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Trends and determinants of home delivery in Ethiopia: Further multivariate decomposition analysis of 2005 to 2016 Ethiopian Demographic Health Surveys

Sofonyas Abebaw Tiruneh[1*], Ayenew Molla Lakew[2], Seblewongel Tigabu Yigizaw [2], Malede Mequanent Sisay[2], Zemenu Tadesse Tessema[2]

Affiliations:

[1] Department of Public Health, College of Health Sciences, Debre Tabor University, Ethiopia. P.O. Box. 272.

[2] Department of Epidemiology and Biostatistics, Institute of Public Health, College of Medicine and Health Sciences, University of Gondar, Ethiopia. P.O. Box. 196.

E-mails:

Sofonyas Abebaw Tiruneh: zephab2@gmail.com

Ayenew Molla Lakew mayenew15@gmail.com

Seblewongel Tigabu Yigizaw stigabu040@gmail.com

Malede Mequanent Sisay maledecsa@gmail.com

Zemenu Tadesse Tessema: zemenut1979@gmail.com

Corresponding author:

Sofonyas Abebaw Tiruneh

Department of Public Health, College of Health Sciences, Debre Tabor University, Ethiopia. PO BOX 272.

Email: zephab2@gmail.com

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Abstract

Objective: This study aimed to analyze the trends and factors that have had contributions to the change of home delivery in Ethiopia over the last decade.

Design, setting and analysis: Nationally representative cross-sectional survey was conducted using 2005, 2011 and 2016 Ethiopian Demographic and Health Survey datasets. The data were weighted and analyzed by STATA version 14.1 software. Multivariate decomposition logistic regression analysis was used to identify significant factors for the change in home delivery. A p-value < 0.05 was taken to declare statistically significant predictors.

Outcome measures: Trends of home delivery

Participants: A total of 33482 women who gave birth preceding each survey were included for this study.

Results: The magnitude of home delivery decreased by 21% over the last decade in Ethiopia. Multivariate decomposition logistic regression analysis revealed that 39% of the decrease in home delivery was due to differences in women's characteristics. Antenatal care visits, educational status of women and husbands, birth order, religion, and distance from health facilities were the main sources of compositional changes for the decline of home delivery. Behavioural changes towards health facility delivery contributed to approximately two-thirds of the decline of home delivery. Antenatal care visits, birth order, and religion were significantly associated with the change from home delivery due to behavioural changes in the use of health care facilities over the last decade.

Conclusion: Despite the importance of health facility delivery, a large number of women still deliver at home in Ethiopia. Women's characteristics and behaviour change were significantly associated with the change from home delivery. Multisectoral interventions needed to improve antenatal care coverage, women's education and health care facilities are needed to improve the practice. Further research needs to be done to identify why protestant women do not deliver at health facilities.

Keywords: Home delivery, multivariate decomposition, EDHS, Ethiopia.

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Strength and limitation of the study

- ✓ We used the Ethiopian Demographic and Health Surveys, which is a large dataset representative of the population.
- ✓ We hope, has increased the power of our findings.
- ✓ Besides, multivariate decomposition logistic regression analysis used to identify factors that positively or negatively contributed to the decline of home delivery could help planners to design interventions.
- ✓ As cross-sectional survey that is likely to prone to recall bias and social desirability bias.

Introduction

Every day, about 830 women die from preventable causes relating to pregnancy and childbirth, of which 99% of the deaths occur in developing countries (1). Worldwide, maternal mortality fell from 385 deaths per 100 000 livebirths in 1990 to 216 deaths in 2015, which a drop by 44% (2,3). Despite the decline in maternal mortality in the last 25 years, the magnitude is still unacceptable in developing countries, including Ethiopia (3,4). The trends of maternal mortality in Ethiopia fell from 1250 deaths per 100 000 livebirths in 1990 to 353 deaths in 2015, a decline by 71.8%, which is below the target of the Millennium Development Goals (MDGs) related to maternal mortality (5,6). Sustainable Development Goal (SDG) goal 3, target 3.1 calls for the reduction of maternal mortality ratio of less than 70 per 100 000 live births between 2016 and 2030 (7).

Studies indicated that nearly one-quarter of maternal deaths occurred in the antepartum period, another quarter in the intrapartum and immediate postpartum periods; one-third occurred in the subacute and delayed postpartum periods and 12% in the late postpartum period (8). Numerous factors contribute to high maternal mortality rates. Most maternal deaths are contributed by direct obstetric complications mainly hemorrhage, pregnancy-induced hypertension, sepsis, and obstructed labour combined account for 64% of the maternal death, and other factors such as poverty, limited access to health care, unskilled childbirth and maternal sociodemographic characteristics are among the other causes of maternal mortality (9–11). Even though, skilled childbirth before, during and after delivery can save the lives of women, in sub-Saharan Africa only 59% of births were attended by skilled health personnel between 2012 and 2017 (12). In Ethiopia, the magnitude of home delivery was 94.5% in 2000, 93.1% in 2005, 87.9% in 2011 and 73.6% in 2016 which was unacceptably high (13,14).

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In Ethiopian several studies evidenced that women's low educational status, cultural and communal factors, limited access to health facilities, poor quality of care, lack of roads, and poor wealth status were significant factors that led to low maternal health service utilization (13,15–17). On the other hand, taking at least one antenatal care during pregnancy, high parity, education of women, urban residence, husband attitude towards institutional delivery, easy access to health facilities, and wealth status contributed to health facility delivery (17–20). The trend of home delivery decreased between 2005 to 2016. To date, there is no evidence that identifies the factors that have contributed to the observed reduction in home delivery during the survey.

Therefore, this multivariate decomposition analysis aimed to identify trends and factors that either positively or negatively contributed to the change for home delivery in order to contribute to improving health facility delivery. The study will help health planners and policymakers in planning to further reduce home delivery and provide baseline information to other researchers.

Methods and materials

Study design, area and period

The data for this study accessed from nationally representative 2005, 2011 and 2016 Ethiopian Demographic and Health Surveys (EDHS). Ethiopia is laying between latitude 3° and 14°N, and longitude 33° and 48°E in the horn of Africa. Ethiopia has a total area of 1,100,000 km^2 and nine regional states, namely Afar, Amhara, Benishangul-Gumuz, Gambela, Harari, Oromia, Somali, Southern Nations Nationalities and Peoples of Region (SNNPR) and Tigray plus Addis Ababa and Dire Dawa city Administrations.

Source and study populations

The source populations were all reproductive age group women who gave birth five years preceding each survey. The study populations were all reproductive-age women who gave birth five years preceding each survey in the selected Enumeration Areas (EAs). In each survey, a nationally representative samples of 10721 in 2005, 11872 in 2011, and 10889 in 2016 weighted number of women participated. All women who gave birth five years before the three surveys. Recorded data were accessed at www.messdhs.com on request with the assistance of ICF International, Inc.

Data collection tools and procedures

The 2016 EDHS sample was stratified and selected at two stages. Each region of the country was stratified into urban and rural areas, yielding 21 sampling strata. In the first stage, 645 EAs were

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selected with a probability proportional to the EA size and with independent selection in each sampling stratum. In the second stage of selection, a fixed number of 28 households per cluster were selected with an equal probability systematic selection from the newly created household listing. The detailed sampling procedure is available in the Ethiopian Demographic and Health Survey reports from Measure DHS website (www.dhsprogram.com).

Outcome variable

The outcome variable was taken as a binary response: a woman gave birth at home coded as home delivery, and women who gave birth at different government, private, and non-government health facilities were taken as health facility delivery.

Predictor variables

All sociodemographic and obstetric characteristics were taken as predictor variables for the three-consecutive surveys.

Patient and public involvement

The patients and the public were not involved for this secondary data analysis. But for original survey the issue of patient and public involvement were considered; Since biomarkers such as anthropometry, anaemia and HIV testing were collected from each household for each survey (21–23).

Statistical analysis

The data were cleaned and analyzed using STATA version 14.1 software. Sample weighting was done for further analysis. Descriptive statistics were done for the description of the variables. A multivariate decomposition logistic regression analysis was done to identify the contributions to group differences to average predictions (24). The purpose of this decomposition analysis was to identify factors that contributed to the change in home delivery in the last decade in Ethiopia.

A nonlinear multivariate logit decomposition model was used to identify the contribution of proportion change to home delivery over the last decade. The output from the multivariate decomposition logistic regression analysis had two contribution effects. These effects were the compositional differences (endowments) “E” and the effects of characteristics that are the difference in the coefficients or behavioural change “C” responses for the selected predictor variables. In the nonlinear model, the dependent variable is a function of a linear combination of predictors and regression coefficients:

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$Y = F(X\beta) = \text{logit}(Y) = x\beta$, where Y denotes the N × 1 dependent variable vector, X an N × K matrix of independent variables, and β a K ×1 vector of coefficients.

The proportion difference in Y between survey A and survey B of successive EDHS surveys of the home delivery can be decomposed as

$$Y_A - Y_B = F(X_A\beta_A) - F(X_B\beta_B)$$

For the log odds of home delivery, the proportion of the model is written as

$$\text{Logit}(Y_A) - \text{logit}(Y_B) = F(X_A\beta_A) - F(X_B\beta_B)$$

$$= \underbrace{F(X_A\beta_A) - F(X_B\beta_A)}_{E} + \underbrace{F(X_B\beta_A) - F(X_B\beta_B)}_{C}$$ is group decomposition (24)

The component "E" is the difference attributable to endowment change, usually called the explained component. The "C" component is the difference attributable to coefficients (behavioural) change, usually called the unexplained component.

The model structure for the decomposition analysis was:

$$\text{Logit}(A) - \text{Logit}(B) = [\beta_{0A} - \beta_{0B}] + \Sigma\beta_{ijA}[X_{ijA} - X_{ijB}] + \Sigma X_{ijB}[\beta_{ijA} - \beta_{ijB}]$$

where

- β_{0A} is the intercept in the regression equation for EDHS 2016
- β_{0B} is the intercept in the regression equation for EDHS 2005
- β_{ijA} is the coefficient of the j^{th} category of the i^{th} determinant for EDHS 2016
- β_{ijB} is the coefficient of the j^{th} category of the i^{th} determinant for EDHS 2005
- X_{ijA} is the proportion of the j^{th} category of the i^{th} determinant for EDHS 2016
- X_{ijB} is the proportion of the j^{th} category of the i^{th} determinant for EDHS 2005

Ethical consideration

We, the authors, submitted a proposal to DHS Program/ICF International Inc, and permission was issued by the International Review Board of Demographic and Health Surveys (DHS) program data archivists to download the dataset for this study.

Results

Background characteristics of women

Table one shows the distribution of individual characteristics of women who gave birth five years preceding each survey in 2005, 2011, and 2016 EDHS dataset. In the three consecutive surveys,

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more than 60% of the women were in the age group of 20-34 years. The respondents had almost the same mean age of 29 (± 6.6 SD) years. In the three surveys, a significant number (48%) of female household heads were identified in the 2011 EDHS report. Almost all (>90%) of the women, were married five years preceding each survey; 79%, 69%, and 66% of the women in each EDHS were unable to read and write, respectively (Table 1).

Table 1: Characteristics of the women who had a live birth in the five years preceding 2005, 2011, and 2016 EDHS, Ethiopia.

Characteristics of women		**Percentage distribution of the surveys**		
		EDHS 2005 N= 10,721	**EDHS 2011 N= 11,872**	**EDHS 2016 N= 10,889**
Mother's age	<20 Years	12.26	9.33	7.81
	20 -34 years	62.07	66.22	67.38
	35-49 Years	25.67	24.25	24.80
	Mean ± SD	29.01 ± 6.95	29.04 ± 6.63	29.23 ± 6.53
Household head	Male	89.15	51.5	86.06
	Female	10.85	48.05	13.94
Marital status	Not having partner	4.56	6.07	6.25
	Had partner	95.44	93.93	93.75
Religion	Orthodox	42.37	38.06	34.14
	Muslim	35.00	35.49	41.50
	Protestant	19.95	23.23	21.09
	Others	2.68	3.22	3.26
Women educational level	Unable to read and write	79.31	69.30	66.13
	Primary education	16.53	27.5	26.67
	Secondary education	3.79	2.24	4.68
	Higher education	0.38	1.42	2.52
Husband educational level	Unable to read and write	59.03	50.60	48.57
	Primary education	30.37	41.26	39.21
	Secondary education	9.58	4.95	7.65
	Higher education	1.01	3.19	4.56
Women occupation	Not working	71.11	47.14	55.62
	Working	28.89	52.86	44.35
Husband occupation	Not working	2.00	1.33	56.93
	Working	98.00	98.67	43.07
Health institution Distance	Big problem	74.40	75.43	60.58
	Not a big problem	25.60	24.57	39.42
Had ANC	No	71.86	57.45	37.42
	Yes	28.14	42.55	62.58

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Birth order	1	17.13	19.05	18.65
	2-4	42.90	43.62	42.80
	>= 5+	39.97	37.33	38.55
Parity	<= 2	26.10	29.22	28.80
	2-5	40.05	39.67	39.67
	>= 5+	33.85	31.11	31.53
Wealth index	Poor	42.98	45.22	46.76
	Middle	22.44	20.53	20.60
	Richer	34.58	34.26	32.64
Residence	Urban	7.09	12.87	11.14
	Rural	92.91	87.13	88.86
Region	Tigray	6.39	6.34	6.44
	Afar	0.97	1.02	1.05
	Amhara	23.99	22.37	18.74
	Oromia	39.69	42.23	44.20
	Somali	4.24	3.07	4.66
	Benishangul	0.78	1.18	1.11
	SNNPR	21.81	21.01	20.67
	Gambla	0.27	0.34	0.24
	Harari	0.19	0.24	0.24
	Addis Ababa	1.32	1.87	2.23
	Dire Dawa	0.34	0.33	0.42
	Total	**100**	**100**	**100**

Trends of home delivery during the surveys

The trend of home delivery over the study period (2005-2016) showed a significant decline, decreasing from 94.20% in 2005 to 73.44% in 2016. The largest decline was observed in the second phase (2011-2016) with a 17% drop in the first phase (2005 -2011) it decreased from 94 to 90, that is a 4% change (Figure 1).

The rate of decline in home delivery from 2005 – 2016 varied in terms of a number of factors. For example, the decrease in the stated period was the highest (52%) in Tigray region and the least (11%) in Afar Regional state. Besides, the drop was higher (36.34%) in urban and lower (17.60%) in rural settlements. The trend declined by 29% among women who received antenatal care services during pregnancy (Table 2).

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Table 2: Trends of home delivery among women who gave birth preceding the survey by women characteristics, 2005, 2011 and 2016 Ethiopia Demographic and Health Surveys.

Individual variables	EDHS 2005 N= 10,721	EDHS 2011 N= 11,872	EDHS 2016 N= 10,889	Percentage point difference in home delivery		
				2011-2005	2016-2011	2016-2005
Mother's age						
<20 Years	93.95	91.16	64.97	-2.79	-26.19	-28.98
20 -34 years	94.16	88.49	72.33	-5.67	-16.16	-21.83
35-49 Years	96.67	93.91	79.14	-2.76	-14.77	-17.53
Household head						
Male	95.51	90.20	74.55	-5.31	-15.65	-20.96
Female	88.77	89.90	66.59	1.13	-23.31	-22.18
Marital status						
Had not a partner	90.51	86.17	66.06	-4.34	-20.11	-24.45
Had partner	94.99	90.31	73.94	-4.68	-16.37	-21.05
Religion						
Orthodox	92.70	84.63	79.91	-8.07	-4.72	-12.79
Muslim	97.09	93.60	79.76	-3.49	-13.84	-17.33
Protestant	94.69	92.90	75.45	-1.79	-17.45	-19.24
Others	98.26	94.58	90.42	-3.68	-4.16	-7.84
Women education						
Illiterate	97.79	95.26	83.91	-2.53	-11.35	-13.88
Primary education	92.22	85.05	62.65	-7.17	-22.4	-29.57
Secondary education	50.58	30.41	22.03	-20.17	-8.38	-28.55
Higher education	18.20	24.47	8.53	6.27	-15.94	-9.67
Husband education						
Illiterate	98.29	95.74	83.03	-2.55	-12.71	-15.26
Primary education	95.20	89.95	75.53	-5.25	-14.42	-19.67
Secondary education	78.17	64.99	39.61	-13.18	-25.38	-38.56
Higher education	37.94	45.05	19.06	7.11	-25.99	-18.88
Women occupation						
Not working	94.95	90.23	76.05	-4.72	-14.18	-18.9
Working	94.36	89.90	70.18	-4.46	-19.72	-24.18
Husband occupation						
Not working	65.89	89.81	75.61	23.92	-14.2	9.72
Working	95.37	90.06	70.58	-5.31	-19.48	-24.79
Health facility						
Big problem	96.97	94.36	82.13	-2.61	-12.23	-14.84
Not a big problem	88.43	76.83	60.10	-11.6	-16.73	-28.33
Had ANC						
No	98.19	96.88	91.50	-1.31	-5.38	-6.69
Yes	82.34	76.64	53.68	-5.7	-22.96	-28.66
Birth order						
1	86.83	79.04	51.01	-7.79	-28.03	-35.82

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2-4	95.01	90.19	72.94	-4.82	-17.25	-22.07
>= 5	97.94	95.51	84.85	-2.43	-10.66	-13.09
Parity						
<= 2	87.89	80.62	52.83	-7.27	-27.79	-35.06
2-5	94.52	92.29	78.06	-2.23	-14.23	-16.46
>= 5+	98.03	96.06	86.45	-1.97	-9.61	-11.58
Wealth status						
Poor	99.08	97.38	85.29	-1.7	-12.09	-13.79
Middle	98.14	96.87	77.39	-1.27	-19.48	-20.75
Rich	87.26	76.31	53.98	-10.95	-22.33	-33.28
Residence						
Urban	56.94	50.18	20.60	-6.76	-29.58	-36.34
Rural	97.67	95.95	80.07	-1.72	-15.88	-17.6
Region						
Tigray	94.12	88.36	41.87	-5.76	-46.49	-52.25
Afar	95.95	93.19	85.28	-2.76	-7.91	-10.67
Amhara	96.49	89.82	72.46	-6.67	-17.36	-24.03
Oromia	95.75	92.00	81.10	-3.75	-10.9	-14.65
Somali	95.23	92.40	82.07	-2.83	-10.33	-13.16
Benishangul	94.67	90.89	74.04	-3.78	-16.85	-20.63
SNNPR	96.30	93.79	73.95	-2.51	-19.84	-22.35
Gambla	84.26	72.48	54.38	-11.78	-18.1	-29.88
Harari	68.20	67.63	49.59	-0.57	-18.04	-18.61
Addis Ababa	21.84	17.66	2.98	-4.18	-14.68	-18.86
Dire Dawa	74.90	60.27	42.81	-14.63	-17.46	-32.09

Detailed multivariate decomposition logistic regression analysis

Difference due to characteristics (Endowment)

This multivariate decomposition analysis revealed that about 39% of the overall change in home delivery was due to difference in compositional characteristics. Among the compositional factors ANC visits, religion, education of women and husbands, birth order, wealth index, distance from health facilities, and residence had statistically significant impact on the contribution (Table 3). Women who had at least one antenatal care follow up during pregnancy were more likely to deliver at health facilities. The coverage of antenatal care follow-up increased from 28 to 62% in the last decade (Table 1), with an important compositional contribution to the decline of home delivery by 35%.

Followers of the Protestant sect were more likely to give birth at home than Orthodox Christians. As a result, the increase in the proportion of the Protestant sect followers (Table 1) had a significant rise to home delivery in the last decade.

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Keeping all other variables constant, the improvement of women's educational status to primary school complete and above before the survey (Table 1) had a positively significant contribution to the decline of the trend.

A decreased in the number of secondary school educated husbands during the surveys (Table 1) had a negative effect on the place of delivery, which a rise in the proportion of husbands with higher education had a positive contribution to the decline of home delivery.

Keeping the coefficient characteristics constant, women who had no significant change in the number of birth orders (from 2-4) (Table 1) had a contribution to the rate of home delivery. On the other hand, a decrease in the number of women who had more than five birth order had a positive contribution to the decline of home delivery in the last decade. (Table 3)

The decline in the proportion of rich women in the last decade increased the prevalence of home delivery. Accessibility of health facility had a positive contribution to decreasing home delivery by 2% over the last decade. Women living in rural areas had a risk of giving birth at home. As shown in Table 1, the composition change of rural residence was minimal, this insignificant compositional change significantly rose the prevalence of home delivery over the last decade (Table 3).

Difference due to effects of coefficient (C)

Controlling the roles of change in compositional characteristics resulted in the decline of two-thirds of home delivery due to behavioural change towards health facility delivery (Table 3).

Antenatal care visits, religion, and birth order had statistically significant effects of coefficient contribution to the observed change in home delivery. Controlling all compositional change factors, 4% of the home delivery decline was due to the change in the behaviour of health facility delivery among the ANC service visitors over the last decade.

Keeping compositional factors constant, Protestant women indicated that the observed changes in home delivery over the past decade had negative effects on the contribution.

Furthermore, about 25% of the decline of home delivery over the last decade was due to changes in health facility delivery use behaviour among women who had a birth order two and above (Table 3).

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Table 3: The detailed multivariate logistic regression decomposition analysis of home delivery women who gave birth in the last ten years preceding 2005 to 2016 EDHS, Ethiopia.

Variables	Difference due to characteristics (E)		Difference due to coefficient (C)	
	Coeff (95% CI)	Pct.	Coeff (95%CI)	Pct.
Age in years				
<20	1	1	1	1
20-34	-0.0026425 (-0.0065794, 0.0012943)	1.2078	0.0097217 (-0.020772, 0.026531)	-1.316
35-49	0.00015715 (-0.000019082,0.00033337)	-0.0718	0.0028792 (-0.0053135, 0.024757)	-4.4434
Religion				
Orthodox	1	1	1	1
Muslim	0.0011654 (-0.00043086, 0.0027617)	-0.53266	0.0019208 (-0.0071241, 0.010966)	-0.87792
protestant	0.0022454 (0.0011048 ,0.0033861) *	-1.0263	0.0067475 (0.00061695, 0.012878) *	-3.084
Others	0.0007805 (0.00022288, 0.0013381)	-0.35674	0.0013868 (-0.00087756, 0.0036511)	-0.63384
Women education				
No education	1	1	1	1
Primary	-0.0045685 (-0.0081609, -0.0009761) *	2.0881	0.0014132 (-0.0034075. 0.0062339)	-0.6460
Secondary	-0.0015069 (-0.0022971, -0.00071672) *	0.68874	0.000085296 (-0.0016957, 0.0018663)	-0.0390
Higher	-0.0030286 (-0.0059084, -0.00014878) *	1.3843	0.00027299 (-0.00021235, 0.00075833)	-0.1248
Husband education				
No education	1	1	1	1
Primary	-0.001852 (-0.0045476, 0.00084366)	0.84646	0.003113 (-0.0053549, 0.011581)	-1.4228
Secondary	0.00084942 (0.00042745, 0.0012714) *	-0.38824	0.0010909 (-0.0027474, 0.0049291)	-0.4986
Higher	-0.0052866 (-0.0080882, -0.0024849) *	2.4163	0.00025019 (-0.00071622, 0.0012166)	-0.11435
women occupation				
Not working	1	1	1	1
Working	0.0006093(-0.011577, 0.012796)	-0.27849	-0.0015175 (-0.014399, 0.011364)	0.69359
Husband occupation				
Not working	1	1	1	1
Working	0.0034081 (-0.033625, 0.040441)	-1.5577	0.033541 (-0.016873, 0.083956)	-15.33
Birth order				
Only one birth	1	1	1	1
2 - 4 birth	0.0015601 (0.00044295, 0.0026773) *	-0.71307	-0.01878 (-0.033508, -0.0040518) *	8.5835
5 and above birth	-0.0003622 (-0.0006497, -0.00007469) *	0.16555	-0.033806 (-0.060462, -0.0071505) *	15.452
ANC visit				
No	1	1	1	1
Yes	-0.076563 (-0.088698, -0.064428) *	34.994	-0.0081231(-0.016207, -0.000039645) *	3.7127
Wealth status				
Poor	1	1	1	1
Middle	-0.0007966 (-1.2357e-06, 0.000077712)	-0.01746	-0.00020032 (-0.0099877, 0.009587)	0.091558
Rich	0.000038238 (-0.00122, -0.00037319) *	0.34409	0.013165 (0.00021347, 1.026117)	-6.0173
Parity				
<2	1	1	1	1
2-5	0.00111(-0.0019906, 0.00018171)	-0.50733	0.0032984 (-0.0092389, 0 .015836)	-1.5076
Above 5	-0.00090444 (-0.0019906, 0.00018171)	0.41338	0.0049123 (-0.014804, 0.024629)	-2.2452

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Distance health				
Not big problem	1	1	1	1
Big problem	-0.0047901(-0.0085384, -0.0010417) *	2.1894	-0.001343(-0.0075911, 0.0049052)	0.61381
Residence				
Urban	1	1	1	1
Rural	0.00007412 (0.000057785, 0.00009046)	-0.03388	0.0058021(-0.022943, 0.034547)	-2.2452
Constants			-0.15848 (-0.23109, -0.085858)	72.433
Overall	**-0.086145(-0.12888, -0.043405) *****	**39.37**	**-0.13264 (-0.087914, -0.087914) *****	**60.63**

Discussion

Women giving birth at health facilities can prevent maternal deaths by providing qualified birth assistance, drugs to address labour complications, and referrals to more advanced health facilities (25). Even though delivering at the health facility has an invaluable effect on the decrease of pregnancy-related complications and deaths among reproductive age group women, a significant number of women still give birth at home.

Multivariate decomposition logistic regression analysis relaxes non-linear models comparable to previous decomposition analysis models (26–28). This method of analysis was used to examine the trends of home delivery and identify factors either positively or negatively contributed to the change of home delivery.

Home delivery in Ethiopia declined by around 21% over the last decade, mainly during the surveys of 2011 to 2016. This could be due to the launching of the Health Development Army (HDA with the aim of extending the achievements of the Health Extension Program (HEP) and improving access to health care to meet the primary attention of the MDG agenda (29,30).

This study revealed that the contribution of behaviour (coefficient) changes was more important than that of composition (endowments) changes to the decline of home delivery over the last decade.

Keeping coefficient changes constant, the explained contribution of the change in compositional characteristics to the decline of home delivery was 39% in Ethiopia. The predominant changes in home delivery were due to the proportion of changes in ANC visits. Antenatal coverage increased by 34% (Table 1) over the last decade which had a 35% contribution to the decline of home delivery. The possible reason might be the fact that women who had antenatal follow-ups were more likely to deliver at health facilities than those who had no follow-ups (18,31–34).

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Women having primary school education and above had a positive impact on the decline of home delivery compared to those unable to read and write. This result supported by the evidence that higher educational attainment of women was more likely to give birth at health facilities compared to those unable to read and write (18,32,35,36). So far, Ethiopia has been working hard to achieve the Millennium Development Goal Agenda that advocates women's educational attainment. In addition, Ethiopia launched the Growth and Transformation Plan I (GTP I) which gave special attention to women's education (29,37). Therefore, the compositional increase in women's education in the last decade had a positive contribution to the decline of home delivery in the country.

As well, higher education of husbands had a significant effect on home delivery. Even since the compositional change, the decrease in the number of husbands with secondary school education (Table 1) had a negative contribution to the decline of home delivery. The possible justification might be that educated husbands had knowledge about the importance of health facility delivery and make decisions on the place of delivery.

Another endowment factor that significantly decreased home delivery was birth order. The increase in the proportion of birth order in the survey period resulted in a decrease in home delivery. This finding supports the evidence that women with high birth order deliver at health facilities (32,34).

The proportion of protestant women increased in the last decade (Table 1) increasing to home delivery because such women were more likely to deliver at home compared to Orthodox Christian women. However, whether religion can a barrier to delivery at health facilities, it needs further investigations.

Wealth status of women had a significant effect on home delivery. The number of rich women decreased in the survey period and staying at home to give birth in the last decade. Studies showed that richer women were more likely to deliver at health facilities than the poorer ones (31,32,35). Furthermore, distance to health facilities had a positive contribution to the place of delivery. This study showed that the inaccessibility of health facilities decreased in Ethiopia over the last decade and that positively contributed to the decline of home delivery. Distance from health facilities was a big problem that added to giving birth at home (17,20,32,33,38). The Ethiopia disease prevention policy has stepped up work on expanding health facilities to achieve access to primary health care in addition to the Extension program.

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The decline of rural residence among women was insignificant in the last decade and posed a negative impact on home delivery reduction. Studies evidenced that women living in rural areas gave birth at home than those living in urban settings (17,20,32,38). The possible justification might be that women living in rural areas could not get health facilities easily due to distance.

Controlling the effects of endowment characteristics, about 61% of the home delivery decline was contributed by behaviour change to the place of delivery. Significant positive and negative contributions of behaviour change in terms of religion, birth order, and ANC visits were noted.

Changes in behavioural characteristics of women in the Protestant sect had a negative impact could be made certain by the fact that at health facility delivery of the women was low. But no documented evidence could be cited to show that religion was a barrier to protestant women choice to deliver at home. Thus, further studies on the issue are necessary.

This study indicated that about one-fourth of the decrease in home delivery over the last decade was the change in behaviour relating to health facility delivery among women who had two and above birth orders. The possible reason might be women with high birth order might be experienced different maternal health care services and had adequate health education from the health care personnel.

Another incredible factor that positively contributed to the decline to home delivery preceding the survey was antenatal care visits. Women who received antenatal care during pregnancy were more likely to give birth at health facilities compared to their counterparts (32,39,40). Women who had ANC visits might have obtained health education about health facility delivery from skilled health care professionals which might have changed their behaviour towards health facility delivery.

Conclusion and recommendation

The trend of home delivery among the reproductive age group of women declined significantly in the last decade although it is still unacceptable. In multivariate decomposition logistic regression analysis, about 39% of the home delivery decline was contributed by the changes in compositional characteristics. The proportional changes in antenatal care visits, educational status of women and husbands, birth order, religion, and distance to health facilities were significantly associated with the decrease in home delivery. Around two-thirds of home delivery decline was due to the changes in behaviour towards health facility delivery in the last decade. Antenatal care visits, birth order, and religion were significantly associated factors to the place of delivery due to coefficients change.

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The Ministry of Health and other stakeholders should continue to enhance the coverage of antenatal care visits and enhance the accessibility of health care facilities. The Ministry of Education should advance the empowerment of girls through education. Researchers need to further investigate the low use of health facility delivery among protestant women.

Declaration

Data Availability

The data was available from the corresponding author and we can provide upon request.

Consent for publication

Not applicable

Competing Interest

We, the authors, declare that we had no competing interests.

Funding Statement

We didn't receive any fund for this study.

Author Contributions

SAT, ZTT, and STY were involved for this study from the inception to design, acquisition of data, data cleaning, data analysis and interpretation and drafting and revising of the manuscript. AML and MMS were involved in project administration, principal supervision, and revising the final manuscript. All authors read and approved the final manuscript.

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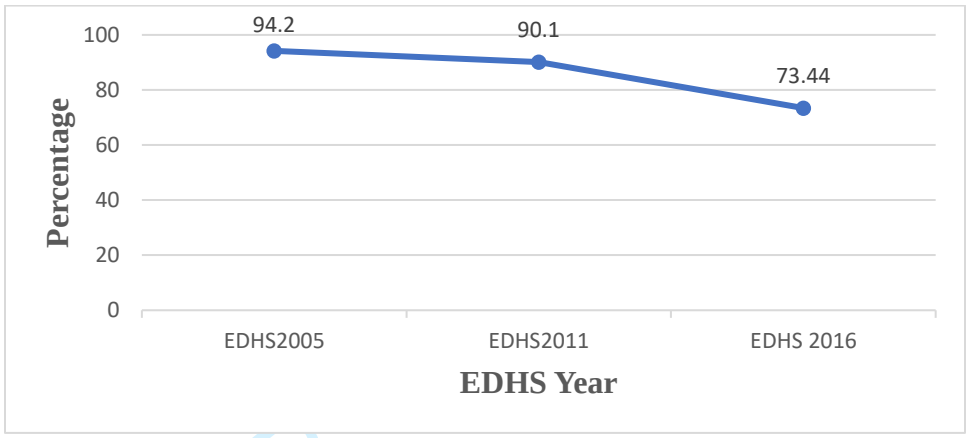

Figure 1: The trend of home delivery from 2005 to 2016 EDHS surveys five years preceding each survey years.

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		Reporting Item	Page Number
Title and abstract			
Title	#1a	Indicate the study's design with a commonly used term in the title or the abstract	1
Abstract	#1b	Provide in the abstract an informative and balanced summary	2

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		of what was done and what was found	
Introduction			
Background / rationale	#2	Explain the scientific background and rationale for the nvestigation being reported	3-4
Objectives	#3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	#4	Present key elements of study design early in the paper	4
Setting	#5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Eligibility criteria	#6a	Give the eligibility criteria, and the sources and methods of selection of participants.	4
	#7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5
Data sources / measurement	#8	For each variable of interest give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group. Give information separately for for exposed and unexposed groups if applicable.	4
Bias	#9	Describe any efforts to address potential sources of bias	n/a
Study size	#10	Explain how the study size was arrived at	4

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Quantitative variables	#11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why	5
Statistical methods	#12a	Describe all statistical methods, including those used to control for confounding	5
Statistical methods	#12b	Describe any methods used to examine subgroups and interactions	n/a
Statistical methods	#12c	Explain how missing data were addressed	n/a
Statistical methods	#12d	If applicable, describe analytical methods taking account of sampling strategy	n/a
Statistical methods	#12e	Describe any sensitivity analyses	n/a
Results			
Participants	#13a	Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed. Give information separately for for exposed and unexposed groups if applicable.	6
Participants	#13b	Give reasons for non-participation at each stage	n/a
Participants	#13c	Consider use of a flow diagram	n/a
Descriptive data	#14a	Give characteristics of study participants (eg demographic,	7

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		clinical, social) and information on exposures and potential confounders. Give information separately for exposed and unexposed groups if applicable.	
Descriptive data	#14b	Indicate number of participants with missing data for each variable of interest	n/a
Outcome data	#15	Report numbers of outcome events or summary measures. Give information separately for exposed and unexposed groups if applicable.	n/a
Main results	#16a	Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	12
Main results	#16b	Report category boundaries when continuous variables were categorized	n/a
Main results	#16c	If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	#17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	n/a
Discussion			
Key results	#18	Summarise key results with reference to study objectives	13
Limitations	#19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias.	15

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Interpretation	#20	Give a cautious overall interpretation considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence.	
Generalisability	#21	Discuss the generalisability (external validity) of the results	n/a
Other Information			
Funding	#22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	16

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Trends and determinants of home delivery in Ethiopia: Further multivariate decomposition analysis of 2005 to 2016 Ethiopian Demographic Health Surveys

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Primary Subject Heading:	Epidemiology
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Trends and determinants of home delivery in Ethiopia: Further multivariate decomposition analysis of 2005 to 2016 Ethiopian Demographic Health Surveys

Sofonyas Abebaw Tiruneh[1*], Ayenew Molla Lakew[2], Seblewongel Tigabu Yigizaw [2], Malede Mequanent Sisay[2], Zemenu Tadesse Tessema[2]

Affiliations:

[1] Department of Public Health, College of Health Sciences, Debre Tabor University, Ethiopia.

[2] Department of Epidemiology and Biostatistics, Institute of Public Health, College of Medicine and Health Sciences, University of Gondar, Ethiopia.

E-mails:

Sofonyas Abebaw Tiruneh: zephab2@gmail.com

Ayenew Molla Lakew mayenew15@gmail.com

Seblewongel Tigabu Yigizaw stigabu040@gmail.com

Malede Mequanent Sisay maledecsa@gmail.com

Zemenu Tadesse Tessema: zemenut1979@gmail.com

Corresponding author:

Sofonyas Abebaw Tiruneh

Department of Public Health, College of Health Sciences, Debre Tabor University, Ethiopia. PO BOX 272.

Email: zephab2@gmail.com

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Abstract

Objective: This study aimed to analyze the trends and factors that had contributions to the change of home delivery in Ethiopia over the last decade.

Design, setting and analysis: Nationally representative repeated cross-sectional survey was conducted using 2005, 2011 and 2016 Ethiopian Demographic and Health Survey datasets. The data were weighted and analyzed by STATA version 14.1 software. Multivariate decomposition logistic regression analysis was used to identify significant factors for the contribution of change in home delivery. A p-value < 0.05 was taken as to declare statistically significant predictors.

Outcome measure: Trends of home delivery

Participants: A total of 33482 women who gave birth preceding each survey were included in this study.

Results: The magnitude of home delivery decreased by 21% over the last decade in Ethiopia. Multivariate decomposition logistic regression analysis revealed that 39% of the decrease in home delivery was due to differences in women's characteristics. Antenatal care visits, educational status of women and husband, birth order, religion, and distance from health facility were the main sources of compositional change factors for the decline of home delivery. Behavioural changes towards health facility delivery contributed to approximately two-thirds of the decline of home delivery. Antenatal care visits, birth order, and religion significantly contributed to the change of home delivery due to behavioural changes in the use of health care facility over the last decade.

Conclusion: Despite the importance of health facility delivery, many women still deliver at home in Ethiopia. Women's characteristics and behaviour change were significantly associated with the change in home delivery. Multisectoral interventions needed to improve antenatal care coverage, women's education and health care facilities are needed to improve the practice. Further research needs to be done to identify why protestant women do not deliver at the health facility.

Keywords: Home delivery, multivariate decomposition, EDHS, Ethiopia.

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Strength and limitation of the study

- ✓ We used three waves of Ethiopian Demographic and Health Surveys, which is a large dataset representative of the population and will increase the power of our findings.
- ✓ Besides, multivariate decomposition logistic regression analysis used to identify factors that positively or negatively contributed to the decline of home delivery in Ethiopia could help policymakers to design interventions.
- ✓ As data were a cross-sectional survey that is likely to prone to recall and social desirability bias.

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Introduction

Every day, about 830 women die from preventable causes relating to pregnancy and childbirth, of which 99% of the deaths occur in developing countries (1). Worldwide, maternal mortality fell from 385 deaths per 100 000 livebirths in 1990 to 216 deaths in 2015, which is dropped by 44% (2,3). Despite the decline in maternal mortality in the last 25 years, the magnitude is still unacceptable in developing countries, including Ethiopia (3,4). The trends of maternal mortality in Ethiopia fell from 1250 deaths per 100 000 livebirths in 1990 to 353 deaths in 2015, declined by 71.8%, which is below the target of the Millennium Development Goals (MDGs) related to maternal mortality (5,6). Sustainable Development Goal (SDG) goal 3, target 3.1 calls for the reduction of maternal mortality ratio of less than 70 per 100 000 live births between 2016 and 2030 (7).

Studies indicated that nearly one-quarter of maternal deaths occurred in the antepartum period, another quarter in the intrapartum and immediate postpartum periods; one-third occurred in the subacute and delayed postpartum periods and 12% in the late postpartum period (8). Numerous factors contribute to high maternal mortality rates. Most maternal deaths are contributed by direct obstetric complications mainly haemorrhage, pregnancy-induced hypertension, sepsis, and obstructed labour combined account for 64% of the maternal death, and other factors such as poverty, limited access to health care, unskilled childbirth and maternal sociodemographic characteristics are among the other causes of maternal mortality (9–11). Even though, skilled childbirth before, during and after delivery can save the lives of women, in sub-Saharan Africa only 59% of births were attended by skilled health personnel between 2012 and 2017 (12). In

Ethiopia, the magnitude of home delivery was 94.5% in 2000, 93.1% in 2005, 87.9% in 2011 and 73.6% in 2016 which was unacceptably high (13,14).

In Ethiopian several studies evidenced that women's low educational status, cultural and communal factors, limited access to health facilities, poor quality of care, lack of roads, and poor wealth status were significant factors that led to low maternal health service utilization (13,15–17). On the other hand, taking at least one antenatal care during pregnancy, high parity, educated women, urban residence, husband attitude towards health facility delivery, easy access to health facilities, and wealth status contributed to health facility delivery (17–20). The trend of home delivery decreased between 2005 to 2016. To date, no evidence that identifies the factors that have contributed to the observed reduction in home delivery during the last decade.

Therefore, this multivariate decomposition analysis aimed to identify trends and factors that either positively or negatively contributed to the change for home delivery. The study will help health planners and policymakers in planning to further reduction of home delivery and provide baseline information to other researchers.

Methods and materials

Study design, area, and period

Nationally representative repeated cross-sectional study design was employed using 2005, 2011 and 2016 Ethiopian Demographic and Health Surveys (EDHS). Ethiopia is laying between latitude 3° and 14°N, and longitude 33° and 48°E in the horn of Africa. Ethiopia has a total area of 1,100,000 km^2 and nine regional states, namely Tigray, Afar, Amhara, Benishangul-Gumuz, Gambela, Harari, Oromia, Somali, and Southern Nations Nationalities and Peoples of Region (SNNPR) plus Addis Ababa and Dire Dawa city Administrations.

Source and study populations

The source populations were all reproductive age group women who gave birth five years preceding each survey. The study populations were all reproductive-age women who gave birth five years preceding each survey in the selected Enumeration Areas (EAs). In each survey, a nationally representative samples of 10721 in 2005, 11872 in 2011, and 10889 in 2016 weighted number of women participated. Recorded data were accessed at www.messdhs.com on request with the assistance of ICF International, Inc.

Data collection tools and procedures

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The data was collected in two-stage stratified sampling techniques in each survey. Each region of the country was stratified into urban and rural areas. In the first stage, 645 in 2016, 624 in 2011, and 540 in 2005 EAs were selected. In the second stage, a fixed number of households per cluster (EAs) were selected with an equal probability systematic selection from the newly created household listing. The detailed sampling procedure is available in the Ethiopian Demographic and Health Survey reports from Measure DHS website (www.dhsprogram.com) for each specific surveys.

Outcome variable

The outcome variable was taken as a binary response; a woman gave birth at home coded as home delivery, and women who gave birth at different (government, private, and non-government) health facilities were taken as health facility delivery.

Independent variables

All sociodemographic and obstetric characteristics were taken as independent variables for the three-consecutive surveys.

Patient and public involvement

The patients and the public were not involved for this secondary data analysis. But for the original survey the issue of patient and public involvement were considered; Since biomarkers such as anthropometry, anaemia and HIV testing were collected from each household for each survey (21–23).

Statistical analysis

The data were cleaned and analyzed using STATA version 14.1 software. Sample weighting was done for further analysis. Descriptive statistics were done for the description of the variables. A multivariate decomposition logistic regression analysis was done to identify the contributions to group differences to average predictions (24). The purpose of this decomposition analysis was to identify factors that contributed to the change in home delivery in the last decade in Ethiopia.

A nonlinear multivariate logit decomposition model was used to identify the contribution of proportion change to home delivery over the last decade. The output from the multivariate decomposition logistic regression analysis had two contribution effects. These effects were the compositional differences (endowments) “E” and the effects of characteristics that are the difference in the coefficients or behavioural change “C” responses for the selected predictor

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variables. In the nonlinear model, the dependent variable is a function of a linear combination of predictors and regression coefficients:

$Y = F(X\beta) = \text{logit}(Y) = x\beta$, where Y denotes the N × 1 dependent variable vector, X an N × K matrix of independent variables, and β a K ×1 vector of coefficients.

The proportion difference in Y between survey A and survey B of successive EDHS surveys of the home delivery can be decomposed as

$$Y_A - Y_B = F(X_A\beta_A) - F(X_B\beta_B)$$

For the log odds of home delivery, the proportion of the model is written as

$$\text{Logit}(Y_A) - \text{logit}(Y_B) = F(X_A\beta_A) - F(X_B\beta_B)$$

$$= \underbrace{F(X_A\beta_A) - F(X_B\beta_A)}_{E} + \underbrace{F(X_B\beta_A) - F(X_B\beta_B)}_{C} \quad \text{is group decomposition (24)}$$

The component "E" is the difference attributable to endowment change, usually called the explained component. The "C" component is the difference attributable to coefficients (behavioural) change, usually called the unexplained component.

The model structure for the decomposition analysis was:

$$\text{Logit}(A) - \text{Logit}(B) = [\beta_{0A} - \beta_{0B}] + \Sigma\beta_{ijA}[X_{ijA} - X_{ijB}] + \Sigma X_{ijB}[\beta_{ijA} - \beta_{ijB}]$$

where

- β_{0A} is the intercept in the regression equation for EDHS 2016
- β_{0B} is the intercept in the regression equation for EDHS 2005
- β_{ijA} is the coefficient of the j^{th} category of the i^{th} determinant for EDHS 2016
- β_{ijB} is the coefficient of the j^{th} category of the i^{th} determinant for EDHS 2005
- X_{ijA} is the proportion of the j^{th} category of the i^{th} determinant for EDHS 2016
- X_{ijB} is the proportion of the j^{th} category of the i^{th} determinant for EDHS 2005

Ethical consideration

We, the authors, submitted a concept note to DHS Program/ICF International Inc, and permission was issued by the International Review Board of Demographic and Health Surveys (DHS) program data archivists to download the dataset for this study.

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Results

Background characteristics of women

Table one shows the distribution of individual characteristics of women who gave birth five years preceding each survey in 2005, 2011, and 2016 EDHSs. In the three consecutive surveys, more than 60% of the women were in the age group of 20-34 years. Besides, women had almost the same mean age of 29 (± 6.6 SD) years. As well, a significant number (48%) of female household heads were identified in the 2011 EDHS report. Almost all (>90%) of the women, were married five years preceding each survey; 79%, 69%, and 66% of the women in each EDHS were unable to read and write, respectively (Table 1).

Table 1: Characteristics of the women in 2005, 2011, and 2016 EDHSs.

Characteristics of women		Percentage distribution for each survey		
		EDHS 2005 N= 10,721	EDHS 2011 N= 11,872	EDHS 2016 N= 10,889
Mother's age	<20 Years	12.26	9.33	7.81
	20 -34 years	62.07	66.22	67.38
	35-49 Years	25.67	24.25	24.80
	Mean ± SD	29.01 ± 6.95	29.04 ± 6.63	29.23 ± 6.53
Household head	Male	89.15	51.5	86.06
	Female	10.85	48.05	13.94
Marital status	Not having partner	4.56	6.07	6.25
	Had partner	95.44	93.93	93.75
Religion	Orthodox	42.37	38.06	34.14
	Muslim	35.00	35.49	41.50
	Protestant	19.95	23.23	21.09
	Others	2.68	3.22	3.26
Women educational level	Unable to read and write	79.31	69.30	66.13
	Primary education	16.53	27.5	26.67
	Secondary education	3.79	2.24	4.68
	Higher education	0.38	1.42	2.52
Husband educational level	Unable to read and write	59.03	50.60	48.57
	Primary education	30.37	41.26	39.21
	Secondary education	9.58	4.95	7.65
	Higher education	1.01	3.19	4.56
Women occupation	Not working	71.11	47.14	55.62
	Working	28.89	52.86	44.35
Husband occupation	Not working	2.00	1.33	56.93
	Working	98.00	98.67	43.07

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Health institution Distance	Big problem	74.40	75.43	60.58
	Not a big problem	25.60	24.57	39.42
Had ANC	No	71.86	57.45	37.42
	Yes	28.14	42.55	62.58
Birth order	1	17.13	19.05	18.65
	2-4	42.90	43.62	42.80
	>= 5^{+}	39.97	37.33	38.55
Parity	<= 2	26.10	29.22	28.80
	2-5	40.05	39.67	39.67
	>= 5^{+}	33.85	31.11	31.53
Wealth index	Poor	42.98	45.22	46.76
	Middle	22.44	20.53	20.60
	Richer	34.58	34.26	32.64
Residence	Urban	7.09	12.87	11.14
	Rural	92.91	87.13	88.86
Region	Tigray	6.39	6.34	6.44
	Afar	0.97	1.02	1.05
	Amhara	23.99	22.37	18.74
	Oromia	39.69	42.23	44.20
	Somali	4.24	3.07	4.66
	Benishangul	0.78	1.18	1.11
	SNNPR	21.81	21.01	20.67
	Gambla	0.27	0.34	0.24
	Harari	0.19	0.24	0.24
	Addis Ababa	1.32	1.87	2.23
	Dire Dawa	0.34	0.33	0.42

Trends of home delivery during the surveys

The trend of home delivery over the study period (2005-2016) showed a significant decline, which is decreased from 94.20% in 2005 to 73.44% in 2016. The largest decline was observed in the survey period 2011to2016 with a 17% drop and in the survey period 2005 to2011 decreased from 94 to 90, that is a 4% change (Figure 1).

The rate of decline in home delivery from 2005 – 2016 varied in terms of different factors. For example, the decrease in the stated period was the highest (52%) in the Tigray region and the lowest (11%) in the Afar Regional State of Ethiopia. Besides, the decline was higher (36.34%) in urban and lower (17.60%) in rural settlements. The trend declined by 29% among women who received antenatal care services during pregnancy (Table 2).

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Table 2: Trends of home delivery among women who gave birth preceding the survey by women characteristics, 2005, 2011 and 2016 Ethiopia Demographic and Health Surveys.

Individual variables	EDHS 2005 N= 10,721	EDHS 2011 N= 11,872	EDHS 2016 N= 10,889	Percentage point difference in home delivery		
				2011-2005	2016-2011	2016-2005
Mother's age						
<20 Years	93.95	91.16	64.97	-2.79	-26.19	-28.98
20 -34 years	94.16	88.49	72.33	-5.67	-16.16	-21.83
35-49 Years	96.67	93.91	79.14	-2.76	-14.77	-17.53
Household head						
Male	95.51	90.20	74.55	-5.31	-15.65	-20.96
Female	88.77	89.90	66.59	1.13	-23.31	-22.18
Marital status						
Had not a partner	90.51	86.17	66.06	-4.34	-20.11	-24.45
Had partner	94.99	90.31	73.94	-4.68	-16.37	-21.05
Religion						
Orthodox	92.70	84.63	79.91	-8.07	-4.72	-12.79
Muslim	97.09	93.60	79.76	-3.49	-13.84	-17.33
Protestant	94.69	92.90	75.45	-1.79	-17.45	-19.24
Others	98.26	94.58	90.42	-3.68	-4.16	-7.84
Women education						
Illiterate	97.79	95.26	83.91	-2.53	-11.35	-13.88
Primary education	92.22	85.05	62.65	-7.17	-22.4	-29.57
Secondary education	50.58	30.41	22.03	-20.17	-8.38	-28.55
Higher education	18.20	24.47	8.53	6.27	-15.94	-9.67
Husband education						
Illiterate	98.29	95.74	83.03	-2.55	-12.71	-15.26
Primary education	95.20	89.95	75.53	-5.25	-14.42	-19.67
Secondary education	78.17	64.99	39.61	-13.18	-25.38	-38.56
Higher education	37.94	45.05	19.06	7.11	-25.99	-18.88
Women occupation						
Not working	94.95	90.23	76.05	-4.72	-14.18	-18.9
Working	94.36	89.90	70.18	-4.46	-19.72	-24.18
Husband occupation						
Not working	65.89	89.81	75.61	23.92	-14.2	9.72
Working	95.37	90.06	70.58	-5.31	-19.48	-24.79
Health facility						
Big problem	96.97	94.36	82.13	-2.61	-12.23	-14.84
Not a big problem	88.43	76.83	60.10	-11.6	-16.73	-28.33
Had ANC						
No	98.19	96.88	91.50	-1.31	-5.38	-6.69
Yes	82.34	76.64	53.68	-5.7	-22.96	-28.66
Birth order						
1	86.83	79.04	51.01	-7.79	-28.03	-35.82

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2-4	95.01	90.19	72.94	-4.82	-17.25	-22.07
>= 5	97.94	95.51	84.85	-2.43	-10.66	-13.09
Parity						
<= 2	87.89	80.62	52.83	-7.27	-27.79	-35.06
2-5	94.52	92.29	78.06	-2.23	-14.23	-16.46
>= 5+	98.03	96.06	86.45	-1.97	-9.61	-11.58
Wealth status						
Poor	99.08	97.38	85.29	-1.7	-12.09	-13.79
Middle	98.14	96.87	77.39	-1.27	-19.48	-20.75
Rich	87.26	76.31	53.98	-10.95	-22.33	-33.28
Residence						
Urban	56.94	50.18	20.60	-6.76	-29.58	-36.34
Rural	97.67	95.95	80.07	-1.72	-15.88	-17.6
Region						
Tigray	94.12	88.36	41.87	-5.76	-46.49	-52.25
Afar	95.95	93.19	85.28	-2.76	-7.91	-10.67
Amhara	96.49	89.82	72.46	-6.67	-17.36	-24.03
Oromia	95.75	92.00	81.10	-3.75	-10.9	-14.65
Somali	95.23	92.40	82.07	-2.83	-10.33	-13.16
Benishangul	94.67	90.89	74.04	-3.78	-16.85	-20.63
SNNPR	96.30	93.79	73.95	-2.51	-19.84	-22.35
Gambla	84.26	72.48	54.38	-11.78	-18.1	-29.88
Harari	68.20	67.63	49.59	-0.57	-18.04	-18.61
Addis Ababa	21.84	17.66	2.98	-4.18	-14.68	-18.86
Dire Dawa	74.90	60.27	42.81	-14.63	-17.46	-32.09

Detailed multivariate decomposition logistic regression analysis

Difference due to characteristics (Endowment)

This multivariate decomposition analysis revealed that about 39% of the overall change in home delivery was due to differences in compositional characteristics. Among the compositional factors ANC visits, religion, education of women and husband, birth order, wealth index, distance from health facilities, and residence had a statistically significant impact on the change contribution (Table 3).

Women who had at least one antenatal care follow up during pregnancy were more likely to deliver at the health facility. The coverage of antenatal care follow-up increased from 28 to 62% in the last decade (Table 1), with an important compositional contribution to the decline of home delivery by 35%.

Followers of the Protestant sect were more likely to give birth at home than Orthodox Christians. As a result, the increase in the proportion of the Protestant sect followers (Table 1) had a significant

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rise to home delivery in the last decade. Keeping all other variables constant, the improvement of women's educational status to primary school complete and above before the survey (Table 1) had a positively significant contribution to the decline of the trend.

A decrease in the number of secondary education level husbands during the surveys (Table 1) had a negative effect on the place of delivery, which is a rise in the proportion of husbands with higher education had a positive contribution to the decline of home delivery.

Keeping the coefficient characteristics constant, women who had no significant change in the number of birth orders from 2-4 (Table 1) had a contribution to the rate of home delivery. On the other hand, a decrease in the number of women who had more than five birth order had a positive contribution to the decline of home delivery in the last decade (Table 3).

The decline in the proportion of rich women in the last decade increased the prevalence of home delivery. Accessibility of health facility had a positive contribution to decreasing home delivery by 2% over the last decade. Women living in rural areas had a risk of giving birth at home. As shown in Table 1, the composition change of rural residence was minimal, this insignificant compositional change significantly rose the prevalence of home delivery over the last decade (Table 3).

Difference due to effects of coefficient (C)

Controlling the roles of change in compositional characteristics, two-thirds of home delivery decline was due to behavioural change towards health facility delivery (Table 3). Antenatal care visits, religion, and birth order had statistically significant effects of coefficient contribution to the observed change in home delivery. Controlling all compositional change factors, 4% of the home delivery decline was due to the change in the behaviour of health facility delivery among the ANC service visitors over the last decade.

Keeping compositional factors constant, Women protestant sect flowers had a negative effect on the contribution in home delivery over the past decade.

Furthermore, about 25% of the decline of home delivery over the last decade was due to changes in health facility delivery use behaviour among women who had a birth order two and above (Table 3).

Table 3: The detailed multivariate logistic regression decomposition analysis of home delivery women who gave birth in the last ten years preceding 2005 to 2016 EDHS, Ethiopia.

Variables	Difference due to characteristics (E)		Difference due to coefficient (C)	
	Coeff (95% CI)	Pct.	Coeff (95%CI)	Pct.

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Age in years				
<20	1	1	1	1
20-34	-0.0026425 (-0.0065794, 0.0012943)	1.2078	0.0097217 (-0.020772, 0.026531)	-1.316
35-49	0.00015715 (-0.000019082,0.00033337)	-0.0718	0.0028792 (-0.0053135, 0.024757)	-4.4434
Religion				
Orthodox	1	1	1	1
Muslim	0.0011654 (-0.00043086, 0.0027617)	-0.53266	0.0019208 (-0.0071241, 0.010966)	-0.87792
protestant	0.0022454 (0.0011048 ,0.0033861) *	-1.0263	0.0067475 (0.00061695, 0.012878) *	-3.084
Others	0.0007805 (0.00022288, 0.0013381)	-0.35674	0.0013868 (-0.00087756, 0.0036511)	-0.63384
Women education				
No education	1	1	1	1
Primary	-0.0045685 (-0.0081609, -0.0009761) *	2.0881	0.0014132 (-0.0034075. 0.0062339)	-0.6460
Secondary	-0.0015069 (-0.0022971, -0.00071672) *	0.68874	0.000085296 (-0.0016957, 0.0018663)	-0.0390
Higher	-0.0030286 (-0.0059084, -0.00014878) *	1.3843	0.00027299 (-0.00021235, 0.00075833)	-0.1248
Husband education				
No education	1	1	1	1
Primary	-0.001852 (-0.0045476, 0.00084366)	0.84646	0.003113 (-0.0053549, 0.011581)	-1.4228
Secondary	0.00084942 (0.00042745, 0.0012714) *	-0.38824	0.0010909 (-0.0027474, 0.0049291)	-0.4986
Higher	-0.0052866 (-0.0080882, -0.0024849) *	2.4163	0.00025019 (-0.00071622, 0.0012166)	-0.11435
women occupation				
Not working	1	1	1	1
Working	0.0006093(-0.011577, 0.012796)	-0.27849	-0.0015175 (-0.014399, 0.011364)	0.69359
Husband occupation				
Not working	1	1	1	1
Working	0.0034081 (-0.033625, 0.040441)	-1.5577	0.033541 (-0.016873, 0.083956)	-15.33
Birth order				
Only one birth	1	1	1	1
2 - 4 birth	0.0015601 (0.00044295, 0.0026773) *	-0.71307	-0.01878 (-0.033508, -0.0040518) *	8.5835
5 and above birth	-0.0003622 (-0.0006497, -0.00007469) *	0.16555	-0.033806 (-0.060462, -0.0071505) *	15.452
ANC visit				
No	1	1	1	1
Yes	-0.076563 (-0.088698, -0.064428) *	34.994	-0.0081231(-0.016207, -0.000039645) *	3.7127
Wealth status				
Poor	1	1	1	1
Middle	-0.0007966 (-1.2357e-06, 0.000077712)	-0.01746	-0.00020032 (-0.0099877, 0.009587)	0.091558
Rich	0.000038238 (-0.00122, -0.00037319) *	0.34409	0.013165 (0.00021347, 1.026117)	-6.0173
Parity				
<2	1	1	1	1
2-5	0.00111(-0.0019906, 0.00018171)	-0.50733	0.0032984 (-0.0092389, 0 .015836)	-1.5076
Above 5	-0.00090444 (-0.0019906, 0.00018171)	0.41338	0.0049123 (-0.014804, 0.024629)	-2.2452
Distance health				
Not big problem	1	1	1	1
Big problem	-0.0047901(-0.0085384, -0.0010417) *	2.1894	-0.001343(-0.0075911, 0.0049052)	0.61381
Residence				

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Urban	1	1	1	1
Rural	0.00007412 (0.000057785, 0.00009046)	-0.03388	0.0058021(-0.022943, 0.034547)	-2.2452
Constants			-0.15848 (-0.23109, -0.085858)	72.433
Overall	**-0.086145(-0.12888, -0.043405) *****	**39.37**	**-0.13264 (-0.087914, -0.087914) *****	**60.63**

Discussion

Women giving birth at health facilities can prevent maternal deaths by providing qualified birth assistance, drugs to address labour complications, and referrals to more advanced health facilities (25). Even though giving birth at the health facility has an invaluable effect on the decrease of pregnancy-related complications and deaths among reproductive age group women, a significant number of women still give birth at home.

Multivariate decomposition logistic regression analysis relaxes non-linear models comparable to previous decomposition analysis models (26–28). Previous studies conducted to identify the factors that affect home delivery. To the best of our knowledge, there are no studies conducted on the place of delivery contribution change through significant factors. This method of analysis was used to examine the trends of home delivery and identify factors either positively or negatively contributed to the change of home delivery.

Home delivery in Ethiopia declined by around 21% over the last decade, mainly during the surveys of 2011 to 2016. This could be due to the launching of the Health Extension Program (HEP) and improving access to health care to meet the primary attention of the MDG agenda (29,30).

This study revealed that the contribution of behaviour (coefficient) changes was more important than that of composition (endowments) changes to the decline of home delivery over the last decade.

Keeping coefficient changes constant, the explained contribution of the change in compositional characteristics to the decline of home delivery was 39% in Ethiopia. The predominant changes in home delivery were due to the proportion of changes in ANC visits. Antenatal coverage increased by 34% (Table 1) over the last decade which had a 35% contribution to the decline of home delivery. The possible reason might be the fact that women who had antenatal follow-up were more likely to deliver at health facilities than those who had no follow-ups (18,31–34).

Women having primary school education and above had a positive impact on the decline of home delivery compared to those unable to read and write. This result supported by the evidence that higher educational attainment of women was more likely to give birth at health facilities compared

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to those unable to read and write (18,32,35,36). Meanwhile, Ethiopia has been worked hard to achieve the Millennium Development Goal agenda that advocates women's educational attainment. In addition, Ethiopia launched the Growth and Transformation Plan I (GTP I) which gave special attention to women's education (29,37). Therefore, the compositional increase in women's education in the last decade had a positive contribution to the decline of home delivery in the country.

As well, higher education of husbands had a significant effect on home delivery. Since the decrease in the number of husbands with secondary school education (Table 1) had a negative contribution to the decline of home delivery. The possible justification might be that educated husbands knew about the importance of health facility delivery and make decisions on the place of delivery.

Another endowment factor that significantly decreased home delivery was birth order. The increase in the proportion of birth order in the survey period resulted in a decrease in home delivery. This finding supports the evidence that women with high birth order deliver at the health facility (32,34). The reason for this finding will be also women with high birth order would have experience about the importance of health facility delivery.

The proportion of protestant women increased in the last decade (Table 1) which increases home delivery proportion because such women were more likely deliver at home compared to Orthodox Christian women. However, whether religion can a barrier to delivery at health facility, it needs further investigations.

Wealth status of women had a significant effect on home delivery. The number of rich women decreased in the survey period and staying at home to give birth in the last decade. Studies showed that rich women were more likely deliver at health facilities than the poor ones (31,32,35). Furthermore, distance to health facilities had a positive contribution to the place of delivery. This study showed that the inaccessibility of health facilities decreased in Ethiopia over the last decade and that positively contributed to the decline of home delivery. Distance from health facilities was a big problem that added to give birth at home (17,20,32,33,38). Ethiopia disease prevention policy has stepped up work on expanding health facilities to achieve access to primary health care in addition to the Extension program.

The decline of rural residence among women was insignificant in the last decade and posed a negative impact on home delivery reduction. Studies evidenced that women living in rural areas

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gave birth at home than those living in urban settings (17,20,32,38). The possible justification might be that women living in rural areas could not get health facilities easily due to distance.

Controlling the effects of endowment characteristics, about 61% of home delivery decline was contributed by behaviour change to the place of delivery. Significant positive and negative contributions of behaviour change in terms of religion, birth order, and ANC visits were noted.

Changes in behavioural characteristics of women in the Protestant sect had a negative impact could be made certain by the fact that at health facility delivery of the women was low. But no documented evidence showed that protestant religion follower women were a barrier for the place of delivery. Thus, further studies needed on this issue.

This study indicated that about one-fourth of the decrease in home delivery over the last decade was the change in behaviour relating to health facility delivery among women who had two and above birth orders. The possible reason might be women with high birth order experienced different maternal health care services and had adequate health education from the health care personnel.

Another incredible factor that positively contributed to the decline to home delivery preceding the survey was antenatal care visits. Women who received antenatal care during pregnancy were more likely to give birth at the health facility compared to their counterparts (32,39,40). Women who had antenatal visits might have obtained health education about the importance of health facility delivery from health care professionals which might have changed their behaviour towards health facility delivery.

Conclusion and recommendation

The trend of home delivery among the reproductive age group of women declined significantly in the last decade although it is still unacceptable. In multivariate decomposition logistic regression analysis, about 39% of the home delivery decline was contributed by the changes in compositional characteristics of the women. The proportional changes in antenatal care visits, educational status of women and husband, birth order, religion, and distance to health facilities were significantly associated with the decrease in home delivery. Around two-thirds of home delivery decline was due to the changes in behaviour towards health facility delivery in the last decade. Antenatal care visits, birth order, and religion were significantly associated factors to place of delivery due to coefficients change.

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The Ministry of Health and other stakeholders should continue to enhance the coverage of antenatal care visits and the accessibility of health care facilities. The Ministry of Education should advance the empowerment of girls through education. Researchers need to further investigate the low use of health facility delivery among protestant women.

Declaration

Data Availability

The data was available from the corresponding author and we can provide upon request.

Consent for publication

Not applicable

Competing Interest

We, the authors, declare that we had no competing interests.

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We did not receive any fund for this study.

Author Contributions

SAT, ZTT, and STY were involved for this study from the inception to design, acquisition of data, data cleaning, data analysis and interpretation and drafting and revising of the manuscript. AML and MMS were involved in project administration, principal supervision, and revising the final manuscript. All authors read and approved the final manuscript.

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Figure legend:

Figure 1: The trend of home delivery from 2005 to 2016 EDHS surveys five years preceding each survey years.

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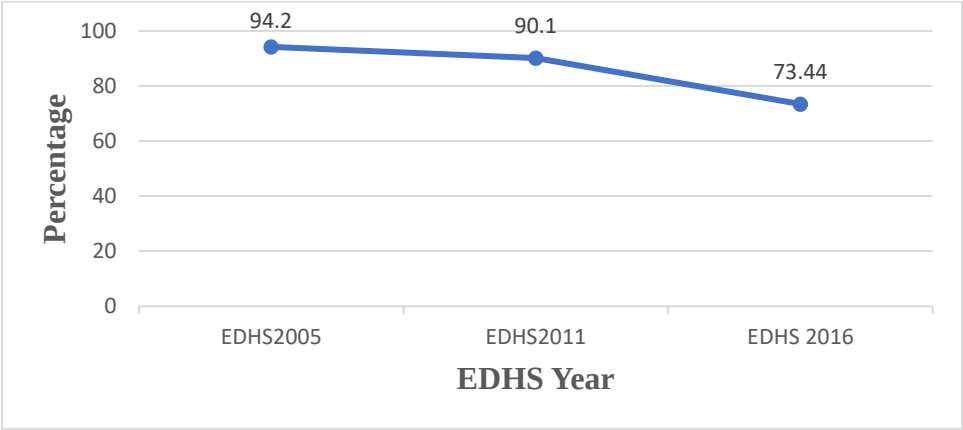

Figure 1: The trend of home delivery from 2005 to 2016 EDHS surveys five years preceding each survey years.

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		Reporting Item	Page Number
Title and abstract			
Title	#1a	The study's design was included in the abstract part	2
Abstract	#1b	Provide in the abstract an informative and balanced summary of what was done and what was found	2

Introduction			
Background / rationale	#2	Explain the scientific background and rationale for the nvestigation being reported	3-4
Objectives	#3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	#4	Present key elements of study design early in the paper	4
Setting	#5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Eligibility criteria	#6a	Give the eligibility criteria, and the sources and methods of selection of participants.	4
	#7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5
Data sources / measurement	#8	For each variable of interest give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group. Give information separately for for exposed and unexposed groups if applicable.	4
Bias	#9	Describe any efforts to address potential sources of bias	n/a
Study size	#10	Explain how the study size was arrived at	4
Quantitative	#11	Explain how quantitative variables were handled in the	5

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variables		analyses. If applicable, describe which groupings were chosen, and why	
Statistical methods	#12a	Describe all statistical methods, including those used to control for confounding	5
Statistical methods	#12b	Describe any methods used to examine subgroups and interactions	n/a
Statistical methods	#12c	Explain how missing data were addressed	n/a
Statistical methods	#12d	If applicable, describe analytical methods taking account of sampling strategy	n/a
Statistical methods	#12e	Describe any sensitivity analyses	n/a
Results			
Participants	#13a	Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed. Give information separately for for exposed and unexposed groups if applicable.	6
Participants	#13b	Give reasons for non-participation at each stage	n/a
Participants	#13c	Consider use of a flow diagram	n/a
Descriptive data	#14a	Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential	7

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		confounders. Give information separately for exposed and unexposed groups if applicable.	
Descriptive data	#14b	Indicate number of participants with missing data for each variable of interest	n/a
Outcome data	#15	Report numbers of outcome events or summary measures. Give information separately for exposed and unexposed groups if applicable.	n/a
Main results	#16a	Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	12
Main results	#16b	Report category boundaries when continuous variables were categorized	n/a
Main results	#16c	If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	#17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	n/a
Discussion			
Key results	#18	Summarise key results with reference to study objectives	13
Limitations	#19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias.	15

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Interpretation	#20	Give a cautious overall interpretation considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence.	
Generalisability	#21	Discuss the generalisability (external validity) of the results	n/a

Other Information

Funding	#22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	16

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Trends and determinants of home delivery in Ethiopia: Further multivariate decomposition analysis of 2005 to 2016 Ethiopian Demographic Health Surveys

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Trends and determinants of home delivery in Ethiopia: Further multivariate decomposition analysis of 2005 to 2016 Ethiopian Demographic Health Surveys

Sofonyas Abebaw Tiruneh[1*], Ayenew Molla Lakew[2], Seblewongel Tigabu Yigizaw [2], Malede Mequanent Sisay[2], Zemenu Tadesse Tessema[2]

Affiliations:

[1] Department of Public Health, College of Health Sciences, Debre Tabor University, Ethiopia.

[2] Department of Epidemiology and Biostatistics, Institute of Public Health, College of Medicine and Health Sciences, University of Gondar, Ethiopia.

E-mails:

Sofonyas Abebaw Tiruneh: zephab2@gmail.com

Ayenew Molla Lakew mayenew15@gmail.com

Seblewongel Tigabu Yigizaw stigabu040@gmail.com

Malede Mequanent Sisay maledecsa@gmail.com

Zemenu Tadesse Tessema: zemenut1979@gmail.com

Corresponding author:

Sofonyas Abebaw Tiruneh

Department of Public Health, College of Health Sciences, Debre Tabor University, Ethiopia. PO BOX 272.

Email: zephab2@gmail.com

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Abstract

Objective: This study aimed to analyze the trends and factors that had contributed to the change of home delivery in Ethiopia over the last decade.

Design, setting, and analysis: Nationally representative repeated cross-sectional survey was conducted using 2005, 2011, and 2016 Ethiopian Demographic and Health Survey datasets. The data were weighted and analyzed by STATA version 14.1 software. Multivariate decomposition logistic regression analysis was used to identify significant factors for the contribution of change in home delivery. A p-value < 0.05 was taken as to declare statistically significant predictors.

Outcome measure: Trends of home delivery

Participants: A total of 33482 women who gave birth preceding each survey were included.

Results: The magnitude of home delivery decreased by 21% over the last decade in Ethiopia. Multivariate decomposition logistic regression analysis revealed that 39% of the decline in home delivery was due to differences in women's characteristics. Antenatal care visits, educational status of women and husband, birth order, religion, and distance from a health facility were the main sources of compositional change factors for the decline of home delivery. Behavioural changes towards health facility delivery contributed approximately two-thirds of the decline of home delivery in Ethiopia. Antenatal care visits, birth order, and religion significantly contributed to the change of home delivery due to behavioural changes in the use of health care facilities over the last decade.

Conclusion: Despite the importance of health facility delivery, many women still deliver at home in Ethiopia. Women's characteristics and behaviour change were significantly associated with the change in home delivery. Multisectoral interventions needed to improve antenatal care coverage, women's education, and health care facilities are needed to improve the practice. Further research needs to be done to identify why protestant women do not deliver at the health facility.

Keywords: Home delivery, multivariate decomposition, EDHS, Ethiopia.

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Strength and limitation of the study

- ✓ To the best of our knowledge, this study was the first study to explore the trend contributions of factors to the change of home delivery in Ethiopia.
- ✓ We used three waves of Ethiopian Demographic and Health Surveys, which is nationally representative data that could enhance the generalizability of the findings.
- ✓ Besides, multivariate decomposition logistic regression analysis used to identify factors that positively or negatively contributed to the decline of home delivery in Ethiopia could help policymakers to design potential interventions.
- ✓ Moreover, the data was collected by self-reported interview would be prone to recall and social desirability bias.

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Introduction

Every day, about 830 women die from preventable causes relating to pregnancy and childbirth, of which 99% of the deaths occur in developing countries (1). Worldwide, maternal mortality fell from 385 deaths per 100 000 livebirths in 1990 to 216 deaths in 2015, which is dropped by 44% (2,3). Despite the decline in maternal mortality in the last 25 years, the magnitude is still unacceptable in developing countries, including Ethiopia (3,4). The trends of maternal mortality in Ethiopia fell from 1250 deaths per 100 000 livebirths in 1990 to 353 deaths in 2015, declined by 71.8%, which is below the target of the Millennium Development Goals (MDGs) related to maternal mortality (5,6). Sustainable Development Goal (SDG) goal 3, target 3.1 calls for the reduction of maternal mortality ratio of less than 70 per 100 000 live births between 2016 and 2030 (7).

Studies indicated that nearly one-quarter of maternal deaths occurred in the antepartum period, another quarter in the intrapartum and immediate postpartum periods; one-third occurred in the subacute and delayed postpartum periods and 12% in the late postpartum period (8). Numerous factors contribute to high maternal mortality rates. Most maternal deaths are contributed by direct obstetric complications mainly hemorrhage, pregnancy-induced hypertension, sepsis, and obstructed labour combined account for 64% of the maternal death, and other factors such as poverty, limited access to health care, unskilled childbirth, and maternal sociodemographic characteristics are among the other causes of maternal mortality (9–11). Even though, skilled

childbirth before, during and after delivery can save the lives of women, in sub-Saharan Africa only 59% of births were attended by skilled health personnel between 2012 and 2017 (12). In Ethiopia, the magnitude of home delivery was 94.5% in 2000, 93.1% in 2005, 87.9% in 2011, and 73.6% in 2016 which was unacceptably high (13,14).

In Ethiopian several studies evidenced that women's low educational status, cultural and communal factors, limited access to health facilities, poor quality of care, lack of roads, and poor wealth status were significant factors that led to low maternal health service utilization (13,15–17). On the other hand, taking at least one antenatal care during pregnancy, high parity, educated women, urban residence, husband attitude towards health facility delivery, easy access to health facilities, and wealth status contributed to health facility delivery (17–20). The trend of home delivery decreased between 2005 to 2016. To date, no evidence that identifies the factors that have contributed to the observed reduction in home delivery during the last decade.

Therefore, this multivariate decomposition analysis aimed to identify trends and factors that either positively or negatively contributed to the change for home delivery. The study will help health planners and policymakers in planning to further reduction of home delivery and provide baseline information to other researchers.

Methods and materials

Study design, area, and period

The nationally representative repeated cross-sectional study design was employed using 2005, 2011, and 2016 Ethiopian Demographic and Health Surveys (EDHS). Ethiopia is laying between latitude 3° and 14°N, and longitude 33° and 48°E in the horn of Africa. Ethiopia has a total area of 1,100,000 km^2 and nine regional states, namely Tigray, Afar, Amhara, Benishangul-Gumuz, Gambela, Harari, Oromia, Somali, and Southern Nations Nationalities and Peoples of Region (SNNPR) plus Addis Ababa and Dire Dawa city Administrations.

Source and study populations

The source populations were all reproductive age group women who gave birth five years preceding each survey. The study populations were all reproductive-age group women who gave birth five years preceding each survey in the selected Enumeration Areas (EAs). In each survey, a nationally representative sample of 10721 in 2005, 11872 in 2011, and 10889 in 2016 weighted number of women participated. Recorded data were accessed at www.messdhs.com on request with the assistance of ICF International, Inc.

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Data collection tools and procedures

The data was collected in two-stage stratified sampling techniques in each survey. Each region of the country was stratified into urban and rural areas. In the first stage, 645 in 2016, 624 in 2011, and 540 in 2005 EAs were selected. In the second stage, a fixed number of households per cluster (EAs) were selected with an equal probability systematic selection from the newly created household listing. The detailed sampling procedure is available in the Ethiopian Demographic and Health Survey reports from Measure DHS website (www.dhsprogram.com) for each specific surveys.

Outcome variable

The outcome variable was taken as a binary response; a woman gave birth at home coded as home delivery, and women who gave birth at different (government, private, and non-government) health facilities were taken as health facility delivery.

Independent variables

All sociodemographic and obstetric characteristics were taken as independent variables for the three-consecutive surveys.

Patient and public involvement

The patients and the public were not involved for this secondary data analysis. But for the original survey the issue of patient and public involvement were considered; Since biomarkers such as anthropometry, anaemia and HIV testing were collected from each household for each survey (21–23).

Statistical analysis

The data were cleaned and analyzed using STATA version 14.1 software. Sample weighting was done for further analysis. Descriptive statistics were done for the description of the variables. A multivariate decomposition logistic regression analysis was done to identify the contributions to group differences to average predictions (24). The purpose of this decomposition analysis was to identify factors that contributed to the change in home delivery in the last decade in Ethiopia.

A nonlinear multivariate logit decomposition model was used to identify the contribution of proportion change to home delivery over the last decade. The output from the multivariate decomposition logistic regression analysis had two contribution effects. These effects were the compositional differences (endowments) “E” and the effects of characteristics that are the difference in the coefficients or behavioural change “C” responses for the selected predictor

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variables. In the nonlinear model, the dependent variable is a function of a linear combination of predictors and regression coefficients:

$Y = F(X\beta) = \text{logit}(Y) = x\beta$, where Y denotes the N × 1 dependent variable vector, X an N × K matrix of independent variables, and β a K ×1 vector of coefficients.

The proportion difference in Y between survey A and survey B of successive EDHS surveys of the home delivery can be decomposed as

$$Y_A - Y_B = F(X_A\beta_A) - F(X_B\beta_B)$$

For the log odds of home delivery, the proportion of the model is written as

$$\text{Logit}(Y_A) - \text{logit}(Y_B) = F(X_A\beta_A) - F(X_B\beta_B)$$

$$= \underbrace{F(X_A\beta_A) - F(X_B\beta_A)}_{E} + \underbrace{F(X_B\beta_A) - F(X_B\beta_B)}_{C} \quad \text{is group decomposition (24)}$$

The component "E" is the difference attributable to endowment change, usually called the explained component. The "C" component is the difference attributable to coefficients (behavioural) change, usually called the unexplained component.

The model structure for the decomposition analysis was:

$$\text{Logit}(A) - \text{Logit}(B) = [\beta_{0A} - \beta_{0B}] + \Sigma\beta_{ijA}[X_{ijA} - X_{ijB}] + \Sigma X_{ijB}[\beta_{ijA} - \beta_{ijB}]$$

where

- β_{0A} is the intercept in the regression equation for EDHS 2016
- β_{0B} is the intercept in the regression equation for EDHS 2005
- β_{ijA} is the coefficient of the j^{th} category of the i^{th} determinant for EDHS 2016
- β_{ijB} is the coefficient of the j^{th} category of the i^{th} determinant for EDHS 2005
- X_{ijA} is the proportion of the j^{th} category of the i^{th} determinant for EDHS 2016
- X_{ijB} is the proportion of the j^{th} category of the i^{th} determinant for EDHS 2005

Ethical consideration

We, the authors, submitted a concept note to DHS Program/ICF International Inc, and permission was issued by the International Review Board of Demographic and Health Surveys (DHS) program data archivists to download the dataset for this study.

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Results

Background characteristics of women

Table one shows the distribution of individual characteristics of women who gave birth five years preceding each survey in 2005, 2011, and 2016 EDHSs. In the three consecutive surveys, more than 60% of the women were in the age group of 20-34 years. Besides, women had almost the same mean age of 29 (± 6.6 SD) years. As well, a significant number (48%) of female household heads were identified in the 2011 EDHS report. Almost all (>90%) of the women, were married five years preceding each survey; 79%, 69%, and 66% of the women in each EDHS were unable to read and write, respectively (Table 1).

Table 1: Characteristics of the women in 2005, 2011, and 2016 EDHSs.

Characteristics of women		Percentage distribution for each survey		
		EDHS 2005 N= 10,721	EDHS 2011 N= 11,872	EDHS 2016 N= 10,889
Mother's age	<20 Years	12.26	9.33	7.81
	20 -34 years	62.07	66.22	67.38
	35-49 Years	25.67	24.25	24.80
	Mean ± SD	29.01 ± 6.95	29.04 ± 6.63	29.23 ± 6.53
Household head	Male	89.15	51.5	86.06
	Female	10.85	48.05	13.94
Marital status	Not having partner	4.56	6.07	6.25
	Had partner	95.44	93.93	93.75
Religion	Orthodox	42.37	38.06	34.14
	Muslim	35.00	35.49	41.50
	Protestant	19.95	23.23	21.09
	Others	2.68	3.22	3.26
Women educational level	Unable to read and write	79.31	69.30	66.13
	Primary education	16.53	27.5	26.67
	Secondary education	3.79	2.24	4.68
	Higher education	0.38	1.42	2.52
Husband educational level	Unable to read and write	59.03	50.60	48.57
	Primary education	30.37	41.26	39.21
	Secondary education	9.58	4.95	7.65
	Higher education	1.01	3.19	4.56
Women occupation	Not working	71.11	47.14	55.62
	Working	28.89	52.86	44.35
Husband occupation	Not working	2.00	1.33	56.93
	Working	98.00	98.67	43.07
Health institution Distance	Big problem	74.40	75.43	60.58

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	Not a big problem	25.60	24.57	39.42
Had ANC	No	71.86	57.45	37.42
	Yes	28.14	42.55	62.58
Birth order	1	17.13	19.05	18.65
	2-4	42.90	43.62	42.80
	>= 5+	39.97	37.33	38.55
Parity	<= 2	26.10	29.22	28.80
	2-5	40.05	39.67	39.67
	>= 5+	33.85	31.11	31.53
Wealth index	Poor	42.98	45.22	46.76
	Middle	22.44	20.53	20.60
	Richer	34.58	34.26	32.64
Residence	Urban	7.09	12.87	11.14
	Rural	92.91	87.13	88.86
Region	Tigray	6.39	6.34	6.44
	Afar	0.97	1.02	1.05
	Amhara	23.99	22.37	18.74
	Oromia	39.69	42.23	44.20
	Somali	4.24	3.07	4.66
	Benishangul	0.78	1.18	1.11
	SNNPR	21.81	21.01	20.67
	Gambla	0.27	0.34	0.24
	Harari	0.19	0.24	0.24
	Addis Ababa	1.32	1.87	2.23
	Dire Dawa	0.34	0.33	0.42

Trends of home delivery during the surveys

The trend of home delivery over the study period (2005-2016) showed a significant decline, which is decreased from 94.20% in 2005 to 73.44% in 2016. The largest decline was observed in the survey period 2011to2016 with a 17% drop and in the survey period, 2005 to 2011 decreased from 94 to 90, which is a 4% change (Figure 1).

The rate of decline in home delivery from 2005 – 2016 varied in terms of different factors. For example, the decrease in the stated period was the highest (52%) in the Tigray region and the lowest (11%) in the Afar Regional State of Ethiopia. Besides, the decline was higher (36.34%) in urban and lower (17.60%) in rural settlements. The trend declined by 29% among women who received antenatal care services during pregnancy (Table 2).

Table 2: Trends of home delivery among women who gave birth preceding the survey by women characteristics, 2005, 2011 and 2016 Ethiopia Demographic and Health Surveys.

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Individual variables	EDHS 2005 N= 10,721	EDHS 2011 N= 11,872	EDHS 2016 N= 10,889	Percentage point difference in home delivery		
				2011-2005	2016-2011	2016-2005
Mother's age						
<20 Years	93.95	91.16	64.97	-2.79	-26.19	-28.98
20 -34 years	94.16	88.49	72.33	-5.67	-16.16	-21.83
35-49 Years	96.67	93.91	79.14	-2.76	-14.77	-17.53
Household head						
Male	95.51	90.20	74.55	-5.31	-15.65	-20.96
Female	88.77	89.90	66.59	1.13	-23.31	-22.18
Marital status						
Had not a partner	90.51	86.17	66.06	-4.34	-20.11	-24.45
Had partner	94.99	90.31	73.94	-4.68	-16.37	-21.05
Religion						
Orthodox	92.70	84.63	79.91	-8.07	-4.72	-12.79
Muslim	97.09	93.60	79.76	-3.49	-13.84	-17.33
Protestant	94.69	92.90	75.45	-1.79	-17.45	-19.24
Others	98.26	94.58	90.42	-3.68	-4.16	-7.84
Women education						
Illiterate	97.79	95.26	83.91	-2.53	-11.35	-13.88
Primary education	92.22	85.05	62.65	-7.17	-22.4	-29.57
Secondary education	50.58	30.41	22.03	-20.17	-8.38	-28.55
Higher education	18.20	24.47	8.53	6.27	-15.94	-9.67
Husband education						
Illiterate	98.29	95.74	83.03	-2.55	-12.71	-15.26
Primary education	95.20	89.95	75.53	-5.25	-14.42	-19.67
Secondary education	78.17	64.99	39.61	-13.18	-25.38	-38.56
Higher education	37.94	45.05	19.06	7.11	-25.99	-18.88
Women occupation						
Not working	94.95	90.23	76.05	-4.72	-14.18	-18.9
Working	94.36	89.90	70.18	-4.46	-19.72	-24.18
Husband occupation						
Not working	65.89	89.81	75.61	23.92	-14.2	9.72
Working	95.37	90.06	70.58	-5.31	-19.48	-24.79
Health facility						
Big problem	96.97	94.36	82.13	-2.61	-12.23	-14.84
Not a big problem	88.43	76.83	60.10	-11.6	-16.73	-28.33
Had ANC						
No	98.19	96.88	91.50	-1.31	-5.38	-6.69
Yes	82.34	76.64	53.68	-5.7	-22.96	-28.66
Birth order						
1	86.83	79.04	51.01	-7.79	-28.03	-35.82
2-4	95.01	90.19	72.94	-4.82	-17.25	-22.07
>= 5	97.94	95.51	84.85	-2.43	-10.66	-13.09

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Parity						
<= 2	87.89	80.62	52.83	-7.27	-27.79	-35.06
2-5	94.52	92.29	78.06	-2.23	-14.23	-16.46
>= 5+	98.03	96.06	86.45	-1.97	-9.61	-11.58
Wealth status						
Poor	99.08	97.38	85.29	-1.7	-12.09	-13.79
Middle	98.14	96.87	77.39	-1.27	-19.48	-20.75
Rich	87.26	76.31	53.98	-10.95	-22.33	-33.28
Residence						
Urban	56.94	50.18	20.60	-6.76	-29.58	-36.34
Rural	97.67	95.95	80.07	-1.72	-15.88	-17.6
Region						
Tigray	94.12	88.36	41.87	-5.76	-46.49	-52.25
Afar	95.95	93.19	85.28	-2.76	-7.91	-10.67
Amhara	96.49	89.82	72.46	-6.67	-17.36	-24.03
Oromia	95.75	92.00	81.10	-3.75	-10.9	-14.65
Somali	95.23	92.40	82.07	-2.83	-10.33	-13.16
Benishangul	94.67	90.89	74.04	-3.78	-16.85	-20.63
SNNPR	96.30	93.79	73.95	-2.51	-19.84	-22.35
Gambla	84.26	72.48	54.38	-11.78	-18.1	-29.88
Harari	68.20	67.63	49.59	-0.57	-18.04	-18.61
Addis Ababa	21.84	17.66	2.98	-4.18	-14.68	-18.86
Dire Dawa	74.90	60.27	42.81	-14.63	-17.46	-32.09
Prevalence	95	90	73	-5	-17	-22
95% CI	94.3, 95.2	89.5, 90.6	72.6, 74.3	-4.8, -4.6	-16.9, -16.3	-21.7, -20.9

Detailed multivariate decomposition logistic regression analysis

Difference due to characteristics (Endowment)

This multivariate decomposition analysis revealed that about 39% of the overall change in home delivery was due to differences in compositional characteristics. Among the compositional factors ANC visits, religion, education of women and husband, birth order, wealth index, distance from health facilities, and residence had a statistically significant impact on the change contribution (Table 3).

Women who had at least one antenatal care follow up during pregnancy were more likely to deliver at the health facility. The coverage of antenatal care follow-up increased from 28 to 62% in the last decade (Table 1), with an important compositional contribution to the decline of home delivery by 35%.

Followers of the Protestant sect were more likely to give birth at home than Orthodox Christians. As a result, the increase in the proportion of the Protestant sect followers (Table 1) had a significant

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rise to home delivery in the last decade. Keeping all other variables constant, the improvement of women's educational status to primary school complete and above before the survey (Table 1) had a positively significant contribution to the decline of the trend.

A decrease in the number of husbands secondary education level during the surveys (Table 1) hurt on the place of delivery, which is a rise in the proportion of husbands with higher education had a positive contribution to the decline of home delivery.

Keeping the coefficient characteristics constant, women who had no significant change in the number of birth orders from 2-4 (Table 1) had a contribution to the rate of home delivery. On the other hand, a decrease in the number of women who had more than five birth order had a positive contribution to the decline of home delivery in the last decade (Table 3).

The decline in the proportion of rich women in the last decade increased the prevalence of home delivery. Accessibility of health facilities had a positive contribution to decreasing home delivery by 2% over the last decade. Women living in rural areas had a risk of giving birth at home. As shown in Table 1, the composition change of rural residence was minimal, this insignificant compositional change significantly rose the prevalence of home delivery over the last decade (Table 3).

Difference due to effects of coefficient (C)

Controlling the roles of change in compositional characteristics, two-thirds of home delivery decline was due to behavioural change towards health facility delivery (Table 3). Antenatal care visits, religion, and birth order had statistically significant effects of coefficient contribution to the observed change in home delivery. Controlling all compositional change factors, 4% of the home delivery decline was due to the change in the behaviour of health facility delivery among the ANC service visitors over the last decade. Keeping compositional factors constant, women protestant sect flowers had a negative effect on the contribution to home delivery over the past decade.

Furthermore, about 25% of the decline of home delivery over the last decade was due to changes in health facility delivery use behaviour among women who had a birth order two and above (Table 3).

Table 3: The detailed multivariate logistic regression decomposition analysis of home delivery women who gave birth in the last ten years preceding 2005 to 2016 EDHS, Ethiopia.

Variables	Difference due to characteristics (E)		Difference due to coefficient (C)	
	Coeff (95% CI)	Pct.	Coeff (95%CI)	Pct.
Age in years				

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<20	1	1	1	1
20-34	-0.0026425 (-0.0065794, 0.0012943)	1.2078	0.0097217 (-0.020772, 0.026531)	-1.316
35-49	0.00015715 (-0.000019082,0.00033337)	-0.0718	0.0028792 (-0.0053135, 0.024757)	-4.4434
Religion				
Orthodox	1	1	1	1
Muslim	0.0011654 (-0.00043086, 0.0027617)	-0.53266	0.0019208 (-0.0071241, 0.010966)	-0.87792
protestant	0.0022454 (0.0011048 ,0.0033861) *	-1.0263	0.0067475 (0.00061695, 0.012878) *	-3.084
Others	0.0007805 (0.00022288, 0.0013381)	-0.35674	0.0013868 (-0.00087756, 0.0036511)	-0.63384
Women education				
No education	1	1	1	1
Primary	-0.0045685 (-0.0081609, -0.0009761) *	2.0881	0.0014132 (-0.0034075. 0.0062339)	-0.6460
Secondary	-0.0015069 (-0.0022971, -0.00071672) *	0.68874	0.000085296 (-0.0016957, 0.0018663)	-0.0390
Higher	-0.0030286 (-0.0059084, -0.00014878) *	1.3843	0.00027299 (-0.00021235, 0.00075833)	-0.1248
Husband education				
No education	1	1	1	1
Primary	-0.001852 (-0.0045476, 0.00084366)	0.84646	0.003113 (-0.0053549, 0.011581)	-1.4228
Secondary	0.00084942 (0.00042745, 0.0012714) *	-0.38824	0.0010909 (-0.0027474, 0.0049291)	-0.4986
Higher	-0.0052866 (-0.0080882, -0.0024849) *	2.4163	0.00025019 (-0.00071622, 0.0012166)	-0.11435
women occupation				
Not working	1	1	1	1
Working	0.0006093(-0.011577, 0.012796)	-0.27849	-0.0015175 (-0.014399, 0.011364)	0.69359
Husband occupation				
Not working	1	1	1	1
Working	0.0034081 (-0.033625, 0.040441)	-1.5577	0.033541 (-0.016873, 0.083956)	-15.33
Birth order				
Only one birth	1	1	1	1
2 - 4 birth	0.0015601 (0.00044295, 0.0026773) *	-0.71307	-0.01878 (-0.033508, -0.0040518) *	8.5835
5 and above birth	-0.0003622 (-0.0006497, -0.00007469) *	0.16555	-0.033806 (-0.060462, -0.0071505) *	15.452
ANC visit				
No	1	1	1	1
Yes	-0.076563 (-0.088698, -0.064428) *	34.994	-0.0081231(-0.016207, -0.000039645) *	3.7127
Wealth status				
Poor	1	1	1	1
Middle	-0.0007966 (-1.2357e-06, 0.000077712)	-0.01746	-0.00020032 (-0.0099877, 0.009587)	0.091558
Rich	0.000038238 (-0.00122, -0.00037319) *	0.34409	0.013165 (0.00021347, 1.026117)	-6.0173
Parity				
<2	1	1	1	1
2-5	0.00111(-0.0019906, 0.00018171)	-0.50733	0.0032984 (-0.0092389, 0 .015836)	-1.5076
Above 5	-0.00090444 (-0.0019906, 0.00018171)	0.41338	0.0049123 (-0.014804, 0.024629)	-2.2452
Distance health				
Not big problem	1	1	1	1
Big problem	-0.0047901(-0.0085384, -0.0010417) *	2.1894	-0.001343(-0.0075911, 0.0049052)	0.61381
Residence				
Urban	1	1	1	1

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Rural	0.00007412 (0.000057785, 0.00009046)	-0.03388	0.0058021(-0.022943, 0.034547)	-2.2452
Constants			-0.15848 (-0.23109, -0.085858)	72.433
Overall	**-0.086145(-0.12888, -0.043405) *****	**39.37**	**-0.13264 (-0.087914, -0.087914) *****	**60.63**

Discussion

Women giving birth at health facilities can prevent maternal deaths by providing qualified birth assistance, drugs to address labour complications, and referrals to more advanced health facilities (25). Even though giving birth at the health facility has an invaluable effect on the decrease of pregnancy-related complications and deaths among reproductive age group women, a significant number of women still give birth at home.

Multivariate decomposition logistic regression analysis relaxes non-linear models comparable to previous decomposition analysis models (26–28). Previous studies conducted to identify the factors that affect home delivery. To the best of our knowledge, there are no studies conducted on the place of delivery contribution change through significant factors. This method of analysis was used to examine the trends of home delivery and identify factors either positively or negatively contributed to the change of home delivery.

Home delivery in Ethiopia declined by around 21% over the last decade, mainly during the surveys of 2011 to 2016. This could be due to the launching of the Health Extension Program (HEP) and improving access to health care to meet the primary attention of the MDG agenda (29,30).

This study revealed that the contribution of behaviour (coefficient) changes was more important than that of composition (endowments) changes to the decline of home delivery over the last decade.

Keeping coefficient changes constant, the explained contribution of the change in compositional characteristics to the decline of home delivery was 39% in Ethiopia. The predominant changes in home delivery were due to the proportion of changes in ANC visits. Antenatal coverage increased by 34% (Table 1) over the last decade which had a 35% contribution to the decline of home delivery. The possible reason might be the fact that women who had antenatal follow-up were more likely to deliver at health facilities than those who had no follow-ups (18,31–34).

Women having primary school education and above had a positive impact on the decline of home delivery compared to those unable to read and write. This result supported by the evidence that higher educational attainment of women was more likely to give birth at health facilities compared to those unable to read and write (18,32,35,36). Meanwhile, Ethiopia has been worked hard to

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achieve the Millennium Development Goal agenda that advocates women's educational attainment. Besides, Ethiopia launched the Growth and Transformation Plan I (GTP I) which gave special attention to women's education (29,37). Therefore, the compositional increase in women's education in the last decade had a positive contribution to the decline of home delivery in the country.

As well, higher education of husbands had a significant effect on home delivery. Since the decrease in the number of husbands with secondary school education (Table 1) had a negative contribution to the decline of home delivery. The possible justification might be that educated husbands knew about the importance of health facility delivery and make decisions on the place of delivery.

Another endowment factor that significantly decreased home delivery was birth order. The increase in the proportion of birth order in the survey period resulted in a decrease in home delivery. This finding supports the evidence that women with high birth order deliver at the health facility (32,34). The reason for this finding will be also women with high birth order would have experience with the importance of health facility delivery.

The proportion of protestant women increased in the last decade (Table 1) which increases home delivery proportion because such women were more likely to deliver at home compared to Orthodox Christian women. However, whether religion can a barrier to delivery at the health facility, it needs further investigations.

The wealth status of women had a significant effect on home delivery. The number of rich women decreased in the survey period and staying at home to give birth in the last decade. Studies showed that rich women were more likely to deliver at health facilities than the poor ones (31,32,35). Furthermore, distance to health facilities had a positive contribution to the place of delivery. This study showed that the inaccessibility of health facilities decreased in Ethiopia over the last decade and that positively contributed to the decline of home delivery. Distance from health facilities was a big problem that added to give birth at home (17,20,32,33,38). Ethiopia disease prevention policy has stepped up work on expanding health facilities to achieve access to primary health care in addition to the Extension program.

The decline of rural residence among women was insignificant in the last decade and posed a negative impact on home delivery reduction. Studies evidenced that women living in rural areas gave birth at home than those living in urban settings (17,20,32,38). The possible justification might be that women living in rural areas could not get health facilities easily due to distance.

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Controlling the effects of endowment characteristics, about 61% of home delivery decline was contributed by behaviour change to the place of delivery. Significant positive and negative contributions of behaviour change in terms of religion, birth order, and ANC visits were noted.

Changes in behavioural characteristics of women in the Protestant sect had a negative impact could be made certain by the fact that at health facility delivery of the women was low. But no documented evidence showed that protestant religion follower women were a barrier to the place of delivery. Thus, further studies needed on this issue.

This study indicated that about one-fourth of the decrease in home delivery over the last decade was the change in behaviour relating to health facility delivery among women who had two and above birth orders. The possible reason might be women with high birth order experienced different maternal health care services and had adequate health education from the health care personnel.

Another incredible factor that positively contributed to the decline to home delivery preceding the survey was antenatal care visits. Women who received antenatal care during pregnancy were more likely to give birth at the health facility compared to their counterparts (32,39,40). Women who had antenatal visits might have obtained health education about the importance of health facility delivery from health care professionals which might have changed their behaviour towards health facility delivery.

Since this study encompasses three waves of nationally representative demographic and health survey data, that could enhance the generalizability of the findings. As well, multivariate decomposition logistic regression analysis used to identify factors that positively or negatively contributed to the decline of home delivery in Ethiopia could help policymakers to design interventions. The limitation of this study; since the data was collected by a self-reported interview that would be prone to recall and social desirability bias.

Conclusion and recommendation

The trend of home delivery among the reproductive age group of women declined significantly in the last decade although it is still unacceptable. In multivariate decomposition logistic regression analysis, about 39% of the home delivery decline was contributed by the changes in compositional characteristics of the women. The proportional changes in antenatal care visits, educational status of women and husband, birth order, religion, and distance to health facilities were significantly associated with the decrease in home delivery. Around two-thirds of home delivery decline was

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due to the changes in behaviour towards health facility delivery in the last decade. Antenatal care visits, birth order, and religion were significantly associated factors to the place of delivery due to coefficients change.

The Ministry of Health and other stakeholders should continue to enhance the coverage of antenatal care visits and the accessibility of health care facilities. The Ministry of Education should advance the empowerment of girls through education. Researchers need to further investigate the low use of health facility delivery among protestant women.

Declaration

Data Availability

The data was available from the corresponding author and we can provide upon request.

Consent for publication

Not applicable

Competing Interest

We, the authors, declare that we had no competing interests.

Funding Statement

We did not receive any funds for this study.

Author Contributions

SAT, ZTT, and STY were involved in this study from the inception to design, acquisition of data, data cleaning, data analysis and interpretation and drafting and revising of the manuscript. AML and MMS were involved in project administration**,** principal supervision, and revising the final manuscript**.** All authors read and approved the final manuscript.

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Figure legend:

Figure 1: The trend of home delivery from 2005 to 2016 EDHS surveys five years preceding each survey years.

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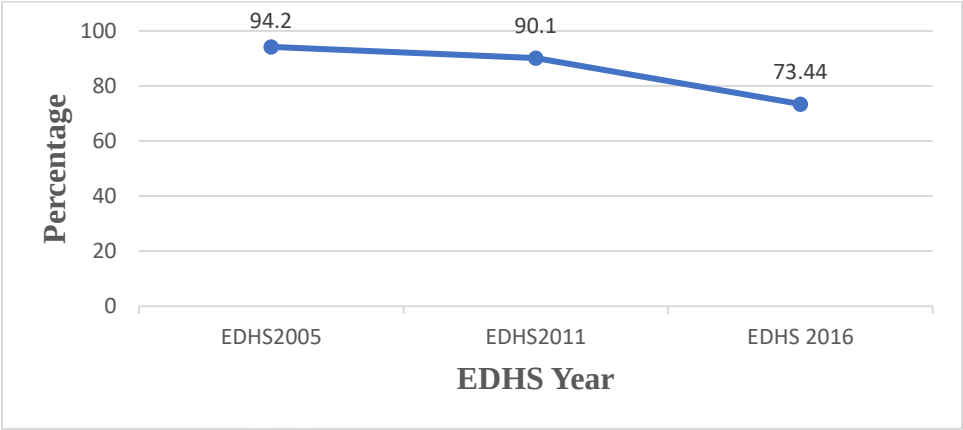

Figure 1: The trend of home delivery from 2005 to 2016 EDHS surveys five years preceding each survey years.

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		Reporting Item	Page Number
Title and abstract			
Title	#1a	The study's design was included in the abstract part	2
Abstract	#1b	Provide in the abstract an informative and balanced summary of what was done and what was found	2

Introduction			
Background / rationale	#2	Explain the scientific background and rationale for the nvestigation being reported	3-4
Objectives	#3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	#4	Present key elements of study design early in the paper	4
Setting	#5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Eligibility criteria	#6a	Give the eligibility criteria, and the sources and methods of selection of participants.	4
	#7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5
Data sources / measurement	#8	For each variable of interest give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group. Give information separately for for exposed and unexposed groups if applicable.	4
Bias	#9	Describe any efforts to address potential sources of bias	n/a
Study size	#10	Explain how the study size was arrived at	4
Quantitative	#11	Explain how quantitative variables were handled in the	5

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variables		analyses. If applicable, describe which groupings were chosen, and why	
Statistical methods	#12a	Describe all statistical methods, including those used to control for confounding	5
Statistical methods	#12b	Describe any methods used to examine subgroups and interactions	n/a
Statistical methods	#12c	Explain how missing data were addressed	n/a
Statistical methods	#12d	If applicable, describe analytical methods taking account of sampling strategy	n/a
Statistical methods	#12e	Describe any sensitivity analyses	n/a
Results			
Participants	#13a	Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed. Give information separately for for exposed and unexposed groups if applicable.	6
Participants	#13b	Give reasons for non-participation at each stage	n/a
Participants	#13c	Consider use of a flow diagram	n/a
Descriptive data	#14a	Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential	7

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		confounders. Give information separately for exposed and unexposed groups if applicable.	
Descriptive data	#14b	Indicate number of participants with missing data for each variable of interest	n/a
Outcome data	#15	Report numbers of outcome events or summary measures. Give information separately for exposed and unexposed groups if applicable.	n/a
Main results	#16a	Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	12
Main results	#16b	Report category boundaries when continuous variables were categorized	n/a
Main results	#16c	If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	#17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	n/a
Discussion			
Key results	#18	Summarise key results with reference to study objectives	13
Limitations	#19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias.	15

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Interpretation	#20	Give a cautious overall interpretation considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence.	
Generalisability	#21	Discuss the generalisability (external validity) of the results	n/a

Other Information

Funding	#22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	16

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Trends and determinants of home delivery in Ethiopia: Further multivariate decomposition analysis of 2005 to 2016 Ethiopian Demographic Health Surveys

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Keywords:	EPIDEMIOLOGY, PUBLIC HEALTH, Quality in health care < HEALTH SERVICES ADMINISTRATION & MANAGEMENT

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Trends and determinants of home delivery in Ethiopia: Further multivariate decomposition analysis of 2005 to 2016 Ethiopian Demographic Health Surveys

Sofonyas Abebaw Tiruneh[1*], Ayenew Molla Lakew[2], Seblewongel Tigabu Yigizaw[2], Malede Mequanent Sisay[2], Zemenu Tadesse Tessema[2]

Affiliations:

[1] Department of Public Health, College of Health Sciences, Debre Tabor University, Ethiopia.

[2] Department of Epidemiology and Biostatistics, Institute of Public Health, College of Medicine and Health Sciences, University of Gondar, Ethiopia.

E-mails:

Sofonyas Abebaw Tiruneh: zephab2@gmail.com

Ayenew Molla Lakew mayenew15@gmail.com

Seblewongel Tigabu Yigizaw stigabu040@gmail.com

Malede Mequanent Sisay maledecsa@gmail.com

Zemenu Tadesse Tessema: zemenut1979@gmail.com

Corresponding author:

Sofonyas Abebaw Tiruneh

Department of Public Health, College of Health Sciences, Debre Tabor University, Ethiopia. PO BOX 272.

Email: zephab2@gmail.com

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Abstract

Objective: This study aimed to assess the trends and factors that had contributed to the change in home delivery in Ethiopia over the last decade.

Design, setting, and analysis: A nationally representative repeated cross-sectional survey was conducted using 2005, 2011, and 2016 Ethiopian Demographic and Health Surveys. Multivariate decomposition logistic regression analysis was employed to identify significant factors that have been contributed to the change in home delivery. Level of statistical significance was declared at a two-sided P-value ≤ 0.05.

Outcome measure: Trends of home delivery.

Participants: A total of 33,482 women were included.

Results: Home delivery has been decreased by 21% over the last decade in Ethiopia. In the last decade, 39% of the decrements in home delivery attributed to change in women's compositional characteristics. Antenatal care visits, educational status of the women and husband, birth order, religion, wealth index and distance from a health facility were the main sources of compositional change factors for the change of home delivery. Behavioral changes towards health facility delivery contributed approximately two-thirds of the decline of home delivery in Ethiopia. Antenatal care visits, birth order, and religion have significantly contributed to the change of home delivery resulted from behavioral changes towards health care facility utilization over the last decade.

Conclusion: Despite the importance of health facility delivery, a significant number of women still deliver at home in Ethiopia. Women's compositional characteristics and behavior changes were significantly associated with the change in home delivery. Multisectoral educational intervention is needed to change women's attitudes towards home delivery. Antenatal care coverage and health care facility coverage should increase thereby to improve healthcare facility based-delivery practice. Further research needs to be done to explore the potential barriers of health facility delivery from a religious perspective.

Keywords: Home delivery, Multivariate decomposition, Ethiopia Demographic Health Survey, Ethiopia.

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Strengths and limitations of the study

- ✓ To the best of our knowledge, this study is first of its kind that identifies the trend contributions of factors to the change in home delivery in Ethiopia.
- ✓ We used three waves of Ethiopian Demographic and Health Surveys, which are nationally representative data that could enhance the generalizability of the findings.
- ✓ Besides, this multivariate decomposition logistic regression analysis used to identify factors that positively or negatively contributed to the decline of home delivery in Ethiopia could help policymakers and health planners to design potential interventions.
- ✓ However, since data were collected using self-reported interview, this might prone to recall and social desirability bias.

Introduction

Every day, more than 800 women die from preventable causes related to pregnancy and childbirth, and almost all deaths occur in developing countries (1). Worldwide, maternal mortality fell from 385 deaths per 100 000 live births in 1990 to 216 deaths in 2015, in other words, 44% of deaths were averted (2,3). Even though in the last two and half decades maternal mortality had declined, it is not still in acceptable spectrum in Ethiopia and other developing countries (3,4). In Ethiopia, the trends of maternal mortality declined 1250 to 353 /100,000 live births between 1990 and 2015, which reflects maternal mortality was reduced by less than three-fourth below the target of the Millennium Development Goals (MDGs) (5,6). Furthermore, Sustainable Development Goal (SDG) 3, target 3.1 calls for the reduction of maternal mortality ratio less than 70 per 100,000 live births between 2016 and 2030 (7).

Studies evidenced that nearly 33% of maternal death occurred in the subacute and delayed postpartum period, 25% in the antepartum period, another 25% in the intrapartum and immediate postpartum periods, and 12% in the late postpartum period (8). However, numerous factors contribute to high maternal mortality ratio. Most maternal deaths are contributed by direct obstetric complications such as hemorrhage, pregnancy-induced hypertension, sepsis, and obstructed labour collectively accounts for 64% of maternal death. Besides, poverty, limited access to health care, unskilled childbirth, and maternal sociodemographic characteristics are among the indirect causes of maternal mortality (9–11). Even though skilled birth attendance can save the lives of women, only 59 % of births were attended by skilled birth attendants between 2012 to 2017 in sub-Saharan

Africa (12). High load of home delivery in Ethiopia is a precipitating factor for high maternal mortality ratio. For example, the magnitude of home delivery was 94.5% in 2000, 93.1% in 2005, 87.9% in 2011, and 73.6% in 2016 which are unacceptably high (13,14).

According to different studies, maternal health service utilization was low due to low educational status, cultural and communal factors, limited access to health facilities, poor quality of care, lack of roads, and poor wealth status in Ethiopia. (13,15–17). On the other hand, taking at least one antenatal care visit, multiparity, being educated women, being urban resident, husband's positive attitude towards health facility delivery, easy access to health facilities, and having good wealth status were reported in the contribution of health facility-based delivery in Ethiopia (17–20). However, between 2005 to 2016, the trends of home delivery show decrements, no evidence that which factors that have been contributed to the observed reduction in the last decade.

Therefore, this multivariate decomposition logistic analysis aimed to assess the trends and factors that either positively or negatively contributed to the change for home delivery in Ethiopia. This study is anticipated to provide data for health planners and policymakers in planning for further reduction of home delivery thereby to decrease maternal mortality in Ethiopia and elsewhere in developing countries.

Methods and materials

Study design, area, and period

The nationally representative repeated cross-sectional study design was employed using 2005, 2011, and 2016 Ethiopian Demographic and Health Surveys (EDHS). Ethiopia is laying between latitude 3° and 14°N, and longitude 33° and 48°E in the horn of Africa. Ethiopia has a total area of 1,100,000 km^2 and structured in nine regional states, namely Tigray, Afar, Amhara, Benishangul-Gumuz, Gambela, Harari, Oromia, Somali, and Southern Nations Nationalities and Peoples of Region (SNNPR) and two city administration (Addis Ababa and Dire Dawa).

Source and study population

The source population were all reproductive age group women who gave birth five years preceding each survey. The study population were all reproductive-age group women who gave birth five years preceding each survey in the selected Enumeration Areas (EAs). In each survey, a nationally representative sample of 10721 in 2005, 11872 in 2011, and 10889 in 2016 weighted number of

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women participated. Recorded data were accessed at www.messdhs.com on request with the assistance of ICF International, Inc.

Data collection tools and procedures

Data were collected in two-stages in each survey years. Stratification was also made as urban and rural in each region of the country. In the first stage, 540, 624 and 645 EAs were selected in 2005, 2011, and 2016 Ethiopian Demographic and Health Surveys respectively. In the second stage, a fixed number of households were selected in each EAs for each survey using systematic sampling. The detailed sampling procedure is available in the Ethiopian Demographic and Health Survey reports from the Measure DHS website (www.dhsprogram.com) for each specific surveys.

Outcome variable

The outcome variable was taken as a binary response; a woman gave birth at home coded as home delivery, and women who gave birth at health facilities (government, private, and non-government) were taken as health facility delivery.

Independent variables

All sociodemographic and obstetric characteristics were taken as independent variables for the three-consecutive surveys.

Patient and public involvement

As the study conducted based on secondary data, therefore, there is no patients and the public involvement in this study.

Statistical analysis

The data were cleaned and analyzed using STATA software (version 14.1). Sample weighting was done for further analysis. Descriptive statistics were also done for the description of the variables. A multivariate decomposition logistic regression analysis was employed to identify the contributions of group differences to average predictions (21). The purpose of this decomposition analysis was to identify factors that contributed to the change in home delivery in the last decade in Ethiopia.

A nonlinear multivariate logit decomposition model was used to identify the contribution of proportion change to home delivery over the last decade. The output from the multivariate decomposition logistic regression analysis had two contribution effects. These effects were the compositional differences (endowments) “E” and the effects of characteristics that are the difference in the coefficients or behavioral change “C” responses for the selected predictor

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variables. In the nonlinear model, the dependent variable is a function of a linear combination of predictors and regression coefficients:

$Y = F(X\beta) = \text{logit}(Y) = x\beta$, where Y denotes the N × 1 dependent variable vector, X an N × K matrix of independent variables, and β a K ×1 vector of coefficients.

The proportion difference in Y between survey A and survey B of successive EDHS surveys of home delivery can be decomposed as

$$Y_A - Y_B = F(X_A\beta_A) - F(X_B\beta_B)$$

For the log odds of home delivery, the proportion of the model is written as

$$\text{Logit}(Y_A) - \text{logit}(Y_B) = F(X_A\beta_A) - F(X_B\beta_B)$$

$$= \underbrace{F(X_A\beta_A) - F(X_B\beta_A)}_{E} + \underbrace{F(X_B\beta_A) - F(X_B\beta_B)}_{C} \quad \text{is group decomposition (21)}$$

The component "E" is the difference attributable to endowment change, usually called the explained component. The "C" component is the difference attributable to coefficients (behavioral) change, usually called the unexplained component.

The model structure for the decomposition analysis was:

$$\text{Logit}(A) - \text{Logit}(B) = [\beta_{0A} - \beta_{0B}] + \Sigma\beta_{ijA}[X_{ijA} - X_{ijB}] + \Sigma X_{ijB}[\beta_{ijA} - \beta_{ijB}]$$

where

- β_{0A} is the intercept in the regression equation for EDHS 2016
- β_{0B} is the intercept in the regression equation for EDHS 2005
- β_{ijA} is the coefficient of the j^{th} category of the i^{th} determinant for EDHS 2016
- β_{ijB} is the coefficient of the j^{th} category of the i^{th} determinant for EDHS 2005
- X_{ijA} is the proportion of the j^{th} category of the i^{th} determinant for EDHS 2016
- X_{ijB} is the proportion of the j^{th} category of the i^{th} determinant for EDHS 2005

Ethical consideration

The authors had submitted a concept note to DHS Program/ICF International Inc, and permission has been issued by the International Review Board of Demographic and Health Surveys (DHS) program data archivists to download the dataset for this study.

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Results

Background characteristics of women

Table one below depicts the distribution of individual characteristics of women who gave birth in five years preceding each survey in 2005, 2011, and 2016. In the three consecutive surveys, more than 60% of the women were in the age group of 20-34 years. Besides, women had almost the same mean age of 29 (± 6.6 SD) years. As well, a significant number (48%) of female household heads were observed in the 2011 EDHS report. Almost all (>90%) of the women, were married five years preceding each survey; 79%, 69%, and 66% of the women in each EDHS were unable to read and write, respectively (Table 1).

Table 1: Socio-demographic and obstetrics characteristics of the women in 2005, 2011, and 2016 EDHSs.

Characteristics of women		Percentage distribution for each survey		
		EDHS 2005 N= 10,721	EDHS 2011 N= 11,872	EDHS 2016 N= 10,889
Mother's age	<20 Years	12.26	9.33	7.81
	20 -34 years	62.07	66.22	67.38
	35-49 Years	25.67	24.25	24.80
	Mean ± SD	29.01 ± 6.95	29.04 ± 6.63	29.23 ± 6.53
Household head	Male	89.15	51.5	86.06
	Female	10.85	48.05	13.94
Marital status	Not having partner	4.56	6.07	6.25
	Had partner	95.44	93.93	93.75
Religion	Orthodox	42.37	38.06	34.14
	Muslim	35.00	35.49	41.50
	Protestant	19.95	23.23	21.09
	Others	2.68	3.22	3.26
Women educational level	Unable to read and	79.31	69.30	66.13
	Primary education	16.53	27.5	26.67
	Secondary education	3.79	2.24	4.68
	Higher education	0.38	1.42	2.52
Husband educational level	Unable to read and	59.03	50.60	48.57
	Primary education	30.37	41.26	39.21
	Secondary education	9.58	4.95	7.65
	Higher education	1.01	3.19	4.56
Women occupation	Not working	71.11	47.14	55.62
	Working	28.89	52.86	44.35

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Husband occupation	Not working	2.00	1.33	56.93
	Working	98.00	98.67	43.07
Health institution Distance	Big problem	74.40	75.43	60.58
	Not a big problem	25.60	24.57	39.42
Had ANC	No	71.86	57.45	37.42
	Yes	28.14	42.55	62.58
Birth order	1	17.13	19.05	18.65
	2-4	42.90	43.62	42.80
	>= 5^{+}	39.97	37.33	38.55
Parity	<= 2	26.10	29.22	28.80
	2-5	40.05	39.67	39.67
	>= 5^{+}	33.85	31.11	31.53
Wealth index	Poor	42.98	45.22	46.76
	Middle	22.44	20.53	20.60
	Richer	34.58	34.26	32.64
Residence	Urban	7.09	12.87	11.14
	Rural	92.91	87.13	88.86
Region	Tigray	6.39	6.34	6.44
	Afar	0.97	1.02	1.05
	Amhara	23.99	22.37	18.74
	Oromia	39.69	42.23	44.20
	Somali	4.24	3.07	4.66
	Benishangul	0.78	1.18	1.11
	SNNPR	21.81	21.01	20.67
	Gambela	0.27	0.34	0.24
	Harari	0.19	0.24	0.24
	Addis Ababa	1.32	1.87	2.23
	Dire Dawa	0.34	0.33	0.42

Trends of home delivery during the survey period

The trend of home delivery over the study period (2005-2016) showed a significant decline, which is decreased from 94.20% in 2005 to 73.44% in 2016. The largest decline was observed in the survey period 2011 to 2016 with a 17% drop down and in the survey period, 2005 to 2011 decreased from 94 to 90, which is a 4% decline (Figure 1).

The rate of decline in home delivery from 2005 to 2016 varied in terms of different factors. For example, the reduction in the stated period was the highest (52%) in the Tigray Regional State and the lowest (11%) in the Afar Regional State of Ethiopia. Besides, the decline was higher (36.34%)

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in urban and lower (17.60%) in rural settlements. The trend was declined by 29% among women who received antenatal care services during pregnancy (Table 2).

Table 2: Trends of home delivery among women who gave birth preceding the survey by women characteristics, 2005, 2011 and 2016 Ethiopia Demographic and Health Surveys.

Individual variables	EDHS 2005 N= 10,721	EDHS 2011 N= 11,872	EDHS 2016 N= 10,889	Percentage point difference in home delivery		
				2011-2005	2016-2011	2016-2005
Mother's age						
<20 Years	93.95	91.16	64.97	-2.79	-26.19	-28.98
20 -34 years	94.16	88.49	72.33	-5.67	-16.16	-21.83
35-49 Years	96.67	93.91	79.14	-2.76	-14.77	-17.53
Household head						
Male	95.51	90.20	74.55	-5.31	-15.65	-20.96
Female	88.77	89.90	66.59	1.13	-23.31	-22.18
Marital status						
Had not a partner	90.51	86.17	66.06	-4.34	-20.11	-24.45
Had partner	94.99	90.31	73.94	-4.68	-16.37	-21.05
Religion						
Orthodox	92.70	84.63	79.91	-8.07	-4.72	-12.79
Muslim	97.09	93.60	79.76	-3.49	-13.84	-17.33
Protestant	94.69	92.90	75.45	-1.79	-17.45	-19.24
Others	98.26	94.58	90.42	-3.68	-4.16	-7.84
Women education						
Illiterate	97.79	95.26	83.91	-2.53	-11.35	-13.88
Primary education	92.22	85.05	62.65	-7.17	-22.4	-29.57
Secondary education	50.58	30.41	22.03	-20.17	-8.38	-28.55
Higher education	18.20	24.47	8.53	6.27	-15.94	-9.67
Husband education						
Illiterate	98.29	95.74	83.03	-2.55	-12.71	-15.26
Primary education	95.20	89.95	75.53	-5.25	-14.42	-19.67
Secondary education	78.17	64.99	39.61	-13.18	-25.38	-38.56
Higher education	37.94	45.05	19.06	7.11	-25.99	-18.88
Women occupation						
Not working	94.95	90.23	76.05	-4.72	-14.18	-18.9
Working	94.36	89.90	70.18	-4.46	-19.72	-24.18
Husband occupation						
Not working	65.89	89.81	75.61	23.92	-14.2	9.72
Working	95.37	90.06	70.58	-5.31	-19.48	-24.79
Health facility						
Big problem	96.97	94.36	82.13	-2.61	-12.23	-14.84
Not a big problem	88.43	76.83	60.10	-11.6	-16.73	-28.33
Had ANC						

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No	98.19	96.88	91.50	-1.31	-5.38	-6.69
Yes	82.34	76.64	53.68	-5.7	-22.96	-28.66
Birth order						
1	86.83	79.04	51.01	-7.79	-28.03	-35.82
2-4	95.01	90.19	72.94	-4.82	-17.25	-22.07
>= 5	97.94	95.51	84.85	-2.43	-10.66	-13.09
Parity						
<= 2	87.89	80.62	52.83	-7.27	-27.79	-35.06
2-5	94.52	92.29	78.06	-2.23	-14.23	-16.46
>= 5+	98.03	96.06	86.45	-1.97	-9.61	-11.58
Wealth status						
Poor	99.08	97.38	85.29	-1.7	-12.09	-13.79
Middle	98.14	96.87	77.39	-1.27	-19.48	-20.75
Rich	87.26	76.31	53.98	-10.95	-22.33	-33.28
Residence						
Urban	56.94	50.18	20.60	-6.76	-29.58	-36.34
Rural	97.67	95.95	80.07	-1.72	-15.88	-17.6
Region						
Tigray	94.12	88.36	41.87	-5.76	-46.49	-52.25
Afar	95.95	93.19	85.28	-2.76	-7.91	-10.67
Amhara	96.49	89.82	72.46	-6.67	-17.36	-24.03
Oromia	95.75	92.00	81.10	-3.75	-10.9	-14.65
Somali	95.23	92.40	82.07	-2.83	-10.33	-13.16
Benishangul	94.67	90.89	74.04	-3.78	-16.85	-20.63
SNNPR	96.30	93.79	73.95	-2.51	-19.84	-22.35
Gambela	84.26	72.48	54.38	-11.78	-18.1	-29.88
Harari	68.20	67.63	49.59	-0.57	-18.04	-18.61
Addis Ababa	21.84	17.66	2.98	-4.18	-14.68	-18.86
Dire Dawa	74.90	60.27	42.81	-14.63	-17.46	-32.09
Prevalence	95	90	73	-5	-17	-22
95% CI	94.3, 95.2	89.5, 90.6	72.6, 74.3	-4.8, -4.6	-16.9, -16.3	-21.7, -20.9

Detailed multivariate decomposition logistic regression analysis

Difference due to characteristics (Endowment)

This multivariate decomposition logistic regression analysis revealed that about 39% of the overall change in home delivery was due to differences in compositional characteristics. Among the compositional change factors antenatal care visits, religion, education of women and husband, birth order, wealth index, distance from health facilities, and residence had a statistically significant effect on the change contribution (Table 3).

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Women who had at least one antenatal care visit during pregnancy were more likely to deliver at the health facility. The coverage of antenatal care visit was increased from 28 to 62% in the last decade (Table 1), that had an important compositional contribution to the decline of home delivery by 35%.

Followers of the Protestant sect were more likely to give birth at home than Orthodox Christians. As a result, the increase in the proportion of the Protestant sect followers (Table 1) had a significant rise to home delivery in the last decade. Keeping all other variables constant, the improvement of women's educational status to primary school complete and above before the survey (Table 1) had a positive significant contribution to the decline of the trend.

A decrease in the composition of husband's secondary education level during the surveys (Table 1) hurt on the place of delivery, whereas a rise in the proportion of husbands with higher education had a positive contribution to the decline of home delivery.

Keeping the coefficient characteristics constant, women who had no significant compositional change in the category of birth order between 2-4 (Table 1) had a contribution to the change of home delivery. On the other hand, a decrease in the number of women who had more than five birth order had a positive contribution to the decline of home delivery in the last decade (Table 3). The decline in the proportion of rich wealth status women in the last decade increased the prevalence of home delivery. Accessibility of health facilities had a positive contribution in decreasing home delivery by 2% over the last decade. Women living in rural areas had a high risk of giving birth at home. As shown in table 1, the composition change of rural residence was minimal; this insignificant compositional change significantly increases the prevalence of home delivery over the last decade (Table 3).

Difference due to effects of coefficient (C)

Controlling the roles of change in compositional characteristics, more than two-thirds (61%) of home delivery was declined resulted from behavioral changes towards health facility delivery (Table 3). Antenatal care visits, religion, and birth order had statistically significant effects of coefficient contribution to the observed change in home delivery. Controlling all compositional change factors, 4% of the home delivery was declined due to the change in the behavior of health facility delivery among the antenatal care service visitors over the last decade. Keeping

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compositional change factors constant, women protestant sect flowers hurt the contribution to home delivery over the past decade.

Furthermore, about 25% of the decrement of home delivery over the last decade was resulted from changes in health facility delivery utilization behavior among women who had a birth order two and above (Table 3).

Table 3: Multivariate logistic regression decomposition analysis of home delivery women who gave birth in the last ten years preceding 2005 to 2016 EDHS, Ethiopia.

Variables	Difference due to characteristics (E) Coeff (95% CI)	Pct.	Difference due to coefficient (C) Coeff (95%CI)	Pct.
Age in years				
<20	1	1	1	1
20-34	-0.0026425 (-0.0065794, 0.0012943)	1.2078	0.0097217 (-0.020772, 0.026531)	-1.316
35-49	0.00015715 (-0.000019082,0.00033337)	-0.0718	0.0028792 (-0.0053135, 0.024757)	-4.4434
Religion				
Orthodox	1	1	1	1
Muslim	0.0011654 (-0.00043086, 0.0027617)	-0.53266	0.0019208 (-0.0071241, 0.010966)	-0.87792
protestant	0.0022454 (0.0011048 ,0.0033861) *	-1.0263	0.0067475 (0.00061695, 0.012878) *	-3.084
Others	0.0007805 (0.00022288, 0.0013381)	-0.35674	0.0013868 (-0.00087756, 0.0036511)	-0.63384
Women education				
No education	1	1	1	1
Primary	-0.0045685 (-0.0081609, -0.0009761) *	2.0881	0.0014132 (-0.0034075. 0.0062339)	-0.6460
Secondary	-0.0015069 (-0.0022971, -0.00071672) *	0.68874	0.000085296 (-0.0016957, 0.0018663)	-0.0390
Higher	-0.0030286 (-0.0059084, -0.00014878) *	1.3843	0.00027299 (-0.00021235, 0.00075833)	-0.1248
Husband education				
No education	1	1	1	1
Primary	-0.001852 (-0.0045476, 0.00084366)	0.84646	0.003113 (-0.0053549, 0.011581)	-1.4228
Secondary	0.00084942 (0.00042745, 0.0012714) *	-0.38824	0.0010909 (-0.0027474, 0.0049291)	-0.4986
Higher	-0.0052866 (-0.0080882, -0.0024849) *	2.4163	0.00025019 (-0.00071622, 0.0012166)	-0.11435
women occupation				
Not working	1	1	1	1
Working	0.0006093(-0.011577, 0.012796)	-0.27849	-0.0015175 (-0.014399, 0.011364)	0.69359
Husband occupation				
Not working	1	1	1	1
Working	0.0034081 (-0.033625, 0.040441)	-1.5577	0.033541 (-0.016873, 0.083956)	-15.33
Birth order				
Only one birth	1	1	1	1
2 - 4 birth	0.0015601 (0.00044295, 0.0026773) *	-0.71307	-0.01878 (-0.033508, -0.0040518) *	8.5835
5 and above birth	-0.0003622 (-0.0006497, -0.00007469) *	0.16555	-0.033806 (-0.060462, -0.0071505) *	15.452
ANC visit				
No	1	1	1	1

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Yes	-0.076563 (-0.088698, -0.064428) *	34.994	-0.0081231(-0.016207, -0.000039645) *	3.7127
Wealth status				
Poor	1	1	1	1
Middle	0.0007966 (-1.2357e-06, 0.000077712)	-0.01746	-0.00020032 (-0.0099877, 0.009587)	0.091558
Rich	-0.000038238 (-0.00122, -0.00037319) *	0.34409	0.013165 (0.00021347, 1.026117)	-6.0173
Parity				
<2	1	1	1	1
2-5	0.00111(-0.0019906, 0.00018171)	-0.50733	0.0032984 (-0.0092389, 0 .015836)	-1.5076
Above 5	-0.00090444 (-0.0019906, 0.00018171)	0.41338	0.0049123 (-0.014804, 0.024629)	-2.2452
Distance health				
Not big problem	1	1	1	1
Big problem	-0.0047901(-0.0085384, -0.0010417) *	2.1894	-0.001343(-0.0075911, 0.0049052)	0.61381
Residence				
Urban	1	1	1	1
Rural	0.00007412 (0.000057785, 0.00009046)	-0.03388	0.0058021(-0.022943, 0.034547)	-2.2452
Constants			-0.15848 (-0.23109, -0.085858)	72.433
Overall	**-0.086145(-0.12888, -0.043405) *****	**39.37**	**-0.13264 (-0.087914, -0.087914) *****	**60.63**

Discussion

Women giving birth at health facilities can prevent maternal deaths through getting skilled birth attendance, drugs to address labour complications, and referrals to more advanced health facilities (22). Still, a significant number of women give birth at home however giving birth at health facilities has an invaluable effect in reducing pregnancy-related complications and deaths among women in the reproductive age group. The present study tried to identify the factors that have been contributed to the change in home delivery during the last decade in Ethiopia.

Multivariate decomposition logistic regression analysis relaxes non-linear models comparable to previous decomposition analysis models (23–25). Previous studies were conducted to identify factors that affect home delivery. To the best of our knowledge, there are no studies have been conducted on the place of delivery change through significant factors. This method of analysis was used to examine the trends of home delivery and identify factors that either positively or negatively contributed to the change of home delivery.

Home delivery in Ethiopia declined by around 21% over the last decade, mainly between 2011 to 2016 survey years. This could be due to the launching of the Health Extension Program (HEP) and improving access to health care to meet the primary attention of the MDG agenda (26,27).

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This study revealed that the contribution of behavior (coefficient) changes were more important than that of composition (endowments) changes to the decline of home delivery over the last decade.

Keeping coefficient changes constant, the explained contribution of the change in compositional characteristics to the decline of home delivery was 39% in Ethiopia. The predominant changes in home delivery were due to the proportion of changes in antenatal care visits. Antenatal coverage increased by 34% (Table 1) over the last decade which had a 35% contribution to the decline of home delivery. The possible reason might be the fact that women who had antenatal follow-up were more likely to deliver at health facilities than those who had no follow-ups (18,28–31).

Women having primary school education and above had a positive effect on the decline of home delivery compared to those unable to read and write. This result supported by the evidence that higher educational attainment of women was more likely to give birth at health facilities compared to those unable to read and write (18,29,32,33). Besides, Ethiopia has been worked hard to achieve the Millennium Development Goal agenda that advocates women's education. Also, Ethiopia launched the Growth and Transformation Plan I (GTP I) which gave special attention to women's education (26,34). Therefore, the compositional increment in women's education profile in the last decade had a positive contribution to the decline of home delivery in the country.

As well, higher education of husbands had a significant effect in reducing home delivery. Since the decrease in the number of husbands with secondary school education (Table 1) had a negative contribution to the decline of home delivery. The possible justification might be that educated husbands knew about the importance of health facility delivery and made decisions on the place of delivery.

Another endowment factor that significantly decreased home delivery was birth order. The increase in the proportion of birth order in the survey period resulted in a decrease in home delivery. This finding supports evidences elsewhere women with high birth order delivered at the health facility (29,31). The reason for this finding might be also women with high birth order would have experience with the importance of health facility delivery.

The proportion of Protestant women has increased in the last decade (Table 1) which increases home delivery proportion because such women were more likely to deliver at home compared to Orthodox Christian women. However, whether religion can be a barrier to delivery at the health facility, it needs further investigations.

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The wealth status of women had a significant effect on home delivery. The proportion of rich wealth status women decreased in the survey period and stayed at home to give birth in the last decade. Studies showed that rich wealth status women were more likely to deliver at health facilities than the poor ones (28,29,32).

Furthermore, access to health facilities with less distance had a positive contribution to health facility delivery. This study showed that Ethiopia is working hard to improve access to health services over the last decade and that positively contributed to the decline of home delivery. Distance from health facilities was the main problem that influence women to give birth at home (17,20,29,30,35). Ethiopia disease prevention policy has stepped up work on expanding health facilities to achieve access to primary health care.

The decline of rural residence among women was insignificant in the last decade and posed a negative effect on home delivery reduction. This finding is supported with different studies women living in rural areas gave birth at home than those living in urban settings (17,20,29,35). The possible justification might be that women living in rural areas could not access health facilities easily due to distance.

Controlling the effects of endowment characteristics, about 61% of home delivery reduction was contributed by behavior change to the place of delivery. Significant positive and negative contributions to behavior change in terms of religion, birth order, and ANC visits were noted.

Changes in behavioral characteristics of women in the Protestant sect had a negative effect that could be made ascertain by the fact that Protestant women gave birth at the health facility were low. But no documented evidence that states Protestant religion as a barrier to the place of delivery. Thus, further studies are needed on this issue.

This study indicated that about one-fourth of the decrement in home delivery over the last decade was the change in behavior related to health facility delivery among women who had two and above birth orders. The possible reason might be women with high birth order experienced different maternal health care services and had adequate health education from the health care personnel.

Another incredible factor that positively contributed to the decline to home delivery preceding the survey was antenatal care visits. Women who received antenatal care during pregnancy were more likely to give birth at the health facility compared to their counterparts (29,36,37). Women who had antenatal visits might have obtained health education about the importance of health facility

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delivery from health care professionals which might have changed their behavior towards health facility delivery.

Since this study encompasses three waves of nationally representative demographic and health survey data, which could enhance the generalizability of the findings. Also, multivariate decomposition logistic regression analysis used to identify factors that positively or negatively contributed to the decline of home delivery in Ethiopia could help policymakers to design interventions. However, the study limitation needs to be considered when interpreting results. One limitation of this study could be recall and social desirability bias as data was collected by a self-reported interview.

Conclusion and recommendations

In the last decade, home delivery in Ethiopia was decline substantially, but this remains unacceptable high. More than one-third of the decrement in home delivery was attributed to the changes in women's compositional characteristics, while two-thirds were attributed to behavioral changes towards health facility delivery over the past ten years. The compositional change in antenatal care visits, educational status of women and husband, birth order, religion, and distance to health facilities were significantly associated with the decline in home delivery. Antenatal care visits, birth order, and religion were significantly associated with the home delivery due to coefficients change.

The Ministry of Health and other stakeholders should continue the current effort to increase heath facility-based delivery through access to health care services and strengthen the coverage of antenatal care visits thereby to achieve SDGs goal. The Ministry of Education should strengthen girls' empowerment through education. Researchers need to further explore the barriers of maternal home delivery from religion perspective.

Declaration

Data Availability

The data is available from the corresponding author and we can provide upon reasonable request.

Consent for publication

Not applicable

Competing Interest

The authors, declare that we had no competing interests.

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Author Contributions

SAT, ZTT, and STY were involved in this study from the inception to design, acquisition of data, data cleaning, data analysis and interpretation and drafting and revising of the manuscript. AML and MMS were involved in project administration, principal supervision, and revising the final manuscript**.** All authors read and approved the final manuscript.

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Figure legend:

Figure 1: The trend of home delivery from 2005 to 2016 EDHS surveys five years preceding each survey years.

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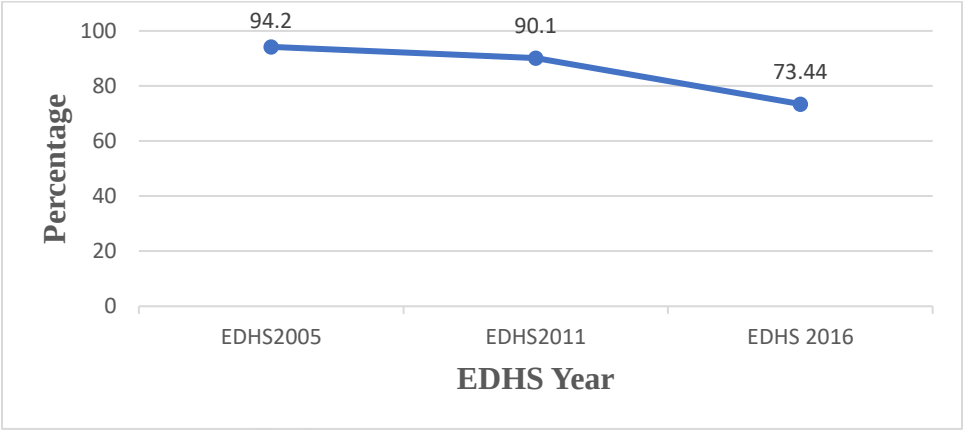

Figure 1: The trend of home delivery from 2005 to 2016 EDHS surveys five years preceding each survey years.

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Complete this checklist by entering the page numbers from your manuscript where readers will find each of the items listed below.

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		Reporting Item	Page Number
Title and abstract			
Title	#1a	The study's design was included in the abstract part	2
Abstract	#1b	Provide in the abstract an informative and balanced summary of what was done and what was found	2

Introduction			
Background / rationale	#2	Explain the scientific background and rationale for the nvestigation being reported	3-4
Objectives	#3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	#4	Present key elements of study design early in the paper	4
Setting	#5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Eligibility criteria	#6a	Give the eligibility criteria, and the sources and methods of selection of participants.	4
	#7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5
Data sources / measurement	#8	For each variable of interest give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group. Give information separately for for exposed and unexposed groups if applicable.	4
Bias	#9	Describe any efforts to address potential sources of bias	n/a
Study size	#10	Explain how the study size was arrived at	4
Quantitative	#11	Explain how quantitative variables were handled in the	5

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variables		analyses. If applicable, describe which groupings were chosen, and why	
Statistical methods	#12a	Describe all statistical methods, including those used to control for confounding	5
Statistical methods	#12b	Describe any methods used to examine subgroups and interactions	n/a
Statistical methods	#12c	Explain how missing data were addressed	n/a
Statistical methods	#12d	If applicable, describe analytical methods taking account of sampling strategy	n/a
Statistical methods	#12e	Describe any sensitivity analyses	n/a
Results			
Participants	#13a	Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed. Give information separately for for exposed and unexposed groups if applicable.	6
Participants	#13b	Give reasons for non-participation at each stage	n/a
Participants	#13c	Consider use of a flow diagram	n/a
Descriptive data	#14a	Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential	7

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		confounders. Give information separately for exposed and unexposed groups if applicable.	
Descriptive data	#14b	Indicate number of participants with missing data for each variable of interest	n/a
Outcome data	#15	Report numbers of outcome events or summary measures. Give information separately for exposed and unexposed groups if applicable.	n/a
Main results	#16a	Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	12
Main results	#16b	Report category boundaries when continuous variables were categorized	n/a
Main results	#16c	If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	#17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	n/a
Discussion			
Key results	#18	Summarise key results with reference to study objectives	13
Limitations	#19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias.	15

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Interpretation	#20	Give a cautious overall interpretation considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence.	
Generalisability	#21	Discuss the generalisability (external validity) of the results	n/a

Other Information

Funding	#22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	16

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