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Title Page

Socioeconomic inequalities and determinants of institutional delivery among women in Ethiopia: a cross-sectional analysis of the 2024-2025 Ethiopia Demographic and Health Survey

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Abstract

Background

Ethiopia has expanded maternal health services through primary healthcare development, facility expansion, the health-extension program, and improved access to skilled delivery care. However, institutional delivery remains unevenly distributed, with women from poorer, less educated, and rural populations continuing to experience disadvantages.

Methods

This cross-sectional study used nationally representative data from the 2024–2025 Ethiopia Demographic and Health Survey. The analysis included 6,833 women aged 15–49 years whose most recent live birth occurred within the five years preceding the survey. Socioeconomic inequality in institutional delivery was assessed using concentration curves, the standard concentration index, Erreygers-corrected concentration index, slope index of inequality, and relative index of inequality. Survey-weighted multivariable logistic regression was used to identify factors independently associated with institutional delivery.

Results

Institutional delivery prevalence was 61.3%, with marked socioeconomic inequality favoring wealthier women. The Erreygers corrected concentration index was 0.576 (95% CI: 0.533–0.619), while the slope and relative indices of inequality were 78.03 percentage points and 5.68, respectively. In the multivariable analysis, women with higher education had greater odds of institutional delivery than those with no education (AOR: 4.03; 95% CI: 1.93–8.43). Women in the richest wealth quintile were also substantially more likely to deliver in a health facility than those in the poorest quintile (AOR: 8.60; 95% CI: 4.59–16.11). Urban residence increased the odds of institutional delivery (AOR: 2.70; 95% CI: 1.76–4.15), whereas having four or more children reduced the odds (AOR: 0.42; 95% CI: 0.27–0.67).

Conclusions

Institutional delivery in Ethiopia remains substantially concentrated among socioeconomically advantaged women. Equity-focused maternal health policies should prioritize poor, rural, less-educated, and high-parity women through improved transportation and referral systems, targeted maternal health education, financial support, and expanded service availability in underserved areas.

Keywords: Institutional delivery; Socioeconomic inequality; Maternal health; Health equity; Ethiopia Demographic and Health Survey.

Background

Maternal mortality continues to pose a significant global public health challenge ^{1,2}. According to the most recent United Nations inter-agency estimates, approximately 260,000 women died from maternal causes worldwide in 2023, corresponding to a global maternal mortality ratio of 197 deaths per 100,000 live births ^{3,4}. While this was a significant reduction compared to 2000, the progress is still insufficient to meet Sustainable Development Goal (SDG) target 3.1 aim of less than 70 maternal deaths per 100,000 live births by 2030 ^{5,6}. Hemorrhage, hypertensive disorders, infection, embolism, and complications of abortion remain leading causes of maternal death, and most are preventable through timely care ⁷⁻⁹. Institutional delivery can facilitate access to skilled professionals, essential medicines, infection-prevention measures, neonatal resuscitation, blood transfusion, operative delivery, and referral for emergency obstetric care ⁹⁻¹¹. But care will only improve health if it is timely, respectful, and technically competent ^{12,13}. Women's decisions about where to give birth are influenced by socioeconomic, geographic, cultural, and health-system conditions, including education, household resources, parity, previous service use, perceived quality, transport, distance, and facility availability ^{14,15}.

Ethiopia has expanded maternal health services through the health-extension programme, primary healthcare development, facility expansion, and efforts to scale up skilled delivery and emergency obstetric care ^{16,17}. Nevertheless, the 2024–2025 EDHS reported that 61% of births in the preceding two years occurred in health facilities, indicating that nearly four in ten births still occurred at home ¹⁸. Previous Ethiopian studies have documented improvements in skilled birth attendance alongside persistent inequalities by household wealth, women's education, residence, and region ^{19,20}. Health inequality refers to measurable differences in outcomes or service coverage across population groups, whereas health inequity emphasizes differences that are avoidable and unfair ²¹. National averages can mask underserved groups and do not describe the distribution of coverage across the socioeconomic gradient ²². Concentration indices summarize wealth-related distribution, while the Erreygers correction is appropriate for bounded binary outcomes ^{23,24}. Concentration indices

summarize wealth-related distribution, the Erreygers correction is appropriate for bounded binary outcomes, and the slope and relative indices of inequality provide complementary absolute and relative comparisons^{10,25,26}.

Evidence from Ethiopia consistently indicates that institutional delivery is concentrated among socioeconomically advantaged women^{27,28}. Previous analyses had shown significant inequalities by education, wealth, place of residence, and region^{29–32}. Although skilled birth attendance has improved over time, it remains among the most inequitably distributed maternal health services^{33–35}. Also, multilevel, spatial, and decomposition studies demonstrate that education, wealth, antenatal-care use, parity, urban residence, and community contextual characteristics are associated with place of delivery^{36–39}. Use of maternal healthcare was also shown to vary significantly according to education and urban rural background in the 2019 mini-EDHS^{40–42}. However, most of the national evidence is based on the 2016 EDHS and subsequent mini-EDHS or other surveys conducted before more recent changes in service capacity and regional administration⁴³. Previous Ethiopian studies have mostly focused on skilled birth attendance, spatial patterns, and individual-associated factors, as well as a single inequality measure, rather than institutional delivery using complementary absolute and relative measures^{19,44}. The study is well-positioned in the literature by integrating the standard and Erreygers concentration indices for both concentration curves within a single framework of survey-weighted multivariable regression using the nationally representative 2024-2025 EDHS dataset. It further assesses the strength of the adjusted associations through sensitivity analyses.

Therefore, this study aimed to measure socioeconomic inequality in institutional delivery and assess demographic, socioeconomic, and geographic factors independently associated with it among Ethiopian women aged 15-49 years whose most recent live birth occurred within the five years preceding the survey. The findings may inform equity-sensitive resource allocation, geographically targeted service expansion, and interventions addressing financial, transport, and information barriers among poorer, less-educated, rural, and high-parity women. They also provide a contemporary national baseline for monitoring progress toward equitable universal health coverage and the maternal health targets of the Sustainable Development Goals.

Methods

Data source and study population

We used cross-sectional data from the 2024-2025 Ethiopia Demographic and Health Survey (EDHS), a nationally representative household survey conducted by the Ethiopian Statistical Service with technical assistance from ICF. The EDHS collected information on demographic

characteristics, reproductive health, maternal and child health, and healthcare utilization. The dataset is available to researchers upon registration and approval of a data-use request through The DHS Program .

The survey used a stratified, two-stage cluster-sampling design. Enumeration areas were selected as primary sampling units in the first stage, followed by systematic selection of households within each enumeration area. Stratification was based on administrative region and urban-rural residence. The present analysis included women aged 15-49 years who had a live birth during the five years preceding the survey. For women with multiple births during this period, information about the most recent live birth was used. Women whose delivery location could not be classified or who had missing information for the prespecified variables were excluded through complete-case analysis. The final analytical sample comprised 6,833 women.

Institutional-delivery indicator

The outcome was the place of delivery of the most recent live birth. Births occurring in government, private, nongovernmental, or other recognized health facilities were classified as institutional deliveries and coded 1. Births occurring in the respondent's home or another home were classified as home deliveries and coded 0. This definition is consistent with previous DHS-based analyses of institutional delivery ^{45,46}.

Institutional delivery was considered a favorable maternal-health service indicator because health-facility delivery can provide access to skilled personnel, referral services, essential medicines, and emergency obstetric and neonatal care ⁴⁶. However, the indicator represents the location of childbirth and does not directly measure the quality of care received.

Inequality stratifier and measures

Household socioeconomic position was measured using the DHS wealth index. The index is constructed from household assets, housing characteristics, utilities, and other indicators of living standards using principal component analysis. Households are subsequently classified into five wealth quintiles: poorest, poorer, middle, richer, and richest ⁴⁷.

Wealth quintiles were used in descriptive and regression analyses. The continuous DHS wealth-index score was used to rank women for the concentration curve and rank-based inequality measures because it preserves more socioeconomic information than comparisons based only on wealth categories.

Socioeconomic inequality in institutional delivery was assessed using the standard concentration index, Erreygers corrected concentration index, slope index of inequality, and relative index of

inequality⁴⁸. These measures were selected because they use information from across socioeconomic distribution and provide complementary assessments of absolute and relative inequality.

Concentration curve and concentration indices

Women were ranked from the lowest to the highest socioeconomic position using the continuous household wealth score and assigned a survey-weighted fractional rank ranging from 0 to 1. The concentration curve plotted the cumulative proportion of women, ranked from poorest to richest, against the cumulative proportion of institutional deliveries. A curve below the line of equality indicated that institutional delivery was concentrated among socioeconomically advantaged women, whereas a curve above the line indicated concentration among disadvantaged women⁴⁹. For presentation, Figure 1 displays cumulative points at wealth-quintile cut points; the concentration indices and rank-based measures were estimated using individual-level weighted fractional ranks.

The standard concentration index was estimated as:

$$C = \frac{2}{\mu} \text{Cov}(y, r),$$

where y denotes institutional-delivery status, μ is the weighted mean of the outcome, and r is the weighted fractional socioeconomic rank. Positive values indicate pro-rich inequality, negative values indicate pro-poor inequality, and zero indicates equality.

Because institutional delivery was a binary outcome, the Erreygers corrected concentration index was treated as the principal concentration measure and calculated as:

$$E = 4\mu C.$$

The Erreygers correction is recommended for bounded health indicators because the limits of the standard concentration index depend on the mean of a binary outcome²⁵.

Slope and relative indices of inequality

The slope index of inequality and relative index of inequality were estimated using a survey-weighted logistic-regression model in which institutional delivery was regressed on the fractional wealth rank. Predicted probabilities were calculated at ranks 0 and 1, representing the theoretical lowest and highest socioeconomic positions.

The slope index of inequality was calculated as the difference between these predicted probabilities and expressed in percentage points:

203
$$SII = p_1 - p_0.$$

204 The probability-ratio relative index of inequality was calculated as:

205
$$RII = \frac{p_1}{p_0}.$$

206 An SII of 0 and an RII of 1 indicate equality. Positive SII values and RII values greater than 1
207 indicate higher institutional-delivery coverage among socioeconomically advantaged women. Both
208 measures were reported because absolute and relative inequalities may produce different
209 interpretations ⁵⁰.

210 **Explanatory variables**

211 The explanatory variables were selected before analysis based on existing evidence, conceptual
212 relevance, and availability in the EDHS. They included maternal age, educational attainment,
213 household wealth, residence, administrative region, parity, religion, and media exposure.

214 Maternal age was grouped as 15-24, 25-34, and 35-49 years. Education was categorized as no
215 education, primary, secondary, and higher education. Parity was grouped as one child, two to three
216 children, and four or more children. Media exposure was defined as exposure to at least one of
217 newspapers or magazines, radio, or television.

218 The original religion variable included Orthodox, Catholic, Protestant, Muslim, traditional, and
219 other religions. Because the Catholic and traditional categories contained only 45 and 47 women,
220 respectively, Catholic, traditional, and other religions were combined into another/minority category
221 in the primary model.

222 **Complex-sample and statistical analyses**

223 The women's sampling weight (V005) was divided by 1,000,000 before analysis. The complex
224 survey design was specified using V021 as the primary sampling unit and V022 as the sampling
225 stratum. The analysis included 27 strata and 794 primary sampling units, resulting in 767 survey-
226 design degrees of freedom. Participant characteristics were summarized using unweighted
227 frequencies and survey-weighted percentages. The weighted prevalence of institutional delivery was
228 estimated overall and for each explanatory-variable category. Univariable associations were
229 assessed using survey-weighted logistic-regression models and design-adjusted Wald tests.

230 A survey-weighted multivariable logistic-regression model was fitted to identify factors
231 independently associated with institutional delivery. Maternal age, education, wealth, residence,

region, parity, religion, and media exposure were entered simultaneously based on conceptual relevance rather than univariable statistical significance. Associations were reported as adjusted odds ratios (AORs) with 95% confidence intervals. Overall factor-level significance was evaluated using design-adjusted Wald tests, and a two-sided p value below .05 was considered statistically significant. Because institutional delivery was common, AORs were interpreted strictly as odds ratios rather than prevalence or risk ratios. Data management and statistical analyses were performed using IBM SPSS Statistics for Windows, version 27.0.

Sensitivity analyses

Two sensitivity analyses assessed the influence of sparse religion categories. First, the model was re-estimated using the original six-category religion variable. Second, women in the Catholic and traditional categories were excluded. Overall religion tests and the principal adjusted estimates were compared across the three specifications.

An exploratory two-level random-intercept logistic model was also estimated, with women nested within primary sampling units, to assess residual cluster-level heterogeneity. Cluster variance, intraclass correlation coefficient, median odds ratio, and proportional change in variance were reported⁵¹. Because appropriate sampling weights were unavailable at both analytical levels, these models were unweighted and were treated only as sensitivity analyses; they were not used to produce nationally representative effect estimates. The complex-survey logistic model remained the primary analysis.

Results

Characteristics of the study population

Table 1 shows the characteristics of the 6,833 women included in the analysis. More than half were aged 25-34 years (52.3%), while 37.4% had no formal education and 38.2% had completed primary education. Most women lived in rural areas (70.1%), 40.0% had four or more children, and 58.3% had no exposure to newspapers or magazines, radio, or television.

Table 1 also shows the distribution of place of delivery. The survey-weighted prevalence of institutional delivery was 61.3%, whereas 38.7% of recent births occurred at home. The unweighted sample included 3,874 institutional deliveries and 2,959 home deliveries.

Table 1. Sociodemographic characteristics of women included in the institutional-delivery analysis

Characteristic	Unweighted n	Weighted %
Age group		

Characteristic	Unweighted n	Weighted %
15-24 years	1,758	24.6
25-34 years	3,563	52.3
35-49 years	1,512	23.1
Education		
No education	2,750	37.4
Primary education	2,471	38.2
Secondary education	958	14.8
Higher education	654	9.6
Household wealth quintile		
Poorest	2,421	22.1
Poorer	1,223	18.1
Middle	970	18.5
Richer	902	20.4
Richest	1,317	20.9
Residence		
Rural	4,826	70.1
Urban	2,007	29.9
Region		
Tigray	603	6.3
Afar	646	1.3
Amhara	511	23.3
Oromia	697	39.6
Somali	667	4.1
Benishangul-Gumuz	432	1.1
Central Ethiopia	482	4.3
Sidama	456	3.6
South West Ethiopia	452	2.9
South Ethiopia	570	7.9
Gambella	416	0.5
Harari	309	0.3
Addis Ababa	300	4.4
Dire Dawa	292	0.4
Parity		
One child	1,482	22.2
Two to three children	2,467	37.8
Four or more children	2,884	40.0
Religion		
Orthodox	1,907	39.2
Catholic	45	0.7
Protestant	1,898	24.7
Muslim	2,795	33.9
Traditional	47	0.4
Other	141	1.1
Media exposure		
No media exposure	4,441	58.3
Has media exposure	2,392	41.7
Place of delivery		
Home delivery	2,959	38.7
Institutional delivery	3,874	61.3

Note. Values are unweighted frequencies and survey-weighted percentages. Percentages may not total 100.0 because of rounding.

Prevalence and bivariate differences

Table 2 shows the survey-weighted prevalence of institutional delivery across demographic, socioeconomic, and geographic groups. Institutional delivery increased with educational attainment, from 40.9% among women with no formal education to 95.7% among women with higher education. The overall education difference was statistically significant, Wald $F(3, 767) = 58.38$, $p < .001$, indicating that institutional-delivery use favoured women with higher levels of education.

Table 2 also shows a pronounced household-wealth gradient. The prevalence of institutional delivery increased from 27.6% in the poorest quintile to 95.3% in the richest quintile, Wald $F(4, 767) = 67.19$, $p < .001$. Thus, women from richer households had substantially greater use of institutional-delivery services than women from poorer households.

Institutional delivery was higher among urban women than rural women (89.8% versus 49.2%), Wald $F(1, 767) = 132.89$, $p < .001$. Regional differences were also substantial, ranging from 32.8% in Afar to 97.8% in Addis Ababa, Wald $F(13, 767) = 13.81$, $p < .001$. Prevalence declined with increasing parity, from 76.4% among women with one child to 46.5% among women with four or more children. Women with media exposure also had higher institutional-delivery coverage than women without media exposure (80.3% versus 47.7%).

Table 2. Survey-weighted prevalence of institutional delivery and univariable comparisons by participant characteristics

Characteristic	n	Home delivery, weighted %	Institutional delivery, weighted %	Design-adjusted Wald F (df1, df2)	p value
Age group					
15-24 years	1,758	37.9	62.1	5.21 (2, 767)	.006
25-34 years	3,563	36.5	63.5	-	-
35-49 years	1,512	44.4	55.6	-	-
Education					
No education	2,750	59.1	40.9	58.38 (3, 767)	< .001
Primary education	2,471	35.7	64.3	-	-
Secondary education	958	16.6	83.4	-	-
Higher education	654	4.3	95.7	-	-
Household wealth quintile					
Poorest	2,421	72.4	27.6	67.19 (4, 767)	< .001
Poorer	1,223	52.8	47.2	-	-
Middle	970	42.5	57.5	-	-
Richer	902	21.0	79.0	-	-
Richest	1,317	4.7	95.3	-	-
Residence					
Rural	4,826	50.8	49.2	132.89 (1, 767)	< .001
Urban	2,007	10.2	89.8	-	-
Region					
Tigray	603	35.5	64.5	13.81 (13, 767)	< .001
Afar	646	67.2	32.8	-	-
Amhara	511	25.8	74.2	-	-
Oromia	697	46.6	53.4	-	-

Characteristic	n	Home delivery, weighted %	Institutional delivery, weighted %	Design-adjusted Wald F (df1, df2)	p value
Somali	667	63.8	36.2	-	-
Benishangul-Gumuz	432	37.9	62.1	-	-
Central Ethiopia	482	21.0	79.0	-	-
Sidama	456	40.2	59.8	-	-
South West Ethiopia	452	45.0	55.0	-	-
South Ethiopia	570	51.3	48.7	-	-
Gambella	416	26.5	73.5	-	-
Harari	309	21.3	78.7	-	-
Addis Ababa	300	2.2	97.8	-	-
Dire Dawa	292	20.9	79.1	-	-
Parity					
One child	1,482	23.6	76.4	65.04 (2, 767)	< .001
Two to three children	2,467	31.8	68.2	-	-
Four or more children	2,884	53.5	46.5	-	-
Religion					
Orthodox	1,907	24.6	75.4	11.74 (5, 767)	< .001
Catholic	45	40.3	59.7	-	-
Protestant	1,898	40.6	59.4	-	-
Muslim	2,795	53.2	46.8	-	-
Traditional	47	26.9	73.1	-	-
Other	141	52.9	47.1	-	-
Media exposure					
No media exposure	4,441	52.3	47.7	143.24 (1, 767)	< .001
Has media exposure	2,392	19.7	80.3	-	-

Note. Percentages are survey-weighted row percentages. Overall associations are design-adjusted Wald F tests from survey-weighted univariable logistic-regression models using V005/1,000,000 as the weight, V021 as the primary sampling unit, and V022 as the stratum. Denominator degrees of freedom were 767.

Concentration curve

Figure 1 shows the distribution of institutional delivery across the household wealth ranking. The concentration curve lies below the line of equality, demonstrating that institutional delivery was disproportionately concentrated among women with higher socioeconomic positions. The distance between the curve and the equality line indicates a pronounced pro-rich inequality in the use of institutional-delivery services.

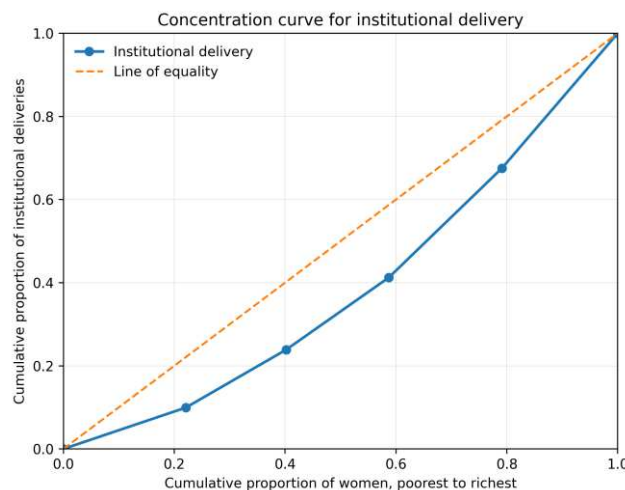


Figure 1. Concentration curve for institutional delivery among Ethiopian women.

Women were ranked from the lowest to the highest socioeconomic position using the continuous DHS wealth-index score and survey weights. The curve below the line of equality indicates pro-rich inequality.

Concentration and rank-based inequality measures

Table 3 presents the concentration and rank-based measures of socioeconomic inequality in institutional delivery. All measures were positive and statistically significant, indicating inequalities that favored women with higher socioeconomic positions. The standard concentration index was 0.235 (95% CI 0.217-0.252; $p < .001$), while the Erreygers corrected concentration index was 0.576 (95% CI 0.533-0.619; $p < .001$).

Table 3 also shows a large difference between the two ends of the socioeconomic distribution. The predicted probability of institutional delivery increased from 16.7% at the theoretical lowest socioeconomic rank to 94.7% at the highest rank. The slope index of inequality was 78.03 percentage points (95% CI 73.68-82.38; $p < .001$), indicating a large absolute inequality. The relative index of inequality was 5.68 (95% CI 4.56-7.08; $p < .001$), showing that the predicted probability at the highest socioeconomic rank was approximately 5.7 times that at the lowest rank.

Table 3. Socioeconomic inequality in institutional delivery among Ethiopian women

Inequality measure	Estimate	95% CI	p value
Standard concentration index	0.235	0.217-0.252	< .001
Erreygers corrected concentration index	0.576	0.533-0.619	< .001
Slope index of inequality, percentage points	78.03	73.68-82.38	< .001
Relative index of inequality, probability ratio	5.68	4.56-7.08	< .001

Note. Positive values indicate that institutional delivery was concentrated among socioeconomically advantaged women. SII = slope index of inequality; RII = relative index of inequality.

Factors associated with institutional delivery

Table 4 shows the survey-weighted multivariable logistic-regression results. The adjusted model was statistically significant overall, Wald $F(29, 739) = 11.32$, $p < .001$. Education, household wealth, residence, region, and parity were significant at the overall factor level, whereas maternal age, religion, and media exposure were not statistically significant overall.

The education estimates in Table 4 show a graded association. Compared with women with no formal education, the adjusted odds of institutional delivery were 1.52 times higher among women with primary education (95% CI 1.19-1.94), 2.10 times higher among women with secondary education (95% CI 1.38-3.18), and 4.03 times higher among women with higher education (95% CI 1.93-8.43).

Table 4 also shows a monotonic wealth gradient. Compared with the poorest quintile, the adjusted odds of institutional delivery increased from 1.84 in the poorer quintile (95% CI 1.37-2.47) to 8.60

in the richest quintile (95% CI 4.59-16.11). The pro-rich pattern therefore remained after adjustment for the other study variables.

Urban women had 2.70 times the adjusted odds of institutional delivery compared with rural women (95% CI 1.76-4.15). Women with four or more children had 58% lower adjusted odds than women with one child (AOR 0.42, 95% CI 0.27-0.67). The estimate for women with two to three children was lower but did not reach the 5% significance level (AOR 0.69, 95% CI 0.47-1.02).

Region was significant overall, Wald $F(13, 755) = 4.46$, $p < .001$. Compared with Tigray, higher adjusted odds were observed in Central Ethiopia (AOR 3.10, 95% CI 1.63-5.92) and Harari (AOR 2.17, 95% CI 1.05-4.47). Maternal age was not significant overall, Wald $F(2, 766) = 1.49$, $p = .225$. Religion was also nonsignificant in the final collapsed-category model, Wald $F(3, 765) = 1.75$, $p = .156$, and media exposure was not independently associated with institutional delivery (AOR 1.14, 95% CI 0.84-1.53; overall $p = .407$).

Table 4. Final survey-weighted logistic-regression model of institutional delivery using collapsed religion categories

Predictor	Survey-weighted AOR	95% CI	Category p value	Overall p value	p
Age group					
15-24 years	1.00 (Ref.)	-	-	.225	
25-34 years	1.23	0.85-1.78	.281		
35-49 years	1.47	0.93-2.32	.102		
Education					
No education	1.00 (Ref.)	-	-	< .001	
Primary	1.52	1.19-1.94	< .001		
Secondary	2.10	1.38-3.18	< .001		
Higher	4.03	1.93-8.43	< .001		
Household wealth					
Poorest	1.00 (Ref.)	-	-	< .001	
Poorer	1.84	1.37-2.47	< .001		
Middle	2.47	1.75-3.49	< .001		
Richer	4.38	2.88-6.67	< .001		
Richest	8.60	4.59-16.11	< .001		
Residence					
Rural	1.00 (Ref.)	-	-	< .001	
Urban	2.70	1.76-4.15	< .001		
Region					
Tigray	1.00 (Ref.)	-	-	< .001	
Afar	0.60	0.32-1.14	.118		
Amhara	1.27	0.79-2.03	.324		
Oromia	0.82	0.51-1.32	.411		
Somali	0.68	0.36-1.27	.223		
Benishangul-Gumuz	1.27	0.70-2.31	.438		
Central Ethiopia	3.10	1.63-5.92	< .001		
Sidama	1.05	0.56-1.97	.884		
South West Ethiopia	0.93	0.54-1.57	.773		
South Ethiopia	0.61	0.33-1.11	.106		

Predictor	Survey-weighted AOR	95% CI	Category p value	Overall p value
Gambella	1.76	0.96-3.23	.066	
Harari	2.17	1.05-4.47	.036	
Addis Ababa	1.93	0.56-6.61	.296	
Dire Dawa	1.75	0.84-3.65	.134	
Parity				
One child	1.00 (Ref.)	-	-	< .001
Two to three children	0.69	0.47-1.02	.059	
Four or more children	0.42	0.27-0.67	< .001	
Religion				
Orthodox	1.00 (Ref.)	-	-	.156
Protestant	0.67	0.42-1.05	.082	
Muslim	0.64	0.42-0.96	.032	
Other/minority	0.78	0.32-1.87	.571	
Media exposure				
No exposure	1.00 (Ref.)	-	-	.407
Has exposure	1.14	0.84-1.53	.407	

Note. AOR = adjusted odds ratio; CI = confidence interval. The model incorporated the normalized women's sampling weight, V021 as the primary sampling unit, and V022 as the sampling stratum. Home delivery was the outcome reference category. Catholic, traditional, and other religions were combined into an other/minority category. Category p values compare each category with its reference; overall p values are design-adjusted tests of each factor.

Adjusted associations displayed graphically

Figure 2 displays selected adjusted odds ratios from the final survey-weighted model. The figure shows the progressive increase in the odds of institutional delivery across education and wealth categories, higher odds among urban women, and lower odds among women with greater parity. The confidence intervals were widest for higher education and the richest wealth quintile, indicating lower precision for these estimates than for several of the other associations.

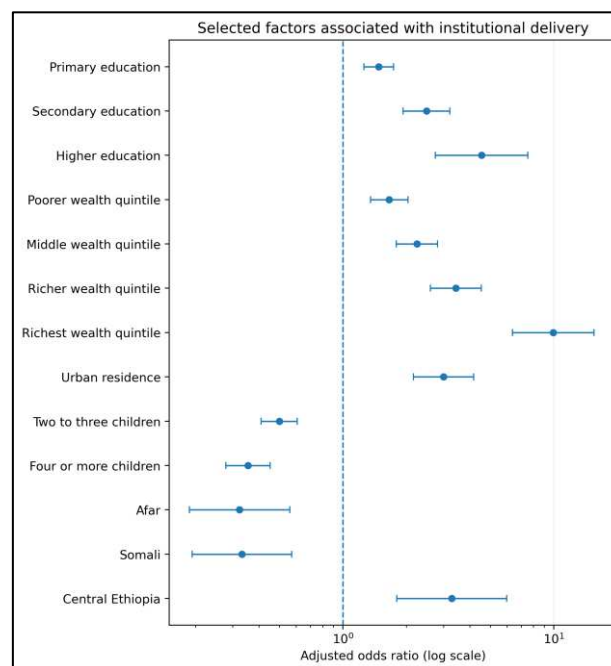


Figure 2. Selected survey-weighted adjusted odds ratios from the final model.

Points represent adjusted odds ratios and horizontal lines represent 95% confidence intervals. The vertical dashed line indicates the null value of 1.0.

Sensitivity analysis of religion specifications

Table 5 compares the three alternative specifications of religion. Religion was not statistically significant in the final collapsed-category model, Wald $F(3, 765) = 1.75$, $p = .156$, or in the model excluding Catholic and traditional respondents, Wald $F(3, 765) = 1.72$, $p = .161$. By contrast, the original six-category model produced a significant overall test, Wald $F(5, 763) = 7.19$, $p < .001$.

The category-specific estimates in Table 5 show that the significant six-category result was strongly influenced by the large traditional-religion estimate (AOR 5.51, 95% CI 2.46-12.33), which was based on only 47 women. The adjusted estimates for education, wealth, residence, parity, Central Ethiopia, and Harari changed only modestly across the three specifications. The stability of these estimates supports the robustness of the principal findings and the use of the collapsed religion variable in the final model.

Table 5. Sensitivity analysis of alternative religion specifications in the survey-weighted logistic-regression model

Measure or comparison	Final collapsed model	Original six-category model	Catholic/traditional excluded model
Panel A. Overall religion tests and category-specific estimates			
Analytical sample, n	6,833	6,833	6,741
Overall religion Wald F (df1, df2)	1.75 (3, 765)	7.19 (5, 763)	1.72 (3, 765)
Overall religion p value	.156	< .001	.161
Catholic vs Orthodox	Combined	0.22 (0.04-1.14)	Excluded
Protestant vs Orthodox	0.67 (0.42-1.05)	0.67 (0.42-1.05)	0.68 (0.43-1.07)
Muslim vs Orthodox	0.64 (0.42-0.96)	0.64 (0.42-0.97)	0.64 (0.42-0.97)
Traditional vs Orthodox	Combined	5.51 (2.46-12.33)	Excluded
Other vs Orthodox	Combined	0.56 (0.26-1.21)	0.59 (0.27-1.27)
Other/minority vs Orthodox	0.78 (0.32-1.87)	-	-
Panel B. Stability of principal adjusted associations, AOR (95% CI)			
Primary education vs no education	1.52 (1.19-1.94)	1.53 (1.20-1.95)	1.52 (1.19-1.94)
Secondary education vs no education	2.10 (1.38-3.18)	2.14 (1.41-3.23)	2.28 (1.49-3.48)
Higher education vs no education	4.03 (1.93-8.43)	4.09 (1.96-8.53)	3.97 (1.86-8.46)
Poorer vs poorest wealth quintile	1.84 (1.37-2.47)	1.87 (1.40-2.52)	1.88 (1.40-2.54)
Middle vs poorest wealth quintile	2.47 (1.75-3.49)	2.52 (1.79-3.55)	2.51 (1.78-3.55)
Richer vs poorest wealth quintile	4.38 (2.88-6.67)	4.44 (2.92-6.77)	4.41 (2.89-6.74)
Richest vs poorest wealth quintile	8.60 (4.59-16.11)	8.87 (4.71-16.70)	8.34 (4.44-15.69)
Urban vs rural residence	2.70 (1.76-4.15)	2.80 (1.83-4.26)	2.89 (1.89-4.41)
Two to three children vs one child	0.69 (0.47-1.02)	0.69 (0.47-1.00)	0.67 (0.46-0.97)
Four or more children vs one child	0.42 (0.27-0.67)	0.42 (0.27-0.66)	0.41 (0.26-0.63)
Central Ethiopia vs Tigray	3.10 (1.63-5.92)	3.13 (1.64-5.99)	3.12 (1.63-5.99)
Harari vs Tigray	2.17 (1.05-4.47)	2.15 (1.04-4.45)	2.17 (1.05-4.50)

Note. Values for category comparisons are survey-weighted adjusted odds ratios with 95% confidence intervals. The final model combined Catholic, traditional, and other religions into another/minority category. The original model retained six categories, whereas the exclusion model omitted Catholic and traditional women.

Multilevel sensitivity analysis

Table 6 presents the exploratory unweighted multilevel random-intercept models. Education, household wealth, urban residence, and parity remained associated with institutional delivery after progressive adjustment. In the fully adjusted model, the odds of institutional delivery increased with education and household wealth and were higher among urban women, whereas women with two to three children and women with four or more children had lower odds than women with one child. Because these models did not incorporate survey weights at both levels, the estimates were interpreted only as sensitivity evidence and not as nationally representative associations.

The random-effects results show that cluster-level variance declined from 3.166 in the empty model to 1.093 in the fully adjusted model. The intraclass correlation coefficient decreased from 49.0% to 24.9%, the median odds ratio declined from 5.46 to 2.71, and the proportional change in variance was 65.5%. These results suggest that the included variables explained a substantial proportion of between-cluster variation, although meaningful residual heterogeneity remained.

Table 6. Unweighted multilevel random-intercept sensitivity models of institutional delivery

Predictor	Model 1 AOR (95% CI)	Model 2 AOR (95% CI)	Model 3 AOR (95% CI)
Education			
No education	1.00 (Ref.)	1.00 (Ref.)	1.00 (Ref.)
Primary	1.88 (1.62-2.17)***	1.63 (1.39-1.91)***	1.48 (1.26-1.74)***
Secondary	3.53 (2.78-4.48)***	2.70 (2.08-3.49)***	2.49 (1.93-3.22)***
Higher	6.68 (4.07-10.96)***	4.85 (2.97-7.92)***	4.54 (2.74-7.52)***
Household wealth			
Poorest	1.00 (Ref.)	1.00 (Ref.)	1.00 (Ref.)
Poorer	1.93 (1.58-2.34)***	1.94 (1.59-2.37)***	1.66 (1.35-2.03)***
Middle	2.69 (2.16-3.35)***	2.63 (2.11-3.28)***	2.24 (1.79-2.81)***
Richer	4.06 (3.10-5.31)***	3.99 (3.03-5.25)***	3.43 (2.60-4.53)***
Richest	13.77 (8.90-21.30)***	12.84 (8.25-19.98)***	9.92 (6.36-15.49)***
Residence			
Rural	1.00 (Ref.)	1.00 (Ref.)	1.00 (Ref.)
Urban	2.73 (1.95-3.83)***	2.76 (1.97-3.88)***	3.00 (2.16-4.17)***
Media exposure			
No exposure	1.00 (Ref.)	1.00 (Ref.)	1.00 (Ref.)
Has exposure	1.07 (0.91-1.27)	1.07 (0.91-1.27)	1.06 (0.89-1.26)
Age group			
15-24 years	-	1.00 (Ref.)	1.00 (Ref.)
25-34 years	-	1.29 (1.06-1.57)*	1.22 (1.00-1.49)
35-49 years	-	1.46 (1.13-1.90)**	1.32 (1.01-1.73)*
Parity			
One child	-	1.00 (Ref.)	1.00 (Ref.)
Two to three children	-	0.49 (0.40-0.59)***	0.50 (0.41-0.61)***

Predictor	Model 1 AOR (95% CI)	Model 2 AOR (95% CI)	Model 3 AOR (95% CI)	
Four or more children	-	0.34 (0.27-0.44)***	0.35 (0.28-0.45)***	
Religion				
Orthodox	-	1.00 (Ref.)	1.00 (Ref.)	
Catholic	-	0.72 (0.26-2.01)	0.73 (0.27-1.99)	
Protestant	-	0.76 (0.59-0.96)*	0.77 (0.56-1.05)	
Muslim	-	0.72 (0.57-0.93)*	1.00 (0.73-1.37)	
Traditional	-	1.42 (0.68-2.97)	1.47 (0.69-3.13)	
Other	-	0.94 (0.56-1.58)	0.90 (0.51-1.58)	
Region				
Tigray	-	-	1.00 (Ref.)	
Afar	-	-	0.32 (0.19-0.56)***	
Amhara	-	-	1.55 (0.98-2.46)	
Oromia	-	-	0.75 (0.47-1.19)	
Somali	-	-	0.33 (0.19-0.57)***	
Benishangul-Gumuz	-	-	0.89 (0.53-1.50)	
Central Ethiopia	-	-	3.29 (1.80-5.99)***	
Sidama	-	-	1.10 (0.63-1.91)	
South West Ethiopia	-	-	1.05 (0.64-1.70)	
South Ethiopia	-	-	0.60 (0.35-1.01)	
Gambella	-	-	1.63 (0.96-2.76)	
Harari	-	-	1.61 (0.83-3.11)	
Addis Ababa	-	-	1.89 (0.66-5.38)	
Dire Dawa	-	-	1.12 (0.55-2.28)	
Panel B. Random-effects measures				
Measure	Empty model	Model 1	Model 2	Full model
Cluster variance	3.166	1.259	1.252	1.093
ICC, %	49.0	27.7	27.6	24.9
Median odds ratio	5.46	2.92	2.91	2.71
PCV, %	-	60.2	60.5	65.5
Overall classification, %	82.7	83.3	83.4	83.5

Note. The GENLINMIXED models were unweighted sensitivity analyses used to quantify residual between-cluster heterogeneity; they were not the primary nationally representative association model. Model 1 included education, wealth, residence, and media exposure. Model 2 additionally included maternal age, parity, and religion. Model 3 additionally included region. ICC = intraclass correlation coefficient; MOR = median odds ratio; PCV = proportional change in variance. * $p < .05$. ** $p < .01$. *** $p < .001$.

Residual clustering across multilevel models

Figure 3 shows the decline in residual clustering across multilevel models. The largest reduction occurred after socioeconomic characteristics were included, with the intraclass correlation coefficient decreasing from 49.0% in the empty model to 27.7% in Model 1. Subsequent adjustment produced smaller reductions, and the intraclass correlation coefficient remained 24.9% in the fully adjusted model.

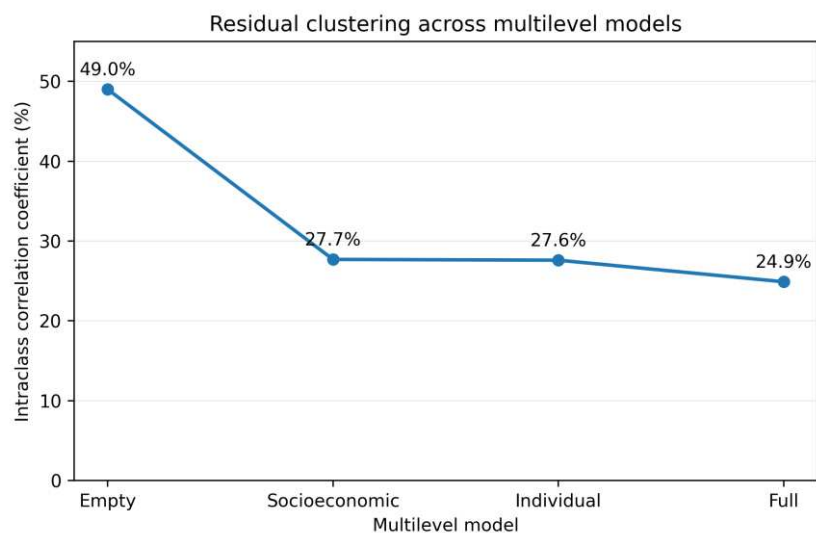


Figure 3. Intraclass correlation coefficient across the unweighted multilevel sensitivity models. Residual clustering declined after adjustment but remained substantial in the fully adjusted model.

Discussion

This study assessed socioeconomic inequality in institutional delivery and factors associated with facility-based childbirth among Ethiopian women. Institutional delivery coverage was 61.3%, but the positive concentration indices and the concentration curve below the equality line demonstrated a marked pro-rich distribution. The Erreygers-corrected concentration index of 0.576, SII of 78.03 percentage points, and RII of 5.68 indicate substantial inequality in both absolute and relative terms. After adjustment, education, household wealth, residence, region, and parity remained associated with institutional delivery. These findings indicate that national maternal health strategies should monitor not only overall institutional-delivery coverage but also absolute and relative inequalities across socioeconomic groups.

Institutional delivery was more common among women from wealthier households and those with formal education. Wealthier families may be better able to manage transportation, childcare, food, and other indirect expenses related to facility delivery, while education may improve women's awareness of pregnancy-related risks and their ability to make informed healthcare decisions. This agrees with previous Ethiopian studies reporting higher maternal healthcare use among wealthier and better-educated women ^{29,42}. The similarity may be explained by the continuing influence of household resources, health knowledge, and decision-making power on access to professional maternity care ^{30,37}. Therefore, interventions should prioritize poor and less-educated women through transport vouchers, financial assistance, community-based maternal health education, and targeted birth-preparedness counselling.

Urban women were more likely to deliver in health facilities, and clear differences were observed between regions. Urban women commonly have better access to nearby facilities, skilled professionals, roads, transport, and emergency referral services. This finding is consistent with earlier Ethiopian evidence showing rural–urban and regional inequalities in maternal healthcare use^{27,41}. The similarity may reflect the unequal distribution of health facilities, variation in service readiness, difficult geography, and differences in the local delivery of maternal health programmes^{16,27}. Policy responses should strengthen rural transportation and emergency referral systems, expand access to adequately staffed maternity facilities, and allocate resources according to regional differences in service availability and readiness.

Women with four or more children were less likely to use institutional delivery than women giving birth for the first time. Women with previous uncomplicated births may perceive themselves as experienced and consider facility care less necessary. Household responsibilities, limited support, and difficulty leaving other children at home may also discourage service use. This result agrees with studies showing that women with more previous births are more likely to deliver at home^{38,39}. The similarity may be related to reduced perception of childbirth risk and greater confidence based on earlier delivery experiences^{14,15}. Maternal health programmes should specifically engage high-parity women through repeated counselling during antenatal care, individualized birth planning, family involvement, and practical support for childcare and transportation.

Some findings were less conventional. Media exposure and maternal age initially appeared important but no longer had an independent influence after education, wealth, residence, and other characteristics were considered, suggesting that their apparent effects were mainly explained by broader socioeconomic advantage. Religion also appeared important only when very small religious groups were analyzed separately, while Addis Ababa’s very high observed use did not remain independently different from Tigray after other characteristics were considered. Similar studies indicate that media access often overlaps with education, wealth, and urban residence rather than acting independently^{40,41}. The regional pattern may differ from earlier descriptive findings because women’s socioeconomic characteristics and local conditions were considered together in the present analysis^{37,44}. These findings suggest that communication interventions should be integrated with broader efforts addressing poverty, education, and geographic access rather than relying on media exposure alone. Policies should also avoid targeting religious groups based on unstable estimates from very small samples and should instead use robust socioeconomic and regional evidence for programme planning.

Strengths and Limitations

This study used recent nationally representative EDHS data, applied complementary absolute and relative inequality measures, and accounted for the complex survey design in the primary analyses. Several limitations should nevertheless be considered. The cross-sectional design precludes causal inference, and self-reported delivery information may be affected by recall or reporting errors, particularly because births from the preceding five years were included.

Complete-case analysis may have introduced selection bias if missingness was systematic. The household wealth index was measured at the time of interview and may not exactly represent socioeconomic circumstances at the time of earlier births. Institutional delivery measures place of birth rather than the technical or experiential quality of care, and potentially important factors such as distance, transport availability, women's decision-making autonomy, perceived quality, and facility readiness were unavailable, leaving scope for residual confounding. Because institutional delivery was common, AORs should not be interpreted as prevalence or risk ratios. In addition, the multilevel sensitivity models were unweighted and were used only to explore residual clustering. Future research should combine longitudinal, spatial, facility-linked, and qualitative approaches to clarify pathways underlying these inequalities.

Conclusions

Institutional delivery in Ethiopia remains markedly concentrated among socioeconomically advantaged women. Greater household wealth, higher education, urban residence, lower parity, and residence in certain regions were associated with higher adjusted odds of facility delivery. These findings indicate that expanding facility numbers alone is unlikely to achieve equitable use. Policies should combine service expansion with targeted financial, transport, referral, and maternal health communication support for poor, rural, less-educated, and high-parity women, while monitoring both coverage and inequality over time.

List of abbreviations

AOR: Adjusted odds ratio
CI: Confidence interval
DHS: Demographic and Health Survey
EDHS: Ethiopia Demographic and Health Survey
ICC: Intraclass correlation coefficient
MOR: Median odds ratio
PCV: Proportional change in variance
RII: Relative index of inequality
SDG: Sustainable Development Goal
SII: Slope index of inequality

Declarations

Ethics approval and consent to participate

This study was based on secondary analysis of anonymized data from the 2024–2025 Ethiopia Demographic and Health Survey. The original survey received ethical approval in accordance with applicable national and DHS Program procedures, and informed consent was obtained from all participants before data collection. Permission to access and use the dataset was obtained from the DHS Program. The present analysis involved no direct contact with participants and no access to personally identifiable information.

Clinical trial number: not applicable.

Consent for publication

Not applicable.

Availability of data and materials

Data are available from The DHS Program's [Ethiopia Standard DHS 2024 dataset page](#) following registration, proposal submission, and approval of a data-use request. The authors are not authorized to redistribute the dataset.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

Fazle Rabby (FR) contributed to the conceptualization of the study, data management, statistical analysis, interpretation of the findings, and preparation of the original manuscript. Md. Ripul Kabir (MRK) supervised the study, contributed to the interpretation of the findings, and critically reviewed and edited the manuscript. Both authors read and approved the final manuscript.

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