

Spatial Distributions and Determinants of High-risk Fertility Behavior among Women in Ethiopia: Further Analysis from 2016 Ethiopia Demographic Health Survey

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Abstract

Background: High-risk fertility behavior associated with numerous unfavorable child and maternal health outcomes such as chronic undernutrition, anemia, and child mortality. Although different studies have been conducted to assess the magnitude and effects of high-risk fertility behaviors, there are limited shreds of evidence about the geographical distributions and determinants in Ethiopia. Therefore, this study aimed to assess the spatial distributions and determinants of high-risk fertility behavior among reproductive-age women in Ethiopia.

Method: This study was based on secondary data analysis from the 2016 Ethiopia Demography and Health Survey. Information about 11,022 women who gave birth five years preceding the survey were extracted from the kid's record (KR) file. For the spatial analysis ArcGIS 10.6 and Sat Scan™ 9.6, were used and for multilevel analysis, STATA 14.1 was used. Mixed effect Multivariable multilevel logistic regression model was fitted to identify determinants of high-risk fertility behavior.

Result: More than three fourth (76.5%) with 95%CI (75.1 to 77.1) women had high-risk fertility behavior. From the spatial analysis, high-risk fertility behavior in Ethiopia geographically varies, the eastern and northern parts of the country such as Somalia and Tigray had an increased risk of fertility behavior. Primary education (AOR=0.71, 95% CI: 0.63 to 0.80) and secondary (AOR=0.73; 95% CI: 0.60 to 0.89), not ever used contraceptive (AOR=1.25, 95%CI: 1.12 1.40), unwanted pregnancy (AOR=1.40, 95%CI: 1.23 1.59), no ANC visit (AOR=1.19, 95%CI: 1.05 1.35), rural-dwelling (AOR=1.26, 95%CI: 1.04 1.51), regions of Ethiopia [Somalia (AOR=1.70,95%CI:1.24 2.32) and Amhara (AOR=0.72,95%CI:0.53 0.96)] were determinants of high risk fertility behavior.

Conclusion: High-risk fertility behavior was significantly higher and geographical variations also noticed and the eastern and northern parts of the country were the hot spot areas. Education, rural residence, unwanted pregnancies, No ANC visit, and contraceptive use were determinants of high-risk fertility behavior. This suggests that areas with high-risk fertilities need special interventions to avert related complications.

Background

Maternal and child mortality is the main public health problem worldwide and it is the major health concern in developing countries such as Africa and Asia[1]. Globally, 830 women die from preventable causes related to pregnancy and childbirth, of which 99% of all deaths occur in developing countries[2]. Ethiopia one of the countries with the highest maternal mortality ratio with 412 deaths per 100,000 live births according to 2016 EDHS reports, of which most of the deaths were attributed to high-risk fertility behavior [1-3]. The maternal mortality issue is under a sustainable development goal (SDG) targeted to reduce below 70 deaths per 100,000 live births at the end of 2030[4].

The global population is rapidly increasing and according to the 2016 report, the total fertility was 2.5 and 4.8 per woman globally and Ethiopia, respectively [5]. Fertility behavior of women characterized in relation to maternal age, birth spacing, and order which has an impact on the health of women and children [6, 7]. High-risk fertility behavior associated with numerous unfavorable child and maternal health outcomes such as chronic undernutrition, anemia, and child and maternal mortality [8-10].

Different studies showed that high-risk fertility behaviors are associated with chronic undernutrition and anemia among under-five children. In addition, these behaviors are also associated with adverse birth outcomes such as stillbirth, low birth weight and prematurity [9, 11-13]. As the birth interval got narrower (less than 24 months) the chance of child mortality increased sharply compared to long spaced birth intervals [14]. The risk of infant mortality from teenage mothers was increased by 30% compared to those women who gave birth between the age of 20 and 30 years. The problem is higher in developing countries where health care services are inaccessible, low socio-economic conditions and high

unmet family planning need [8, 11, 12, 15-17]. In addition, early age women marriage is also another problem for high-risk fertility problems in Ethiopia and other low and middle-income countries[15].

Different factors are associated with high-risk fertility behavior such as socio-demographic characteristics (residence, religion, level of education and marital status) and reproductive health characteristics such as history of child death, facility delivery, and family planning utilizations are factors associated with high-risk fertility behavior [8, 10-12, 15-18]. Government and stakeholders made tremendous efforts such as increasing health services accessibility and coverage, providing maternal health services free of charge and postnatal care follow up for mothers for halting high-risk fertilities[19]. Although, different studies conducted to assess the magnitude and effects of high-risk fertility behaviors no study was conducted to assess the geographical distribution and determinants of these behaviors in Ethiopia.

Therefore, this study aimed to assess the spatial distributions and determinants of high-risk fertility behavior among reproductive-age women in Ethiopia. This study could help health care planners for evidence-based interventions and appropriate allocation of resources in hot spot areas.

Methods

Study design, area and period:

A cross-sectional study design was conducted using a nationally representative Ethiopian Demographic and Health Survey (EDHS) 2016 dataset. Ethiopia is the second-largest populous country located in the Horn of Africa from 3⁰ to 14⁰ and 33⁰ to 48⁰E. The study was conducted from December to June 2016.

Sources and study populations:

Women age 15-49 years in the enumeration areas within five years before the survey in Ethiopia were the source population. 15,683 women aged 15–49 years were interviewed and 11,023 women included in the analysis. In the 2016 EDHS, a total of 645 clusters (EAs) (202 urban and 443 rural) were selected with a probability proportional to each EAs size and independent selection in each sampling stratum. Among the total of selected clusters with zero coordinates and clusters without a proportion, HRFB was excluded for the analysis. Finally, a total of (185 urban and 413 rural) clusters were used for this study. Among the selected clusters a total of 11,023 weighted women were included in this study. The recorded data were accessed at www.measuredhs.com on request with the help of ICF International, Inc.

Data collection tools and procedures:

Ethiopian Demographic and Health Survey data were collected by two-stage stratified sampling. Each region of the country was stratified into urban and rural areas, yielding 21 sampling strata. In the first stage, 645 EAs were selected with probability proportional to Enumeration Area size by independent selection in each sampling stratum. In the second stage of selection, a fixed number of 28 households per cluster were selected with an equal probability systematic sampling from the newly created household listing. The detail sampling procedure was available in the Ethiopian Demographic and Health Survey reports from Measure DHS website (www.dhsprogram.com).

Outcome variable

For this study, we considered three parameters, maternal age at the time of delivery, birth order and birth interval, to define the high-risk fertility behaviors. Three exposure variables were defined for this analysis. Any high-risk fertility behavior versus non-risk coded as 1/0 respectively. The presence of any of the following four conditions was termed high-risk fertility behavior: (i) mothers aged less than 18 years at the time of delivery; (ii) mothers aged over 34 years at the time of delivery; (iii) latest child born less than 24 months after the previous birth; and (iv) latest child of order three or higher. We

applied the definition of ' high-risk fertility behaviors' adopted by the 2016 EDHS(11). The dependent variable in this analysis was high-risk fertility behavior (proportion in the cluster).

Predictor variables:

Predictor variables for this study were demographic characteristics such as sex of a child, religion, educational level, occupation, wealth index, media exposure, residence and region and reproductive characteristics contraceptive use, wanted pregnancy, ANC follow up, stillbirth, and place of delivery

Data processing and Analysis

After data was cleaned and extracted, descriptive statistics and multivariable multi-level logistic regression were done using STATA 14.1, whereas, for spatial analysis, ArcGIS 10.6 and Sat ScanTM 9.6 was used. The data were weighted using cluster number, primary sampling unit, and strata before any statistical analysis to restore the representativeness of the survey and to tell the STATA to take into account the sampling design when calculating SEs.

Spatial autocorrelation and hot spot analysis:

Spatial autocorrelation (Global Moran's I) statistic measure was used to assess whether HRFB among reproductive-age women were dispersed, clustered, or randomly distributed in Ethiopia. Moran's I values close to -1 indicates the low proportion of HRFB and dispersed, close to +1 indicates clustered, and if Moran's I value zero indicates randomly distributed. A statistically significant Moran's I value ($p < 0.05$) had a chance to rejection of the null hypothesis which indicates the presence of spatial autocorrelation. Hot Spot Analysis (the Getis-Ord G_i^* statistic) of the z-scores and significant p-values tells the features with either hot spot or cold spot values for the clusters spatially.

Spatial interpolation:

The spatial interpolation technique is used to predict HRFB proportion among reproductive-age women for unsampled areas in the country based on sampled EAs. For the prediction of unsampled EAs, we used deterministic and geostatistical Empirical Bayesian Kriging spatial interpolation techniques. Ordinal Kriging method of Gaussian distribution was used.

Spatial scan statistics:

We employed Bernoulli based model spatial scan statistics to determine the geographical locations of statistically significant clusters for HRFB using Kuldorff's SaTScan version 9.6 software (15). The scanning window that moves across the study area in which HRFB was taken as cases and no HRFB were taken as controls to fit the Bernoulli model. The default maximum spatial cluster size of <50% of the population was used as an upper limit, allowing both small and large clusters to be detected, and ignored clusters that contained more than the maximum limit with the circular shape of the window. Most likely clusters were identified using p-values and likelihood ratio tests on the basis of the 999 Monte Carlo replications.

Model Building:

We fit four models, the null model without predictors, the model I with only individual-level variables, model II with only community-level variables, and model III both individual-level and community-level variables. These models were fitted by a STATA command "**xtmelogit**" for the identification of predictors with the outcome variable. For model comparison, we used the log-likelihood ratio (LLR) and Akaike Information Criteria (AIC) test. The highest log-likelihood and the lowest AIC wins the best fit model.

Parameter Estimation Methods

In the multilevel multivariable logistic regression model, fixed effect estimates measure the association between the odds of HRFB of individual and community level factors with a 95% confidence interval. The random effect measures variation HRFB across clusters expressed by Intraclass Correlation (ICC) quantifies the degree of heterogeneity of HRFB between clusters, Percentage Change in Variance (PCV) the proportion of the total observed individual variation in-HRFB that is attributable to between cluster variations and Median Odds Ratio (MOR) median value of the odds ratio between the cluster at HRFB and cluster at lower risk of HRFB when randomly picking out two clusters (EAs)

Ethics approval and consent to participate

Ethical clearance was obtained from measure DHS through filling requesting form for accessing data. The data used in this study are publicly available, aggregated secondary data that hasn't any personal identifying information that can be linked to study participants. The confidentiality of data was maintained anonymously.

Result

Socio-demographic characteristics of respondents

A total of 11,022 women who gave birth in the preceding five years before the survey were included in the final analysis. The median age of women was 28 with an interquartile range of 25 to 34 years, about half (53%) of them aged between 25 and 34 years. The majority (89%) of women were rural dwellers, most (93.1%) were married, and about 41.4% and 34.2% were Muslim and Orthodox followers, respectively. Two-third (66.1%) of women had not attended any formal education and 59.3% of them had no occupation (Table 1).

Reproductive characteristics and high-risk fertility behavior

This study revealed that 76.5% with (95%CI: 75.1 to 77.1) of women had high-risk fertility behavior, of which 31.4% were in single risk category, 27.1% of them had a birth interval of less than 24 months and about 45.1% of women were categorized in multiple high-risk category.

Out of total mothers who participated 43.1% of them were grand multiparous, the majority (75%) of pregnancy forth recent birth were wanted of which three-fourth (74.4%) of mothers had antenatal care follow up for their recent child. The majority (98.1%) of women gave birth vaginally for their recent child, of which 72.5% delivered at home, and 8.5% of them had experience of stillbirth. About 30.1% of women had anemia during pregnancy (Table 2).

Spatial autocorrelation of High-Risk Fertility Behavior in Ethiopia

This study revealed that the spatial distribution of HRFB was found to be non-random in Ethiopia with Global Moran's I 0.113 ($p < 0.001$) (Fig1)

The clustered patterns (on the right sides) show high rates of HRFB occurred over the study area. The outputs have automatically generated keys on the right and left sides of each panel. Given the z-score of 3.78 indicated that there is less than 1% likelihood that this clustered pattern could be the result of random chance. The bright red and blue colors to the end tails indicate an increased significance level. The table shows that the observed value is greater than the expected value and P-value is < 0.05 , it is statistically significant and nonrandom distribution of high-risk fertility behavior in the population.

Incrementa Spatial I Autocorrelation among reproductive-age women in Ethiopia.

To determine spatial clustering for HRFB, global spatial statistics were estimated using Moran's I value. As shown in the figure below a statistically significant z-scores indicate at 166 Km distances where spatial processes promoting clustering are most pronounced. The incremental spatial Autocorrelation indicates that a total of 10 distance bands were detected with a beginning distance of 121813 meters. The spatial distribution of HRFB among reproductive-age women in Ethiopia was found non-random with a Global Moran's I was 0.11 and p-value 0.0001. The z-score of 3.77, there is a less than 1% likelihood that this high-clustered pattern could be the result of random chance. (Fig 2)

The spatial autocorrelation by a function of distance

The spatial autocorrelation by a function of distance was a peak of 166149.46 meters and significant at a z-score value of 6.868081. so that this distance helps to fix the band for neighbors (conceptualization of relationships) during hot spot analysis to identify the hot and cold areas for high-risk fertility behavior across regions of Ethiopia (Fig.2)

Hot spot (Getis-Ord Gi) analysis:

As shown in the figure below, the red color indicates the more intense clustering of high (hot spot) proportion HRFB preceding the survey period. A high proportion of HRFB was clustered at the Somali and Afar region of Ethiopia. Whereas, Amhara, SNNPR and Addis Ababa regions of Ethiopia were less risk area. (Fig 3)

Spatial Sat Scan analysis of High-risk fertility behavior among women across regions of Ethiopia, 2016

Most likely (primary clusters) and secondary clusters of HRFB were identified. A total of 383 significant clusters were identified. Of these, 181 of them were most likely (primary) clusters and 102 were secondary clusters. The primary clusters' spatial window was located in the Somali, Eastern Oromia, Dire Dawa and Harari region which was centered at 5.848373 N, 43.527981 E with 569.73 km radius, and Log-Likelihood ratio (LLR) of 65.24, at $p < 0.001$. It showed that women within the spatial window had 1.13 times higher risk of HRFB than women outside the window (Table 3). The secondary clusters' spatial window was typically located in the central part of the Amhara region. Which was centered at 11.287790 N, 38.406887 E with 71.42 km radius, and LLR of 9.46 at p-value 0.032. It showed that women within the spatial window had a 1.16 times higher risk of HRFB than women outside the window (Fig.4).

Interpolation of high-risk fertility behavior

The predicted high-risk fertility behavior over the area increases from green to red-colored areas. The red color indicates high-risk areas of predicted HRFB and the green color indicates the predicted low fertility behavior risk areas. The Somali region, the Afar region, Eastern parts of the Oromia region, and center parts of the Beneshangul Region were predicted as more risky areas compared to other regions. Continuous images produced by interpolating (Kriging interpolation method) HRFB among women. The red color indicates the predicted high-risk areas and green color indicates fewer risk areas of HRFB (Figure.5).

Individual and community-level determinants of high-risk fertility behavior

The results of multilevel logistic regression for the individual-level and community-level variables are presented in **Table 4**. In the full model in which all individual-level and community-level factors are included education status of women, ANC visit during pregnancy, contraceptive utilization, wanted pregnancy, residence and region were factors significantly associated with high-risk fertility behavior.

Women who attend primary or secondary education, the odds of high-risk fertility behavior were decreased by 29 and 27 %, respectively compared to those who had no formal education (AOR=0.71; 95% CI 0.63 to 0.80) and (AOR=0.73; 95% CI: 0.60 to 0.89). Those women had not used contraceptives previously, the odds of high-risk fertility behavior were increased by 25% compared to those who had used contraceptives (AOR=1.25; 95%CI 1.12 to 1.40). Those women who

had unwanted pregnancies, the odds of high-risk fertility behavior were 40% more likely compared to those who had wanted pregnancies (AOR=1.40; 95%CI 1.23 to 1.59). Women who had no antenatal care visits for their recent child, the odds of high-risk fertility behavior were 19% more likely compared who had follow-ups (AOR=1.19; 95%CI 1.05 to 1.35).

Moreover, living in a rural area was also associated with a 26 % higher odds of high-risk fertility behavior among women of reproductive age than women who were urban residents (AOR=1.26; 95%CI 1.04 to 1.51). Higher odds of high-risk fertility behavior were observed in the Somali regional state (AOR=1.70; 95% CI: 1.24 to 2.32) compared with Addis Ababa. However, the odds of high-risk fertility behavior among women were lower in the Amhara region compared with Addis Ababa (AOR= 0.72 95% CI: 0.53 to 0.96) (Table 4).

The high-risk fertility behavior prevalence rate was not similarly distributed across the communities. About 5.4 % of the variance in the odds of high-risk fertility behavior in women could be attributed to community-level factors, as calculated by the ICC based on estimated intercept component variance and also the variation was statistically significant (p-value <0.001). After adjusting for individual-level and community-level factors, the variation in high-risk fertility behavior across communities remained statistically significant. About 1.18 % of the odds of high-risk fertility behavior variation across communities was observed in the full model (model 4). Moreover, the MOR indicated that high-risk fertility behavior was attributed to community-level factors. The MOR for high-risk fertility behavior was 1.50 in the empty model (model 1); this showed that there was variation between communities (clustering) since MOR was 1.5 times higher than the reference (MOR=1). The unexplained community variation in high-risk fertility behavior decreased to MOR of 1.20 when all factors were added to the null model (empty model). This indicates that when all factors are included, the effect of clustering is still statistically significant in the full model (Table 4).

Discussion

This study revealed more than three fourth of women had high-risk fertility behavior of which 31.4% and 45.1% of them in single and multiple risk categories, respectively. Furthermore, the birth interval of less than 24 months was the most common single risk on 27.4% of women. This finding was lower than a study conducted in the Afar region of Ethiopia (86.3%). However, this finding was higher than 58% of 2011 EDHS report [30], 34% in Bangladesh DHS[20], (38.3%) in Nepal[31] and 44.9% in India [31]. The possible explanation for the observed discrepancies might be due to the fact that socio-demographic characteristics changes and increased intention of fertility in society. Specifically, when compared with Asian countries such as Nepal the socio-demographic characteristics are quite different and also the health system variations could be the reason. In addition, in Ethiopia, child marriage is higher which might be responsible for the increased magnitude of risky fertility behavior[32].

From the spatial analysis high-risk fertility behavior in Ethiopia geographically varies, the eastern part of the country such as Somalia and northern Tigray had an increased high-risk fertility behavior. This could be explained by the low family planning acceptance rate and child marriage are the possible explanations. According to the 2016 review of pieces of evidence, the Somalia region is among the top 50 hotspot areas for child marriage [32].

Those women who had attended primary and secondary school associated with decreased high-risk fertility behavior compared to those who had no formal education. This finding was consistent with the study result in Ethiopia, Nigeria and Nepal [6, 30, 31, 33]. This could be due to the fact that those attend school had better knowledge and awareness about high-risk fertility behavior and lower probability of experiencing early marriage.

Women who had no ever used contraceptive associated with an increased occurrence of high-risk fertility behavior compared to those who had used. This finding is supported by other studies and evidence [15, 17]. One of the purposes of contraceptive use is spacing birth and decreasing unintended pregnancies which might affect the health of mother and

child. One of the basic postnatal intervention is family planning service provision for mothers with the aim of spacing birth intervals [18].

Women who had a history of unwanted pregnancies were more likely to had high-risk fertility behavior compared to wanted pregnancies. This finding was consistent with other studies conducted in Nigeria [6]. Women who had experienced unwanted pregnancies is an indicator of low family planning accessibility.

Women who were rural dwellers were positively associated with high-risk fertility behavior compared to those urban dwellers. This finding was consistent with the study conducted in Ethiopia. Women in rural areas are highly disadvantaged in terms of reproductive health services besides low literacy levels in rural areas. This finding was consistent with the previous study in Ethiopia [30]. Those women who no had ANC care follow-ups for their recent children were associated with increased risky fertility behavior. During ANC follow up in addition, to medical and clinical checkups for the mother and fetus, counseling about postnatal care including choice of family planning for the widening of intervals between births. Therefore not had ANC follow up during pregnancy may contribute to risk fertility behavior among reproductive-age women.

Compared to Addis Ababa women who reside in the Somalia region, high-risk fertility behavior was doubled, in contrast, women who live in the Amhara region high-risk fertility behavior were decreased. This might be explained due because of health service inaccessibility, low family planning acceptance rate due to community believes and myths from religious perspectives. Moreover, in the Somalia region, the community follows nomadic ways of life and difficult for health services in addition to a serious security problem. This finding was consistent with the findings of spatial analysis in the above-depicted figures.

This study has strengths of data were nationally representative, the multi-level analysis used to account cluster correlations and spatial analysis were also used for identifying hotspot areas for efficient interventions. However, this study has faced the following limitations firstly cross-sectional nature of the study affects the cause-effect relationship, secondly, health system characteristics were not assessed and finally the data this study had problems of recall bias such as a number of months for the birth interval.

Conclusion

High-risk fertility behavior was significantly higher and geographical variations also noticed and the eastern and northern parts of the country were the hot spot areas. Education, rural residence, unwanted pregnancies, ANC visits, and not used contraceptives were determinants of high-risk fertility behavior. This suggests that areas with high-risk fertilities need special interventions to avert related complications.

Abbreviations

ANC: Antenatal Care, AOR: Adjusted Odds Ratio, CI: Confidence Interval, DHS: Demographic and Health Survey, EA: Enumeration Area, E: East, EDHS: Ethiopian Demographic and Health Survey, GIS: Geographical Information System, HH: High High, HL: High Low, ICC: Intra Class Correlation, Km: Kilometer, KR: Kids Record, LH, Low High, LL: Low Low, LLR: Likelihood Ratio, , MOR: Median Odds Ratio, N: North, PCV: Proportion of Cluster Variance, SE: Standard Error, SGD: Sustainable Development Goal, SNNP: Southern Nation: Nationality and People

Declarations

Availability of data and materials

The datasets used during the current study is available from the corresponding author

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Consent for publication

Not applicable as there is no image or other confidentiality related issues.

Competing interests

The authors declared that they have no competing interests.

Authors' contributions

ZTT and KST conceived the study, involved in the study design, data analysis, drafted the manuscript and critically reviewed the manuscript. All authors read and approved the final manuscript.

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Tables

Table 1: Socio-demographic characteristics of women who gave birth in the preceding five years before the survey in Ethiopia, 2016 (n=11,022)

Characteristics	Category	Frequency	Percentage
Mother's age	15-24	2446	22.2
	25 -34	5842	53
	35-49	2734	24.8
Sex of child	Male	5297	52
	Female	5725	48
Religion	Orthodox	3772	34.2
	Muslim	4561	41.4
	Protestant	2329	21.1
	Others	360	3.3
Residence	Urban	1215	11
	Rural	9807	89
Region	Tigray	716	6.5
	Afar	114	1
	Amhara	2072	18.8
	Oromia	4851	44
	Somalia	508	4.6
	Benishangul Gumuz	121	1.1
	SNNP	2296	20.8
	Gambela	26	0.24
	Harari	25	0.23
	Addis Ababa	244	2.2
Educational status of mother	Dire Dawa	47	0.43
	No formal education	7284	66.1
	Primary education	2950	26.8
	Secondary education	514	4.7
Educational status of the husband	Higher education	274	2.5
	No formal education	5077	48.5
	Primary education	4115	39.3
	Secondary education	798	7.6
Occupational status of women	Higher education	471	4.5
	Working	4896	44.4
the mother	Not working	6126	55.6
	Wealth index		
Wealth index	Poor	5155	46.8
	Middle	2280	20.7
	Rich	3587	32.5
Media exposure	Yes	10,035	91
	No	987	9

Table 2: Reproductive and high-risk fertility behavior of women who gave birth five years before the survey in Ethiopia, 2016 (n=11,022)

Characteristics	Category	Frequency	Percentages
Wanted pregnancy	Yes	8279	75.1
	No	2743	24.9
Had ANC follow up	Yes	8204	74.4
	No	2818	25.6
History of stillbirth	Yes	966	8.8
	No	10056	91.2
Anemia	Severe	157	1.5
	Moderate	745	7
	Mild	2321	21.8
	No anemia	7416	69.7
Place of delivery	Home	7997	72.5
	Health facility	3025	27.5
Parity	Primiparous	1434	13
	Multiparous	4836	43.9
	Grand multiparity	4752	43.1
Birth order	1	2058	18.7
	2-4	4718	42.8
	≥5	4246	38.5

Table 3: SaT Scan analysis of high-risk fertility behavior among women in the last five years in Ethiopia, 2016.

Cluster type	Significant Enumeration Areas(clusters) detected	Coordinates /Radius	Populations	Cases	RR	LLR	P-value
Primary	164, 358, 85, 138, 278, 492, 92, 543, 490, 146, 318, 187, 171, 198, 95, 556, 497, 520, 480, 521, 588, 553, 458, 208, 77, 214, 251, 394,573, 239, 116, 629, 22, 286, 568, 277, 289, 33, 472, 452, 527, 377,64, 439, 186, 57, 8, 210, 454, 513, 436, 501, 68, 212, 580, 483, 133,587, 115, 500, 240, 194, 418, 58, 29, 622, 321, 44, 179, 534, 607, 257, 387, 56, 397, 157, 228, 28, 614, 393, 60, 396, 443, 173, 357, 566, 238, 419, 269, 383, 329, 495, 288, 381, 610, 372, 1, 473, 453, 378, 630, 242, 523, 281, 166, 642, 311, 557, 441, 30, 594, 202, 613,74, 380, 519, 352, 273, 535, 471, 631, 151, 307, 5, 111, 185, 282,444, 514, 606, 390, 27, 493, 385, 224, 467, 43, 476, 644, 363, 190, 546, 93, 101, 140, 25, 529, 123, 412, 245, 7, 506, 319, 333, 422, 122, 562, 491, 213, 34, 71, 518, 26, 49, 619, 524, 405, 51, 82, 230, 468, 564, 576, 313, 365, 589, 438, 316, 149, 39, 12, 398, 125, 391,522, 600, 336	(5.848373 N, 43.527981 E) / 569.73 km	3450	2870	1.13	64.24	< 0.001
Secondary	278, 318, 187, 358, 85, 164, 556, 480, 492, 543, 138, 490, 92, 198, 171, 95, 497, 521, 588, 146, 553, 286, 458, 520, 394, 289, 472, 214, 452, 251, 208, 573, 239, 116, 22, 568, 377, 277, 372, 454, 513, 186, 527, 33, 68, 501, 580, 436, 64, 133, 115, 212, 483, 8, 500, 587, 240, 29, 418, 58, 439, 607, 179, 194, 44, 321, 534, 257, 56, 397, 210, 157, 228, 387, 28, 614, 57, 393, 60, 396, 173, 443, 622, 238, 383, 357, 329, 419, 495, 381, 288, 610, 453, 473, 566, 123, 529, 1, 476, 245, 242, 166	(6.273056 N, 42.688145 E) / 370.11 km	1684	1457	1.16	61.29	< 0.001

Table 4: Multivariable multilevel logistic regression analysis of high-risk fertility behavior among reproductive-age women in Ethiopia, 2016 (n=11,022)

Variables	Category	Model (I) AOR(95% CI) Without factor	Model(II) AOR(95% CI) Individual-level factor	Model (III) AOR(95% CI) Community-level factor	Model (III) AOR(95% CI) Individual+Community Level factor
Sex of child	Male		Ref		Ref
	Female		0.94(0.85,1.03)		0.93(0.85,1.02)
Religion	Orthodox		Ref		Ref
	Muslim		1.35(1.19,1.52)		1.10(0.93,1.29)
	Protestant		1.07(0.93,1.24)		1.08(0.89,1.30)
	Others		1.14(0.82,1.59)		1.15(0.82,1.62)
Educational status of mother	Unable to read and write		Ref		Ref
	Primary education		0.69(0.62,0.78)		0.71(0.63,0.80)*
	Secondary education		0.69(0.57,0.84)		0.73(0.60,0.89)*
	Higher education		0.76(0.59,0.99)		0.82(0.63,1.07)
Occupational status women the mother	Working		Ref		Ref
	Not working		0.99(0.89,1.09)		0.96(0.87,1.06)
Wealth index	Poor		Ref		Ref
	Middle		0.90(0.78,1.04)		0.95(0.82,1.10)
	Rich		0.91(0.80,1.04)		0.98(0.85,1.13)
Media exposure	Has media exposure		Ref		Ref
	No media exposure		0.81(0.69,0.96)		0.83(0.70,1.004)
Contraceptive use	Yes		Ref		Ref
	No		1.31(1.17,1.47)		1.25(1.12,1.40)*

Wanted pregnancy	Yes		Ref		Ref
	No		1.34(1.18,1.53)		1.40(1.23,1.59)*
Had ANC	Yes		Ref		Ref
	No		1.19(1.05,1.34)		1.19(1.05,1.35)*
Still birth	No		Ref		Ref
	Yes		1.08(0.88,1.28)		1.07(0.90,1.27)
Delivery place	Institution		Refe		Ref
	Home		0.99(0.88,1.12)		0.97(0.85,1.11)
Residence	Urban			Ref	Ref
	Rural			1.65(1.43,1.90)	1.26(1.04,1.51)*
Region	Addis			Ref	Ref
	Afar			1.56(1.16,2.10)	1.19(0.86,1.63)
	Amhara			0.81(0.61,1.08)	0.72(0.53,0.96)*
	Oromia			1.18(0.89,1.57)	0.98(0.73,1.31)
				2.289	
	Somalia			2.29(1.73,3.05)	1.70(1.24,2.32)*
	Benishangul Gumuz			1.12(0.83,1.52)	0.99(0.73,1.35)
	SNNP			1.05(0.79,1.39)	0.93(0.69,1.26)
	Gambela			0.92(0.69,1.24)	0.79(0.57,1.09)
	Harari			1.08(0.80,1.47)	0.97(0.71,1.32)
	Tigray			1.07(0.811,1.43)	1.03(0.77,1.39)
Dire Dawa			1.43(1.05,1.94)	1.22(0.88,1.68)	
Random effects (effects of variation) i.e measure of variation for high-risk fertility behavior					
Community level variance(SE)		0.188(0.032)	0.062(0.024)	0.064(0.023)	0.039(0.024)
p-vale		<0.001	<0.001	<0.001	<0.001
Deviance		11,372	11,146	11,202	11,092
ICC%		5.4	1.8	1.91	1.18
PCV%		Reference	67.03	65.97	79.26

MOR	1.50	1.26	1.27	1.20
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* show a p-value less than 0.05,
 Ref: reference category

Figures

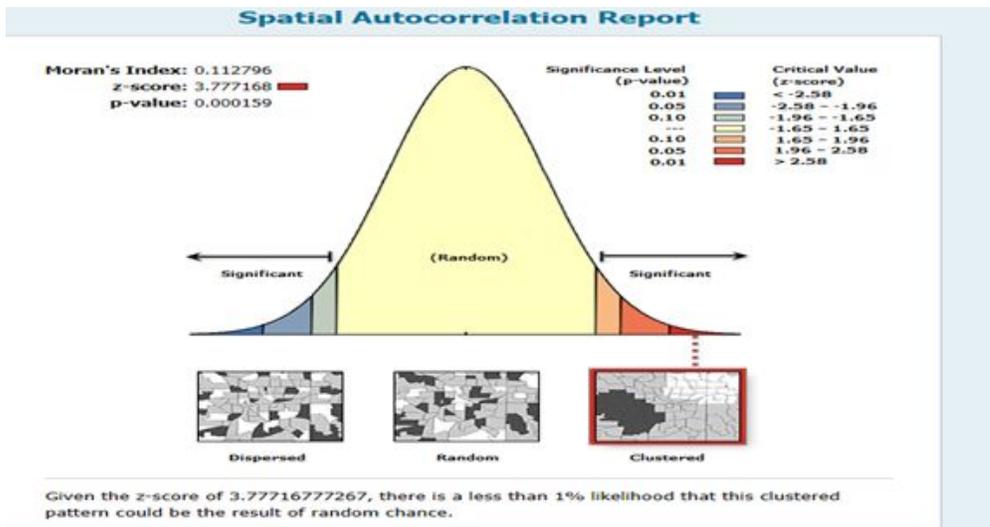


Figure 1

Spatial autocorrelation of high-risk fertility behavior of reproductive age group women in Ethiopia, 2016

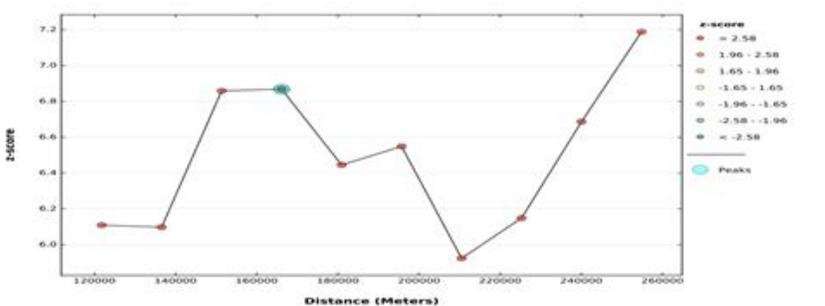


Figure 2

Incremental autocorrelation of high-risk fertility behavior in EHDS, 2016

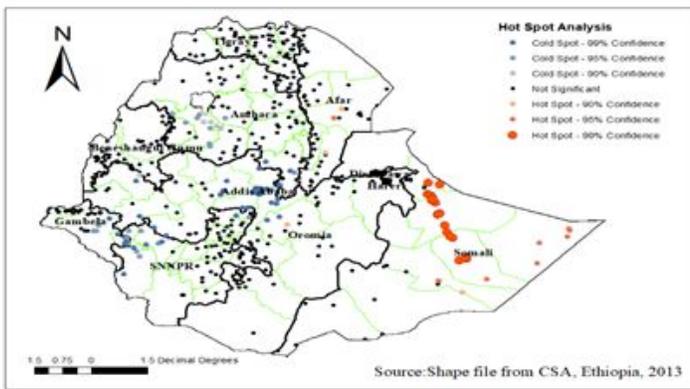


Figure 3

Hot spot analysis of high-risk fertility behavior among women within 5 years preceding the survey in Ethiopia, 2016

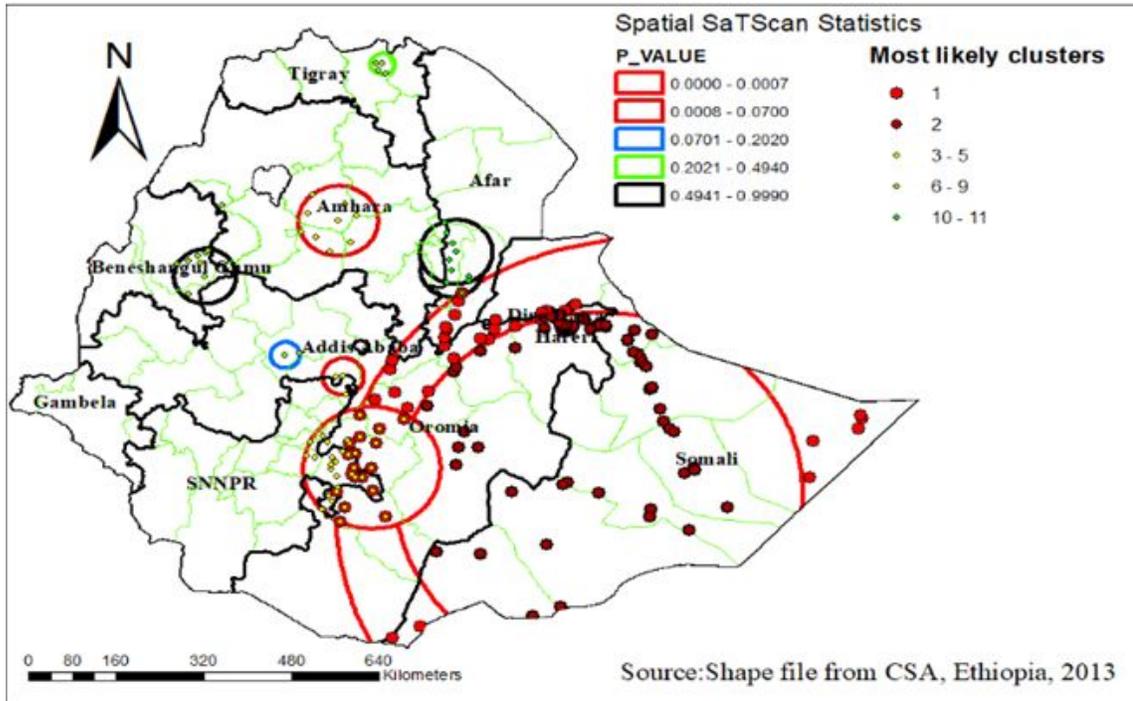


Figure 4

Spatial SaTScan analysis of high-risk fertility behavior among reproductive-age women in Ethiopia, 2016

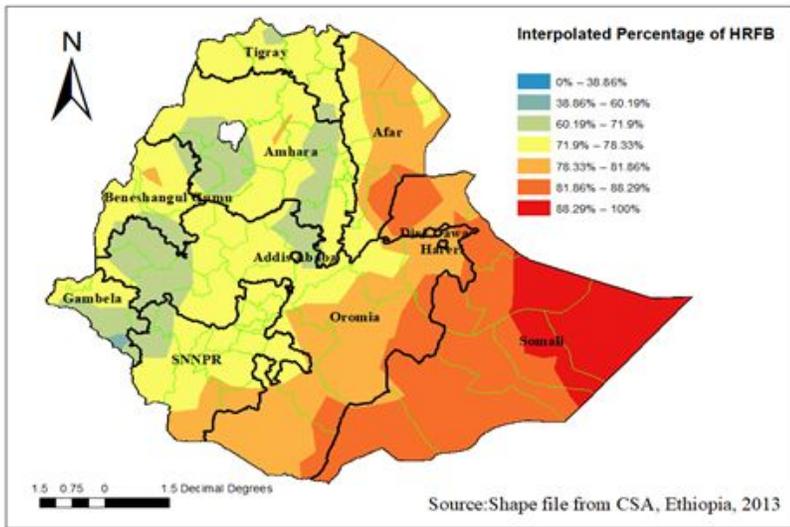


Figure 5

Interpolation of high-risk fertility behavior among reproductive-age women in Ethiopia, 2016.