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

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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3 In Ethiopian several studies evidenced that women's low educational status, cultural and
4 communal factors, limited access to health facilities, poor quality of care, lack of roads, and poor
5 wealth status were significant factors that led to low maternal health service utilization (13,15–
6 17). On the other hand, taking at least one antenatal care during pregnancy, high parity, education
7 of women, urban residence, husband attitude towards institutional delivery, easy access to health
8 facilities, and wealth status contributed to health facility delivery (17–20). The trend of home
9 delivery decreased between 2005 to 2016. To date, there is no evidence that identifies the factors
10 that have contributed to the observed reduction in home delivery during the survey.
11

12 Therefore, this multivariate decomposition analysis aimed to identify trends and factors that either
13 positively or negatively contributed to the change for home delivery in order to contribute to
14 improving health facility delivery. The study will help health planners and policymakers in
15 planning to further reduce home delivery and provide baseline information to other researchers.
16

17 **Methods and materials**

18 **Study design, area and period**

19 The data for this study accessed from nationally representative 2005, 2011 and 2016 Ethiopian
20 Demographic and Health Surveys (EDHS). Ethiopia is laying between latitude 3° and 14°N, and
21 longitude 33° and 48°E in the horn of Africa. Ethiopia has a total area of 1,100,000 km² and nine
22 regional states, namely Afar, Amhara, Benishangul-Gumuz, Gambela, Harari, Oromia, Somali,
23 Southern Nations Nationalities and Peoples of Region (SNNPR) and Tigray plus Addis Ababa and
24 Dire Dawa city Administrations.
25

26 **Source and study populations**

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

36 The 2016 EDHS sample was stratified and selected at two stages. Each region of the country was
37 stratified into urban and rural areas, yielding 21 sampling strata. In the first stage, 645 EAs were
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3 selected with a probability proportional to the EA size and with independent selection in each
4 sampling stratum. In the second stage of selection, a fixed number of 28 households per cluster
5 were selected with an equal probability systematic selection from the newly created household
6 listing. The detailed sampling procedure is available in the Ethiopian Demographic and Health
7 Survey reports from Measure DHS website (www.dhsprogram.com).
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10 11 **Outcome variable**

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13 The outcome variable was taken as a binary response: a woman gave birth at home coded as home
14 delivery, and women who gave birth at different government, private, and non-government health
15 facilities were taken as health facility delivery.
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18 19 **Predictor variables**

20 All sociodemographic and obstetric characteristics were taken as predictor variables for the three-
21 consecutive surveys.
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24 25 **Patient and public involvement**

26 The patients and the public were not involved for this secondary data analysis. But for original
27 survey the issue of patient and public involvement were considered; Since biomarkers such as
28 anthropometry, anaemia and HIV testing were collected from each household for each survey (21–
29 23).
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32 33 **Statistical analysis**

34 The data were cleaned and analyzed using STATA version 14.1 software. Sample weighting was
35 done for further analysis. Descriptive statistics were done for the description of the variables. A
36 multivariate decomposition logistic regression analysis was done to identify the contributions to
37 group differences to average predictions (24). The purpose of this decomposition analysis was to
38 identify factors that contributed to the change in home delivery in the last decade in Ethiopia.
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42 A nonlinear multivariate logit decomposition model was used to identify the contribution of
43 proportion change to home delivery over the last decade. The output from the multivariate
44 decomposition logistic regression analysis had two contribution effects. These effects were the
45 compositional differences (endowments) “E” and the effects of characteristics that are the
46 difference in the coefficients or behavioural change “C” responses for the selected predictor
47 variables. In the nonlinear model, the dependent variable is a function of a linear combination of
48 predictors and regression coefficients:
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$Y = F(X\beta) = \text{logit}(Y) = x\beta$, where Y denotes the $N \times 1$ dependent variable vector, X an $N \times K$ matrix of independent variables, and β a $K \times 1$ 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

$$\begin{aligned} \text{Logit}(Y_A) - \text{logit}(Y_B) &= F(X_A\beta_A) - F(X_B\beta_B) \\ &= \underbrace{F(X_A\beta_A) - F(X_B\beta_A)}_E + \underbrace{F(X_B\beta_A) - F(X_B\beta_B)}_C \end{aligned} \text{ is group decomposition (24)}$$

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:

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

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,

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 \pm SD	29.01 \pm 6.95	29.04 \pm 6.63	29.23 \pm 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

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).

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	EDHS 2011	EDHS 2016	Percentage point difference in home delivery		
	N= 10,721	N= 11,872	N= 10,889	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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3 Keeping all other variables constant, the improvement of women's educational status to primary
4 school complete and above before the survey (Table 1) had a positively significant contribution to
5 the decline of the trend.
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8 A decreased in the number of secondary school educated husbands during the surveys (Table 1)
9 had a negative effect on the place of delivery, which a rise in the proportion of husbands with
10 higher education had a positive contribution to the decline of home delivery.
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13 Keeping the coefficient characteristics constant, women who had no significant change in the
14 number of birth orders (from 2-4) (Table 1) had a contribution to the rate of home delivery. On
15 the other hand, a decrease in the number of women who had more than five birth order had a
16 positive contribution to the decline of home delivery in the last decade. (Table 3)
17
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19 The decline in the proportion of rich women in the last decade increased the prevalence of home
20 delivery. Accessibility of health facility had a positive contribution to decreasing home delivery
21 by 2% over the last decade. Women living in rural areas had a risk of giving birth at home. As
22 shown in Table 1, the composition change of rural residence was minimal, this insignificant
23 compositional change significantly rose the prevalence of home delivery over the last decade
24 (Table 3).
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30 **Difference due to effects of coefficient (C)**

31 Controlling the roles of change in compositional characteristics resulted in the decline of two-
32 thirds of home delivery due to behavioural change towards health facility delivery (Table 3).
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35 Antenatal care visits, religion, and birth order had statistically significant effects of coefficient
36 contribution to the observed change in home delivery. Controlling all compositional change
37 factors, 4% of the home delivery decline was due to the change in the behaviour of health facility
38 delivery among the ANC service visitors over the last decade.
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41 Keeping compositional factors constant, Protestant women indicated that the observed changes
42 in home delivery over the past decade had negative effects on the contribution.
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45 Furthermore, about 25% of the decline of home delivery over the last decade was due to changes
46 in health facility delivery use behaviour among women who had a birth order two and above (Table
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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

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

12
13 As well, higher education of husbands had a significant effect on home delivery. Even since the
14 compositional change, the decrease in the number of husbands with secondary school education
15 (Table 1) had a negative contribution to the decline of home delivery. The possible justification
16 might be that educated husbands had knowledge about the importance of health facility delivery
17 and make decisions on the place of delivery.

18
19 Another endowment factor that significantly decreased home delivery was birth order. The
20 increase in the proportion of birth order in the survey period resulted in a decrease in home
21 delivery. This finding supports the evidence that women with high birth order deliver at health
22 facilities (32,34).

23
24 The proportion of protestant women increased in the last decade (Table 1) increasing to home
25 delivery because such women were more likely to deliver at home compared to Orthodox Christian
26 women. However, whether religion can a barrier to delivery at health facilities, it needs further
27 investigations.

28
29 Wealth status of women had a significant effect on home delivery. The number of rich women
30 decreased in the survey period and staying at home to give birth in the last decade. Studies showed
31 that richer women were more likely to deliver at health facilities than the poorer ones (31,32,35).
32 Furthermore, distance to health facilities had a positive contribution to the place of delivery. This
33 study showed that the inaccessibility of health facilities decreased in Ethiopia over the last decade
34 and that positively contributed to the decline of home delivery. Distance from health facilities was
35 a big problem that added to giving birth at home (17,20,32,33,38). The Ethiopia disease prevention
36 policy has stepped up work on expanding health facilities to achieve access to primary health care
37 in addition to the Extension program.

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3 The decline of rural residence among women was insignificant in the last decade and posed a
4 negative impact on home delivery reduction. Studies evidenced that women living in rural areas
5 gave birth at home than those living in urban settings (17,20,32,38). The possible justification
6 might be that women living in rural areas could not get health facilities easily due to distance.
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9
10 Controlling the effects of endowment characteristics, about 61% of the home delivery decline was
11 contributed by behaviour change to the place of delivery. Significant positive and negative
12 contributions of behaviour change in terms of religion, birth order, and ANC visits were noted.
13

14
15 Changes in behavioural characteristics of women in the Protestant sect had a negative impact could
16 be made certain by the fact that at health facility delivery of the women was low. But no
17 documented evidence could be cited to show that religion was a barrier to protestant women choice
18 to deliver at home. Thus, further studies on the issue are necessary.
19

20
21 This study indicated that about one-fourth of the decrease in home delivery over the last decade
22 was the change in behaviour relating to health facility delivery among women who had two and
23 above birth orders. The possible reason might be women with high birth order might be
24 experienced different maternal health care services and had adequate health education from the
25 health care personnel.
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28
29 Another incredible factor that positively contributed to the decline to home delivery preceding the
30 survey was antenatal care visits. Women who received antenatal care during pregnancy were more
31 likely to give birth at health facilities compared to their counterparts (32,39,40). Women who had
32 ANC visits might have obtained health education about health facility delivery from skilled health
33 care professionals which might have changed their behaviour towards health facility delivery.
34
35

36 **Conclusion and recommendation**

37
38 The trend of home delivery among the reproductive age group of women declined significantly in
39 the last decade although it is still unacceptable. In multivariate decomposition logistic regression
40 analysis, about 39% of the home delivery decline was contributed by the changes in compositional
41 characteristics. The proportional changes in antenatal care visits, educational status of women and
42 husbands, birth order, religion, and distance to health facilities were significantly associated with
43 the decrease in home delivery. Around two-thirds of home delivery decline was due to the changes
44 in behaviour towards health facility delivery in the last decade. Antenatal care visits, birth order,
45 and religion were significantly associated factors to the place of delivery due to coefficients
46 change.
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3 The Ministry of Health and other stakeholders should continue to enhance the coverage of
4 antenatal care visits and enhance the accessibility of health care facilities. The Ministry of
5 Education should advance the empowerment of girls through education. Researchers need to
6 further investigate the low use of health facility delivery among protestant women.
7
8
9

10 **Declaration**

11 **Data Availability**

12 The data was available from the corresponding author and we can provide upon request.
13

14 **Consent for publication**

15 Not applicable
16

17 **Competing Interest**

18 We, the authors, declare that we had no competing interests.
19

20 **Funding Statement**

21 We didn't receive any fund for this study.
22

23 **Author Contributions**

24 SAT, ZTT, and STY were involved for this study from the inception to design, acquisition of data,
25 data cleaning, data analysis and interpretation and drafting and revising of the manuscript. AML
26 and MMS were involved in project administration, principal supervision, and revising the final
27 manuscript. All authors read and approved the final manuscript.
28

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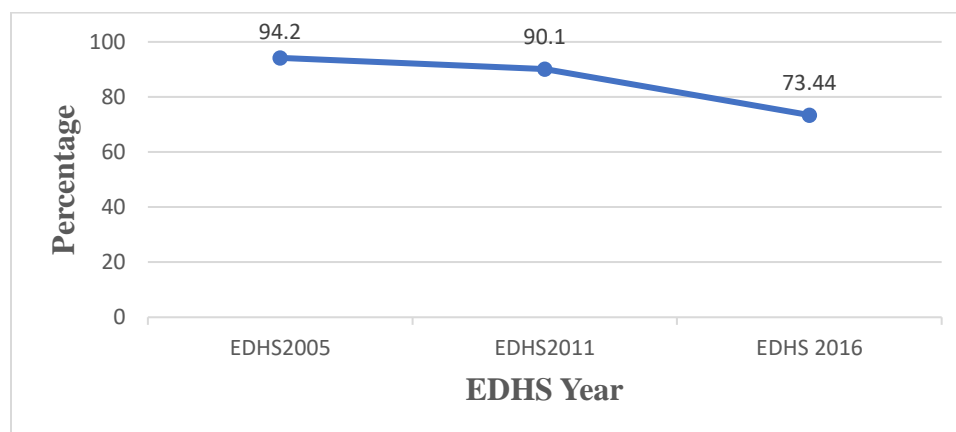


Figure 1: The trend of home delivery from 2005 to 2016 EDHS surveys five years preceding each survey years.

Reporting checklist for cross sectional study.

Based on the STROBE cross sectional guidelines.

Instructions to authors

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

Your article may not currently address all the items on the checklist. Please modify your text to include the missing information. If you are certain that an item does not apply, please write "n/a" and provide a short explanation.

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In your methods section, say that you used the STROBE cross sectional reporting guidelines, and cite them as:

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			Page
		Reporting Item	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

of what was done and what was found

Introduction

Background / [#2](#) Explain the scientific background and rationale for the 3-4
 rationale investigation being reported

Objectives [#3](#) State specific objectives, including any prespecified 4
 hypotheses

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 4
 periods of recruitment, exposure, follow-up, and data collection

Eligibility criteria [#6a](#) Give the eligibility criteria, and the sources and methods of 4
 selection of participants.

[#7](#) Clearly define all outcomes, exposures, predictors, potential 5
 confounders, and effect modifiers. Give diagnostic criteria, if
 applicable

Data sources / [#8](#) For each variable of interest give sources of data and details of 4
 measurement 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.

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

1	Quantitative	#11	Explain how quantitative variables were handled in the	5
2				
3	variables		analyses. If applicable, describe which groupings were chosen,	
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5			and why	
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8	Statistical	#12a	Describe all statistical methods, including those used to control	5
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10	methods		for confounding	
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13	Statistical	#12b	Describe any methods used to examine subgroups and	n/a
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15	methods		interactions	
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17	Statistical	#12c	Explain how missing data were addressed	n/a
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19	methods			
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21	Statistical	#12d	If applicable, describe analytical methods taking account of	n/a
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23	methods		sampling strategy	
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25	Statistical	#12e	Describe any sensitivity analyses	n/a
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38	Participants	#13a	Report numbers of individuals at each stage of study—eg	6
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40			numbers potentially eligible, examined for eligibility, confirmed	
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42			eligible, included in the study, completing follow-up, and	
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44			analysed. Give information separately for for exposed and	
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46			unexposed groups if applicable.	
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50	Participants	#13b	Give reasons for non-participation at each stage	n/a
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53	Participants	#13c	Consider use of a flow diagram	n/a
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56	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.

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8	Descriptive data	#14b	Indicate number of participants with missing data for each variable of interest
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13	Outcome data	#15	Report numbers of outcome events or summary measures. Give information separately for exposed and unexposed groups if applicable.
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21	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
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31	Main results	#16b	Report category boundaries when continuous variables were categorized
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36	Main results	#16c	If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
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42	Other analyses	#17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses
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47	Discussion		
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50	Key results	#18	Summarise key results with reference to study objectives
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53	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.
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1 Interpretation [#20](#) Give a cautious overall interpretation considering objectives,
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3 limitations, multiplicity of analyses, results from similar studies,
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5 and other relevant evidence.
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9 Generalisability [#21](#) Discuss the generalisability (external validity) of the results n/a
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12 Other Information

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15 Funding [#22](#) Give the source of funding and the role of the funders for the 16
16 present study and, if applicable, for the original study on which
17
18 the present article is based
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23 None The STROBE checklist is distributed under the terms of the Creative Commons Attribution
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25 made by the [EQUATOR Network](#) in collaboration with [Penelope.ai](#)
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BMJ Open

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

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

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.

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

1
2
3 Ethiopia, the magnitude of home delivery was 94.5% in 2000, 93.1% in 2005, 87.9% in 2011 and
4 73.6% in 2016 which was unacceptably high (13,14).

5
6 In Ethiopian several studies evidenced that women's low educational status, cultural and
7 communal factors, limited access to health facilities, poor quality of care, lack of roads, and poor
8 wealth status were significant factors that led to low maternal health service utilization (13,15–
9 17). On the other hand, taking at least one antenatal care during pregnancy, high parity, educated
10 women, urban residence, husband attitude towards health facility delivery, easy access to health
11 facilities, and wealth status contributed to health facility delivery (17–20). The trend of home
12 delivery decreased between 2005 to 2016. To date, no evidence that identifies the factors that have
13 contributed to the observed reduction in home delivery during the last decade.

14
15 Therefore, this multivariate decomposition analysis aimed to identify trends and factors that either
16 positively or negatively contributed to the change for home delivery. The study will help health
17 planners and policymakers in planning to further reduction of home delivery and provide baseline
18 information to other researchers.

19 20 **Methods and materials**

21 22 **Study design, area, and period**

23
24 Nationally representative repeated cross-sectional study design was employed using 2005, 2011
25 and 2016 Ethiopian Demographic and Health Surveys (EDHS). Ethiopia is laying between latitude
26 3° and 14°N, and longitude 33° and 48°E in the horn of Africa. Ethiopia has a total area of
27 1,100,000 km² and nine regional states, namely Tigray, Afar, Amhara, Benishangul-Gumuz,
28 Gambela, Harari, Oromia, Somali, and Southern Nations Nationalities and Peoples of Region
29 (SNNPR) plus Addis Ababa and Dire Dawa city Administrations.

30 31 **Source and study populations**

32
33 The source populations were all reproductive age group women who gave birth five years
34 preceding each survey. The study populations were all reproductive-age women who gave birth
35 five years preceding each survey in the selected Enumeration Areas (EAs). In each survey, a
36 nationally representative samples of 10721 in 2005, 11872 in 2011, and 10889 in 2016 weighted
37 number of women participated. Recorded data were accessed at www.messdhs.com on request
38 with the assistance of ICF International, Inc.

39 40 **Data collection tools and procedures**

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2
3 The data was collected in two-stage stratified sampling techniques in each survey. Each region of
4 the country was stratified into urban and rural areas. In the first stage, 645 in 2016, 624 in 2011,
5 and 540 in 2005 EAs were selected. In the second stage, a fixed number of households per cluster
6 (EAs) were selected with an equal probability systematic selection from the newly created
7 household listing. The detailed sampling procedure is available in the Ethiopian Demographic and
8 Health Survey reports from Measure DHS website (www.dhsprogram.com) for each specific
9 surveys.

15 **Outcome variable**

16
17 The outcome variable was taken as a binary response; a woman gave birth at home coded as home
18 delivery, and women who gave birth at different (government, private, and non-government)
19 health facilities were taken as health facility delivery.

22 **Independent variables**

23
24 All sociodemographic and obstetric characteristics were taken as independent variables for the
25 three-consecutive surveys.

27 **Patient and public involvement**

28
29 The patients and the public were not involved for this secondary data analysis. But for the original
30 survey the issue of patient and public involvement were considered; Since biomarkers such as
31 anthropometry, anaemia and HIV testing were collected from each household for each survey (21–
32 23).

36 **Statistical analysis**

37
38 The data were cleaned and analyzed using STATA version 14.1 software. Sample weighting was
39 done for further analysis. Descriptive statistics were done for the description of the variables. A
40 multivariate decomposition logistic regression analysis was done to identify the contributions to
41 group differences to average predictions (24). The purpose of this decomposition analysis was to
42 identify factors that contributed to the change in home delivery in the last decade in Ethiopia.

43
44 A nonlinear multivariate logit decomposition model was used to identify the contribution of
45 proportion change to home delivery over the last decade. The output from the multivariate
46 decomposition logistic regression analysis had two contribution effects. These effects were the
47 compositional differences (endowments) “E” and the effects of characteristics that are the
48 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 $N \times 1$ dependent variable vector, X an $N \times K$ matrix of independent variables, and β a $K \times 1$ 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

$$\begin{aligned} \text{Logit}(Y_A) - \text{logit}(Y_B) &= F(X_A\beta_A) - F(X_B\beta_B) \\ &= \underbrace{F(X_A\beta_A) - F(X_B\beta_A)}_E + \underbrace{F(X_B\beta_A) - F(X_B\beta_B)}_C \end{aligned} \text{ is group decomposition (24)}$$

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:

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

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.

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 (\pm 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 \pm SD	29.01 \pm 6.95	29.04 \pm 6.63	29.23 \pm 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
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 2011 to 2016 with a 17% drop and in the survey period 2005 to 2011 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).

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	EDHS 2011	EDHS 2016	Percentage point difference in home delivery		
	N= 10,721	N= 11,872	N= 10,889	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

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				

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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3 to those unable to read and write (18,32,35,36). Meanwhile, Ethiopia has been worked hard to
4 achieve the Millennium Development Goal agenda that advocates women's educational
5 attainment. In addition, Ethiopia launched the Growth and Transformation Plan I (GTP I) which
6 gave special attention to women's education (29,37). Therefore, the compositional increase in
7 women's education in the last decade had a positive contribution to the decline of home delivery
8 in the country.
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13 As well, higher education of husbands had a significant effect on home delivery. Since the decrease
14 in the number of husbands with secondary school education (Table 1) had a negative contribution
15 to the decline of home delivery. The possible justification might be that educated husbands knew
16 about the importance of health facility delivery and make decisions on the place of delivery.
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20 Another endowment factor that significantly decreased home delivery was birth order. The
21 increase in the proportion of birth order in the survey period resulted in a decrease in home
22 delivery. This finding supports the evidence that women with high birth order deliver at the health
23 facility (32,34). The reason for this finding will be also women with high birth order would have
24 experience about the importance of health facility delivery.
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29 The proportion of protestant women increased in the last decade (Table 1) which increases home
30 delivery proportion because such women were more likely deliver at home compared to Orthodox
31 Christian women. However, whether religion can a barrier to delivery at health facility, it needs
32 further investigations.
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37 Wealth status of women had a significant effect on home delivery. The number of rich women
38 decreased in the survey period and staying at home to give birth in the last decade. Studies showed
39 that rich women were more likely deliver at health facilities than the poor ones (31,32,35).
40 Furthermore, distance to health facilities had a positive contribution to the place of delivery. This
41 study showed that the inaccessibility of health facilities decreased in Ethiopia over the last decade
42 and that positively contributed to the decline of home delivery. Distance from health facilities was
43 a big problem that added to give birth at home (17,20,32,33,38). Ethiopia disease prevention policy
44 has stepped up work on expanding health facilities to achieve access to primary health care in
45 addition to the Extension program.
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50 The decline of rural residence among women was insignificant in the last decade and posed a
51 negative impact on home delivery reduction. Studies evidenced that women living in rural areas
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3 gave birth at home than those living in urban settings (17,20,32,38). The possible justification
4 might be that women living in rural areas could not get health facilities easily due to distance.

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6 Controlling the effects of endowment characteristics, about 61% of home delivery decline was
7 contributed by behaviour change to the place of delivery. Significant positive and negative
8 contributions of behaviour change in terms of religion, birth order, and ANC visits were noted.
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11 Changes in behavioural characteristics of women in the Protestant sect had a negative impact could
12 be made certain by the fact that at health facility delivery of the women was low. But no
13 documented evidence showed that protestant religion follower women were a barrier for the place
14 of delivery. Thus, further studies needed on this issue.
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17 This study indicated that about one-fourth of the decrease in home delivery over the last decade
18 was the change in behaviour relating to health facility delivery among women who had two and
19 above birth orders. The possible reason might be women with high birth order experienced
20 different maternal health care services and had adequate health education from the health care
21 personnel.
22

23
24 Another incredible factor that positively contributed to the decline to home delivery preceding the
25 survey was antenatal care visits. Women who received antenatal care during pregnancy were more
26 likely to give birth at the health facility compared to their counterparts (32,39,40). Women who
27 had antenatal visits might have obtained health education about the importance of health facility
28 delivery from health care professionals which might have changed their behaviour towards health
29 facility delivery.
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31 32 33 **Conclusion and recommendation**

34
35 The trend of home delivery among the reproductive age group of women declined significantly in
36 the last decade although it is still unacceptable. In multivariate decomposition logistic regression
37 analysis, about 39% of the home delivery decline was contributed by the changes in compositional
38 characteristics of the women. The proportional changes in antenatal care visits, educational status
39 of women and husband, birth order, religion, and distance to health facilities were significantly
40 associated with the decrease in home delivery. Around two-thirds of home delivery decline was
41 due to the changes in behaviour towards health facility delivery in the last decade. Antenatal care
42 visits, birth order, and religion were significantly associated factors to place of delivery due to
43 coefficients change.
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3 The Ministry of Health and other stakeholders should continue to enhance the coverage of
4 antenatal care visits and the accessibility of health care facilities. The Ministry of Education should
5 advance the empowerment of girls through education. Researchers need to further investigate the
6 low use of health facility delivery among protestant women.
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10 **Declaration**

11 **Data Availability**

12 The data was available from the corresponding author and we can provide upon request.
13

14 **Consent for publication**

15 Not applicable
16

17 **Competing Interest**

18 We, the authors, declare that we had no competing interests.
19

20 **Funding Statement**

21 We did not receive any fund for this study.
22

23 **Author Contributions**

24 SAT, ZTT, and STY were involved for this study from the inception to design, acquisition of data,
25 data cleaning, data analysis and interpretation and drafting and revising of the manuscript. AML
26 and MMS were involved in project administration, principal supervision, and revising the final
27 manuscript. All authors read and approved the final manuscript.
28

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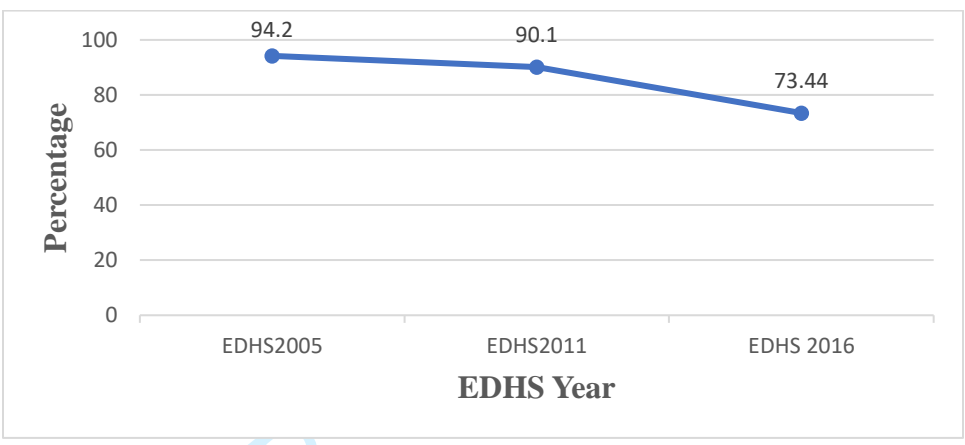


Figure 1: The trend of home delivery from 2005 to 2016 EDHS surveys five years preceding each survey years.

Peer review only

Reporting checklist for cross sectional study.

Based on the STROBE cross sectional guidelines.

Instructions to authors

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

Your article may not currently address all the items on the checklist. Please modify your text to include the missing information. If you are certain that an item does not apply, please write "n/a" and provide a short explanation.

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In your methods section, say that you used the STROBE cross sectional reporting guidelines, and cite them as:

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			Page
	Reporting Item		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

1	Introduction			
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3				
4	Background /	#2	Explain the scientific background and rationale for the	3-4
5	rationale		investigation being reported	
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9	Objectives	#3	State specific objectives, including any prespecified	4
10			hypotheses	
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15	Methods			
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18	Study design	#4	Present key elements of study design early in the paper	4
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21	Setting	#5	Describe the setting, locations, and relevant dates, including	4
22			periods of recruitment, exposure, follow-up, and data collection	
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26	Eligibility criteria	#6a	Give the eligibility criteria, and the sources and methods of	4
27			selection of participants.	
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32		#7	Clearly define all outcomes, exposures, predictors, potential	5
33			confounders, and effect modifiers. Give diagnostic criteria, if	
34			applicable	
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39	Data sources /	#8	For each variable of interest give sources of data and details of	4
40	measurement		methods of assessment (measurement). Describe	
41			comparability of assessment methods if there is more than one	
42			group. Give information separately for for exposed and	
43			unexposed groups if applicable.	
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51	Bias	#9	Describe any efforts to address potential sources of bias	n/a
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55	Study size	#10	Explain how the study size was arrived at	4
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58	Quantitative	#11	Explain how quantitative variables were handled in the	5
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1	variables		analyses. If applicable, describe which groupings were chosen,	
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3			and why	
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6	Statistical	#12a	Describe all statistical methods, including those used to control	5
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8	methods		for confounding	
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11	Statistical	#12b	Describe any methods used to examine subgroups and	n/a
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13	methods		interactions	
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16	Statistical	#12c	Explain how missing data were addressed	n/a
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18	methods			
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22	Statistical	#12d	If applicable, describe analytical methods taking account of	n/a
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24	methods		sampling strategy	
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27	Statistical	#12e	Describe any sensitivity analyses	n/a
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29	methods			
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32	Results			
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36	Participants	#13a	Report numbers of individuals at each stage of study—eg	6
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38			numbers potentially eligible, examined for eligibility, confirmed	
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40			eligible, included in the study, completing follow-up, and	
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42			analysed. Give information separately for for exposed and	
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44			unexposed groups if applicable.	
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48	Participants	#13b	Give reasons for non-participation at each stage	n/a
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51	Participants	#13c	Consider use of a flow diagram	n/a
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54	Descriptive data	#14a	Give characteristics of study participants (eg demographic,	7
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56			clinical, social) and information on exposures and potential	
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1		confounders. Give information separately for exposed and	
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3		unexposed groups if applicable.	
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6	Descriptive data	#14b Indicate number of participants with missing data for each	n/a
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8		variable of interest	
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11	Outcome data	#15 Report numbers of outcome events or summary measures.	n/a
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13		Give information separately for exposed and unexposed	
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15		groups if applicable.	
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19	Main results	#16a Give unadjusted estimates and, if applicable, confounder-	12
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21		adjusted estimates and their precision (eg, 95% confidence	
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23		interval). Make clear which confounders were adjusted for and	
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25		why they were included	
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29	Main results	#16b Report category boundaries when continuous variables were	n/a
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31		categorized	
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34	Main results	#16c If relevant, consider translating estimates of relative risk into	n/a
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36		absolute risk for a meaningful time period	
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39	Other analyses	#17 Report other analyses done—e.g., analyses of subgroups and	n/a
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41		interactions, and sensitivity analyses	
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45	Discussion		
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48	Key results	#18 Summarise key results with reference to study objectives	13
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51	Limitations	#19 Discuss limitations of the study, taking into account sources of	15
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53		potential bias or imprecision. Discuss both direction and	
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55		magnitude of any potential bias.	
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1	Interpretation	#20	Give a cautious overall interpretation considering objectives,	
2			limitations, multiplicity of analyses, results from similar studies,	
3			and other relevant evidence.	
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9	Generalisability	#21	Discuss the generalisability (external validity) of the results	n/a
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Other Information

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

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.

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

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3 childbirth before, during and after delivery can save the lives of women, in sub-Saharan Africa
4 only 59% of births were attended by skilled health personnel between 2012 and 2017 (12). In
5 Ethiopia, the magnitude of home delivery was 94.5% in 2000, 93.1% in 2005, 87.9% in 2011, and
6 73.6% in 2016 which was unacceptably high (13,14).
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10 In Ethiopian several studies evidenced that women's low educational status, cultural and
11 communal factors, limited access to health facilities, poor quality of care, lack of roads, and poor
12 wealth status were significant factors that led to low maternal health service utilization (13,15–
13 17). On the other hand, taking at least one antenatal care during pregnancy, high parity, educated
14 women, urban residence, husband attitude towards health facility delivery, easy access to health
15 facilities, and wealth status contributed to health facility delivery (17–20). The trend of home
16 delivery decreased between 2005 to 2016. To date, no evidence that identifies the factors that have
17 contributed to the observed reduction in home delivery during the last decade.
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24 Therefore, this multivariate decomposition analysis aimed to identify trends and factors that either
25 positively or negatively contributed to the change for home delivery. The study will help health
26 planners and policymakers in planning to further reduction of home delivery and provide baseline
27 information to other researchers.
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31 **Methods and materials**

32 **Study design, area, and period**

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34 The nationally representative repeated cross-sectional study design was employed using 2005,
35 2011, and 2016 Ethiopian Demographic and Health Surveys (EDHS). Ethiopia is laying between
36 latitude 3° and 14°N, and longitude 33° and 48°E in the horn of Africa. Ethiopia has a total area
37 of 1,100,000 km² and nine regional states, namely Tigray, Afar, Amhara, Benishangul-Gumuz,
38 Gambela, Harari, Oromia, Somali, and Southern Nations Nationalities and Peoples of Region
39 (SNNPR) plus Addis Ababa and Dire Dawa city Administrations.
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45 **Source and study populations**

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

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

$$\begin{aligned} \text{Logit}(Y_A) - \text{logit}(Y_B) &= F(X_A\beta_A) - F(X_B\beta_B) \\ &= \underbrace{F(X_A\beta_A) - F(X_B\beta_A)}_E + \underbrace{F(X_B\beta_A) - F(X_B\beta_B)}_C \end{aligned} \text{ is group decomposition (24)}$$

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:

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

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.

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 \pm SD	29.01 \pm 6.95	29.04 \pm 6.63	29.23 \pm 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
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 2011 to 2016 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.

Individual variables	EDHS 2005	EDHS 2011	EDHS 2016	Percentage point difference in home delivery		
	N= 10,721	N= 11,872	N= 10,889	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

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

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				

1					
2					
3	<20	1	1	1	1
4	20-34	-0.0026425 (-0.0065794, 0.0012943)	1.2078	0.0097217 (-0.020772, 0.026531)	-1.316
5	35-49	0.00015715 (-0.000019082, 0.00033337)	-0.0718	0.0028792 (-0.0053135, 0.024757)	-4.4434
6					
7	Religion				
8	Orthodox	1	1	1	1
9	Muslim	0.0011654 (-0.00043086, 0.0027617)	-0.53266	0.0019208 (-0.0071241, 0.010966)	-0.87792
10	protestant	0.0022454 (0.0011048, 0.0033861) *	-1.0263	0.0067475 (0.00061695, 0.012878) *	-3.084
11	Others	0.0007805 (0.00022288, 0.0013381)	-0.35674	0.0013868 (-0.00087756, 0.0036511)	-0.63384
12					
13	Women education				
14	No education	1	1	1	1
15	Primary	-0.0045685 (-0.0081609, -0.0009761) *	2.0881	0.0014132 (-0.0034075, 0.0062339)	-0.6460
16	Secondary	-0.0015069 (-0.0022971, -0.00071672) *	0.68874	0.000085296 (-0.0016957, 0.0018663)	-0.0390
17	Higher	-0.0030286 (-0.0059084, -0.00014878) *	1.3843	0.00027299 (-0.00021235, 0.00075833)	-0.1248
18					
19	Husband education				
20	No education	1	1	1	1
21	Primary	-0.001852 (-0.0045476, 0.00084366)	0.84646	0.003113 (-0.0053549, 0.011581)	-1.4228
22	Secondary	0.00084942 (0.00042745, 0.0012714) *	-0.38824	0.0010909 (-0.0027474, 0.0049291)	-0.4986
23	Higher	-0.0052866 (-0.0080882, -0.0024849) *	2.4163	0.00025019 (-0.00071622, 0.0012166)	-0.11435
24					
25	women occupation				
26	Not working	1	1	1	1
27	Working	0.0006093(-0.011577, 0.012796)	-0.27849	-0.0015175 (-0.014399, 0.011364)	0.69359
28					
29	Husband occupation				
30	Not working	1	1	1	1
31	Working	0.0034081 (-0.033625, 0.040441)	-1.5577	0.033541 (-0.016873, 0.083956)	-15.33
32					
33	Birth order				
34	Only one birth	1	1	1	1
35	2 - 4 birth	0.0015601 (0.00044295, 0.0026773) *	-0.71307	-0.01878 (-0.033508, -0.0040518) *	8.5835
36	5 and above birth	-0.0003622 (-0.0006497, -0.00007469) *	0.16555	-0.033806 (-0.060462, -0.0071505) *	15.452
37					
38	ANC visit				
39	No	1	1	1	1
40	Yes	-0.076563 (-0.088698, -0.064428) *	34.994	-0.0081231(-0.016207, -0.000039645) *	3.7127
41					
42	Wealth status				
43	Poor	1	1	1	1
44	Middle	-0.0007966 (-1.2357e-06, 0.000077712)	-0.01746	-0.00020032 (-0.0099877, 0.009587)	0.091558
45	Rich	0.000038238 (-0.00122, -0.00037319) *	0.34409	0.013165 (0.00021347, 1.026117)	-6.0173
46					
47	Parity				
48	<2	1	1	1	1
49	2-5	0.00111(-0.0019906, 0.00018171)	-0.50733	0.0032984 (-0.0092389, 0.015836)	-1.5076
50	Above 5	-0.00090444 (-0.0019906, 0.00018171)	0.41338	0.0049123 (-0.014804, 0.024629)	-2.2452
51					
52	Distance health				
53	Not big problem	1	1	1	1
54	Big problem	-0.0047901(-0.0085384, -0.0010417) *	2.1894	-0.001343(-0.0075911, 0.0049052)	0.61381
55					
56	Residence				
57	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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3 achieve the Millennium Development Goal agenda that advocates women's educational
4 attainment. Besides, Ethiopia launched the Growth and Transformation Plan I (GTP I) which gave
5 special attention to women's education (29,37). Therefore, the compositional increase in women's
6 education in the last decade had a positive contribution to the decline of home delivery in the
7 country.
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11 As well, higher education of husbands had a significant effect on home delivery. Since the decrease
12 in the number of husbands with secondary school education (Table 1) had a negative contribution
13 to the decline of home delivery. The possible justification might be that educated husbands knew
14 about the importance of health facility delivery and make decisions on the place of delivery.
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17 Another endowment factor that significantly decreased home delivery was birth order. The
18 increase in the proportion of birth order in the survey period resulted in a decrease in home
19 delivery. This finding supports the evidence that women with high birth order deliver at the health
20 facility (32,34). The reason for this finding will be also women with high birth order would have
21 experience with the importance of health facility delivery.
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25 The proportion of protestant women increased in the last decade (Table 1) which increases home
26 delivery proportion because such women were more likely to deliver at home compared to
27 Orthodox Christian women. However, whether religion can a barrier to delivery at the health
28 facility, it needs further investigations.
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32 The wealth status of women had a significant effect on home delivery. The number of rich women
33 decreased in the survey period and staying at home to give birth in the last decade. Studies showed
34 that rich women were more likely to deliver at health facilities than the poor ones (31,32,35).
35 Furthermore, distance to health facilities had a positive contribution to the place of delivery. This
36 study showed that the inaccessibility of health facilities decreased in Ethiopia over the last decade
37 and that positively contributed to the decline of home delivery. Distance from health facilities was
38 a big problem that added to give birth at home (17,20,32,33,38). Ethiopia disease prevention policy
39 has stepped up work on expanding health facilities to achieve access to primary health care in
40 addition to the Extension program.
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44 The decline of rural residence among women was insignificant in the last decade and posed a
45 negative impact on home delivery reduction. Studies evidenced that women living in rural areas
46 gave birth at home than those living in urban settings (17,20,32,38). The possible justification
47 might be that women living in rural areas could not get health facilities easily due to distance.
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3 Controlling the effects of endowment characteristics, about 61% of home delivery decline was
4 contributed by behaviour change to the place of delivery. Significant positive and negative
5 contributions of behaviour change in terms of religion, birth order, and ANC visits were noted.
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8 Changes in behavioural characteristics of women in the Protestant sect had a negative impact could
9 be made certain by the fact that at health facility delivery of the women was low. But no
10 documented evidence showed that protestant religion follower women were a barrier to the place
11 of delivery. Thus, further studies needed on this issue.
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15 This study indicated that about one-fourth of the decrease in home delivery over the last decade
16 was the change in behaviour relating to health facility delivery among women who had two and
17 above birth orders. The possible reason might be women with high birth order experienced
18 different maternal health care services and had adequate health education from the health care
19 personnel.
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24 Another incredible factor that positively contributed to the decline to home delivery preceding the
25 survey was antenatal care visits. Women who received antenatal care during pregnancy were more
26 likely to give birth at the health facility compared to their counterparts (32,39,40). Women who
27 had antenatal visits might have obtained health education about the importance of health facility
28 delivery from health care professionals which might have changed their behaviour towards health
29 facility delivery.
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34 Since this study encompasses three waves of nationally representative demographic and health
35 survey data, that could enhance the generalizability of the findings. As well, multivariate
36 decomposition logistic regression analysis used to identify factors that positively or negatively
37 contributed to the decline of home delivery in Ethiopia could help policymakers to design
38 interventions. The limitation of this study; since the data was collected by a self-reported interview
39 that would be prone to recall and social desirability bias.
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45 **Conclusion and recommendation**

46 The trend of home delivery among the reproductive age group of women declined significantly in
47 the last decade although it is still unacceptable. In multivariate decomposition logistic regression
48 analysis, about 39% of the home delivery decline was contributed by the changes in compositional
49 characteristics of the women. The proportional changes in antenatal care visits, educational status
50 of women and husband, birth order, religion, and distance to health facilities were significantly
51 associated with the decrease in home delivery. Around two-thirds of home delivery decline was
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3 due to the changes in behaviour towards health facility delivery in the last decade. Antenatal care
4 visits, birth order, and religion were significantly associated factors to the place of delivery due to
5 coefficients change.
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8 The Ministry of Health and other stakeholders should continue to enhance the coverage of
9 antenatal care visits and the accessibility of health care facilities. The Ministry of Education should
10 advance the empowerment of girls through education. Researchers need to further investigate the
11 low use of health facility delivery among protestant women.
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16 **Declaration**

17 **Data Availability**

18 The data was available from the corresponding author and we can provide upon request.
19

20 **Consent for publication**

21 Not applicable
22

23 **Competing Interest**

24 We, the authors, declare that we had no competing interests.
25

26 **Funding Statement**

27 We did not receive any funds for this study.
28

29 **Author Contributions**

30 SAT, ZTT, and STY were involved in this study from the inception to design, acquisition of data,
31 data cleaning, data analysis and interpretation and drafting and revising of the manuscript. AML
32 and MMS were involved in project administration, principal supervision, and revising the final
33 manuscript. All authors read and approved the final manuscript.
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42 U.S. Agency for International Development (USAID) for the accusation dataset.
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18 **Figure legend:**
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20 Figure 1: The trend of home delivery from 2005 to 2016 EDHS surveys five years preceding each
21 survey years.
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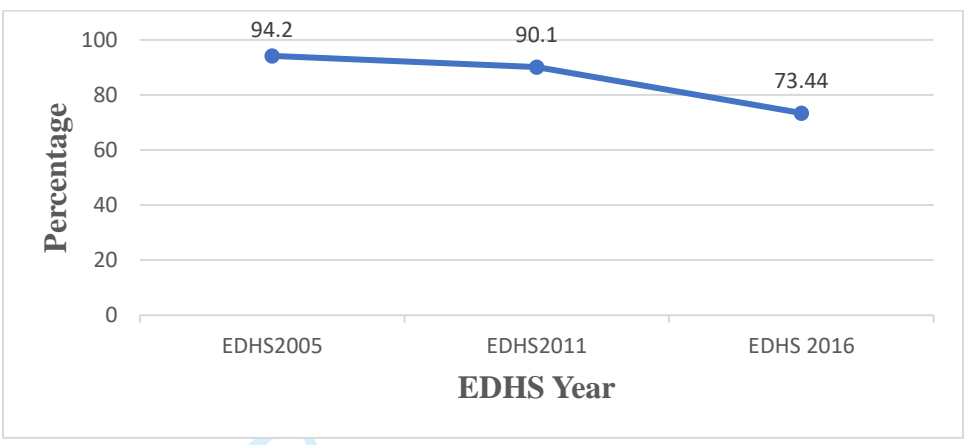


Figure 1: The trend of home delivery from 2005 to 2016 EDHS surveys five years preceding each survey years.

Peer review only

Reporting checklist for cross sectional study.

Based on the STROBE cross sectional guidelines.

Instructions to authors

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

Your article may not currently address all the items on the checklist. Please modify your text to include the missing information. If you are certain that an item does not apply, please write "n/a" and provide a short explanation.

Upload your completed checklist as an extra file when you submit to a journal.

In your methods section, say that you used the STROBE cross sectional reporting guidelines, and cite them as:

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			Page
	Reporting Item		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

1	Introduction			
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3				
4	Background /	#2	Explain the scientific background and rationale for the	3-4
5	rationale		investigation being reported	
6				
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8				
9	Objectives	#3	State specific objectives, including any prespecified	4
10			hypotheses	
11				
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15	Methods			
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18	Study design	#4	Present key elements of study design early in the paper	4
19				
20				
21	Setting	#5	Describe the setting, locations, and relevant dates, including	4
22			periods of recruitment, exposure, follow-up, and data collection	
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26	Eligibility criteria	#6a	Give the eligibility criteria, and the sources and methods of	4
27			selection of participants.	
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32		#7	Clearly define all outcomes, exposures, predictors, potential	5
33			confounders, and effect modifiers. Give diagnostic criteria, if	
34			applicable	
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40	Data sources /	#8	For each variable of interest give sources of data and details of	4
41	measurement		methods of assessment (measurement). Describe	
42			comparability of assessment methods if there is more than one	
43			group. Give information separately for for exposed and	
44			unexposed groups if applicable.	
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51	Bias	#9	Describe any efforts to address potential sources of bias	n/a
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55	Study size	#10	Explain how the study size was arrived at	4
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57				
58	Quantitative	#11	Explain how quantitative variables were handled in the	5
59				
60				

1	variables		analyses. If applicable, describe which groupings were chosen,	
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3			and why	
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5				
6	Statistical	#12a	Describe all statistical methods, including those used to control	5
7				
8	methods		for confounding	
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11	Statistical	#12b	Describe any methods used to examine subgroups and	n/a
12				
13	methods		interactions	
14				
15				
16	Statistical	#12c	Explain how missing data were addressed	n/a
17				
18	methods			
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21	Statistical	#12d	If applicable, describe analytical methods taking account of	n/a
22				
23	methods		sampling strategy	
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27	Statistical	#12e	Describe any sensitivity analyses	n/a
28				
29	methods			
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32	Results			
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36	Participants	#13a	Report numbers of individuals at each stage of study—eg	6
37				
38			numbers potentially eligible, examined for eligibility, confirmed	
39				
40			eligible, included in the study, completing follow-up, and	
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42			analysed. Give information separately for for exposed and	
43				
44			unexposed groups if applicable.	
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48	Participants	#13b	Give reasons for non-participation at each stage	n/a
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51	Participants	#13c	Consider use of a flow diagram	n/a
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54	Descriptive data	#14a	Give characteristics of study participants (eg demographic,	7
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56			clinical, social) and information on exposures and potential	
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1		confounders. Give information separately for exposed and	
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3		unexposed groups if applicable.	
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6	Descriptive data	#14b Indicate number of participants with missing data for each	n/a
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8		variable of interest	
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11	Outcome data	#15 Report numbers of outcome events or summary measures.	n/a
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13		Give information separately for exposed and unexposed	
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15		groups if applicable.	
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19	Main results	#16a Give unadjusted estimates and, if applicable, confounder-	12
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21		adjusted estimates and their precision (eg, 95% confidence	
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23		interval). Make clear which confounders were adjusted for and	
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25		why they were included	
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29	Main results	#16b Report category boundaries when continuous variables were	n/a
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31		categorized	
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34	Main results	#16c If relevant, consider translating estimates of relative risk into	n/a
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36		absolute risk for a meaningful time period	
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39	Other analyses	#17 Report other analyses done—e.g., analyses of subgroups and	n/a
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41		interactions, and sensitivity analyses	
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45	Discussion		
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48	Key results	#18 Summarise key results with reference to study objectives	13
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51	Limitations	#19 Discuss limitations of the study, taking into account sources of	15
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53		potential bias or imprecision. Discuss both direction and	
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55		magnitude of any potential bias.	
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1	Interpretation	#20	Give a cautious overall interpretation considering objectives,	
2			limitations, multiplicity of analyses, results from similar studies,	
3			and other relevant evidence.	
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9	Generalisability	#21	Discuss the generalisability (external validity) of the results	n/a
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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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3 **Trends and determinants of home delivery in Ethiopia: Further multivariate decomposition**
4 **analysis of 2005 to 2016 Ethiopian Demographic Health Surveys**
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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.

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

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3 Africa (12). High load of home delivery in Ethiopia is a precipitating factor for high maternal
4 mortality ratio. For example, the magnitude of home delivery was 94.5% in 2000, 93.1% in 2005,
5 87.9% in 2011, and 73.6% in 2016 which are unacceptably high (13,14).
6
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8 According to different studies, maternal health service utilization was low due to low educational
9 status, cultural and communal factors, limited access to health facilities, poor quality of care, lack
10 of roads, and poor wealth status in Ethiopia. (13,15–17). On the other hand, taking at least one
11 antenatal care visit, multiparity, being educated women, being urban resident, husband's positive
12 attitude towards health facility delivery, easy access to health facilities, and having good wealth
13 status were reported in the contribution of health facility-based delivery in Ethiopia (17–20).
14 However, between 2005 to 2016, the trends of home delivery show decrements, no evidence that
15 which factors that have been contributed to the observed reduction in the last decade.
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18 Therefore, this multivariate decomposition logistic analysis aimed to assess the trends and factors
19 that either positively or negatively contributed to the change for home delivery in Ethiopia. This
20 study is anticipated to provide data for health planners and policymakers in planning for further
21 reduction of home delivery thereby to decrease maternal mortality in Ethiopia and elsewhere in
22 developing countries.
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32 **Methods and materials**

33 **Study design, area, and period**

34 The nationally representative repeated cross-sectional study design was employed using 2005,
35 2011, and 2016 Ethiopian Demographic and Health Surveys (EDHS). Ethiopia is laying between
36 latitude 3° and 14°N, and longitude 33° and 48°E in the horn of Africa. Ethiopia has a total area
37 of 1,100,000 km² and structured in nine regional states, namely Tigray, Afar, Amhara,
38 Benishangul-Gumuz, Gambela, Harari, Oromia, Somali, and Southern Nations Nationalities and
39 Peoples of Region (SNNPR) and two city administration (Addis Ababa and Dire Dawa).
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46 **Source and study population**

47 The source population were all reproductive age group women who gave birth five years preceding
48 each survey. The study population were all reproductive-age group women who gave birth five
49 years preceding each survey in the selected Enumeration Areas (EAs). In each survey, a nationally
50 representative sample of 10721 in 2005, 11872 in 2011, and 10889 in 2016 weighted number of
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3 women participated. Recorded data were accessed at www.messdhs.com on request with the
4 assistance of ICF International, Inc.
5

6 **Data collection tools and procedures**

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8 Data were collected in two-stages in each survey years. Stratification was also made as urban and
9 rural in each region of the country. In the first stage, 540, 624 and 645 EAs were selected in 2005,
10 2011, and 2016 Ethiopian Demographic and Health Surveys respectively. In the second stage, a
11 fixed number of households were selected in each EAs for each survey using systematic sampling.
12 The detailed sampling procedure is available in the Ethiopian Demographic and Health Survey
13 reports from the Measure DHS website (www.dhsprogram.com) for each specific surveys.
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15

16 **Outcome variable**

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

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25 All sociodemographic and obstetric characteristics were taken as independent variables for the
26 three-consecutive surveys.
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29 **Patient and public involvement**

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31 As the study conducted based on secondary data, therefore, there is no patients and the public
32 involvement in this study.
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34

35 **Statistical analysis**

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37 The data were cleaned and analyzed using STATA software (version 14.1). Sample weighting was
38 done for further analysis. Descriptive statistics were also done for the description of the variables.
39 A multivariate decomposition logistic regression analysis was employed to identify the
40 contributions of group differences to average predictions (21). The purpose of this decomposition
41 analysis was to identify factors that contributed to the change in home delivery in the last decade
42 in Ethiopia.
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45
46 A nonlinear multivariate logit decomposition model was used to identify the contribution of
47 proportion change to home delivery over the last decade. The output from the multivariate
48 decomposition logistic regression analysis had two contribution effects. These effects were the
49 compositional differences (endowments) “E” and the effects of characteristics that are the
50 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 $N \times 1$ dependent variable vector, X an $N \times K$ matrix of independent variables, and β a $K \times 1$ 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

$$\begin{aligned} \text{Logit}(Y_A) - \text{logit}(Y_B) &= F(X_A\beta_A) - F(X_B\beta_B) \\ &= \underbrace{F(X_A\beta_A) - F(X_B\beta_A)}_E + \underbrace{F(X_B\beta_A) - F(X_B\beta_B)}_C \quad \text{is group decomposition (21)} \end{aligned}$$

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:

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

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.

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 \pm SD	29.01 \pm 6.95	29.04 \pm 6.63	29.23 \pm 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

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%)

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	EDHS 2011	EDHS 2016	Percentage point difference in home delivery		
	N= 10,721	N= 11,872	N= 10,889	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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3	No	98.19	96.88	91.50	-1.31	-5.38	-6.69
4	Yes	82.34	76.64	53.68	-5.7	-22.96	-28.66
5	<hr/>						
6	Birth order						
7	1	86.83	79.04	51.01	-7.79	-28.03	-35.82
8	2-4	95.01	90.19	72.94	-4.82	-17.25	-22.07
9	>= 5	97.94	95.51	84.85	-2.43	-10.66	-13.09
10	<hr/>						
11	Parity						
12	<= 2	87.89	80.62	52.83	-7.27	-27.79	-35.06
13	2-5	94.52	92.29	78.06	-2.23	-14.23	-16.46
14	>= 5+	98.03	96.06	86.45	-1.97	-9.61	-11.58
15	<hr/>						
16	Wealth status						
17	Poor	99.08	97.38	85.29	-1.7	-12.09	-13.79
18	Middle	98.14	96.87	77.39	-1.27	-19.48	-20.75
19	Rich	87.26	76.31	53.98	-10.95	-22.33	-33.28
20	<hr/>						
21	Residence						
22	Urban	56.94	50.18	20.60	-6.76	-29.58	-36.34
23	Rural	97.67	95.95	80.07	-1.72	-15.88	-17.6
24	<hr/>						
25	Region						
26	Tigray	94.12	88.36	41.87	-5.76	-46.49	-52.25
27	Afar	95.95	93.19	85.28	-2.76	-7.91	-10.67
28	Amhara	96.49	89.82	72.46	-6.67	-17.36	-24.03
29	Oromia	95.75	92.00	81.10	-3.75	-10.9	-14.65
30	Somali	95.23	92.40	82.07	-2.83	-10.33	-13.16
31	Benishangul	94.67	90.89	74.04	-3.78	-16.85	-20.63
32	SNNPR	96.30	93.79	73.95	-2.51	-19.84	-22.35
33	Gambela	84.26	72.48	54.38	-11.78	-18.1	-29.88
34	Harari	68.20	67.63	49.59	-0.57	-18.04	-18.61
35	Addis Ababa	21.84	17.66	2.98	-4.18	-14.68	-18.86
36	Dire Dawa	74.90	60.27	42.81	-14.63	-17.46	-32.09
37	<hr/>						
38	Prevalence	95	90	73	-5	-17	-22
39	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
40	<hr/>						

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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3 Women who had at least one antenatal care visit during pregnancy were more likely to deliver at
4 the health facility. The coverage of antenatal care visit was increased from 28 to 62% in the last
5 decade (Table 1), that had an important compositional contribution to the decline of home delivery
6 by 35%.
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10 Followers of the Protestant sect were more likely to give birth at home than Orthodox Christians.
11 As a result, the increase in the proportion of the Protestant sect followers (Table 1) had a significant
12 rise to home delivery in the last decade. Keeping all other variables constant, the improvement of
13 women's educational status to primary school complete and above before the survey (Table 1) had
14 a positive significant contribution to the decline of the trend.
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18 A decrease in the composition of husband's secondary education level during the surveys (Table
19 1) hurt on the place of delivery, whereas a rise in the proportion of husbands with higher education
20 had a positive contribution to the decline of home delivery.
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24 Keeping the coefficient characteristics constant, women who had no significant compositional
25 change in the category of birth order between 2-4 (Table 1) had a contribution to the change of
26 home delivery. On the other hand, a decrease in the number of women who had more than five
27 birth order had a positive contribution to the decline of home delivery in the last decade (Table 3).
28 The decline in the proportion of rich wealth status women in the last decade increased the
29 prevalence of home delivery. Accessibility of health facilities had a positive contribution in
30 decreasing home delivery by 2% over the last decade. Women living in rural areas had a high risk
31 of giving birth at home. As shown in table 1, the composition change of rural residence was
32 minimal; this insignificant compositional change significantly increases the prevalence of home
33 delivery over the last decade (Table 3).
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43 **Difference due to effects of coefficient (C)**

44 Controlling the roles of change in compositional characteristics, more than two-thirds (61%) of
45 home delivery was declined resulted from behavioral changes towards health facility delivery
46 (Table 3). Antenatal care visits, religion, and birth order had statistically significant effects of
47 coefficient contribution to the observed change in home delivery. Controlling all compositional
48 change factors, 4% of the home delivery was declined due to the change in the behavior of health
49 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

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				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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3 This study revealed that the contribution of behavior (coefficient) changes were more important
4 than that of composition (endowments) changes to the decline of home delivery over the last
5 decade.
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8 Keeping coefficient changes constant, the explained contribution of the change in compositional
9 characteristics to the decline of home delivery was 39% in Ethiopia. The predominant changes in
10 home delivery were due to the proportion of changes in antenatal care visits. Antenatal coverage
11 increased by 34% (Table 1) over the last decade which had a 35% contribution to the decline of
12 home delivery. The possible reason might be the fact that women who had antenatal follow-up
13 were more likely to deliver at health facilities than those who had no follow-ups (18,28–31).
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16 Women having primary school education and above had a positive effect on the decline of home
17 delivery compared to those unable to read and write. This result supported by the evidence that
18 higher educational attainment of women was more likely to give birth at health facilities compared
19 to those unable to read and write (18,29,32,33). Besides, Ethiopia has been worked hard to achieve
20 the Millennium Development Goal agenda that advocates women's education. Also, Ethiopia
21 launched the Growth and Transformation Plan I (GTP I) which gave special attention to women's
22 education (26,34). Therefore, the compositional increment in women's education profile in the last
23 decade had a positive contribution to the decline of home delivery in the country.
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26 As well, higher education of husbands had a significant effect in reducing home delivery. Since
27 the decrease in the number of husbands with secondary school education (Table 1) had a negative
28 contribution to the decline of home delivery. The possible justification might be that educated
29 husbands knew about the importance of health facility delivery and made decisions on the place
30 of delivery.
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33 Another endowment factor that significantly decreased home delivery was birth order. The
34 increase in the proportion of birth order in the survey period resulted in a decrease in home
35 delivery. This finding supports evidences elsewhere women with high birth order delivered at the
36 health facility (29,31). The reason for this finding might be also women with high birth order
37 would have experience with the importance of health facility delivery.
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40 The proportion of Protestant women has increased in the last decade (Table 1) which increases
41 home delivery proportion because such women were more likely to deliver at home compared to
42 Orthodox Christian women. However, whether religion can be a barrier to delivery at the health
43 facility, it needs further investigations.
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3 The wealth status of women had a significant effect on home delivery. The proportion of rich
4 wealth status women decreased in the survey period and stayed at home to give birth in the last
5 decade. Studies showed that rich wealth status women were more likely to deliver at health
6 facilities than the poor ones (28,29,32).
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10 Furthermore, access to health facilities with less distance had a positive contribution to health
11 facility delivery. This study showed that Ethiopia is working hard to improve access to health
12 services over the last decade and that positively contributed to the decline of home delivery.
13 Distance from health facilities was the main problem that influence women to give birth at home
14 (17,20,29,30,35). Ethiopia disease prevention policy has stepped up work on expanding health
15 facilities to achieve access to primary health care.
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20 The decline of rural residence among women was insignificant in the last decade and posed a
21 negative effect on home delivery reduction. This finding is supported with different studies women
22 living in rural areas gave birth at home than those living in urban settings (17,20,29,35). The
23 possible justification might be that women living in rural areas could not access health facilities
24 easily due to distance.
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29 Controlling the effects of endowment characteristics, about 61% of home delivery reduction was
30 contributed by behavior change to the place of delivery. Significant positive and negative
31 contributions to behavior change in terms of religion, birth order, and ANC visits were noted.
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34 Changes in behavioral characteristics of women in the Protestant sect had a negative effect that
35 could be made ascertain by the fact that Protestant women gave birth at the health facility were
36 low. But no documented evidence that states Protestant religion as a barrier to the place of delivery.
37 Thus, further studies are needed on this issue.
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41 This study indicated that about one-fourth of the decrement in home delivery over the last decade
42 was the change in behavior related to health facility delivery among women who had two and
43 above birth orders. The possible reason might be women with high birth order experienced
44 different maternal health care services and had adequate health education from the health care
45 personnel.
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50 Another incredible factor that positively contributed to the decline to home delivery preceding the
51 survey was antenatal care visits. Women who received antenatal care during pregnancy were more
52 likely to give birth at the health facility compared to their counterparts (29,36,37). Women who
53 had antenatal visits might have obtained health education about the importance of health facility
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3 delivery from health care professionals which might have changed their behavior towards health
4 facility delivery.

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

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20 In the last decade, home delivery in Ethiopia was decline substantially, but this remains
21 unacceptable high. More than one-third of the decrement in home delivery was attributed to the
22 changes in women's compositional characteristics, while two-thirds were attributed to behavioral
23 changes towards health facility delivery over the past ten years. The compositional change in
24 antenatal care visits, educational status of women and husband, birth order, religion, and distance
25 to health facilities were significantly associated with the decline in home delivery. Antenatal care
26 visits, birth order, and religion were significantly associated with the home delivery due to
27 coefficients change.
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34 The Ministry of Health and other stakeholders should continue the current effort to increase health
35 facility-based delivery through access to health care services and strengthen the coverage of
36 antenatal care visits thereby to achieve SDGs goal. The Ministry of Education should strengthen
37 girls' empowerment through education. Researchers need to further explore the barriers of maternal
38 home delivery from religion perspective.
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44 **Declaration**

45 **Data Availability**

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

47 **Consent for publication**

48 Not applicable

49 **Competing Interest**

50 The authors, declare that we had no competing interests.
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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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20 **Figure legend:**

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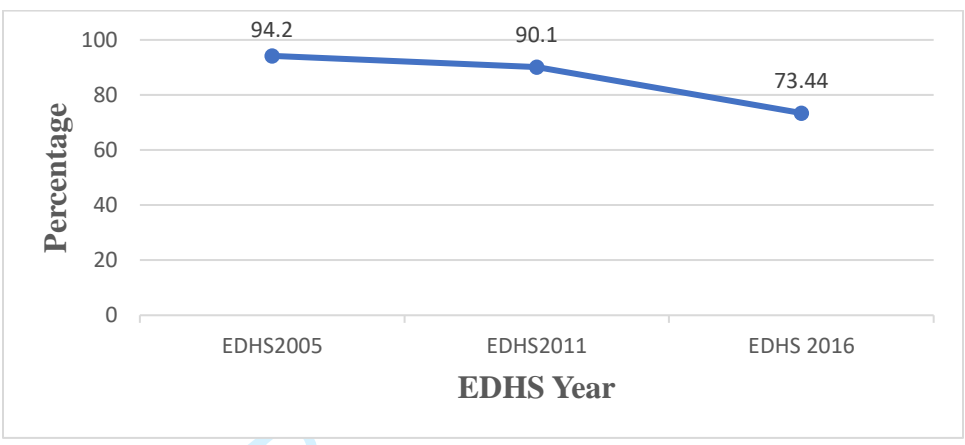


Figure 1: The trend of home delivery from 2005 to 2016 EDHS surveys five years preceding each survey years.

Peer review only

Reporting checklist for cross sectional study.

Based on the STROBE cross sectional guidelines.

Instructions to authors

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

Your article may not currently address all the items on the checklist. Please modify your text to include the missing information. If you are certain that an item does not apply, please write "n/a" and provide a short explanation.

Upload your completed checklist as an extra file when you submit to a journal.

In your methods section, say that you used the STROBE cross sectional reporting guidelines, and cite them as:

von Elm E, Altman DG, Egger M, Pocock SJ, Gotsche PC, Vandenbroucke JP. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: guidelines for reporting observational studies.

			Page
	Reporting Item		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

1	Introduction			
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3				
4	Background /	#2	Explain the scientific background and rationale for the	3-4
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6	rationale		investigation being reported	
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8				
9	Objectives	#3	State specific objectives, including any prespecified	4
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11			hypotheses	
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15	Methods			
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18	Study design	#4	Present key elements of study design early in the paper	4
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21	Setting	#5	Describe the setting, locations, and relevant dates, including	4
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23			periods of recruitment, exposure, follow-up, and data collection	
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26	Eligibility criteria	#6a	Give the eligibility criteria, and the sources and methods of	4
27			selection of participants.	
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32		#7	Clearly define all outcomes, exposures, predictors, potential	5
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34			confounders, and effect modifiers. Give diagnostic criteria, if	
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36			applicable	
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39	Data sources /	#8	For each variable of interest give sources of data and details of	4
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41	measurement		methods of assessment (measurement). Describe	
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43			comparability of assessment methods if there is more than one	
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45			group. Give information separately for for exposed and	
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47			unexposed groups if applicable.	
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51	Bias	#9	Describe any efforts to address potential sources of bias	n/a
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55	Study size	#10	Explain how the study size was arrived at	4
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58	Quantitative	#11	Explain how quantitative variables were handled in the	5
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1	variables		analyses. If applicable, describe which groupings were chosen,	
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3			and why	
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6	Statistical	#12a	Describe all statistical methods, including those used to control	5
7				
8	methods		for confounding	
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11	Statistical	#12b	Describe any methods used to examine subgroups and	n/a
12				
13	methods		interactions	
14				
15				
16	Statistical	#12c	Explain how missing data were addressed	n/a
17				
18	methods			
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21				
22	Statistical	#12d	If applicable, describe analytical methods taking account of	n/a
23				
24	methods		sampling strategy	
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27	Statistical	#12e	Describe any sensitivity analyses	n/a
28				
29	methods			
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32	Results			
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36	Participants	#13a	Report numbers of individuals at each stage of study—eg	6
37				
38			numbers potentially eligible, examined for eligibility, confirmed	
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40			eligible, included in the study, completing follow-up, and	
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42			analysed. Give information separately for for exposed and	
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44			unexposed groups if applicable.	
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48	Participants	#13b	Give reasons for non-participation at each stage	n/a
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51	Participants	#13c	Consider use of a flow diagram	n/a
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54	Descriptive data	#14a	Give characteristics of study participants (eg demographic,	7
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56			clinical, social) and information on exposures and potential	
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1		confounders. Give information separately for exposed and	
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3		unexposed groups if applicable.	
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6	Descriptive data	#14b Indicate number of participants with missing data for each	n/a
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8		variable of interest	
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11	Outcome data	#15 Report numbers of outcome events or summary measures.	n/a
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13		Give information separately for exposed and unexposed	
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15		groups if applicable.	
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19	Main results	#16a Give unadjusted estimates and, if applicable, confounder-	12
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21		adjusted estimates and their precision (eg, 95% confidence	
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23		interval). Make clear which confounders were adjusted for and	
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25		why they were included	
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29	Main results	#16b Report category boundaries when continuous variables were	n/a
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31		categorized	
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34	Main results	#16c If relevant, consider translating estimates of relative risk into	n/a
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36		absolute risk for a meaningful time period	
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39	Other analyses	#17 Report other analyses done—e.g., analyses of subgroups and	n/a
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41		interactions, and sensitivity analyses	
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45	Discussion		
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48	Key results	#18 Summarise key results with reference to study objectives	13
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51	Limitations	#19 Discuss limitations of the study, taking into account sources of	15
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53		potential bias or imprecision. Discuss both direction and	
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55		magnitude of any potential bias.	
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1	Interpretation	#20	Give a cautious overall interpretation considering objectives,	
2			limitations, multiplicity of analyses, results from similar studies,	
3			and other relevant evidence.	
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9	Generalisability	#21	Discuss the generalisability (external validity) of the results	n/a
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Other Information

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