR = 1.70; 95% CI: (1.09, 2.66)], poorest [AOR = 6.98; 95% CI: (2.89, 16.83)] and poorer wealth statuses [AOR = 2.77; 95% CI: (1.19, 6.45)], and 2–3 birth order [AOR = 2.48; 95% CI: (1.45, 4.21)]. Secondary education reduced home delivery risk [AOR = 0.37; 95% CI: (0.17, 0.80)]. Community-level factors included rural residence [AOR = 2.74; 95% CI: (1.19, 6.30)] and poor communities [AOR = 2.13; 95% CI: (1.03, 4.40)].

Conclusion Socioeconomic disparities and rural settings contribute to home delivery prevalence. Policies should prioritize education, rural health infrastructure, and economic empowerment to address these gaps.

Keywords Ethiopia, Ethiopian Mini Demographic and Health Survey, Home delivery, Individual and community-level factors, Multilevel analysis

Introduction

Maternal mortality remains a pressing issue globally, with the majority of deaths stemming from preventable pregnancy and childbirth complications such as infections and postpartum haemorrhage. In 2017, approximately 800 women died daily due to these complications, with 94% of these deaths occurring in low- and middle-income

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countries (LMICs) [1]. The World Health Organization (WHO) emphasizes that the antenatal period, spanning from conception to birth, is critical for maternal health. WHO recommends pregnant women in LMICs begin antenatal care (ANC) within the first four months of pregnancy, with a minimum of eight visits per the 2016 guidelines. However, Ethiopia still adheres to the earlier 2002 recommendation of at least four ANC visits [2].

In Ethiopia, the rate of institutional delivery is low and complications related to pregnancy and childbirth are one of the leading causes of morbidity and mortality for women of childbearing age [3]. In Ethiopia, maternal health challenges are significant, with a maternal mortality rate of 412 per 100,000 live births reported in 2019. Additionally, neonatal, infant, and under-five child mortality rates were 30, 43, and 55 deaths per 1000 live births, respectively. Home deliveries contribute significantly to these figures, with over half of Ethiopian women delivering at home in 2019. Rural areas, where healthcare access is limited, accounted for 60% of home births. Despite increased ANC coverage, with 43% of women attending at least four ANC visits in 2019 compared to 12% in 2005, many still delivered at home [4, 5].

Despite the World Health Organization's (WHO) 2016 recommendation for at least eight antenatal care (ANC) visits for pregnant women, Ethiopia continues to follow the previous 2002 guideline of four ANC visits [4, 6, 7]. Between 2005 and 2019, the proportion of women receiving adequate ANC visits increased from 12 to 43%. However, more than half of these women still delivered at home in 2019 [7].The proportion of home delivery in Ethiopia varies from 3.3 to 89.6% across the regions [8]. The rate of home delivery in Ethiopia varies widely, with studies showing it at 48.53%, influenced by factors such as rural residence, lack of ANC, lower education levels, women's age, and socio-demographic factors [9, 10]. Other factors include poor literacy, multiple pregnancies, lack of ANC attendance, limited knowledge of obstetric complications, and long distances to health centers. Additionally, home deliveries were linked to lack of exposure to media, poor ANC quality, and limited access to health insurance, with women's beliefs about home delivery playing a significant role. Education and wealth levels appear to reduce the likelihood of home deliveries [11–19].

In Ethiopia, although antenatal care (ANC) is provided by skilled health professionals at health facilities, the rate of home deliveries remains high, especially in low-income countries. It is widely acknowledged that receiving ANC can reduce home deliveries, yet more than half of women who attended four or more ANC visits still delivered at home in 2019. While previous studies have not fully considered women who received adequate ANC or the influence of individual and community-level factors, this study aims to explore these factors associated with home delivery after adequate ANC visits in Ethiopia.

Methods and materials

Study setting and data source

The data for this study was sourced from the 2019 Ethiopian Mini Demographic and Health Survey (EMDHS), which is a nationally representative, community-based, cross-sectional household survey. The survey was conducted using multi-stage stratified cluster-sampling techniques. Data collection took place between March 21 and June 28, 2019, and the study utilized the Kids Record (KR) file from the 2019 EMDHS dataset. Detailed information on the sampling and data collection procedures can be found on the DHS website (https://www.dhsprogram.com/).

Sampling procedures

The 2019 EMDHS used a nationally representative sample that provided estimates at the national and regional levels as well as for urban and rural areas. The survey interviewed 8855 women of reproductive age [15–49 years] from a nationally representative sample of 8663 households. In this study, women were included if they had one or more births in the five years preceding the survey, had adequate (at least four) ANC visits, and had a record of the place of the more recent birth. Women who had ≤ 3 ANC visits, women who had another place of delivery (rather than the respondent's home, government or private health institution, their own home), or women who were visitors (not live in the respondents' home permanently) were excluded. From a total weighted sample of 3927 women who had last live births in five years (coded in the survey data as "midx = 1"), a weighted sample of 1643 women who had at least four ANC follow-ups were included in the analysis (Fig. 1).

Outcome variables

The place of delivery among mothers who had adequate ANC visits (at least four ANC visits at a health facility) was as follows: Home delivery was assigned 1, and health institution delivery was assigned 0. Home delivery is a delivery that was not attended by doctor, nurse, midwife, health officer, and health extension worker [4].

Explanatory variables

Individual level and community-level factors included in this study were as follows: (i) Individual-level factors include; women's highest educational level, women's age, marital status of the women, religion, number ≤ 5 years old children in household, sex of household head (is house is led by the male or female?), wealth index

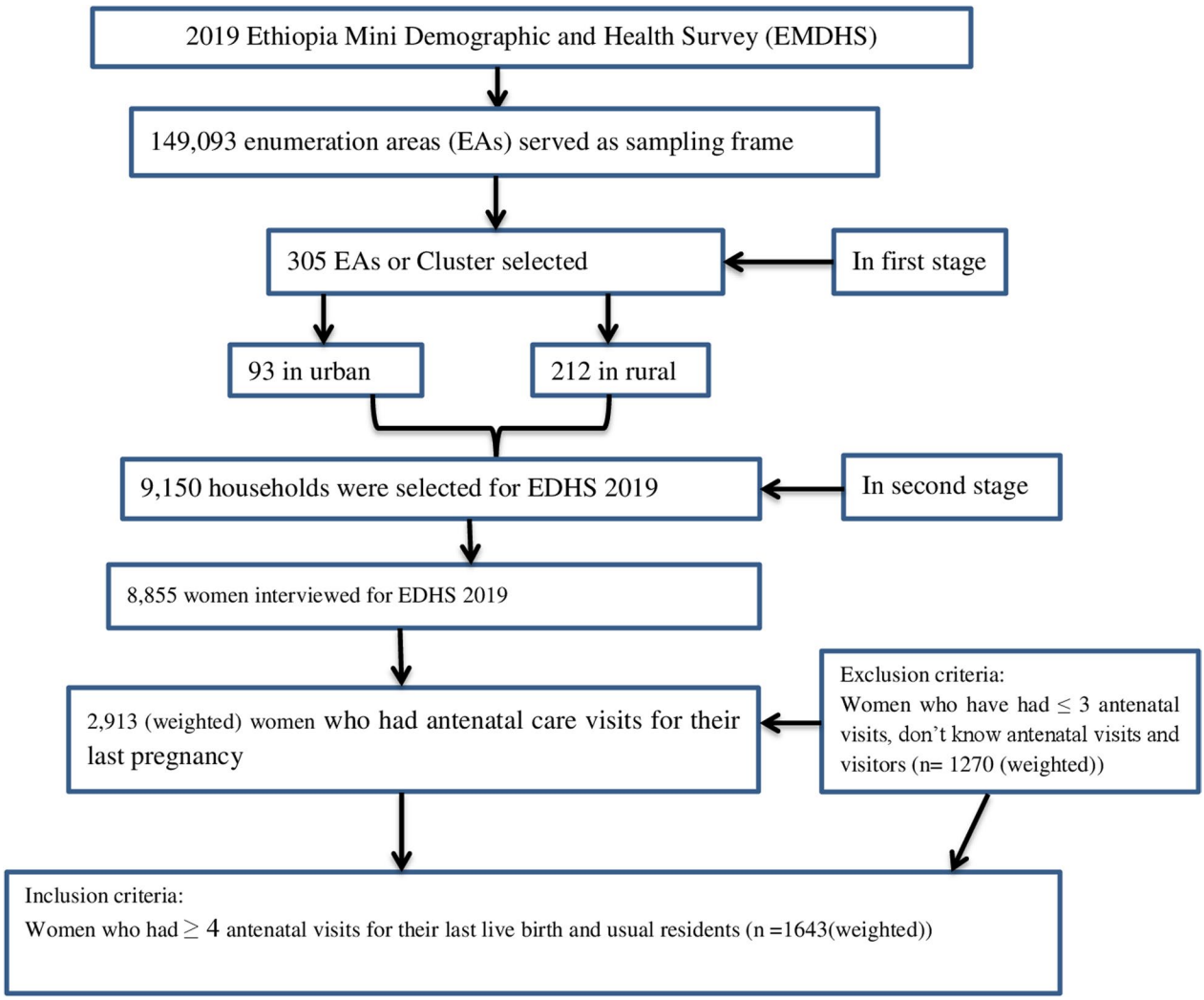

Fig. 1 Sampling procedures for individual and community level determinant of delivery after adequate antenatal care visits, EMDHS 2019

(household level wealth index calculated from wealth index indices and categorized into poorest, poorer, middle, richer, and richest), sons or daughters who have died (sons or daughters born alive but later died), age of women at first birth, birth order of the most recent birth; the number of household members (includes all people that lives in the household, but not visitors), number of living children, the timing of first antenatal check (month of pregnancy in which first prenatal check was received).

(ii) Community-level factors were of two types: integral variables (community type) and derived (aggregates) variables. Community level variable was generated by aggregating the individual characteristics with which interest in a cluster. The aggregate was computed using the proportion of a given variable's subcategory; we were concerned about in a given cluster. Since the aggregated value for generated variables was not normally distributed. It was categorized into groups based on the median values [20]. Community-type community-level factors included in this study were the place of residence "urban or rural, and the regions were also one of the community variables further categorized as agrarian (Tigray, Amhara, Oromia, Southern Nations, Nationalities and People's region (SNNPR)), pastoralists (Afar, Benshangul-Gumuz, Gambela, and Somali), and metropolises (city administrations) (Harari, Addis Ababa, and Dire Dawa).

The aggregated type of the community-level variables included in this study was the community wealth index, which indicates the proportion of women in the two lower levels (poorest and poorer). Wealth index components in the community and categorized using the median split (median = 14.3%) as high community wealth

and low community wealth for the proportion above and below the median, respectively, and the community education which was defined as the proportion of women who attended primary and secondary education or above within the cluster. This proportion was divided into two using the median value (median = 63.6%), categorized as low for the proportions, below the median value, and high for the proportions above the median value within the cluster (Table 1).

Statistical analysis

Due to the dichotomous nature of the place of delivery, a two-level mixed effect logistic regression analysis was conducted. Individual and cluster (community) levels made up the two levels. The log of the likelihood of giving birth at home was thus represented using a two-level multilevel model as follows. $\log\left(\frac{\pi ij}{1-\pi ij}\right)=\beta_0+\beta_1\log X_{ij}+\beta_2 Z_{ij}\times U_j$ Where, i and j are the level 1 (individual) and level 2 (community) units, respectively; X and Z refer to individual and community-level Variables, respectively, πij is the probability of home delivery for the ith woman in the jth community; the β′s are the fixed coefficients. Therefore, for every one unit increase in X or Z (a set of predictor variables), there is a corresponding effect on the probability of the woman having a home delivery. Whereas, β0 is the intercept the effect on the probability of a woman to have a home delivery in the absence of influence from predictors; and Uj shows the random effect (effect of the community on whether a woman has to have a home delivery for the j^{th} community. Four models were fitted to estimate both the fixed effects of the individual and community-level factors and the random effects of between-cluster variation.

Data analysis was done by STATA 17, and sample weights were applied to adjust for non-proportional allocation of samples and possible differences in response rates across regions included in the survey.. No missing data was present. Due to the hierarchical nature of the EMDHS data and the presence of intra-class correlation (ICC), multilevel logistic regression analysis was used. Bivariate and multivariate multilevel logistic regression analyses were conducted to determine the independent effect of individual and community level variables on the dependent variable. Independent variables with a p-value of less than 0.25 during bivariate multilevel logistic regression analyses were considered for multivariable multilevel logistic regression analysis. The results of the fixed effects model were presented as OR along with 95% confidence intervals (CIs).

An adjusted odd ratio (AOR) along with 95% CIs was computed to estimate the strength of the associations between factors associated with place of delivery among women who had full ANC visits. A p-value less than 0.05 determined to be statistically significant. ICC, proportional change in variance (PCV), and median odd ratio (MOR) measured the random effects (variation of effects), which measure the variability between clusters in the multilevel models [21–23]. ICC explains the cluster variability, while MOR can quantify unexplained cluster variability (heterogeneity). MOR converts cluster variance into an OR scale. In the multilevel model, PCV can measure the total variation due to factors at the community and individual level [22].

The ICC, PCV and MOR were determined using the estimated variance of clusters using the following formula. ICC = $\frac{V}{V+\frac{\pi^2}{3}}$ Where, V denotes community variance; and $\frac{\pi^2}{3}$ denotes individual level variance that is fixed for log distribution (equal to 3.29). MOR = $\sqrt{2\times V\times 0.6745}\sim\exp\left(0.95\sqrt{V}\right)$ *or* $e^{(0.95\sqrt{V})}$; Where V is the estimated variance of clusters and PCV = $\left(\frac{VA-VB}{VA}\right)\times 100$ Where VA = variance of the initial (null) model, VB = variance of the model with more terms ([21, 22]. Model fits were assessed using log likelihood (LL), deviance, and Akaike information criterion (AIC). LL, AIC, and deviance was used to estimate the goodness of fit of the adjusted final model in comparison to the preceding models (individual and community level model adjustments). The LL, AIC, and deviance values for each subsequent model were compared and the model with the highest value of LL and lowest value of deviance and AIC was considered the best-fit model.

Model comparison was conducted for the null/model 1 (model without explanatory variables), model 2 (model adjusted for individual level factors), model 3 (model adjusted for community level factors), and model 4 (final model adjusted for both individual and community-level factors). A variance inflation factor (VIF) was conducted to check for the presence of multicollinearity among exposure variables.

Operational definitions

Adequate antenatal care (ANC) visits: If women had ≥ 4 antenatal visits at health facilities [24–26].

Results

Sociodemographic characteristics of the respondents

This study analyzed data from 1643 women who had received full antenatal care (ANC) visits at health facilities and had given birth to a live child in the five years preceding the 2019 EMDHS. Of these women, 39% (n = 633) had no formal education, while 14.5% (n = 240) had completed secondary education. Over half 60.7% (n = 998) of the women lived in households with five or more members. Regarding wealth, 9.8% (n = 162) of the

Table 1 Individual and community variables used in the analysis

Characteristics	Category
Highest educational level	No education
	Primary
	Secondary
	Higher
Religion	Orthodox
	Protestant
	Muslim
	Others[a]
Family size	< 5 members
	>= 5 members
Number of children ≤ 5 years old in household	No child
	1 child
	2–5 child
Age of respondents	15–19
	20–24
	25–29
	30–34
	35–39
	40+
Sex of household head	Male
	Female
Wealth index	Poorest
	Poorer
	Middle
	Richer
	Richest
Sons or daughters who have died	No son and daughter died
	Son/s or daughter/s died
	Son/s and daughter/s died
Age of respondent at 1st birth	< 18 years
	≥ 18 years
Number of living children	No
	1–2 child
	3–4 child
	5–11 child
Current marital status	Never in union
	Married and or living with a partner
	Widowed/divorced/separated
Birth order	1 order
	2–3 order
	4–5 order
	6 + order
Timing of 1st antenatal check	< 4 months
	≥ 4 months
	Unknown
Residence	Urban
	Rural
Region	Agrarian
	Pastoralist
	Metropolis
Community education	Low
	High
Community wealth index	Low
	High

[a] Catholic, traditional and other religion

women were in the poorest wealth index, and 18.5% (n = 304) were in the poorer wealth index. Additionally, more than half (55.1%) (n = 904) of the women in the community had primary or higher education levels (Table 2).

Prevalence of home delivery

The study found that 25.6% (95% CI: 23.55, 27.78) of women who had adequate antenatal care (≥ 4 visits) delivered at home, with 26.08% (n = 410) of women having 4–7 antenatal visits and 14.9% (n = 10) having 8 or more visits in 2019. A chi-square analysis revealed that the proportion of home deliveries significantly decreased from 26.1% for women with 4–7 ANC visits to 14.9% for those with ≥ 8 visits ($\chi 2 = 14.56$, $p < 0.001$), indicating that more frequent ANC visits were associated with fewer home deliveries.

Bivariate analysis

In the study, individual-level variables such as the highest educational level, age at first birth, sex of the household head, death of sons or daughters, wealth index, birth order, family size, and number of living children, as well as community-level factors like community wealth index, community education, and region, were found to be significant in bivariate analysis (p-value ≤ 0.2).

Variables with p-values greater than 0.2 (e.g., religion, age, marital status, and timing of first ANC visit) were excluded from further models. Additionally, the number of living children was excluded due to collinearity with birth order.

Only 12 (9.9%) of the women who had higher highest educational level were gave birth at home while more than half 88 (54.4) of the poorest women gave births in home. About 417 (55.1%) of the women who lives in agrarian and pastoralist region gave birth at home (Table 3).

Model selection process

The study used a multilevel logistic regression model to analyze the factors associated with home delivery after adequate ANC visits in Ethiopia. The null model showed a 59% intra-cluster correlation (ICC), indicating significant variability in home delivery rates across communities. After adjusting for individual and community-level factors, this variability decreased to 37%. The null model's variance was 4.73 ($p < 0.001$), confirming that the odds of home delivery were significantly different across communities. The median odds ratio (MOR) of 2.53 indicated that community-level factors had a notable influence, with individuals in communities with higher odds of home delivery being

Table 2 Sociodemographic characteristics of women who had adequate ANC visits in Ethiopia, 2019 EMDHS, (N = 1643)

Variables	Category	Frequency	Percent*
Woman's age	15–19	68	4.1
	20–24	339	20.6
	25–29	545	33.2
	30–34	350	21.3
	35–39	224	13.7
	40 +	117	7.1
Highest educational level	No education	633	38.5
	Primary	654	39.8
	Secondary	240	14.6
	Higher	116	7.1
Current marital status	Never in union	5	0.3
	Married or living with partner	1581	96.3
	Widowed	43	2.6
	Divorced	13	0.8
Religion	Orthodox	725	44.1
	Protestant	416	25.3
	Muslim	491	29.9
	Other (traditional, Catholic and other religion)	11	0.7
Number of children ≤ 5 years	No ≤ 5 years old child in household	40	2.4
	1 ≤ 5 years old child in household	972	59.2
	2–5 ≤ 5 years children in household	631	38.4
Family size	< 5	645	39.3
	≥ 5	998	60.7
Number of living children	1–4 children	1262	76.8
	> 4 children	381	23.2
Sex of household head	Male	1438	87.5
	Female	205	12.5
Timing of 1st antenatal check (months)	< 4 months	809	49.3
	≥ 4 months	822	50.0
	Unknown	12	0.7
Age of respondent at 1st birth	< 18 years	609	37.1
	≥ 18 years	1034	63.0
Wealth index	Poorest	162	9.8
	Poorer	304	18.5
	Middle	289	17.6
	Richer	323	19.7
	Richest	565	34.4
Sons or daughters who have died	No son and daughter died	1349	82.1
	Son/s or daughter/s died	263	16.0
	Son/s and daughter/s died	31	1.9
Birth order	1 Birth order	406	24.7
	2–3 Birth order	599	36.5
	4 + Birth order	638	38.8
Residence	Urban	593	36.1
	Rural	1050	63.9
Region	Agrarian	1453	88.4
	Pastoralist	71	4.3
	Metropolis	119	7.2
Community Wealth index	Low	738	44.9
	High	904	55.1
Community education	Low	919	56.0
	High	724	44.0

* Any discrepancies in sums are due to rounding

Table 3 Bivariate multilevel logistic regression analysis for individual and community level factors associated with home delivery after adequate ANC visits, EMDHS 2019

	Place of delivery	Health facility count (%)	Home count (%)	COR (95%CI)	P value
Individual level factors					
Highest educational level	No education	409 (64.7)	223 (35.3)	Ref.	
	Primary	494 (75.5)	160 (24.5)	0.60 (0.41,0.87)	0.008
	Secondary	214 (89.3)	26 (10.8)	0.22 (0.10,0.48)	0.001
	Higher	105 (90.1)	12 (9.9)	0.20 (0.05,0.78)	0.021
Age at 1st birth	< 18	401 (65.8)	208 (34.2)	2.01 (1.40,2.88)	0.001
	≥ 18	822 (79.4)	213 (20.6)	Ref.	
Sex of household head	Male	1052 (73.1)	387 (26.9)	1.85 (1.05,3.24)	0.032
	Female	171 (83.4)	34 (16.6)	Ref.	
Sons or daughters who have died	No son and daughter died	1033 (76.6)	316 (23.4)	Ref.	
	Son/s or daughter/s died	167 (63.6)	96 (36.4)	1.87 (1.20, 2.92)	0.005
	Sons and daughters died	22 (71.5)	9 (28.5)	1.30 (0.46,3.69)	0.618
Family size	< 5	556 (86.2)	89 (13.8)		
	≥ 5	666 (66.8)	332 (33.3)		
Wealth index	Poorest	74 (45.6)	88 (54.4)	10.20 (5.16,20.37)	0.001
	Poorer	196 (64.4)	108 (35.6)	4.75 (2.46, 9.16)	0.001
	Middle	191 (65.8)	99 (34.2)	4.46 (2.31, 8.62)	0.001
	Richer	256 (79.4)	67 (20.7)	2.23 (1.12, 4.45)	0.022
	Richest	506 (48.8)	59 (10.4)	Ref.	
Birth order	1 Birth order	364 (89.7)	42 (10.3)	Ref.	
	2–3 Birth order	455 (75.9)	144 (24.1)	2.75 (1.46, 5.19)	0.002
	4 + Birth order)	403 (63.2)	235 (36.8)	5.06 (2.75, 9.29)	0.001
Community level factors					
Community education	Low	623 (67.7)	297 (32.3)	2.31 (1.54, 3.46)	0.001
	High	600 (82.9)	124 (17.1)	Ref.	
Community Wealth index	Low	647 (87.6)	91 (12.4)	0.25 (0.16,0.38)	0.001
	High	575 (63.6)	329 (36.4)	Ref.	
Residence	Urban	507 (85.5)	86 (14.5)	Ref.	
	Rural	715 (68.1)	335 (31.9)	2.75 (1.66, 4.57)	0.001
Region	Agrarian	1056 (72.7)	397 (27.3)	10.61 (5.85, 19.26)	0.001
	Pastoralist	51 (72.2)	20 (27.8)	10.89 (5.58, 21.24)	0.001
	Metropolis	115 (96.6)	4 (3.4)	Ref.	

2.53 times more likely to give birth at home. The final model, which had the highest log-likelihood (− 619.11), lowest AIC (1280.23), and lowest deviance (1238.22), was selected for interpretation (Table 4).

Determinants of home delivery after adequate antenatal care visits

The final multivariable multilevel model/model 4 (model adjusted for both individual and community factors) revealed household members, wealth index, and birth order. While community wealth index and residence were significantly associated with home delivery after adequate ANC visits, and having a higher education was significantly associated with home delivery. Among women who had at least four ANC visits (adequate ANC), those who had a secondary educational level were less likely to deliver at home as compared to those who had no formal education [AOR = 0.37; 95%CI: (0.17, 0.80)]. Besides, the odds of having a home delivery after having an adequate ANC visit were higher among women

Table 4 Random effect parameters and model comparators for the study individual and community level factors associated with home delivery after adequate ANC visits, 2019 EMDHS

Comparator	Null/ model 1	Model 2	Model 3	Model 4
Community variance (SE) (95%CI)	4.73 (0.9295) (3.21,6.95)	1.68 (0.393) (1.06,2.66)	2.32 (0.504) (1.52,3.55)	1.89 (0.442) (1.20, 2.99)
ICC (%) (95%CI)	59.0 (49.42,67.87)	33.8 (24.39,44.67)	41.4 (31.57,51.93)	36.5 (26.67, 47.61)
PCV (%)	Reference	64.48	50.95	60.04
MOR	2.53	1.51	1.77	1.60
Log-likelihood (LL)	− 715.84	− 628.48	− 659.17	− 618.08
AIC	14 35.682	1288.95	1332.36	1278.167
BIC	1446.456	1375.14	1370.069	1391.295
Deviance	1431.68	1256.96	1318.34	1236.16

AIC Akaike information criteria, *ICC* Intra cluster correlation, *MOR* Median odds ratio, *PCV* Proportional change in variance, *Null/model 1* model without explanatory variables, *Model 2* Model adjusted for individual level factors, *Model 3* Model adjusted for community level factors, *Model 4* Final model adjusted for both individual and community level factors

who had ≥ 5 family size compared to those who had < 5 family size [AOR = 1.70; 95%CI: (1.09, 2.66)].

Additionally, the likelihood of having a home delivery after having adequate ANC visits was higher among women who were in the poorest wealth index as compared to those who were in the richest wealth index [AOR = 6.98; 95%CI (2.89, 16.83)]. The odds of having a home delivery after having adequate ANC visits were higher among women whose last birth was in a 2 to 3 birth order when compared to those whose last birth was in the first birth order [AOR = 2.48; 95% CI (1.45, 4.21)]. Among community-level variables, women from highly poor communities were more likely to deliver at home after having adequate ANC visits compared to women from low-poor communities [AOR = 2.13; 95%CI (1.03, 4.40)]. Women from rural residences were more likely to deliver at home after having adequate ANC visits when compared to urban women [AOR = 2.74; 95%CI (1.19, 6.30)] (Table 5).

Discussion

Antenatal care (ANC) attendance, especially in LMICs is one of one of the significant contributors to reducing infant and maternal morbidity and mortality, and has been acknowledged to be effective in monitoring and managing any complications during pregnancy and childbirth [27]. The 2019 EMDHS was conducted in the last five years of 2019 and in 2002; the WHO recommendation is for all pregnant women to have at least four ANC visits, with additional appointments should complications be detected during the course of the pregnancy. A number of factors can influence pregnant women's attendance to ANC services and a place where the woman would deliver their baby [28]. This study examined the individual and community level factors associated with home delivery among women who had at least four ANC visits for their last birth preceding the Ethiopian 2019 mini demographic health survey. In Ethiopia, per the prior WHO recommendation, four ANC visits is considered to be adequate ANC [7].The analysis works among women who had at least 4 ANC and it might in support to recommend whether the new WHO recommendation is still important in Ethiopia. The analysis showed that the between-cluster variability declined over successive models, from 59% in the empty model to 36.5% in the final model that was adjusted for both individual and community level factors.

Thereafter, the final model revealed that different individual and community factors were responsible for home deliveries after having adequate ANC visits (at least four ANC visits). From individual-level factors, low educational level, the number of household members, wealth index, and birth order were significantly associated with home delivery after having adequate ANC visits in Ethiopia. On the other hand, community-level wealth index and place of residence were community factors associated with home delivery.

Therefore, after controlling for individual and community factors, among women who had adequate ANC visits the odds of having a home delivery were lower among women who had a secondary education level than among women who had no educational level. The findings of this study were consistent with those of studies conducted in Ethiopia [18, 29, 30] and study in India [31].

Educated women are more likely to use healthcare facilities in Ethiopia [32, 33]. Overall, this study reaffirms the significance of educating women. Education has been used as a vehicle for national socioeconomic development [34], as well as for individual advancements including in decision-making. It is plausible to assume

Table 5 Multivariable multilevel logistic regression analysis for individual and community level factors associated with home delivery after adequate ANC visits, EMDHS 2019

Place of delivery							
		Health facility count (%)	Home count (%)	Null/Model 1 AOR (95%CI)	Model 2 AOR (95%CI)	Model 3 AOR (95%CI)	Model 4 AOR (95%CI)
Individual level factors							
Highest educational level	No education	409 (64.7)	223 (35.3)	_	Ref	_	Ref
	Primary	494 (75.5)	160 (24.5)	_	0.85 (0.58, 1.25)	_	0.86 (0.57, 1.29)
	Secondary	214 (89.3)	26 (10.8)	_	0.35 (0.16,0.74)*	_	0.37 (0.17,0.80)*
	Higher	105 (90.1)	12 (9.9)	_	0.41 (0.15,1.12)	_	0.49 (0.17, 1.39)
Age at 1st birth	< 18	401 (65.8)	208 (34.2)	_	0.99 (0.70,1.39)	_	0.96 (0.68, 1.36)
	≥ 18	822 (79.4)	213 (20.6)	_	Ref	_	Ref
Sex of household head	Male	1052 (73.1)	387 (26.9)	_	1.30 (0.81,2.08)	_	1.21 (0.74, 1.96)
	Female	171 (83.4)	34 (16.6)	_	Ref	_	Ref
Sons or daughters who have died	No son and daughter died	1033 (76.6)	316 (23.4)	_	Ref	_	Ref
	Son/s or daughter/s died	167 (63.6)	96 (36.4)	_	1.27 (0.83, 1.95)	_	1.29 (0.84,1.99)
	Sons and daughters died	22 (71.5)	9 (28.5)		0.65 (0.25,1.70)		0.66 (0.25,1.75)
Family size	< 5	556 (86.2)	89 (13.8)		Ref		Ref
	≥ 5	666 (66.8)	332 (33.3)		1.67 (1.08,2.59)*		1.70 (1.09,2.66)*
Wealth index combined	Poorest	74 (45.6)	88 (54.4)	_	23.20 (11.80,45.61)**	_	6.98 (2.89,16.83)**
	Poorer	196 (64.4)	108 (35.6)	_	9.66 (5.05,18.47)**	_	2.77 (1.19,6.45)*
	Middle	191 (65.8)	99 (34.2)	_	5.86 (3.04,11.26)**	_	1.86 (0.82,4.21)
	Richer	256 (79.4)	67 (20.7)	_	4.72 (2.49,8.94)**	_	1.81 (0.84, 3.89)
	Richest	506 (48.8)	59 (10.4)	_	Ref	_	Ref
Birth order	1 Birth order	364 (89.7)	42 (10.3)	_	Ref	_	Ref
	2–3 Birth order	455 (75.9)	144 (24.1)	_	2.35 (1.39, 3.96)**	_	2.48 (1.45,4.21)**
	4 + Birth order)	403 (63.2)	235 (36.8)	_	1.67 (0.89,3.15)	_	1.70 (0.90,3.22)
Community level factors							
Community education	Low	623 (67.7)	297 (32.3)	_	_	1.78 (0.99, 3.19)	1.19 (0.66, 2.14)
	High	600 (82.9)	124 (17.1)	_	_	Ref	Ref
Community Wealth index	Low poor	647 (87.6)	91 (12.4)	_	_	Ref	Ref
	High poor	575 (63.6)	329 (36.4)	_	_	4.55 (2.26,9.14)*	2.13 (1.03,4.40)*
Residence	Urban	507 (85.5)	86 (14.5)	_	_	Ref	Ref
	Rural	715 (68.1)	335 (31.9)	_	_	4.71 (2.12,10.45)**	2.74 (1.19,6.30)*

Table 5 (continued)

Place of delivery							
		Health facility count (%)	**Home count (%)**	**Null/Model 1 AOR (95%CI)**	**Model 2 AOR (95%CI)**	**Model 3 AOR (95%CI)**	**Model 4 AOR (95%CI)**
Region	Agrarian	1056 (72.7)	397 (27.3)	_	_	1.45 (0.64,3.28)	1.58 (0.71, 3.49)
	Pastoralist	51 (72.2)	20 (27.8)	_	_	1.23 (0.51, 3.00)	1.04 (0.44, 2.46)
	Metropolis	115 (96.6)	4 (3.4)	_	_	Ref	Ref
Intercept				0.175 (0.13,0.24)	0.017 (0.01,0.04)	0.064 (0.023,0.173)	0.017 (0.005,0.062)

* p value < = 0.05; ** p value < = 0.001; *AOR* adjusted odds ratio; *CI* confidence interval

that educated women would have a better understanding of why they should need skilled care attendance during delivery. Additionally, educated women can travel outside the home, assuming that their education would have placed them in a better socioeconomic situation to afford transport and may have a greater decision-making capability and autonomy [35] in seeking health services and Women with secondary education were significantly less likely to deliver at home, highlighting the role of education in shaping health-seeking behavior. Educated women are more likely to understand the risks associated with home deliveries and the benefits of skilled attendance during childbirth. This awareness, coupled with better decision-making capacity, contributes to improved maternal and neonatal outcomes. Furthermore, education often correlates with improved socioeconomic status, enabling women to access health facilities for delivery [33, 36, 37].

Yet, this study showed that the odds of having home delivery after a full antenatal care visit were higher among women who had ≥ 5 family size than those who had < 5 family size. This is possibly due to the family responsibilities of having a large family size that might have interfered with travel plans or a stay in a health facility. Additionally, the likelihood of having a home delivery after having full ANC visits was higher among women who were in the poorest wealth index as compared to those who were in the richest wealth index. This study's findings are in line with findings from studies conducted in Ethiopia [29, 38], and supported by the studies carried out in Afghanistan, and Mozambique [39, 40]. This might be because 91.7% (n = 220) of the poorest women were from rural areas where there was low access to health facilities and low educational levels, due to poor access to education opportunities, especially in Ethiopia and further increases home deliveries [41, 42].

Moreover, the odds of having home delivery after having adequate antenatal care visits were higher among women whose last birth was in 2 to 3 birth orders when compared to those whose last birth was in the first birth order. This finding is consistent with findings from other parts of Ethiopia [19, 43]. Similarly, this finding is supported by findings from Ghana and Pakistan [44–46]. However, evidence exists that the high likelihood of home delivery among multiparous women could also be due to socioeconomic burden and the potential association between the number of children and delivery location, with women of higher parity being more likely to deliver at home. Women with multiple children may perceive institutional delivery as less necessary due to previous uncomplicated births or may face logistical challenges such as managing household responsibilities or accessing care. However, this perception overlooks the increased risks associated with higher-parity pregnancies, such as postpartum hemorrhage or uterine rupture, which require skilled medical intervention. Education plays a crucial role in dispelling misconceptions about the necessity of skilled delivery, even for multiparous women [32, 45, 47, 48], where these women could, for example not be able to afford transport with large families needing more resources for living.

Among community-level variables, women from the high-poor community were more likely to deliver at home after having adequate ANC visits compared to the low-poor community. This finding is comparable with findings from Ethiopia [18, 49], Bangladesh [45], Nigeria [50], and other studies (Delta state Nigeria, Nigeria, and India) [51–53]. This might be because home delivery may be the norm in communities with high concentrations of poverty, and the majority of poor communities were found in rural areas in Ethiopia where there is low accessibility to health facility might prompt women to deliver at home.

Like other studies [8, 32, 49, 54, 55], we found that women from rural areas were more likely to deliver at home when compared to urban women. The possible reason might be due to low access to health facilities as compared to urban residents [8], The other reason might also due to distance to the health facilities, ambulance delays due to distance and difficult roads, inaccessibility of information about the advantage of institutional delivery and low educational status of women from rural areas and women from poorer households are disproportionately represented among those delivering at home, indicating financial and structural barriers to institutional delivery. Education, as a driver of economic empowerment, can reduce these barriers by equipping women with better employment opportunities and financial resources to prioritize health services. This interdependence between education, economic status, and health-seeking behavior highlights the need for integrated policies that address these factors holistically [56].

Overall, the findings showed that delivering at home after adequate ANC in Ethiopia was common with over a quarter of women (25.6%) reporting having home delivery. The determinants of home delivery were consistent with the WHO Social Determinants of Health Framework [57]. The Social Determinants of Health Framework recognizes poor access to health services, low levels of education, and poverty as significant determinants of health.

Strength and limitations of the study

This is the first study to assess the determinants of individual and community level determinants of home

delivery among women who had adequate ANC (at least four ANC visits at a health facility) in Ethiopia using a nationally representative cross-sectional study from 2019 EMDHS (Mini Demographic and Health Survey) data. This is the first study that assessed both individual-level and community-level factors related to home delivery among women who have at least 4 ANC visits in Ethiopia. The study used a multilevel logistic regression model, which enhances the accuracy of estimates since EMDHS data has a hierarchical nature. Due to the secondary nature of the data, a limited number of variables were included, in this analysis. Due to the cross-sectional nature of the data, a cause-effect relationship between the outcome and independent variables could not be established. On the other hands this study not delve into the clinical aspects of pregnancy, such as categorizing pregnancies into high-risk or low-risk groups or examining maternal and neonatal outcomes.

Conculsion

Home delivery is a significant issue not only in Ethiopia but also in other developing countries. Having a secondary education, a larger number of household members, the poorest, and poorer wealth index, a lower birth order (2–3 birth order and above), rural residence, and being from a highly poor community were predictors of home delivery after having adequate ANC visits (at least four ANC visits at a health facility). To improve maternal and child outcomes in Ethiopia, it is necessary to address broader socioeconomic determinants in the community including individual and community factors that were observed in the current study, acknowledging that home delivery can be unsafe, especially for pregnant women with complications [58]. Notably, strategies to improve women's levels of education and economic empowerment are indispensable. Increasing the health services for all women, especially for women living in rural areas where low accessibility to the health facility. Additionally, increasing the antenatal care visits (at least 8) is recommended.

Policy implications of the findings

The findings of this study underscore the need for targeted policies to address both individual and community-level factors contributing to the high rates of home delivery in Ethiopia, even among women with adequate ANC visits. One critical policy implication is the necessity of strengthening rural health infrastructure. The higher prevalence of home deliveries in rural areas highlights the lack of accessible health facilities and transportation. Policymakers must prioritize expanding birthing centers, equipping health posts with skilled birth attendants, and establishing emergency transportation services to ensure that women in remote areas can access institutional delivery care.

Economic empowerment is another essential area for policy focus. The association between poverty and increased home delivery emphasizes the need to alleviate financial barriers to facility-based deliveries. Conditional cash transfer programs, subsidies for maternal healthcare services, and support for income-generating activities can empower women from poorer households to seek skilled delivery services. Additionally, programs providing free or subsidized transportation to health facilities for delivery could significantly reduce the economic burden on families in disadvantaged communities.

Education also plays a transformative role in reducing home delivery prevalence. Women with secondary education were found to have significantly lower odds of delivering at home, indicating that education equips women with the knowledge and confidence to seek skilled delivery care. Policymakers should invest in expanding access to quality education for girls, particularly in rural and underserved regions. Awareness campaigns that emphasize the benefits of institutional deliveries and the risks of home deliveries can further reinforce positive health-seeking behavior, especially among women with prior birth experience.

Finally, addressing community-level disparities is vital to reducing home delivery rates. Poorer communities face systemic inequities that limit access to healthcare, highlighting the need for targeted investments in these areas. Initiatives such as mobile clinics, community-based maternal health programs, and culturally sensitive health promotion campaigns can address the specific needs of these communities. By engaging community leaders and influencers, policymakers can foster an environment that supports institutional deliveries and ensures equitable access to maternal healthcare services for all women.

Recommendations

Future research should adopt a mixed-methods design, combining quantitative and qualitative approaches to uncover both statistical patterns and cultural nuances influencing home delivery. Longitudinal studies can track changes over time, while stratified cluster sampling ensures diverse regional representation. Incorporating geospatial mapping can highlight geographic disparities, enabling targeted interventions. Community participation and behavioral frameworks, such as the Health Belief Model, can deepen understanding of barriers to facility-based delivery. Detailed data collection on individual, household, and community variables—like transportation access and healthcare perceptions—is crucial. Advanced statistical techniques, including multilevel

analysis, should explore interactions between factors, such as education and rural residence. This approach will yield actionable insights for policymakers to address socioeconomic disparities and improve maternal health outcomes.

Further studies could integrate clinical data to explore the relationship between high-risk pregnancies and delivery location, helping policymakers address specific gaps in maternal healthcare.

Abbreviations

ANC	Antenatal care
AOR	Adjusted odds ratio
CI	Confidence interval
COR	Crude odds ratio
EA	Enumeration area
EMDHS	Ethiopian Mini Demographic Health Survey
ETB	Ethiopian Birr
EHSTP	Ethiopian Health Sector Transformation Plan
WHO	World Health Organization

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Author contributions
DG conceptualizes the idea, study design, execution, and acquisition of data, analysis, interpretation of the result, drafted the manuscript, revise, or critically reviewed the article. KS contributed to obtaining data, statistical analysis, interpretation of the results, and revision of the manuscript. GB, KS, YT, BS, DA, NE, CK, TM, and LM contributed to the conceptualization of the study, analytical strategy, and interpretation of results reviewed the first draft, and drafted the subsequent versions of the manuscript. All authors read and approved the final manuscript. All authors have agreed on the journal to which the article be submitted. Agree to take responsibility and be accountable for the contents of the article.

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Data availability
The dataset used for the preparation of this manuscript is available from http://www.dhsprogram.com/, and anyone can access it through an online request as an authorized user. The corresponding author (Degefa Gomora) prepared the data that was used for the preparation of this manuscript, which can be shared if required.

Declarations

Ethics approval and consent to participate
Data from the 2019 Ethiopian Demographic and Health Survey were used in this study as a secondary analysis. Following submission of a proposal to the DHS Program, ethical approval was obtained, and the International Review Board of the Demographic and Health Surveys (DHS) (Reference No. DHS ICF 13/2023), program data archivists confirmed that download of the data set for this study was permitted. The secondary data utilized in this study were collected from publically available sources and did not contain any information that could be used to personally identify study participants. When collecting data for the MEDHS 2019, anonymity was maintained to protect data confidentiality. For this particular investigation, there was no formal ethical review necessary. Information gleaned from the data set was made available to anyone else.

Consent for publication
Not applicable

Competing interests
The authors declare no competing interests.

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