Spatial Distribution And Determinant Factors Of Birth Interval Among Reproductive Age Group Women, Based On Edhs 2016, Ethiopia, 2019.

Zegeye Regasa (zegeyerega@gmail.com)
Debre Markos University  https://orcid.org/0000-0002-6257-9068

Biniyam chakilu Tilahun
University of Gondar College of Medicine and Health Sciences

Araya Mesfin
University of Gondar College of Medicine and Health Sciences

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Abstract

Birth interval is time between two successive live births. Ethiopia is one of the populated African countries with total fertility rate of 4.6 and annual population growth rate of 2.6. Short birth intervals (<24 months) contribute to infant and child mortality risks. Currently, in Ethiopia women still have shorter birth intervals and studies addressing its determinants and maps to show the varied spatial distribution are scarce. This study examined individual and community level factors associated with duration of birth interval.

Method: Data from the Ethiopian Demographic and Health Survey undertaken in 2016 was used for this analysis. Data was analyzed using STATA version 14, Arc Map GIS 10.3 and SaTScan. Multilevel Binary Logistic regression models were also used to explain regional inequalities in duration of birth intervals among women of reproductive age.

Result: The median birth interval of the study population was 32 months (2.67 years). The result of this study reveals that 1935(25%) of women have intervals shorter than 24 months. Duration of birth interval was associated with index child died, women from highest economic level, women who breastfeed and women aged 45-49. Duration of birth interval had spatial variation across the country. A high proportion of shorter duration of birth interval was identified in Somalia and Affar Regions. Whereas the lower proportion of short birth interval found in Amhara, Tigray and Gambela.

Conclusion: In this study both the individual and community level Factors were found to have significant influence on preceding birth interval of children. The spatial effect of duration of birth was captured by the spatial analysis. Additionally dissemination of information about recommended interval and cooperative effort to improve women’s economic independency and decision making power to increase maternal social status has to be conducted.

Background

Birth interval or Birth spacing refers to how soon after a prior pregnancy a woman becomes pregnant or gives birth again (1). Until recently, international guidance on birth spacing stated that births should be spaced at least two years apart (2–5) to ensure maximum health benefits for mothers, newborns, and older children (2).

There are health risks associated with both pregnancies placed closely together and those placed far apart, but the majority of health risks are associated with births that occur too close together and also Evidence showed that a relationship prevails between shorter birth intervals and high infant and child mortality (1–3).

It was also indicated that short inter birth intervals have been linked to increased risk for preterm birth, low birth weight, being small for gestational age, labor dystocia, and maternal morbidity and mortality (4).
Every year, more than 500,000 women worldwide die from pregnancy-related causes, with the vast majority of deaths occurring in developing countries (5).

Now a day a number of researches and reports mentions family planning as one of the most cost effective way to reduce high fertility (6). While the main benefit of contraception for maternal health is through reduction in unintended pregnancies, its main benefit for newborn, infant and child health and survival lies in its potential to lengthen the intervals between successive births (7).

Based on evidence from different research findings individual level factors and community level factors, are the major predictors for duration of birth interval. Major variables which significantly influence duration of birth interval are residence geographic location, age of mother, educational status of the mothers, breast feeding habit of the mother, religion, index child sex, survival status of the index child, income /wealth and contraceptive use (8,9).

In Ethiopia like many other Sub-Saharan African countries, fertility, maternal mortality, and child mortality are still high. Recent estimates showed that the country still experiences higher rates of maternal, neonatal, and infant mortality of 412/100,000, 30/1000, and 48 per 1000 live births, respectively (10).

However, little is known about the current level of birth spacing and determinant factors in Ethiopia, specially a finding supported by spatial dimensions. Thus, understanding the level of birth interval and factors influencing birth spacing is critical for countries like Ethiopia with a population policy aiming at reducing fertility. Therefore, the finding of this study would be helpful in reminding local and possibly nationwide policy makers of how fertility and birth spacing situation looks like all over Ethiopia and to design appropriate strategies for encouraging greater use of optimal birth spacing and thereby ensuring further declines in fertility and maternal and child mortality. It is also hoped that the result of this research will be an input for regional and national health care planners and program managers in designing site specific and scientifically sound interventions to address the gap in the utilization of family planning and optimal birth spacing.

**Method**

**Study design and study area**

A survey-based cross sectional study was conducted using EDHS 2016 datasets which conducted from January 18, 2016, to June 27, 2016. Ethiopia is located in the horn of Africa and the second most populated nation on the African continent, with over 100 million inhabitants (2017 estimates). It occupies a total area of 1,104,300 km2 and has Addis Ababa as its capital city (2,4). The country is divided into 11 administrative divisions - 9 regional states and 2 city administrations (Addis Ababa which is the capital city of the country, & Dire Dawa). The latest recorded population growth rate was 2.6 percent (4).

The survey target groups were women age 15-49 and men age 15- 59 in randomly selected households across Ethiopia. Detailed information was collected from 16,650 households, 15,683 female respondents,
and 12,688 male respondents

**Study variables**

**Dependent variable**

- Duration of birth interval (< 24 month = short birth interval and 24-60 month = normal birth interval )

**Independent variables**

The independent variables are the respondents’ geographic location and regional administrative of residence, in addition to various individual level and household level control variables such as socio-demographics and household socio-economic status, contraception use. The respondent’s age at the time of survey was also included as an indicator of the birth interval of the participant. Other socio-demographic variables are education of the respondent (no education vs. primary, secondary and higher education), household socio-economic status based on level of income (low and middle income versus high income households), breastfeeding (never and exclusive versus mixed feeding). Finally, environmental factors included place (locality) of residence (rural vs. urban) and region of residence of the respondents.

**Study population**

The study populations for this study were 7740 non-first birth children who were born with five years before the survey undertaken, nested within 645 clusters across the country. The interval for multiple births was the number of months since the preceding pregnancy that ended in a live birth. Long birth intervals (>5 years), First birth order and their twins were excluded. Thus, the current analysis was based on approximately 7740 non-first birth within five years preceding the survey with a complete set of data.

**Sample size determination and sampling procedure**

A total of 7740 (weighted) non-first birth children were included in the study; to restore the representativeness of sample Weighted data values was used. After extraction of the data, the missing values for the significant independent variables were excluded and the analysis was undertaken using complete set of data.

A Multi-stage stratified sampling technique was used for 2016 EDHS, sampling was based on the Census Enumeration Areas (CEAs) of the 2007 Population and Housing Census of Ethiopia. The sample for the 2016 EDHS was designed to provide estimates of key indicators for the country as a whole, for urban and rural areas separately, and for each of the nine regions and the two administrative cities.

The 2016 EDHS sample was stratified and selected in two stages. Each region was stratified into urban and rural areas, yielding 21 sampling strata. Samples of EAs were selected independently in each stratum in two stages. Implicit stratification and proportional allocation were achieved at each of the lower administrative levels by sorting the sampling frame within each sampling stratum before sample
selection, according to administrative units in different levels, and by using a probability proportional to size selection at the first stage of sampling. A total of 645 EAs (202 in urban areas and 443 in rural areas) were selected with probability proportional to EA size (based on the 2007 PHC) and with independent selection in selection in each sampling stratum.

**Data management and Statistical analysis**

Data were extracted using STATA version 14 and Excel (for extraction of latitude and longitudinal address). Arc Map GIS 10.3 and SaTScan 9.4 were used to show areas with cluster of short birth interval using different features/tools of arc map and SaTScan. Descriptive and multilevel logistic regression analyses were carried out. Descriptive analysis such as frequency, percent and median, were performed and the result was presented using text, tables and figures. Bivariate and multivariate multilevel logistic regression analyses were performed. Since the DHS data is a hierarchal data by its nature, it sound to use multilevel regression which account both between and within cluster differences. Candidate variables with p-value less than 0.2 were entered into the model. four models were considered in multilevel logistic regression: model 1: empty model without explanatory variables which examines duration of birth interval without explanatory variables that specified only random intercept and it presents the total variance in duration of birth interval among clusters, model 2: individual variables which examines duration of birth interval with individual level factors which affecting it. Model 3: which examines duration of birth interval with cluster based factors affecting it. Model 4: adjusted cluster and individual level factors which examines duration of birth interval with both individual factors and cluster or community level factors. After all, measures of association were determined by odds ratio of individual and cluster level variables.

Measurements of variations were also determined using interclass correlation (ICC), median odds ratio (MOR) and proportional change in variation (PCV). Multilevel model was estimated with likelihood. Finally, the fitted model were selected based on Akakie information criteria (smallest AIC), Likelihood ratio (highest LL) and Deviance (smallest). P value <0.05 was considered as statistically significant.

As a useful tool for geographical cluster detection of events, the spatial scan statistic is widely applied in many fields and plays an increasingly important role. The classic version of the spatial scan statistic for the binary outcome is developed by Kulldorff, based on the Bernoulli or the Poisson probability model. In this study a Bernoulli-based model was used in which events at particular places were analyzed if women practice short birth or not represented by a 1/0 variable.

Spatial interpolation was also the procedure for estimating the value of properties at unsampled sites within an area covered by existing observation. A wide variety of spatial interpolation techniques exist. Among those techniques Kriging is an advanced geostatistical procedure that generates an estimated surface from a scattered set of points with z-values. Other tools like hot/cold spot detector (local Getis ord) and outlier detectors (local Moran's I) are used for the geo-statistical analysis.

**Ethical issues**
The EDHS 2016, datasets was downloaded from DHS (Demographic and Health Survey) website after obtained the necessary permissions for the download and further analyses and a written consent form was prepared and sent through email for the researcher to confirm authorization.

The study was approved by the institutional ethical review committee board of the University of Gondar and ethical clearance was obtained from the board. Upon this clearance the study was conducted. Confidentiality of the data was maintained by using the extracted data only for the study purpose and keeping the data from third party.

Result

Background information

In this study, a total of 7740(weighted) non first birth children in the 5 years prior to the survey were included in the analysis. Among the total women (mothers of children) whose data were analyzed 45 % (3483) of them were with the age range of 20-29 years, nearly three-fourth 74 % (5728) of them were uneducated and 25 % (1935) were from poorest households. The majority 91% (7043) of the respondents resides in rural areas and 44.7% (3460) of the respondents were from Oromiya region and also 30% (2322) of women were use modern contraception method. The median birth interval of the study population was 32 months; thus, half of non-first births occur within 3 years after the first birth. One in four births (25%) occurs within less than 2 years after the previous birth.

*Table 1 Individual Level Factors of women participated on EDHS (2016), Ethiopia. (N=7740)*
| Background characteristics | Birth Interval | Total (%) | Number of non-first birth | Median birth interval |
|-----------------------------|---------------|-----------|--------------------------|----------------------|
|                             | Short (%)     | Normal (%)|                          |                      |
| Individual level factors    |               |           |                          |                      |
| Sex                         |               |           |                          |                      |
| Male                        | 25(1004)      | 75(3013)  | 100.00                   | 4017                 |
| Female                      | 25.3(942)     | 74.7(2781)| 100.00                   | 3723                 |
| Age                         |               |           |                          |                      |
| 15-19                       | 46(20)        | 54(23)    | 100.00                   | 43                   |
| 20-29                       | 28(979)       | 72(2516)  | 100.00                   | 3495                 |
| 30-39                       | 22.1(762)     | 78.1(2688)| 100.00                   | 3450                 |
| 40-49                       | 21.9(165)     | 78.1(587) | 100.00                   | 752                  |
| Occupation                  |               |           |                          |                      |
| Working                     | 23.4(780)     | 76.6(2554)| 100.00                   | 3334                 |
| Not working                 | 26.4(1163)    | 73.6(3243)| 100.00                   | 4406                 |
| Education                   |               |           |                          |                      |
| No education                | 25.9(1497)    | 74.1(4282)| 100.00                   | 5779                 |
| Primary                     | 23.3(389)     | 77.7(1303)| 100.00                   | 1693                 |
| Secondary                   | 16.7(32)      | 83.3(160)| 100.00                   | 192                  |
| Higher                      | 25.1(19)      | 75.7(57)  | 100.00                   | 76                   |
| Wealth quintile             |               |           |                          |                      |
| Poorest                     | 29.2(611)     | 71.8(1482)| 100.00                   | 2093                 |
| Poorer                      | 27.1(508)     | 72.9(1365)| 100.00                   | 1873                 |
| Middle                      | 23.6(381)     | 76.4(1234)| 100.00                   | 1615                 |
| Richer                      | 21.7(295)     | 78.3(1065)| 100.00                   | 1360                 |
| Richest                     | 18.1(145)     | 81.9(654)| 100.00                   | 799                  |
| Status of prior birth       |               |           |                          |                      |
| Living                      | 24.1(1760)    | 75.9(5543)| 100.00                   | 7303                 |
| Dead                        | 41(179)       | 59(258)   | 100.00                   | 437                  |
| Birth order                 |               |           |                          |                      |
| 2-3                         | 23(640)       | 77(2142)  | 100.00                   | 2782                 |
| 4-6                         | 26.4(831)     | 73.6(2316)| 100.00                   | 3147                 |
| 7+                          | 25.9(469)     | 74.1(1342)| 100.00                   | 1811                 |
| Contraceptive use           |               |           |                          |                      |
| Modern                      | 22.2(469)     | 77.8(1644)| 100.00                   | 2113                 |
| Traditional                 | 42.8(9)       | 57.2(12)| 100.00                   | 21                   |
| Non-user                    | 26.1(1463)    | 73.9(4143)| 100.00                   | 5606                 |
| Breastfeeding habit         |               |           |                          |                      |
| Never                       | 32(124)       | 68(263)   | 100.00                   | 387                  |
| Not currently               | 29.2(1230)    | 70.8(2981)| 100.00                   | 4211                 |
| Still breast feed           | 18.7(588)     | 81.3(2554)| 100.00                   | 3142                 |
### Table 2 Community Level Factors of Women participated on EDHS (2016), Ethiopia. (N=7740)

| Background characteristics | Birth Interval | Total | Number of non-first birth | Median birth interval |
|----------------------------|----------------|-------|---------------------------|-----------------------|
| **Community level factors** |                |       |                           |                       |
| Residence                  |                |       |                           |                       |
| Urban                      | 23(123)        | 77(413) | 100.00                    | 536                   | 34.1 |
| Rural                      | 25(1801)       | 75(5403) | 100.00                    | 7204                  | 31.9 |
| **Region**                 |                |       |                           |                       |
| Tigray                     | 14.5(64)       | 83.5(376) | 100.00                    | 440                   | 36.7 |
| Afar                       | 36.5(30)       | 63.5(52)  | 100.00                    | 82                    | 25.4 |
| Amhara                     | 14.6(179)      | 83.4(1047) | 100.00                    | 1226                  | 37.3 |
| Oromiya                    | 27.5(1005)     | 72.5(2649) | 100.00                    | 3654                  | 30.3 |
| Somali                     | 47.6(203)      | 52.4(223) | 100.00                    | 426                   | 24.7 |
| Ben-Gunz                   | 27.7(25)       | 72.3(65)  | 100.00                    | 90                    | 30.9 |
| SNNP                       | 24.3(409)      | 75.8(1274) | 100.00                    | 1683                  | 31.9 |
| Gambela                    | 17.6(3)        | 82.4(13)  | 100.00                    | 16                    | 34.8 |
| Harari                     | 29.5(5)        | 71.5(12)  | 100.00                    | 17                    | 29.3 |
| Addis Abeba                | 19.5(17)       | 81.5(70)  | 100.00                    | 87                    | 35.8 |
| Dire Dawa                  | 34.5(10)       | 65.5(19)  | 100.00                    | 29                    | 30.9 |
| **Community poverty**      |                |       |                           |                       |
| Low                        | 20.2(571)      | 79.8(2257) | 100.00                    | 2828                  | 34.1 |
| High                       | 27.8(1366)     | 73.2(3546) | 100.00                    | 4912                  | 30.5 |
| **Community education**    |                |       |                           |                       |
| Low                        | 26.5(1376)     | 73.5(3815) | 100.00                    | 5191                  | 31.1 |
| High                       | 22.3(568)      | 77.3(1981) | 100.00                    | 2549                  | 33.6 |
| **Total**                  | 25% (1935)     | 75% (5805) | 100.00                    | 7740                  | 32 |

**Spatial distribution of short birth interval**

**Spatial auto correlation**

This study identified that the spatial distribution of birth interval was found non-random distribution with Moran's I 0.065 z-score 2.17 and p-value 0.029.

Based on EDHS-2016 sampled data, geostatistical (local gets ord) analysis predict that highest percent of short birth intervals were detected in North-Eastern of Somali regional zones, some southern part of Afar regional zones, Eastern part of Oromiya regional zones, some part of Harari regional zones and Dire Dawa.
Cluster outlier’s areas were detected by using local Moran's I (Anselin). Higher cluster outlier areas were found in Addis Abeba, western zone of Tigray, Harari, some parts of Benishagul and SNNPR. On the other hand low cluster outliers were detected in some western parts of Benishagul and some Eastern parts of Gambela regional states.

**Spatial interpolation**

Based on EDHS 2016 sampled data geostatistical analysis predict that highest short birth interval percentage were detected mainly in Somali, Affar, Oromiya and Amhara regions.

**Multilevel logistic regression analysis**

The results of the empty model (Model 1) explained that there was a statistically significant variability in the odds of birth intervals between communities. Similarly, the ICC in the empty model implied that 16.4 % of the total variance in the distribution of birth interval was attributed to differences between communities.

In model II only individual variables which examines duration of birth interval with individual factors with p-value less than 0.2 were added. The results showed that women age, index child living status, household wealth index, occupation, birth order and breastfeeding habit were significantly associated with duration of birth interval. The ICC in Model II indicated that, 11.2 % of the variation in women's birth interval distribution was attributable to differences across communities. As shown by the PCV, 26% of the variance in distribution of birth interval across communities was explained by the individual level characteristics.

In Model III only community level variables with p-value less than 0.2 were added. The result showed that women from urban areas, residing in communities with low poverty level, residing in communities with low education level and region were significantly associated birth interval. The ICC in Model III implied that differences between communities account for about 8.3 % of the variation in women's preceding birth interval. In addition, the PCV indicated that 41.2 % of the variation in preceding birth interval between communities was explained by community level characteristics.

The final model was Model IV which included both individual and communities factor. Additionally model IV was used for the interpretation of this study findings because of its model fitness than the reset three models. By holding other individual and communities factors constant, women aged 20-29 were 57% less likely to have subsequent birth compared to those age group 15-19 years (AOR 0.43 CI 0.22-0.84). Likewise women aged 30-39 years were 70% (AOR 0.30 CI 0.15-0.59) and women aged 40-49 years were 70% (AOR 0.30 CI 0.15-0.61) less likely to have subsequent birth respectively.

After controlling other factors constant women from richest households were 54% [AOR 0.46 95% CI 0.33-0.63]; women from richer households were 20 % [AOR 0.80 95% CI 0.65-0.98] and women from middle economic households were 20 % [AOR 0.80 95% CI 0.66-0.97] less likely to have a subsequent birth as compared to women from poorest households.
Women whose index child died were 78% more likely to have subsequent birth compared with women whose index child is alive [AOR 1.78, 95% CI 1.41-2.24]. Women who breastfed until the survey time were 39% less likely to have subsequent birth compared to those who never breastfed their child [AOR 1.84, 95% CI 1.41-2.39].

With respect to region, women from Tigray and Amhara regional state were among the ones who had reported the highest number of women with normal birth intervals. They were nearly 79% less likely to have subsequent birth [AOR 0.21, 95% CI 0.14-0.33] [AOR 0.21, 95% CI 0.14-0.30]. Respectively than women in Somali regional state which had the highest number of women with subsequent birth, Women reside in Gambela 77%, in SNNPR 62%, in Oromiya 60% and in Addis Ababa 57% less likely to have subsequent births than Somali regional state [AOR 0.23, 95% CI 0.06-0.93] [AOR 0.38, 95% CI 0.27-0.53] [AOR 0.40, 95% CI 0.29-0.55] [AOR 0.43, 95% CI 0.21-0.89] respectively.

Table 3 Multilevel Analysis for Individual Level Factors (EDHS 2016), Ethiopia
| Characteristics fixed effects | Model I | Model II | Model III | Model IV |
|-------------------------------|---------|---------|-----------|----------|
|                               | AOR (CI 95%) | AOR (CI 95%) | AOR (CI 95%) | AOR (CI 95%) |
| Sex                           |         |         |           |          |
| Male                          | 0.96 (0.86-1.10) | -         | 0.96 (0.85-1.07) |          |
| Female                        | 1       | -       | 1         |          |
| Age                           |         |         |           |          |
| 15-19                         | 1       | -       | 1         |          |
| 20-29                         | 0.32 (0.16-0.62) | -       | 0.43 (0.22-0.84)** |          |
| 30-39                         | 0.17 (0.08-0.33) | -       | 0.30 (0.15-0.59)*** |          |
| 40-49                         | 0.15 (0.07-0.30) | -       | 0.30 (0.15-0.61)*** |          |
| Education                     |         |         |           |          |
| No education                  | 1       | -       | 1         |          |
| Primary                       | 1.06 (0.91-1.23) | -         | 0.90 (0.77-1.05) |          |
| Secondary                     | 1.18 (0.76-1.86) | -         | 0.92 (0.58-1.44) |          |
| Higher                        | 1.59 (0.85-2.99) | -         | 1.02 (0.54-1.92) |          |
| Wealth quintile               |         |         |           |          |
| Poorest                       | 1       | -       | 1         |          |
| Poorer                        | 0.86 (0.72-1.01) | -         | 0.96 (0.81-1.14) |          |
| Middle                        | 0.67 (0.56-0.81) | -         | 0.80 (0.66-0.97)** |          |
| Richer                        | 0.66 (0.54-0.80) | -         | 0.80 (0.65-0.98)** |          |
| Richest                       | 0.47 (0.36-0.61) | -         | 0.46 (0.33-0.63)*** |          |
| Status of prior birth         |         |         |           |          |
| Living                        | 1.66 (1.32-2.09) | -         | 1.78 (1.41-2.24)*** |          |
| Dead                          | 1       | -       | 1         |          |
| Birth order                   |         |         |           |          |
| 2-3                           | 1.11 (0.97-1.26) | -         | 1.23 (0.98-1.35) |          |
| 4-6                           | 1.04 (0.89-1.21) | -         | 1.13 (0.97-1.31) |          |
| Contraceptive use             |         |         |           |          |
| Modern                        | 1.05 (0.92-1.22) | -         | 1.13 (0.98-1.30) |          |
| Traditional                   | 3.75 (0.71-9.80) | -         | 3.65 (0.89-9.45) |          |
| Non-user                      | 1       | -       | 1         |          |
| Breastfeeding habit           |         |         |           |          |
| Never                         | 1       | -       | 1         |          |
| Not currently                 | 0.93 (0.72-1.20) | -         | 0.98 (0.76-1.27) |          |
| Still breast feed             | 0.53 (0.40-0.70) | -         | 0.61 (0.46-0.80)*** |          |
| Occupation                    |         |         |           |          |
| Working                       | 0.87 (0.77-0.98) | -         | 0.98 (0.86-1.11) |          |
| Not working                   | 1       | -       | 1         |          |
Spatial SaTScan analysis

A total of 5 clusters were identified and three of them were significant cluster with p-value <0.05. A total of 42 location/spot with total sampled population of 793 were found as primary cluster areas were identified using sat scan analysis with p- value < 0.000001. The primary cluster spatial window was located mainly in Somali region and 402 cases were found among the total population.(Table 4)

Table 4 SaT scan report on significant clusters of short birth interval (EDHS 2016), Ethiopia

| Types of clusters | Num. of location | Coordinate/radius | population | case | RR   | LLR      | p-value  |
|-------------------|------------------|-------------------|------------|------|------|----------|----------|
| Primary clusters  | 42               | 7.453674 N, 46.955230 E/ 546.25 km | 793        | 402  | 2.02 | 103.69736 | 0.0001   |
| Secondary cluster | 75               | 11.845228 N, 41.915793 E/ 259.44 km | 851        | 301  | 1.31 | 12.531635 | 0.0025   |
| Secondary cluster | 104              | 10.259205 N, 40.558314 E / 199.30 km | 1187       | 394  | 1.23 | 9.297747  | 0.050    |
The primary cluster spatial window was centered at 6.559519 N, 46.154797 E / 826.74 km, with a relative risk (RR) of 2.02 and log-likelihood ratio (LLR) of 103.6 at p<0.00001. It showed that women within the spatial window had 2 times more likely higher risk of short birth interval than the women outside areas of the spatial window.

**Discussion**

This study tried to identify spatial distribution and predictors of birth interval across the regions in Ethiopia. 2016 Ethiopian Demographic and Health Survey data were used. Non-first birth children within five years before the survey were included. Long birth intervals (> 5 years) and first order child and their twins were excluded. The result of the study showed that 25% of births occur with less than 24 months in Ethiopia with a median birth interval of 32 months, and this finding are in line with study conducted in Dabat town, northwest Ethiopia and Rufiji Tanzania which had a median birth interval of 32.6 and 33.4 respectively (9,11). Also this study figure out the geographical inequality of birth interval using saT scan and GIS spatial techniques like cluster mapping tools and interpolation techniques. The spatial analysis indicates that the distribution of short and normal birth interval was non-random across the country with global Moran’s I index of 0.065 and significant p-value which indicate significant clustering areas. Using saT scan analysis 5 hot/high rate cluster areas of short birth interval were identified.

Based on the GIS analysis there were a significant difference across regions, highest proportion of short duration of birth intervals were reported in Somali, Affar, Harari, whereas comparatively lowest proportion was reported in Amhara, Tigray regions and Addis Abeba. This finding is consistent with findings of another study in DRC (8). This variation may be because of proximity of the health facility in the village and the geographical distribution of family planning service center. Those regions with low percent of short duration interval are relatively urban in which health facilities are more accessible and women are more aware of family planning services.

The study showed that duration of birth intervals are equally the same for women in rural and urban areas. The findings was in contrast to the existing literature, which shows that differential access to better social services and information, education and employment opportunities in urban areas have brought about a variation in birth spacing by rural–urban residence (12,13). This is may be due to that women from urban areas had less numbers in the sample than that of rural women from areas, which is 9% only.

Other variable which has influence on birth duration was index child living status; the odds of short birth interval among mothers who lost their index child were higher as compared to their women counterpart who had alive index child. This finding was consistent with evidence from study conducted in Dabat town northern Ethiopia, EDHS 2000 and Manipur north-eastern India (9,14,15). This could happen due to the desire of parents to replace the dead child sooner and In addition, if the child dies, the woman is less likely to be protected from lactational amenorrhea.
A number of studies identified wealth index as a significant predictor of birth interval. Results of this study also verified women from low economic level household had odd of being in short birth interval than women from high economic status. Study conducted in Saudi Arabia stated that shorter birth intervals were independently predicted by lower family income (16). Similar study conducted in Lemo District, Ethiopia, showed that the median length of birth interval grew as one shift from lowest quartile to highest quartile of the wealth index (17). This may happen due to Women from the better wealth category more likely to access health care information, education and afford health care services and materials and education.

According to the findings of this study, birth interval also showed a significant difference based on women age group, younger women had higher odds of short birth interval than women with older age group. Based on different research findings age of mothers had a significant effect on length of birth interval for instance study done in democratic republic of Congo, Dabat northern Ethiopia and southern Ethiopia (8,9,18) This could be due to as age increase the ability women to produce their off spring would be decrease and additional older women are likely to have achieved the desired number of children.

Breastfeeding had a significant association with duration of birth interval, based on the findings of this study women who breastfeed their child until the survey undertaken were less likely to have short duration of birth than women who never breastfeed their children. Many of the researches also in line with this finding among those researches, a research conducted in Maichew, Tigray and Manipur (14,19). The possible reason is the duration of breast feeding can lengthen the post-partum amenorrhea

**Conclusion**

In this study both the individual and community level characteristics were found to have significant influence on preceding birth interval of children. The median birth interval of this study population was 32 months which implies 50% of the study population has birth interval less than the median that reflects majority of birth intervals are below three years. Index child living status, Women's age, household socio economic level, occupation and breastfeeding were the factors that influence preceding birth interval in at the individual level factors.

In population with low contraceptive use, this finding may help as a basis for promoting longer breastfeeding for non- contraceptive mothers in the study area.

The study also showed that the communities in which the women reside play a significant role in shaping a women's decision to prolong their preceding birth interval. Among the community factors region of residence was the major important factor to determine preceding birth interval. This study identified spatial clusters of birth interval in Somalia and Affar Regions with high proportion short duration of birth interval and Amhara, Tigray and Addis Ababa with the lowest proportion of short duration birth interval.

**Abbreviations**
SBI: short birth interval; AOR: Adjusted Odds ratio; CSA: Central statistics agency; EDHS: Ethiopian demographic and health survey; IRB: Institutional Review Board; FMOH: Federal Ministry of Health; ICC: intra class correlation coefficient; MM: maternal mortality; PCV: proportional change in variance; WHO: World Health Organization; SNNPR: Southern Nations and Nationality and peoples region;

**Declarations**

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**Availability of data and materials**

The datasets were downloaded from DHS (Demographic and Health Survey) website after obtaining the necessary permissions for the download and further analyses.

**Authors’ contributions**

Proposal preparation, acquisition of data, analysis and Interpretation of data was done by ZR. Drafting the article, Revising it critically for intellectual content, and final approval of the version to be published was done by ZR, BT and AM. All authors read and approved the final manuscript.

**Ethics approval and consent to participate**

The study was approved by the institutional ethical review committee board of the University of Gondar and ethical clearance was obtained from the board. Upon this clearance the study was conducted. Confidentiality of the data was maintained by using the extracted data only for the study purpose and keeping the data from third party.

**Competing interests**

The authors declare that they have no competing interests.

**Author’s details**

1 College of Medicine and Health Sciences Institute of Public Health, Department of Health Informatics, Debre Markos university, Debre Markos ,Ethiopia.

2 College of Medicine and Health Sciences, Institute of Public Health, Department of Health Informatics, University of Gondar, Gondar, Ethiopia.
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Figures

**short birth interval across regions**

| Region    | Percentage |
|-----------|------------|
| Tigray    | 14.50%     |
| Afar      | 14.60%     |
| Amhara    | 28%        |
| Oromiya   | 28%        |
| Somali    | 47.60%     |
| Ben-Guin   | 28%        |
| SNNP      | 24.30%     |
| Gambela   | 17.60%     |
| Harari    | 29.50%     |
| Addis Ababa | 19.50%  |
| Dire Dawa | 34.50%     |

**Figure 1**

Shows the Regional Distribution of Short Birth Interval in Ethiopia, (EDHS 2016)
Figure 2

Show Spatial Autocorrelation Report for Short birth clusters in Ethiopia, (EDHS 2016).
Figure 3 shows Areas with High spot and Cold spot for Short birth interval Across Ethiopia, (EDHS 2016).
Figure 4 shows Areas with hot Spot, Cold Spot and outliers of SBI across Ethiopia, (EDHS 2016)
Figure 5

Interpolated Spatial Distributions of short Birth interval (EDHS 2016), Ethiopia.
Figure 6

spatial Distribution of short birth (EDHS 2016), Ethiopia