

# Age at First Marriage and Fertility Decline in Dabat Health and Demographic Surveillance System Site, northwest Ethiopia: Decomposition analysis

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## Research article

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# Abstract

**Background:** Fertility declines in Ethiopia have been documented since 1990s. Amhara National Regional State has recorded the most noticeable fertility decline. However, specific factors that explain the incipient course of fertility decline in the study area and their relative contributions were not well investigated. Hence, the purpose of this study was to determine the factors that contributed for fertility decline, and to assess the variations in fertility that can be attributed to both changes in characteristics and reproductive behaviors of women aged 15–49 years between 2008 and 2014 in Dabat Demographic and Health Surveillance System Site, Northwest Ethiopia.

**Methods:** Cross sectional censuses were carried out in Dabat Health and Demographic Surveillance System site in 2008 and 2014. Data for 4,775 and 10,807 women with reproductive age in 2008 and 2014 were used for the analysis. Poisson regression model was employed to assess the trends of determinants of fertility, and Multivariate Decomposition technique was applied to evaluate observed changes in fertility using data from two consecutive cross-sectional censuses of Dabat HDSS conducted in 2008 and 2014.

**Results:** The findings indicated that there was a reduction of an average 640.69 births per 1,000 women of the reproductive age during the year 2014 compared to the year 2008 in the surveillance site (P-value <0.001; 95% CI: -669.5 to -582.4). This overall change in fertility during the study period was attributed to both changing characteristics of women (the distribution effect) (76%) (P-value < 0.001; 95%CI: -524.74, -453.13, and their reproductive behavior (the effect shown by regression coefficients of the variables on the outcome) (24%) (P-value <0.001; 95% CI: -224.36 to -79.14). The drivers of the recent fertility decline during the study period were the shift observed in the age at first marriage, the change in the proportion of currently married women, the shift in women's birth to later age and the change in women's educational status.

**Conclusion:** This study indicated that the overall reduction in fertility was attributed to both changing characteristics of women and their reproductive behavior. The major contributors to the changes in fertility were the postponing of women's first marriage to later age and the change in the proportion of currently married women over the study period. Encouraging women to complete at least secondary education are important to increase the age at first marriage and birth which intern accelerate the current fertility transition.

## Background

In Sub-Saharan African countries, the fertility level, measured by Total Fertility Rate (TFR), increased between 1950s and early 1970s from about 6.57 in 1950 to 6.7 children per woman in 1970 [1,2]. It has started declining in the mid-1970s and reached to 5.1 children per woman in 2015 [3]. The pace of fertility decline was claimed to be slower than the declines in other developing regions. However, in recent decades, Sub-Saharan Africa has become the region with the most rapid pace of fertility decline [4,5].

Fertility differences among sub-regions in Africa are now bigger than ever because transitions to replacement fertility (TFR= 2.1) is slower in some sub-regions and countries [6]. Compared to other regions of Africa, Southern Africa and Northern Africa showed a relatively high fertility decline, from 6.1 and 6.8 in 1950 to 2.64 and 3.31 in 2015, respectively. But in Western and Middle Africa, fertility decline was low, from 6.43 and 6.08 in 1950 to 5.53 and 5.94 in 2015 respectively [3]. On the other hand, the same author stated that fertility in Eastern Africa has showed a modest fertility decline in the same period, from 7.05 in 1950 to 4.89 children per woman in 2015.

However, in some East African countries, the fertility is still high and the decline is relatively low. For instance, in Uganda fertility declined from 6.7 in 2006 to 5.4 children per woman in 2016 [7]. TFR in Tanzania is also high and the decline has not been that much significant over the past decade, declined from 5.7 in 2004-05 to 5.2 children per woman in 2015-16 [8]. On the other hand, fertility decline in some other eastern African countries is relatively high. In Rwanda, for, instance, fertility has decreased from 6.1 births per woman in 2005 to 4.2 in 2014-15, a two-child decline in a decade [9]. Fertility in Kenya has also decreased from 4.9 births per woman in 2003 to 3.9 births per woman in 2014 [10].

Ethiopia, in the horn of Africa, is Africa's second-most populous nation with about 101 million people in 2020 [11]. Ethiopia is with the highest prevalence rate of child marriage in the world with median age at first marriage of 17.1 years in 2016. The contraceptive prevalence rate is among the lowest, though an increasing trend, only 36% of married women used family planning methods in 2016 [12]. The Ethiopian school system consists of eight years of elementary education, divided into two cycles of four years, and four years of secondary education, divided into two stages of two years (4+4+2+2) education. Ethiopia's standard tertiary degree structure also includes a minimum of three-year bachelor's, master's, and doctoral degrees. Education is technically compulsory for all children until grade eight and is tuition-free until grade 10, whereas upper-secondary (grade 11 and 12) and university students have to pay school fees. However, in secondary and tertiary education, overall enrollment is much smaller, but growing modestly [13].

Ethiopia is also among the countries with high fertility decline in the past couple of decades. The Ethiopia's Demographic and Health Surveys (EDHS) results indicated that TFR of the country continued to fall from 6.4 in 1990 to 4.6 children per woman in 2016 [12,14]. Moreover, there are regional disparities in fertility decline in the country. The Total fertility rates of Amhara National Regional State (ANRS) where this study was conducted, has recorded the most noticeable fertility decline. The TFR of the region has declined by 28.8% over 11 years, from 5.9 in 2000 to 4.2 in 2011, and further declined by another 11.9% in five years alone, from 4.2 in 2011 to 3.7 children per woman in 2016 [14-16]. The total fertility rate of the population of Dabat Health and demographic surveillance Site was found to be 3.9 children per woman in 2012 which was below the regional average in the same year [17].

For these fertility reductions, a number of studies have suggested that it has been associated with many factors. Some studies have revealed that fertility declines have been accompanying with changes in demographic, socioeconomic and cultural factors which particularly influence the attitudes regarding large family sizes [18-21]. Other studies have examined factors responsible for rapid fertility declines in developing countries including the changes in proximate determinants of fertility [22-24]. All these factors could bring changes in women's characteristics as well as changes in their reproductive behavior that occur as a result of changing characteristics [19]. Changing characteristics of women and changing reproductive behavior can lead to changes in fertility with varying influences [25]. Changing characteristics refer to changes in proportion of the population with particular social, economic and demographic characteristics, while the change in reproductive behavior refers to the changes in the fertility behavior of the population as a result of the change in characteristics [26].

These studies, however, did not differentiate the change in fertility, particularly in the study area, that could be attributable to changing characteristics of women over time from that of the change in reproductive behavior. Hence, the purpose of this study was to determine the factors contributing for fertility decline, and to assess the variations in fertility between 2008 and 2014 in Dabat Health and Demographic Surveillance System Site that can be attributed to both changes in characteristics and reproductive behaviors of women aged 15–49 years.

# Methods

## Study Setting,

The study was conducted at the Dabat Health and Demographic Surveillance Site (HDSS) located at Dabat district, 75 Kms to the north of Gondar town and 804 Kms to the northwest of Addis Ababa. Dabat district has a total of 30 kebeles (the smallest administration unit in Ethiopia) (26 rural and 4 urban kebeles). According to the 2007 census report, the district had an estimated total population of 145,458. The size of the population was projected to 172, 836 in 2015. Of these, 50.37% were female and 13% were urban inhabitants [27, 28]. Dabat district was initially selected purposively as a surveillance site for its unique three agro-climatic zones (lowland, midland and highland) with the altitude ranges from about 1000 to 2500 meters above sea level [17]. The Dabat HDSS was launched in 1996 with ten kebeles, seven from rural and three from urban kebeles, among which seven were from highland, one from midland and two from lowland areas sampled from the entire district using a probability proportional to size technique. Currently the site incorporates thirteen kebeles by including another three kebeles in the district in 2014, but the three kebeles were not included in this study.

## Study Design and Data Collection

The study was based on data obtained from two consecutive cross-sectional censuses of Dabat HDSS conducted in February to May, 2008, and from October to December, 2014. The censuses were carried out at household level to assess the socio-economic and demographic changes of the population in the surveillance site. All households in the surveillance site were covered during the data collection period. The heads of households were interviewed to collect the necessary information including the demographic, socio-economic and housing characteristics of household members, and events that happened in the family. When there are women with reproductive age group as a member of a family in the households, they were interviewed about their birth history. Data were collected using structured, pretested, and interviewer administered questionnaires. The questionnaires for both censuses were prepared in English and later translated to Amharic and then back to English by professional translators and Public Health experts to check consistency. All interviews were carried out in the local language, Amharic, but saved in English in the database. Diploma and first-degree graduate data collectors and supervisors working in the surveillance site were recruited as an interviewer. Training regarding the objective of the study, content of the questionnaires and techniques to conduct interview was given to data collectors and supervisors. Data collectors submitted completed questionnaires to their respective supervisors daily to be checked for completeness and consistency. Incomplete questionnaires were returned to data collectors immediately for correction.

## Data Processing and Analysis

The collected data on women aged 15 to 49 years old was entered into the Household Registration System (HRS) version 2.1 and exported to STATA version 14 for analysis. Descriptive statistics were carried out after cleaning the inconsistencies in the data to compute the mean children ever born and the changes over time in the statistics of some other demographic characteristics of women. As the outcome variable, children ever born, is a count data, Poisson regression Incidence Rate Ratio (IRR) with 95 percent confidence interval (CI) was used to assess the trends of association of various background characteristics with fertility. Decomposition analysis technique was also employed in identifying characteristics that may explain the difference in actual fertility between 2008 and 2014. The analysis technique that was employed is multivariate Poisson decomposition model. This method allows the decomposition of changes over time in levels of an outcome variable into those due to differences in

observable characteristics (*endowments*) and those due to the different effects of these characteristics (*coefficients*). The technique also partitions the two components into portions that represent the unique contribution of each predictor to each of the two components in a detailed decomposition [29]. The 2014 census was considered for the sake of comparison while the 2008 data was taken as a reference group. A negative coefficient for a covariate indicates the expected reduction in the variation of children ever born between the two census periods. The assumptions of Poisson regression was checked using the likelihood ratio test of overdispersion parameter alpha by running the same regression model using negative binomial distribution and the assumptions were fulfilled, i.e. the means and variances of the response were about the same, there was no more variation in the response than the model implies. All the statistical significances of associations were determined at the 0.05 level of significance.

## **Ethical Consideration**

Ethical approval was obtained from the University of Gondar Ethical Review Board. A formal letter was written to the local district administrative and health offices. Informed verbal consent was secured from all study participants. The right of the respondent to withdraw from the interview or not to participate at all was informed and respected. Each piece of information that was given by every responding subject was made strictly confidential.

## **Results**

### **Demographic and Socio-economic Characteristics**

The study included a total of 4,775 and 10,807 women with reproductive age in 2008 and 2014 census periods respectively. In the study area, substantial proportion of women were rural residents (75.8 % in 2008 and 62 % in 2014), though showing a declining trend. The proportion of women of reproductive age who desired to bear an additional child has shown a significant reduction from about 63% to 30 % in the period 2008 to 2014. Women who got married before reaching 18 years of age was still high accounted 86% in 2014. Moreover, the proportion of women who had at least a primary level of education increased from 20.5% to 51.3% where as women with no formal education decreased from 79.5% to 48.7% in 2008 and 2014 respectively. With regard to marital status, the percentage of single and dissolved (divorced and widowed) women increased from 2.8% and 11% in 2008 to 30% and 15% respectively, whereas currently married women decreased from 86% in 2008 to 55% in 2014. The proportion of women who used any contraceptive method showed no change in both census with 19% (Table 1).

A decline in the average number of children ever born was observed during the study period. The mean children ever born to women in the reproductive age group decreased from 3.3 to 2.4 children in the years 2008 and 2014 respectively whereas the average number of children at the end of their reproductive years (45-49 years) was higher and has showed a slight increase from 6.0 to 6.2 children respectively, but showed a decreasing trend among young age groups. Average number of children ever born was high among women who had the desire to bear additional child, illiterate, rural residents, currently married, married early and currently used contraceptive methods during both censuses. In addition, during the study period, the mean number of children ever born has showed a declining trend in all wealth quantiles except women in rich families that showed a slight increase. The last census result also indicated that average number of children to women of reproductive age increased with an improvement of their wealth status (Table 1).

**Table 1:** Distribution of Women and Number of Children Ever Born by Demographic and Socioeconomic Characteristics of Women in age 15-49 in Dabat HDSS, 2008 - 2014,

| Variables and categories  |              | Census year                 |        |                   |                              |        |                   |
|---------------------------|--------------|-----------------------------|--------|-------------------|------------------------------|--------|-------------------|
|                           |              | 2008                        |        |                   | 2014                         |        |                   |
|                           |              | Women<br>(4,775)<br>No. (%) | CEB    | ACEB per<br>Women | Women<br>(10,807)<br>No. (%) | CEB    | ACEB per<br>Women |
| Current Age               | 15-19        | 542(11.35)                  | 485    | 0.9               | 2977 (27.55)                 | 432    | 0.2               |
|                           | 20-24        | 1036 (21.70)                | 1852   | 1.8               | 1857 (17.18)                 | 1817   | 1.1               |
|                           | 25-29        | 1235 (25.86)                | 3858   | 3.1               | 1729 (16.00)                 | 3898   | 2.4               |
|                           | 30-34        | 873 (18.28)                 | 3588   | 4.1               | 1264 (11.70)                 | 4496   | 3.8               |
|                           | 35-39        | 570 (11.94)                 | 2837   | 4.9               | 1344 (12.44)                 | 6264   | 4.9               |
|                           | 40-44        | 363 (7.60)                  | 1926   | 5.3               | 977 (9.04)                   | 5316   | 5.7               |
|                           | 45-49        | 156 (3.27)                  | 931    | 6.0               | 659 (6.10)                   | 3561   | 6.2               |
| Early Marriage            | Yes          | 3622 (75.85)                | 12536  | 3.5               | 8547 (86.60)                 | 23336  | 2.7               |
|                           | No           | 1153 (24.15)                | 2941   | 2.6               | 1322 (13.40)                 | 2448   | 1.9               |
| Reproductive Intention    | Yes          | 3005 (62.93)                | 9342   | 3.1               | 3202 (29.63)                 | 10394  | 3.3               |
|                           | No           | 1770 (37.07)                | 6135   | 3.5               | 7605 (70.37)                 | 15390  | 2.3               |
| Educational Status        | No Education | 3796 (79.50)                | 13553  | 3.6               | 5264 (48.71)                 | 21137  | 4.4               |
|                           | Primary      | 450 (9.42)                  | 1084   | 2.4               | 2012 (18.62)                 | 2505   | 1.4               |
|                           | Secondary+   | 529 (11.08)                 | 840    | 1.6               | 3531 (32.67)                 | 2142   | 0.7               |
| Residence                 | Urban        | 1157 (24.23)                | 2758   | 2.4               | 4093 (37.87)                 | 5216   | 1.4               |
|                           | Rural        | 3618 (75.77)                | 12719  | 3.5               | 6714 (62.13)                 | 20568  | 3.4               |
| Marital Status            | Single       | 134 (2.81)                  | 154    | 1.1               | 3281 (30.36)                 | 286    | 0.1               |
|                           | Married      | 4103 (85.93)                | 13607  | 3.3               | 5896 (54.56)                 | 21623  | 3.9               |
|                           | Dissolved    | 538 (11.27)                 | 1716   | 3.2               | 1629 (15.07)                 | 3875   | 2.6               |
| Migration Status          | None-Migrant | 1951 (40.86)                | 6669   | 3.4               | 3809 (35.25)                 | 8659   | 2.5               |
|                           | In-migrant   | 2824 (59.14)                | 8808   | 3.1               | 6998 (64.75)                 | 17125  | 2.7               |
| Current Contraceptive Use | Yes          | 891(18.66)                  | 2826   | 3.2               | 2079 (19.24)                 | 6783   | 3.3               |
|                           | No           | 3884 (81.34)                | 12651  | 3.3               | 8728 (80.76)                 | 19001  | 2.4               |
| Wealth Quantile           | Lowest       | 694 (14.53)                 | 2546   | 3.7               | 1503 (14.48)                 | 2386   | 1.8               |
|                           | Lower        | 1182 (24.75)                | 4498   | 3.8               | 1668 (16.07)                 | 3641   | 2.3               |
|                           | Middle       | 859 (17.99)                 | 2687   | 3.1               | 2203 (21.23)                 | 4971   | 2.4               |
|                           | Higher       | 1084 (22.70)                | 3580   | 3.3               | 2245 (21.63)                 | 6104   | 2.9               |
|                           | Highest      | 956 (20.02)                 | 2166   | 2.3               | 2758 (26.58)                 | 7649   | 3.0               |
| Total                     |              | 4,775 (100)                 | 15,477 | 3.3               | 10,907 (100)                 | 25,784 | 2.4               |

Source Calculated from Dabat DHSS Census and Re-census Data

Note: CEB = Children Ever Born, and ACEB = Average Number of Children Ever Born.

### Factors Associated with Fertility Changes

The study showed that current age of women, age at first marriage, educational status, marital status and family size were significant predictors of fertility changes in both censuses. The result also revealed that residence was significantly associated with fertility changes only for 2014 census.

Current age of women had a strong effect on their fertility. Compared to women with age group 15-19, older women were more likely to have birth in both 2008 and 2014 censuses and the magnitude of the rate ratios increased from 2008 to 2014. Educational status is also significantly and negatively correlated with fertility of women with reproductive age. Women with secondary or higher education were 21% (95%CI: 0.72 - 0.86) and 36%

(95%CI: 0.61 - 0.68) lower fertility in 2008 and 2014 respectively compared with women with no formal education (Table 2).

The result also indicated that age at first marriage influences fertility of women. Women whose age at first marriage was 18 or above were 23% lower fertility (95%CI: 0.74 -0.80) in 2008 whereas it was 26% lower (95%CI: 0.70-0.77) in 2014 compared with women whose age at first marriage was below eighteen years. Marital status of women had also an effect on fertility. Compared to never married women, currently married and women whose marriage was dissolved (divorced and widowed) had more births with an increasing effect from 2008 to 2014 censuses. With regard to residence, women who lived in rural areas had 1.17 times (95% CI: 1.07-1.28) and 1.27 times (95% CI: 1.22-1.32) more births in 2008 and 2014 respectively compared to women who lived in urban areas. Women who had the intention to have birth in the future had lower number of births compared to those who didn't have the intention to have more births in both censuses. With regard to wealth status, the result showed that women with better wealth status had lower birth in 2008, but higher number of births in 2014 compared with those who had low wealth status (Table 2).

Results from the pooled data also showed that current age, age at first marriage, educational status, place of residence, marital status and family size were significantly associated with fertility among women with reproductive age in the decade. The census year variables also revealed that fertility was lower in 2014 compared with 2008 (AIRR= 0.95; 95%CI: 0.93 – 0.97) (Table 2).

**Table 2: Trends in Poisson Regression of CEB to Woman in Age 15-49 in Dabat HDSS, 2008-2014**

|                          |              | Census year |             |          |              |                    |             |
|--------------------------|--------------|-------------|-------------|----------|--------------|--------------------|-------------|
|                          |              | 2008        |             | 2014     |              | Pooled (2008-2014) |             |
| Variables and categories |              | AIRR        | 95% CI      | AIRR     | 95% CI       | AIRR               | 95% CI      |
| Current Age              | 15-19        | 1.00        |             | 1.00     |              | 1.00               |             |
|                          | 20-24        | 2.16***     | 1.95 - 2.39 | 3.04***  | 2.72 - 3.40  | 2.65***            | 2.46 - 2.86 |
|                          | 25-29        | 3.68***     | 3.34 - 4.05 | 5.19***  | 4.66 - 5.77  | 4.54***            | 4.22 - 4.87 |
|                          | 30-34        | 4.82***     | 4.38 - 5.31 | 6.99***  | 6.28 - 7.78  | 6.03***            | 5.61 - 6.48 |
|                          | 35-39        | 5.89***     | 5.35 - 6.50 | 8.58***  | 7.72 - 9.54  | 7.43***            | 6.92 - 7.99 |
|                          | 40-44        | 6.45***     | 5.83 - 7.15 | 9.82***  | 8.83 - 10.93 | 8.41***            | 7.82 - 9.04 |
|                          | 45-49        | 7.16***     | 6.40 - 8.01 | 10.52*** | 9.44 - 11.73 | 9.09***            | 8.43 - 9.81 |
| Early Marriage           | Yes          | 1.00        |             | 1.00     |              | 1.00               |             |
|                          | No           | 0.77***     | 0.74 - 0.80 | 0.74***  | 0.70 - 0.77  | 0.76***            | 0.73 - 0.78 |
| Reproductive Intention   | Yes          | 1.00        |             | 1.00     |              | 1.00               |             |
|                          | No           | 1.05**      | 1.02 - 1.09 | 1.02**   | 1.00 - 1.05  | 1.03**             | 1.01 - 1.05 |
| Educational Status       | No Education | 1.00        |             | 1.00     |              | 1.00               |             |
|                          | Primary      | 0.98        | 0.91 - 1.04 | 0.90**   | 0.86 - 0.95  | 0.91***            | 0.88 - 0.95 |
|                          | Secondary+   | 0.79***     | 0.72 - 0.86 | 0.64***  | 0.61 - 0.68  | 0.67***            | 0.63 - 0.70 |
| Residence                | Urban        | 1.00        |             | 1.00     |              | 1.00               |             |
|                          | Rural        | 1.17***     | 1.07 - 1.28 | 1.27***  | 1.22 - 1.32  | 1.29***            | 1.25 - 1.33 |
| Marital Status           | Single       | 1.00        |             | 1.00     |              | 1.00               |             |
|                          | Married      | 1.57**      | 1.33 - 1.85 | 9.49***  | 8.34 - 10.79 | 7.01***            | 6.33 - 7.76 |
|                          | Dissolved    | 1.25***     | 1.05 - 1.48 | 7.38***  | 6.47 - 8.41  | 5.40***            | 4.87 - 5.99 |
| Migration Status         | None-Migrant | 1.00        |             | 1.00     |              | 1.00               |             |
|                          | In-migrant   | 1.01        | 0.97 - 1.04 | 0.99     | 0.96 - 1.02  | 1.00               | 0.98 - 1.02 |
| Wealth Quantile          | Lowest       | 1.00        |             | 1.00     |              | 1.00               |             |
|                          | Lower        | 0.97        | 0.92 - 1.02 | 1.04     | 0.99 - 1.09  | 1.01               | 0.97 - 1.04 |
|                          | Middle       | 0.94        | 0.89 - 1.00 | 1.04     | 0.99 - 1.09  | 0.99               | 0.96 - 1.03 |
|                          | Higher       | 0.93*       | 0.88 - 0.98 | 1.11***  | 1.06 - 1.17  | 1.04*              | 1.00 - 1.08 |
|                          | Highest      | 0.87***     | 0.78 - 0.96 | 1.17***  | 1.11 - 1.22  | 1.12**             | 1.08 - 1.16 |
| Year                     | 2008         |             |             |          |              | 1.00               |             |
|                          | 2014         |             |             |          |              | 0.95***            | 0.93 - 0.97 |
| Total Number             |              |             |             |          |              |                    |             |

Significance level: \*\*\*  $p < 0.001$ , \*\*  $p < 0.01$ , \*  $p < 0.05$ ; AIRR = Adjusted Incidence Risk Ratio

Source: Calculated from Dabat DHSS Census and Re-census Data

## Decomposition of Fertility Decline

The findings indicated that there was a reduction of an average 640.69 births per 1,000 women of the reproductive age during the year 2014 compared to the year 2008 in the surveillance site (P-value  $< 0.001$ ; 95% CI: -669.5 to -582.4). This overall change in fertility between 2008 and 2014 was attributed to both changing characteristics of women and reproductive behavior. The result showed that 76.3% (488.94 births per 1,000 women) of the births were attributable to differences in characteristics of women (endowment) (P-value  $< 0.001$ ; 95%CI: -524.74, -453.13), whereas the remaining 23.7% (151.75 births per 1,000 women) were explained by the changes in the reproductive behavior of women (coefficient) during the study period, between 2008 and 2014 (P-value  $< 0.001$ ; 95% CI: -224.36 to -79.14).

Under the endowment component, the larger proportion of the discrepancy, 31.4% (201.49 births per 1000 women) was due to the postponing of women's first marriage to later age over the years (P-value  $< 0.001$ , 95%CI: -215.90 to

-187.08). The decline in the proportion of currently married women observed in the comparison period also resulted to an average reduction of 137.62 births per 1,000 women (21.4%) with P-value <0.001; 95% CI: -147.66 to -127.57. Postponing of women's birth to later age has also contributed to 20.4% (130.80 births per 1,000 women) (P-value <0.001; 95% CI: -141.01 to -120.59). A decrease in the proportion of women who had no formal education contributed a 29.107 births per 1000 women (4.5%) fertility decline (P-value <0.001; 95% CI: -34.642 to -23.572) and an increase in the proportion of women whose educational attainment was secondary and above contributed a 31.15 births per 1000 women (4.8%) fertility decline (P-value < 0.001; 95% CI: -36.599 to -25.70) (Table 3).

On the other hand, under the coefficient component; the change of women's reproductive behavior in the study period was mainly attributed to the postponing of births to the later age among young women (6.2% or a 39.99 births per 1000 women decline) (P-value < 0.05; 95% CI: -54.544 to -22.452), postponing of first marriage (5.7% or a 36.876 births per 1000 women decline) (P-value < 0.05; 95% CI: -49.515 to -24.236), and the increase in the proportion of women whose educational attainment was secondary and above contributed a 13.27 births per 1000 women (2.1%) fertility decline (P-value < 0.05; 95% CI: -22.361 to -4.181). A decrease in the proportion of women in the low wealth status, (both in the lower and lowest wealth quintile) also contributed a 5.7% fertility decline (37 births per 1000 women) in 2014.

**Table 3: Decomposition of the Decline in Children Ever Born in Dabat HDSS, 2008-2014, Northwest Ethiopia**

| Variables                     | Endowment (E) |         |         |          |       | Coefficient (C) |         |         |         |        |
|-------------------------------|---------------|---------|---------|----------|-------|-----------------|---------|---------|---------|--------|
|                               | Coef.         | P-value | 95% CI  |          | %     | Coef.           | P-value | 95% CI  |         | %      |
| <b>Residence</b>              |               |         |         |          |       |                 |         |         |         |        |
| Urban                         | -9.931        | 0.000   | -11.613 | -8.249   | 1.5   | -10.68          | 0.119   | -24.115 | 2.755   | 1.6    |
| Rural                         | -9.931        | 0.000   | -11.613 | -8.249   | 1.5   | 33.397          | 0.119   | -8.615  | 75.410  | -5.2   |
| <b>Age Group</b>              |               |         |         |          |       |                 |         |         |         |        |
| 15-19                         | -130.80       | 0.000   | -141.01 | -120.59  | 20.4  | -39.998         | 0.000   | -57.544 | -22.452 | 6.2    |
| 20-24                         | 11.80         | 0.000   | 10.544  | 13.057   | -1.8  | 5.223           | 0.503   | -10.049 | 20.496  | -0.8   |
| 25-29                         | 0.255         | 0.766   | -1.943  | 1.431    | -0.4  | 6.830           | 0.323   | -6.706  | 20.367  | -1.06  |
| 30-34                         | -10.27        | 0.000   | -11.549 | -8.991   | 1.6   | 10.417          | 0.032   | 0.881   | 19.953  | -1.6   |
| 35-39                         | 1.997         | 0.000   | 1.839   | 2.154    | -0.3  | 7.396           | 0.024   | 0.961   | 13.832  | -1.1   |
| 40-44                         | 5.920         | 0.000   | 5.478   | 6.361    | -0.9  | 8.447           | 0.001   | 3.387   | 13.507  | -1.3   |
| 45-49                         | 9.815         | 0.000   | 9.089   | 10.543   | -1.5  | 2.347           | 0.073   | -0.218  | 4.912   | -0.4   |
| <b>Education</b>              |               |         |         |          |       |                 |         |         |         |        |
| No Education                  | -29.107       | 0.000   | -34.642 | -23.572  | 4.5   | 80.388          | 0.001   | 32.145  | 128.63  | -12.5  |
| Primary                       | 3.574         | 0.000   | 2.183   | 4.964    | -0.6  | 1.759           | 0.556   | -4.095  | 7.614   | -0.3   |
| Secondary+                    | -31.15        | 0.000   | -36.599 | -25.70   | 4.8   | -13.271         | 0.004   | -22.361 | -4.181  | 2.1    |
| <b>Marital Status</b>         |               |         |         |          |       |                 |         |         |         |        |
| Single                        | -201.49       | 0.000   | -215.90 | -187.080 | 31.4  | -36.876         | 0.000   | -49.515 | -24.236 | 5.7    |
| Married                       | -137.62       | 0.000   | -147.66 | -127.570 | 21.4  | 574.20          | 0.000   | 377.74  | 770.66  | -89.6  |
| Dissolved                     | 13.30         | 0.000   | 12.187  | 14.414   | -2.1  | 72.761          | 0.000   | 47.105  | 98.417  | -11.3  |
| <b>Migration Status</b>       |               |         |         |          |       |                 |         |         |         |        |
| None-Migrant                  | -0.104        | 0.651   | -0.555  | 0.347    | 0.01  | 3.750           | 0.450   | -5.975  | 13.477  | -0.5   |
| In-migrant                    | -0.104        | 0.651   | -0.571  | 0.347    | 0.01  | -5.429          | 0.450   | -19.507 | 8.648   | 0.8    |
| <b>Early Marriage</b>         |               |         |         |          |       |                 |         |         |         |        |
| Yes                           | 8.505         | 0.000   | 7.206   | 9.804    | -1.3  | 16.794          | 0.234   | -10.855 | 44.442  | -2.6   |
| No                            | 8.505         | 0.000   | 7.207   | 9.804    | -1.3  | -5.345          | 0.234   | -14.147 | 3.455   | 0.8    |
| <b>Fertility Intention</b>    |               |         |         |          |       |                 |         |         |         |        |
| Yes                           | 2.350         | 0.036   | 0.153   | 4.546    | -0.4  | 9.750           | 0.219   | -5.795  | 25.296  | -1.5   |
| No                            | 2.350         | 0.036   | 0.153   | 4.546    | -0.4  | -5.743          | 0.219   | -14.90  | 3.413   | 0.8    |
| <b>Wealth Quintile</b>        |               |         |         |          |       |                 |         |         |         |        |
| Lowest                        | 0.128         | 0.000   | 0.066   | 0.189    | -0.02 | -20.702         | 0.000   | -31.882 | -9.522  | 3.2    |
| Lower                         | 1.294         | 0.048   | 0.012   | 2.575    | -0.2  | -16.404         | 0.022   | -30.415 | -2.392  | 2.5    |
| Middle                        | -0.493        | 0.039   | -0.962  | -0.023   | 0.07  | -4.156          | 0.200   | -15.583 | 3.269   | 0.9    |
| Higher                        | -0.222        | 0.001   | -0.352  | -0.926   | 0.03  | 13.276          | 0.016   | 2.433   | 24.118  | -2.1   |
| Highest                       | 3.002         | 0.000   | 2.267   | 3.737    | -0.50 | 36.929          | 0.001   | 14.924  | 58.934  | -5.7   |
| Constant                      | NA            | NA      | NA      | NA       | NA    | -874.81         | 0.000   | -1184.5 | -565.18 | 136.54 |
| Component                     | -488.94       | 0.000   | -524.74 | -453.13  | 76.31 | -151.75         | 0.000   | -224.36 | -79.14  | 23.69  |
| <b>Raw Difference</b>         |               |         |         |          |       |                 |         |         |         |        |
|                               | -640.69       | 0.000   | -699.24 | -582.14  | 100   |                 |         |         |         |        |
| <b>Number of observations</b> |               |         |         |          |       |                 |         |         |         |        |
|                               |               |         |         |          |       | 15,582          |         |         |         |        |

Source: Calculated from Dabat DHSS Census (2008) and Re-census (2014) Data

Notes: NA = Not Applicable, and CI = Confidence Interval

## Discussion

In this study, there was significant fertility decline observed during the study period. The detailed decomposition analysis outlined the overall contributions of determinants on the observed reduction of an average 641 CEB per 1,000 women during the year 2014 compared with the year 2008 which was attributable to both the change in characteristics of women and their reproductive behavior. The major drivers of the recent fertility decline during the

study period were the shift observed in the age at first marriage, the change in the proportion of currently married women, the shift in women's birth to later age and the change in women's educational status.

The study revealed that a decline in the average number of children ever born was observed during the study period. The mean children ever born to women in the reproductive age group decreased from 3.3 to 2.4 children in the years 2008 and 2014 respectively whereas the average number of children at the end of their reproductive years (45-49 years) was higher and has showed a slight increase from 6.0 in 2008 to 6.2 children in 2014, which was similar to the study done in Amhara National Regional State, northwest Ethiopia using the Demographic and Health Surveys [30].

The analysis of the trends of determinants of fertility revealed there were significant predictors of fertility in both 2008 and 2014 censuses. Current age of women had a strong effect on their fertility in which older women were more likely to have high CEB in both 2008 and 2014 censuses compared to women with younger age group which is supported with similar studies [31-34]. Similarly, adolescent fertility was nearly absent during the latter census indicating a shift in the average age of entry to fertility. This postponement of births to later age and changes in the age structure have great contribution to the observed fertility reduction between the two censuses (20.4% and 9.9% attributed to the change in women's characteristics and the changes in response to behavior, respectively) which was similar to other studies [29]. Several studies have shown that postponement of childbirth to later ages leads to fertility reductions since women would have fewer years of reproduction window [32-36].

The present study also shows that education was significantly associated with fertility. Women with secondary or higher education had lower fertility compared with women with no formal education in both censuses. The decomposition analysis also indicated that a decrease in the proportion of women who had no formal education and an increase in the proportion of women whose educational attainment was secondary and above contributed (27.21 and 30.498 births per 1000 women respectively) for the observed fertility decline in the study period. This is supported by previous studies [37-40]. This could be the fact that the increased attainment of higher level of education could have delayed entry into marriage, increased desire for small family and adoption of contraceptive methods [41].

Marital status was one of the variables that significantly associated with fertility. Ever married women including currently married had more parity across the study period. Under the decomposition analysis, the postponing of women's first marriage to later age (or increasing the number of never married women) largely contributed to the observed reduction of women's fertility by both changing in women's characteristics and behavior (221.1 and 32.95 birth per 1000 women respectively). The decline in the proportion of currently married women also contributed to the reduction of women's fertility by changing in women's characteristics (148.89 births per 1000 women). This result is similar to the other studies that indicated the reduction of fertility observed when women are entering into unions at older ages and an increasing proportion of women never married at each age which are accompanied by very low premarital fertility [42] which might be a reflection of the presence of negative social sanctions associated with out-of-wedlock births. These shift in union formation to the later age are commonly attributed to women's increasing levels of education, greater participation in wage employment outside of the home, and the development of alternative roles for women outside of marriage and motherhood [43,44].

In recent times, in developing countries, poor people have the same desired fertility and even they tended to have lower number of births as compared to their wealthy compatriots. The result of this study revealed that women with better wealth status had higher number of births in 2014 compared with those who had low wealth status.

This might be attributed to the increasing severe economic difficulties that may initiate women not to give birth to a child which is consistent with the study conducted in Tanzania [45].

The strength of this study is that the analysis is based on census data which provide accurate information for many subdivisions of the population in which the estimates are not subject to sampling error in the study of determinants of fertility. In addition, the multivariate decomposition analysis technique enables us to observe changes in reproductive behaviors and shifts in the socio-demographic composition of the population. This analysis technique also partitions the change in an outcome over time into components attributable to changing characteristics and reproductive behavior of women, and portions the unique contribution of each predictor to each of the two components. The limitation of the study is that we did not determine the cause-effect relationships for the reason that we used cross-sectional surveys.

## Conclusion

In this study, the observed reduction in fertility was explained by both the differences in characteristics of women and changes in response to behavior between the two census periods. The major drivers of the recent fertility decline during the study period in the study area were the shift observed in the age at first marriage, the change in the proportion of currently married women, the shift in women's birth to later age and the change in women's educational status. The postponing of women's first marriage to later age largely contributed to the observed fertility reduction. The low level of non-marital fertility in the study area highlights the prevalence of close connection between marriage and childbearing. Hence, encouraging women to complete at least secondary education are important to increase the age at first marriage and birth which can intern speed up the current fertility transition.

## Abbreviations

|        |  |
|--------|--|
| DHDSS: | Dabat Health and Demographic Surveillance Site |
| TFR:   | Total Fertility Rate                           |
| EDHS:  | Ethiopia's Demographic and Health Surveys      |
| ANRS:  | Amhara National Regional State                 |
| CEB:   | Children Ever Born                             |

## Declarations

### Ethics approval and consent to participate

Dabat HDSS has obtained ethical clearance from the Health Research Ethics Review Committee (HRERC) of the University of Gondar. Informed consent was obtained from the head of the family or other eligible adult in the family when relevant. The authors have also obtained an ethical clearance from the Health Research Ethics Review Committee (HRERC) of the University of Gondar for further analysis of the 2008 and 2014 census data conducted in Dabat HDSS site.

### Consent for publication

Not applicable, no individual detail is presented.

### **Competing interests**

The authors declare that they have no competing interest.

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### **Authors' contributions**

NM participated from conception to the final approval of the final version of the article. AH, MY and KA supervised the whole exercise and made critical comments at each step in the research. They also approved the final version of the article.

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## Figures

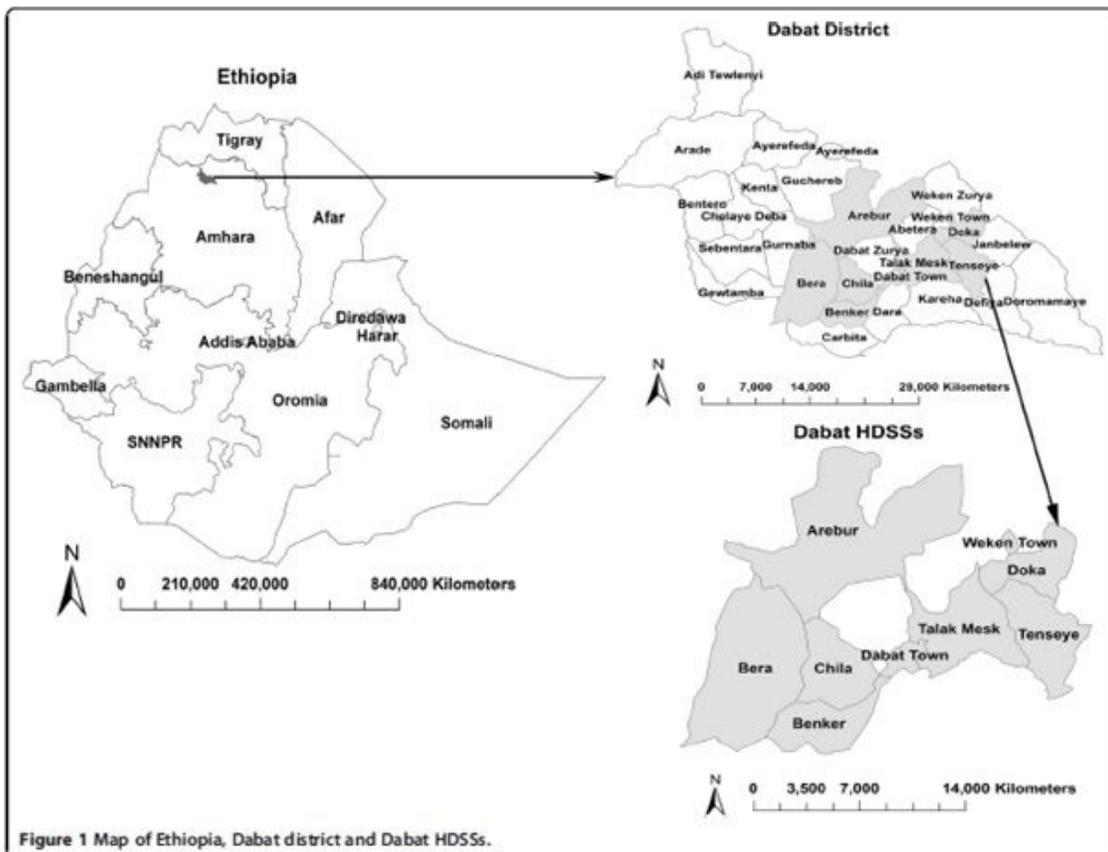


Figure 1 Map of Ethiopia, Dabat district and Dabat HDSSs.

Figure 1

Map of Ethiopia, Dabat district and Dabat HDSSs