

Spatial patterns and associated factors' of Early Marriage among Reproductive age women in Ethiopia: a Secondary Analysis of Ethiopian Demographic and Health Survey 2016

CURRENT STATUS: UNDER REVIEW

BMC Women's Health  BMC Series

Zemenu Tessema Tadesse

 zemenut1979@gmail.com *Corresponding Author*

DOI:

10.21203/rs.2.23055/v1

SUBJECT AREAS

Preventive Medicine *Internal Medicine*

KEYWORDS

Early marriage, childhood marriage, Ethiopia

Abstract

Background

Besides, the presence of national law, the country has to set up its own mid-term and long term goals to bring about a significant reduction in child marriages in Ethiopia. To achieve this, determining the spatial pattern of early marriage and factors associated is important for government, other concerned bodies, program implementers and policy developers to end up early childhood marriage. Thus, the aim of this study was to assess the spatial patterns and associated factors of Early marriage among reproductive-age women in Ethiopia.

Methods

This study analyzed retrospectively a cross-sectional data on a weighted sample of 11,646 women aged 15-49 years after requesting from Ethiopian Demographic and Health Survey 2016 via the link www.measuredhs.com. ArcGIS version 10.7 software was used to visualize spatial distribution for Early marriage. The Bernoulli model was applied using Kilduff SaTScan version 9.6 software to identify significant purely spatial clusters for Early marriage in Ethiopia multiple logistic regression analysis was used to identify factors associated with early marriage. Finally, variables with a p-value<0.05 were considered as statistically significant.

Results

In this analysis, about 62.8% (95%CI: 61.9, 63.74%) of the study participants were married before they reached 18 years. The overall median age at first marriage was 17.1 with IQR 5 years. The high clustering of early marriage was located in Amhara, Afar, and Gambella Regions. In spatial Scan statistics 87 clusters (RR = 1.28, P-value < 0.001) significant primary clusters were identified. The associated factors of early marriage were lesser among women's attending primary (AOR=0.60; 95%CI: 0.51, 0.71), secondary (AOR=0.19; 95%CI: 0.13, 0.26) and tertiary education (AOR=0.11; 95%CI: 0.07, 0.18). Similarly, women found in Addis Ababa were at a lesser risk of early marriage compared to other regions of the country.

Conclusion

Marriage below age 18 was high in Ethiopia. High-risk area of early marriage was located in Amhara,

Afar, and Gambella and special attention should be given for identified risk areas. Therefore, providing educational opportunities to young girls was important in addition to inhibiting the marriage of girls under 18 years.

Background

Early marriage is defined as the marriage of a girl < 18 years of age and is a common phenomenon worldwide(1). According to the United Nations Children’s Fund (UNICEF), Each year, 12 million girls are married before the age of 18 years (2). The problem is highly prevalent in Asia (45%) followed by sub-Saharan Africa (39%), Latin America (23%) and 18% in the Middle East and North Africa(3). As an illustration, in Africa, the prevalence of early marriage was 31.4% in Zambia(4). Similarly, in Ethiopia, the percentage of women marrying before age 18 has declined slightly since 2011 from 63–58%. During the same period, the median age at first marriage among women age 25–49 has increased from 16.5 years to 17.1 years(5).

Childbearing below the age of 18 years is associated with a higher rate of mortality, eclampsia, postpartum hemorrhage, HIV infection, malaria, and obstructed labor (6,7). In addition, early marriage is associated with lower levels of schooling for girls, higher intimate partner violence and poor maternal and child nutrition status (6). The probability of being stunted and wasting is higher among children born from early married women. The consequence of early marriage is not limited to the mother and her child, it has also social, economic, and political implications(8).

Despite the presence of national laws in Ethiopia, a marriage of girls < 18 years of age is common and it affects a number of girls(9). The problem may worsen when it exists with a high prevalence of HIV and other sexually transmitted diseases, malnutrition, cervical cancer, and others. The governments of Ethiopia have adopted strategies to end the practice and investments are being made to that effect, including by promoting girls’ education and sexual and reproductive health and rights. But ending child marriage requires a multifaceted approach focused on the girls, their families, the community, and the government.

In Ethiopia, several studies identified that education, harmful tradition practice, income, family size, media exposure and culture of the community were the significant factors associated with early

marriage(9-16). So far different studies in Ethiopia done to identify the factors associated with early marriage. The spatial pattern of early marriage was not done before. Identifying the spatial pattern of early marriage in Ethiopia can help health planners and policymakers to develop target interventions to decrease early marriage

The the reseach hypothesis of this study is that is there any relationship beteevn outcome variable (early marriage) and the indeprent variables include age, religion, respondents' highest education attainment, educational status of husbands/parents, occupational status of respondents, occupational status of parents, media exposure, and household wealth status, residence, and region. The other hypothesis is that where early marriage was randomly distributed across the county.

Therefore, besides the presence of national law, the country has to set up its own mid-term and long term goals to bring about a significant reduction in child marriages in Ethiopia. To achieve this, showing the spatial pattern and its factors associated are important for government, other concerned bodies, program implementers and policy developers to end early childhood marriage. Thus, the aim of this study was to assess the spatial patterns and associated factors of Early marriage among reproductive-age women in Ethiopia.

Methods

Study area, data source, sample

The study was based on the Ethiopian demographic and health survey (EDHS) 2016 data set. Ethiopia is situated in the Horn of Africa and has 9 Regional states (Afar, Amhara, Benishangul-Gumuz, Gambela, Harari, Oromia, Somali, Southern Nations, Nationalities, and People's Region (SNNP) and Tigray) and two Administrative Cities (Addis Ababa and Dire Dawa).

Approval letter for the use of this data was gained from the Measure DHS and the data set was downloaded from the Measure DHS website; www.measuredhs.com. The survey covered all the nine regions and the two city administrations of Ethiopia and participants were selected through a stratified two-stage cluster sampling technique. The full details of the methods and procedures used for the collection of the EDHS data have been published elsewhere(5).The survey collected information from a nationally representative sample of 16,683 women aged 15-49 years. Finally,

11,646 eligible women were included in this study which was nested within 643 clusters across the country.

Source And Study Population

The source population was all reproductive-age women within five years before the survey in Ethiopia and all women whose age between 15–49 years in the enumeration areas within five years before the survey was the study population. A total of 18008 households were selected and 16,650 were successfully interviewed. A total of 11,646 women who had married five years preceding the survey were included in this analysis (Fig. 1).

Variables Of The Study

The outcome variable for this study was age at first marriage (binary) either below 18 or 18 and above. The variables that may influence early marriage include age, religion, respondents' highest education attainment, educational status of husbands/parents, occupational status of respondents, occupational status of parents, media exposure, and household wealth status, residence, and region(9–16).

Data collection procedure, tools, and quality control

The data was obtained from Individual Records (IR) file EDHS 2016 survey year at www.dhsprogram.com website. The web provided the data only for authorized users. Data also contained longitude and latitude coordinates. 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. The EDHS 2016 was used as a structured and pre-tested questionnaire for data collection. The 2016 EDHS data collectors used tablet computers to record responses during the interview. The tablet was equipped with Bluetooth technology to enable remote electronic transfer of files for this study the detail is found at (5).

Spatial autocorrelation and hot spot analysis:

We used Arc GIS 10.7 software for spatial autocorrelation and detection of hot spot areas analysis.

Spatial autocorrelation (Global Moran's I) statistic measure was used to assess whether an early marriage was dispersed, clustered, or randomly distributed in Ethiopia. Moran's I values close to -1 indicates early marriage dispersed, close to $+1$ indicates clustered, and if Moran's I value zero

indicates randomly distributed (17). Hot Spot Analysis (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 early marriage for unsampled areas based on sampled EAs. For the prediction of unsampled EAs, we used deterministic and geostatistical Ordinary Kriging spatial interpolation technique using ArcGIS 10.7 software.

Spatial scan statistics:

We employed Bernoulli based model spatial scan statistics to determine the geographical locations of statistically significant clusters for early marriage using Kuldorff's SaTScan version 9.6 software (18).

The scanning window that moves across the study area in which early marriage was taken as cases and those women who married after age 18 and above 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.

Statistical analysis

STATA version 14 was used for data analysis. Then data cleaning was carried out. Both descriptive and analytical studies were done. Both bi-variable and multiple logistic regression analysis was performed to determine the existing association. Initially, bivariate analysis was performed and variables with a p-value of 0.2 and below were used for further analysis in the multivariable logistic regression model. At the same time, Crude Odds Ratio (COR) and Adjusted Odds Ratio (AOR) with their corresponding confidence interval (CI) also determined for the bivariate and multivariate logistic analysis, respectively. Finally, a p-value of less than 0.05 level of significance was used to declare the significance of association in the multi-variable model.

Results

In this analysis, about 62.8% (95%CI: 61.9, 63.74%) of the study participants were married before they reached 18 years. The overall median age at first marriage was 17.1 years with IQR 5. The majority, 88.95%), of the respondents were rural areas. More than half (60.61%) of respondents had

no formal education. Near to three-fourth, (77.9%), of the respondents had no exposure to mass media. (Table 1).

Table 1
socio-demographic and economic characteristics of the study participants, EDHS 2016.

Variables	Frequency n = 11,646	Percentages
Age at marriage		
Less than 18 year	4324	37.13
18 years and above	7322	62.87
Mother's age		
< 20	1237	10.61
20-34	6268	53.81
35-49	4142	36.56
Religion		
Orthodox	4970	42.67
Muslim	3906	33.54
Protestant	2498	21.45
Others*	271	2.33
Residence		
Urban	2102	18.05
Rural	9544	81.95
Region		
Tigray	487	7.23
Afar	108	0.93
Amhara	2888	24.79
Oromia	4433	38.08
Somalia	358	3.07
Benishangul Gumuz	125	1.07
SNNP	12310	19.08
Gambela	34	0.79
Harari	29	0.25
Addis Ababa	451	3.88
Dire Dawa	63	0.54
Mother's Educational status		
Unable to read and write	7059	60.61
Primary education	3351	28.77
Secondary education	764	6.56
Higher education	473	4.06
Husband Educational status		
Unable to read and write	4763	46.59
Primary education	3772	39.90
Secondary education	975	9.54
Higher education	713	6.97
Mother's Occupation		
Not working	5968	48.76
Working	5679	51.24
husband Occupation		
Not working	807	5.16
Working	9416	94.84
Media exposure		
No media exposure	2583	22.10
Has media exposure	7782	77.90
Wealth index		
Poor	4504	38.67
Middle	2324	19.95
Rich	4819	41.38

* Others represent Catholic and Traditional religion follower

Spatial distribution of Early Marriage in Ethiopia.

Spatial Autocorrelation

The spatial distribution of Early marriage in Ethiopia was non-random in the EDHS 2016 dataset. The

global Moran's I value was 0.354 (P-value < 0.001) and Z-score 21.6 in the 2016 Ethiopian Demographic and health survey (Fig. 2).

Incremental Spatial I Autocorrelation Early marriage among reproductive-age women in Ethiopia.

To determine spatial clustering for early marriage, global spatial statistics were estimated using Moran's I value. As shown in the figure below a statistically significant z-scores indicate at 151.3 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 121,813 meters. (Fig. 3)

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 early marriage preceding the survey period. A high proportion of early marriage was clustered at the Amhara, Afar, and Gambella region of Ethiopia. Whereas, Amhara, SNNPR and Addis Ababa regions of Ethiopia were less risk area. (Fig. 4)

Spatial Sat Scan analysis of Early marriage among women across regions of Ethiopia, 2016 Most likely (primary clusters) and secondary clusters of early marriage were identified. A total of 163 (87 primary and 76 secondary) significant clusters were identified. The primary clusters' spatial window was located in the Amhara Tigray and Benishangul regions, which was centered at 11.66 N, 37.31 E with a 254.88 km radius, and Log-Likelihood ratio (LLR) of 126.18, at $p < 0.001$. It showed that women within the spatial window had 1.28 times higher risk of early marriage than women outside the window. The secondary clusters' spatial window was typically located in the Somali and Oromia regions. Which was centered at 6.30 N, 41.25E with 340.06 km radius, and LLR of 18.95 at p -value < 0.001 It showed that women within the spatial window had a 1.11 times higher risk of early marriage than women outside the window (Fig. 5 and Table 2).

Table 2
SaT Scan analysis of Early marriage among women in the last five years in Ethiopia, 2016

Cluster type	Significant Enumeration/Radius Areas(clusters) detected	Coordinates	Populations	Cases	RR	LLR	P-value
Primary	169, 73, 431, 158, 512, 303	(11.699828 N, 37.312042 E)	2756	2803	1.28	126.18	< 0.001

	<p> 919, 302, 167, 512, 292, 163, 361, 456, 403, 429, 132, 24, 259, 109, 602, 3, 541, 327, 640, 120, 515, 415, 548, 279, 386, 615, 498, 375, 152, 38, 312, 627, 638, 199, 474, 206, 533, 246, 545, 628, 322, 559, 176, 482, 531, 52, 494, 36, 229, 80, 150, 218, 350, 66, 10, 183, 184, 296, 460, 591, 612, 401, 504, 137, 267, 425, 364, 244, 542, 35, 354, 478, 510, 258, 616, 617, 300, 188, 256, 320, 136, 410, 340, 200, 392, 551 </p>	<p> 57.515042 E) / 254.88 km </p>					
Secondary	<p> 480, 187, 318, 286, 289, 556, 472, 394, 452, 278, 377, 123, 422, 562, 520, 34, 213, 319, 358, 85, 164, 518, 208, 26, 529, 619, 405, 245, 468, 576, 313, 122, 524, 476, 365, 372, 589, 316, 12, 391, 438, 95, 412, 198, 578, 445, 600, 492, 522, 398, 308, 506, 171, 634, 497, 7, 71, 216, 232, 521, 215, 588, 553, 148, 32, 149, 138, 408, 458, 543, 555 </p>	<p> (6.300866 N , 41.252617 E) / 340.06 km </p>	2691	1833	1.11	61.2918.95	< 0.001

Interpolation Of Early Marriage In Ethiopia

The predicted early marriage over the area increases from green to red-colored areas. The red color indicates high-risk areas of predicted early marriage and the green color indicates the predicted low-risk areas of early marriage. The Amhara, Afar, Gambela and some parts of the Somali region, were predicted high-risk areas of early marriage. Continuous images produced by interpolating (Kriging interpolation method) early marriage among women (Fig. 6)

Factors associated with early marriage.

After adjusting for different confounding variables, age group, women education level and region were significantly associated with early marriage in Ethiopia. As age group increases the odds of early marriage decreases. Women's in age group of 20-34 and 35-49 were decrease by 61% (AOR = 0.39; 95%CI: 0.30,0.51) as compared to age group of women 15 to 19. The odds of early marriage decreases as educational level increases. Being primary education level of women decreases the odds of early marriage by 40% (AOR = 0.60; 95%CI: 0.51, 0.71), being secondary education level decreases the odds of early marriage by 81%(AOR = 0.19; 95%CI: 0.13, 0.26], being higher education level decreases the odds early marriage by 89%(AOR = 0.11; 95%CI: 0.07, 0.18] as compared to women unable to read and write. The odds of early marriage increase by 47% (AOR = 1.47; 95%CI: 1.16, 1.87) in Amhara and 42% (AOR = 1.47; 95%CI: 1.16, 1.87) Gambella Region as compared to women live in Tigray region. The odds of early marriage decreases by 21% (AOR = 0.79; 95%CI: 0.63, 0.99) in Oromia, 45% (AOR = 0.55; 95%CI: 0.42, 0.70) in Somali, 28% (AOR = 0.72; 95%CI: 0.56, 0.92) in SNNP and Harari, 65% (AOR = 0.35; 95%CI: 0.25, 0.47) and 31%(AOR = 0.69; 95%CI: 0.52, 0.91) as compared to women live in Tigray region (Table 3).

Table 3

Multiple logistic regression analysis of factors associated with early marriage among reproductive age in Ethiopia, EDHS 2016

Variables	Marriage year Under 18 year above 18 year	Crude odds ratio (95% CI)	Adjusted odds ratio (95% CI)
Place of Residence			
Urban	1026 1077	1	1
Rural	6297 3247	2.03(1.71,2.42)	0.95(0.72,1.18)
Age group			
< 20	966 271	1	1
20-34	3692 2576	0.41(0.32,0.50)	0.39(0.30,0.51)*
35-49	2664 4477	0.50(0.40,0.63)	0.39(0.30,0.51)*
Women Level of education			
Unable to read and write	4909 2148	1	1
Primary education	2039 1311	0.68(0.59,0.78)	0.60(0.51,0.71)*
Secondary education	267 497	0.23(0.18,0.30)	0.19(0.13,0.26)*
Higher education	106 366	0.12(0.08,0.17)	0.11(0.07,0.18)*
Husband Level of education			
Unable to read and write	3247 1516	1	1
Primary education	3448 1323	0.86(0.74,1.03)	1.10(0.93,1.30)
Secondary education	466 508	0.42(0.34,0.53)	0.89(0.70,1.14)
Higher education	241 471	0.23(0.17,0.31)	0.82(0.55,1.23)
Wealth quartile			
Poor	3043 1559	1	1
Middle	1530 793	0.92(0.78,1.08)	0.95(0.79,1.14)
Rich	2747 2070	0.63(0.53,0.75)	0.98(0.80,1.21)
Region			
Tigray	542 304	1	1
Afar	81 27	1.67(1.25,2.23)	1.25(0.92,1.70)
Amhara	2108 778	1.51(1.19,1.93)	1.47(1.16,1.87)*
Oromia	2751 1681	0.91(0.72,1.15)	0.79(0.63,0.99)*
Somalia	199 158	0.70(0.55,0.89)	0.55(0.42,0.70)*
Benishangul Gumuz	81 43	1.04(0.80,1.35)	0.94(0.70,1.25)
SNNP	343 966	0.77(0.60,0.99)	0.72(0.56,0.92)*
Gambela	21 12	0.97(0.75,1.27)	1.42(1.02,1.97)*
Harari	15 13	0.65(0.50,0.85)	0.72(0.55,0.95)*
Addis Ababa	141 310	0.25(0.20,0.31)	0.35(0.25,0.47)*
Dire Dawa	34 27	0.69(0.53,0.90)	0.69(0.52,0.91)*
Media exposure			
No media exposure	5968 3095	1	1
Has media exposure	1353 1229	0.59(0.49,0.66)	1.17(0.97,1.42)
Occupation status of mothers			
No	3551 2127	1	1
Yes	3771 2196	1.02(0.95,1.15)	1.08(0.96,1.23)

* indicates significance at 5% level and CI: Confidence Interval

Discussion

This study has strengths of having large dataset include the EDHS survey and were nationally representative. Multiple logistic regression analysis was used to reduce confounding among explanatory variables. The spatial analysis was also used for identifying hotspot areas, most likely clusters and the prediction was performed to predict unsampled/unmeasured areas in the country. Despite Ethiopia has instituted laws inhibiting marriage under 18 years and early female marriage is associated with a number of poor social and physical outcomes for young women and their

offspring(19) child marriage is a norm in the country. Similarly, more than 62% of the study participants in this study were married before they reached the age of 18 years. This finding is higher than the findings from Zambia, 31.4% (20), and Ghana, 29.9% (21). This might be explained by the disparity in educational, socioeconomic and cultural differences between the study settings. The problem needs a comprehensive approach, including their families, the community, the government, and religious leaders, to reduce child marriage, teenage childbearing, and its negative consequences. The spatial distribution of early marriage in Ethiopia was non-random. The spatial distribution of early marriage was high in Amhara, Afar, Gambella regional states of Ethiopia. The 2016 EDHS most likely significant cluster located at Amhara and Tigray and Secondary clusters were located in Somali and Oromia regional states of Ethiopia. The possible geographical variation of Early marriage Ethiopia might be socio-demographic factors, cultural behaviors.

Early marriage is often common among poor and less educated communities. A similar finding is found in this study. Women who attended primary education and above were less likely to marry before 18 years compared to their counterparts. Because educated women have a chance to determine their first age of marriage and are more likely to have a say in decision-making regarding the size of their families and the spacing of their children. In addition, educated women are also likely to be more informed and knowledgeable about contraception and the healthcare needs of their children (22,23).

In this study, women were more likely to early marriage in other regions of the country compared to Addis Ababa. It is true that poverty is one of the most powerful drivers of the harmful practices and poor families believed they will be more financially secure once their daughters are married off and out of their responsibility. In addition, poor families want to reduce the number of children to feed, clothe and educate and families may agree to child marriage because of community pressures and norms (23).

Strength And Limitation Of The Study

This study has strengths of having large dataset include the EDHS survey and were nationally representative. Multiple logistic regression analysis was used to reduce confounding among

explanatory variables. The spatial analysis was also used for identifying hotspot areas, most likely clusters and the prediction was performed to predict unsampled/unmeasured areas in the country. However, the limitation of this study is the cross-sectional nature of the study design may affect causality.

Conclusion

Early marriage was high in Ethiopia. High-risk area of early marriage was located in Amhara, Afar, and Gambella and special attention should be given for identified risk areas. Therefore, providing educational opportunities to young girls was important in addition to inhibiting the marriage of girls under 18 years.

Abbreviations

CI:Confidence Interval EDHS = Ethiopia Demographic and Health Survey; SNNPR = Southern Nation Nationality Perole of Ethiopia Region

Declarations

Acknowledgment

I would like to than the EDHS measure for accessing the data

Author contribution

Conceptualization: Zemenu Tadesse Tessema

Data curation: Zemenu Tadesse Tessema

Formal analysis: Zemenu Tadesse Tessema

Methodology: Zemenu Tadesse Tessema

Writing-original draft: Zemenu Tadesse Tessema

Writing-review & editing: Zemenu Tadesse Tessema

Funding

I didn't receive any funds for this study.

Availability of data and materials

The datasets generated during the study are publicly available from the Measure DHS Website

www.measuredhs.com

Ethical approval and consent to participate

I, author, submitted a proposal to DHS Program/ICF International Inc, and permission was confirmed from the International Review Board of Demographic and Health Surveys (DHS) program data archivists to download the dataset for this study

Consent for publication

Not applicable.

Competing interests

The author declare that no competing interests.

Author details

Department of Epidemiology and Biostatistics, Institute of Public Health College of Medicine and Health Science, University of Gondar, Gondar, Ethiopia.

References

1. WHO. Child marriages : 39 000 every day. WHO Media Cent [Internet]. 2013;(March 2013):1-7. Available from: https://www.who.int/mediacentre/news/releases/2013/child_marriage_20130307/en/#content
2. UNICEF. 25 million child marriages prevented in last decade due to accelerated progress, according to new UNICEF estimates. New York; Accessed from <https://www.unicef.org/eca/press-releases/25-million-child-marriages-prevented> on August 19, 2019; 2018.
3. United Nations Children’s Fund. Early marriage: a harmful traditional practice. New York; 2005.
4. Population Council and Government of the Republic of Zambia, U. “Child Marriage in Zambia.” . Lusaka, Zambia; 2017.
5. Central Statistical Agency [Ethiopia] and ICF International. Ethiopia Demographic and Health Survey 2016. Addis Ababa, Ethiopia, and Rockville, Maryland, USA: CSA and ICF.; 2016.
6. UNFPA Engender Health. Obstetric Fistula Needs Assessment Report: Findings from Nine African Countries . 2003.
7. Nour NM. Health consequences of child marriage in Africa. Emerg Infect Dis. 2006;12(11):1644.

8. odon Q, C. Male, A. Nayihouba, A. Onagoruwa, A. Savadogo, A. Yedan, et al. Economic Impacts of Child Marriage: Global Synthesis Report, Washington, DC: The World Bank and International Center for Research on Women . 2017;
9. Erulkar A. Early marriage, marital relations and intimate partner violence in Ethiopia. *Int Perspect Sex Reprod Heal*. 2013/04/16. 2013;39(1):6-13.
10. Wondie Y, Zemene W, Reschke K, Schroder H. Early marriage, rape, child prostitution, and related factors determining the psychosocial effects severity of child sexual abuse in Ethiopia. *J Child Sex Abus*. 2011/06/11. 2011;20(3):305-21.
11. Bezie M, Addisu D. Determinants of early marriage among married women in Injibara town, north West Ethiopia: community-based cross-sectional study. *BMC Womens Heal*. 2019/11/11. 2019;19(1):134.
12. Erulkar A, Tamrat T. Evaluation of a reproductive health program to support married adolescent girls in rural Ethiopia. *Afr J Reprod Heal*. 2014/07/16. 2014;18(2):68-76.
13. Gage AJ. Child marriage prevention in Amhara Region, Ethiopia: association of communication exposure and social influence with parents/guardians' knowledge and attitudes. *Soc Sci Med*. 2013/10/29. 2013;97:124-33.
14. Alemu Z. Early marriage - the silent carnage of our women. *NewsI Inter Afr Comm Tradit Pr Affect Heal Women Child*. 1988/03/01. 1988;(5):5-6.
15. Berhane A, Biadgilign S, Berhane A, Memiah P. Male involvement in family planning program in Northern Ethiopia: an application of the Transtheoretical model. *Patient Educ Couns*. 2015/01/30. 2015;98(4):469-75.
16. Ketema H, Erulkar A. Married Adolescents and Family Planning in Rural Ethiopia: Understanding Barriers and Opportunities. *Afr J Reprod Heal*. 2019/01/12. 2018;22(4):26-34.
17. O'Sullivan D. Geographically Weighted Regression: The Analysis of Spatially Varying Relationships (review). *Geogr Anal*. 2003;35(3):272-5.

8. Kulldorff M. Theory and Methods A spatial scan statistic. *Commun Stat.* 1997;26(6)(February 2013):1481-96.
9. Field E, Ambrus A. Early marriage, age of menarche, and female schooling attainment in Bangladesh. *J Polit Econ.* 2008;116(5):881-930.
10. Chitempa N. *Girl Empowerment and Child Marriage: Empowering girls to prevent and end child marriage in Zambia.* 2018;
11. de Groot R, Kuunyem MY, Palermo T. Child marriage and associated outcomes in northern Ghana: a cross-sectional study. *BMC Public Health.* 2018;18(1):285.
12. Wodon Q, Male C, Nayihouba A, Onagoruwa A, Savadogo A, Yedan A, et al. *Economic impacts of child marriage: global synthesis report.* 2017;
13. Ahmed T. *Child marriage: A discussion paper.* *Bangladesh J Bioeth.* 2015;6(2):8-14.

Figures

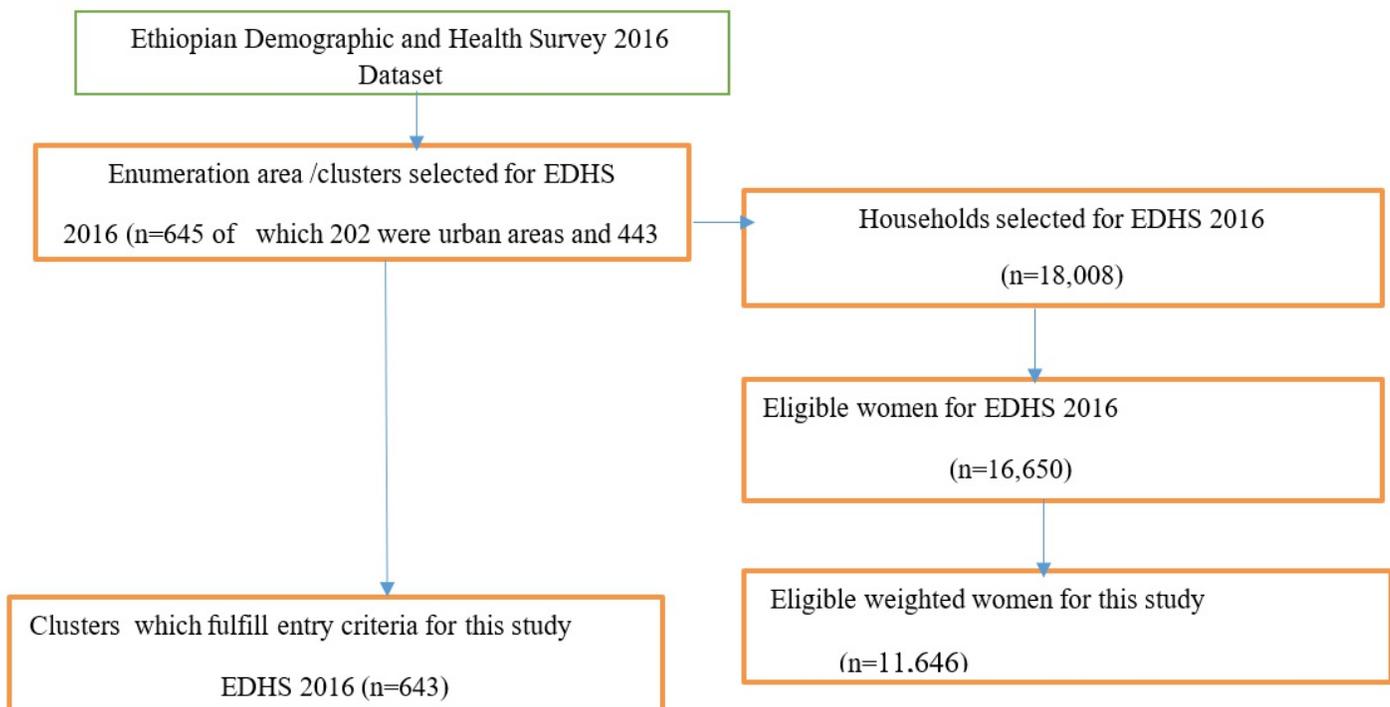


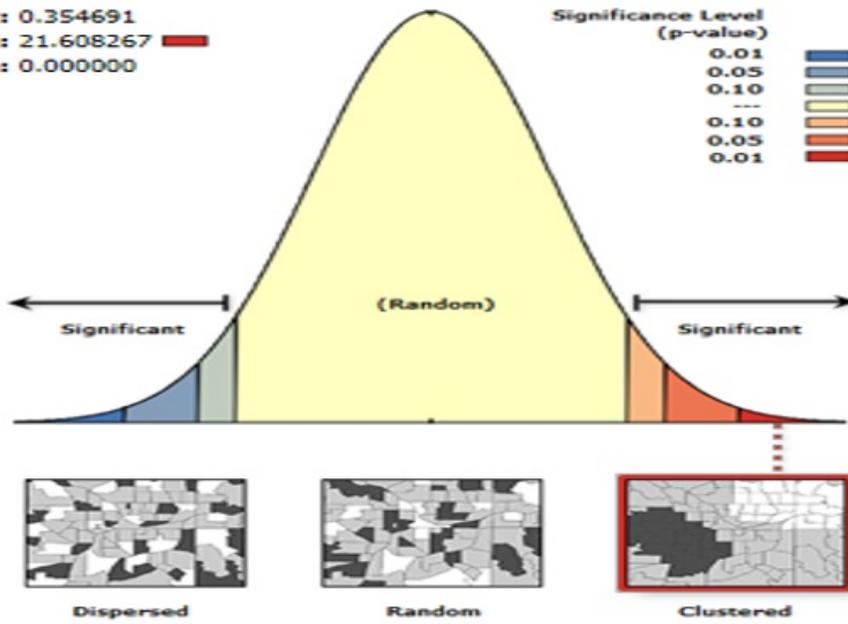
Figure 1

Sampling procedures of age at first marriage among Ethiopia women age 15-49 using EDHS 2016 data.

Spatial Autocorrelation Report

Moran's Index: 0.354691
z-score: 21.608267
p-value: 0.000000

Significance Level (p-value)	Critical Value (z-score)
0.01	< -2.58
0.05	-2.58 - -1.96
0.10	-1.96 - -1.65
---	-1.65 - 1.65
0.10	1.65 - 1.96
0.05	1.96 - 2.58
0.01	> 2.58



Given the z-score of 21.6082673801, there is a less than 1% likelihood that this clustered pattern could be the result of random chance.

Figure 2

Spatial autocorrelation of Early marriage in Ethiopia among the reproductive age group in EDHS 2016.

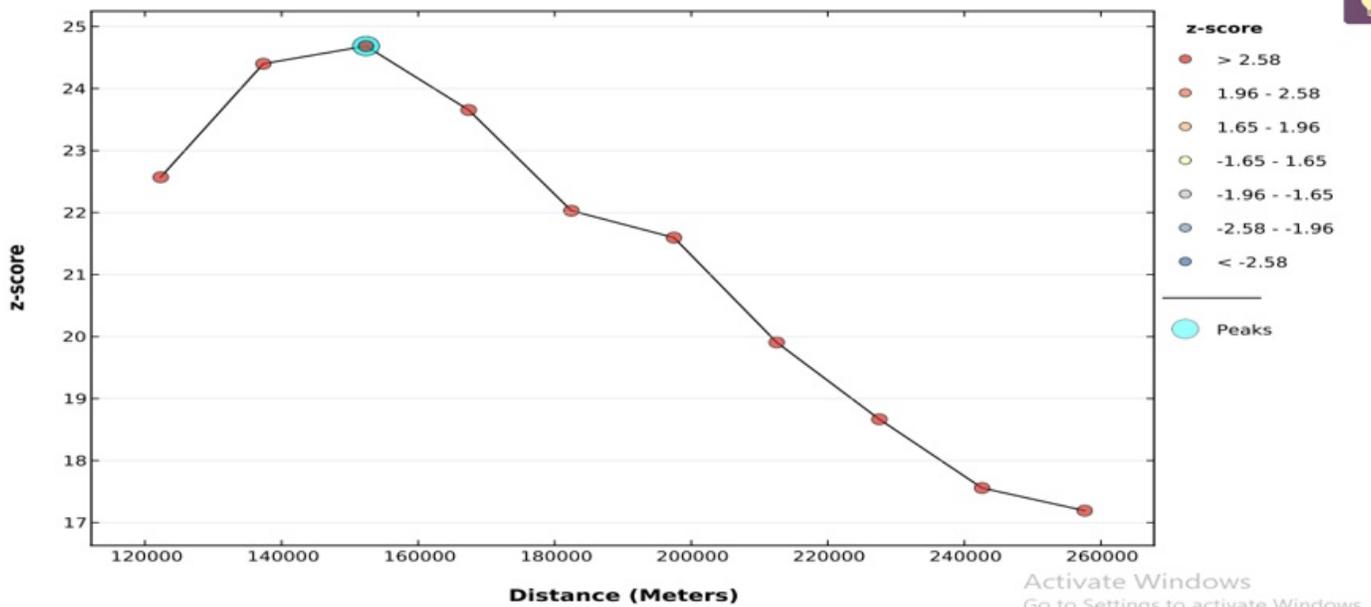


Figure 3

The spatial autocorrelation of early marriage among reproductive age group women in Ethiopia by a function of distance.

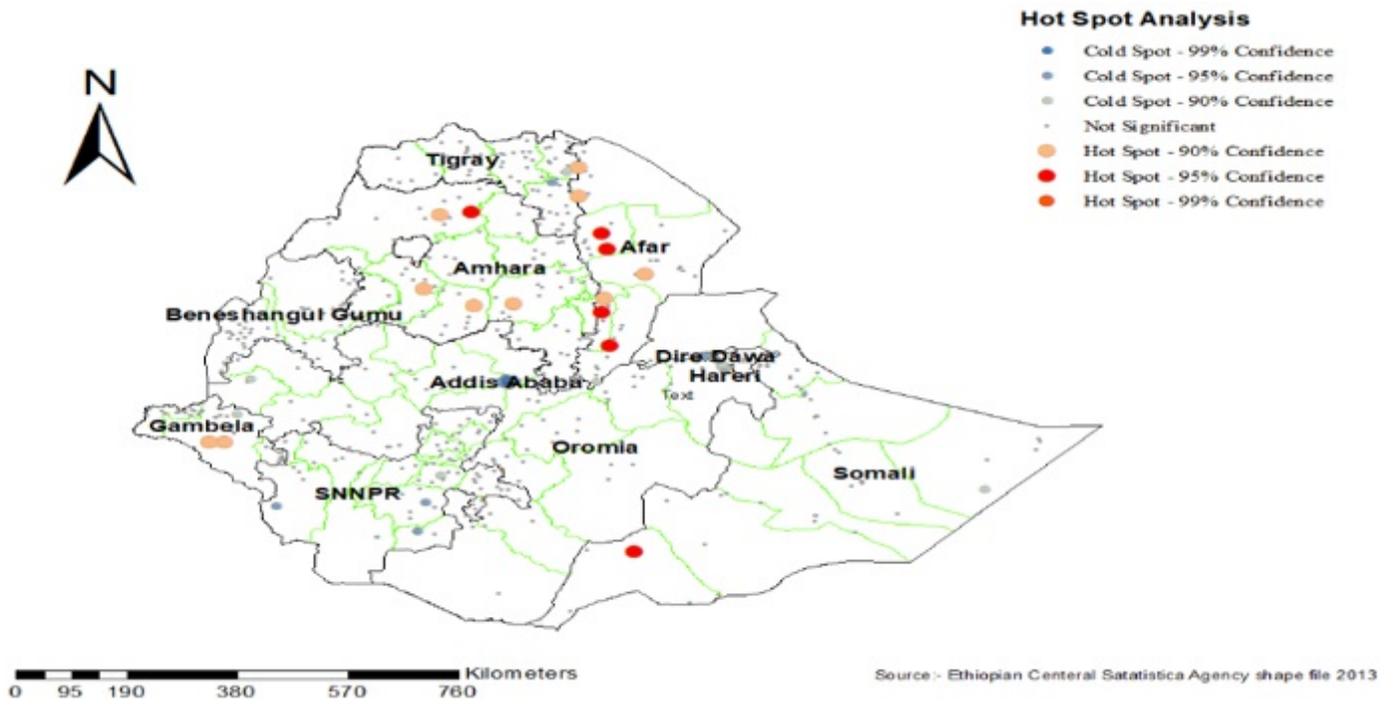


Figure 4

Hot spot analysis of Early marriage among women within 5 years preceding the survey in Ethiopia, 2016

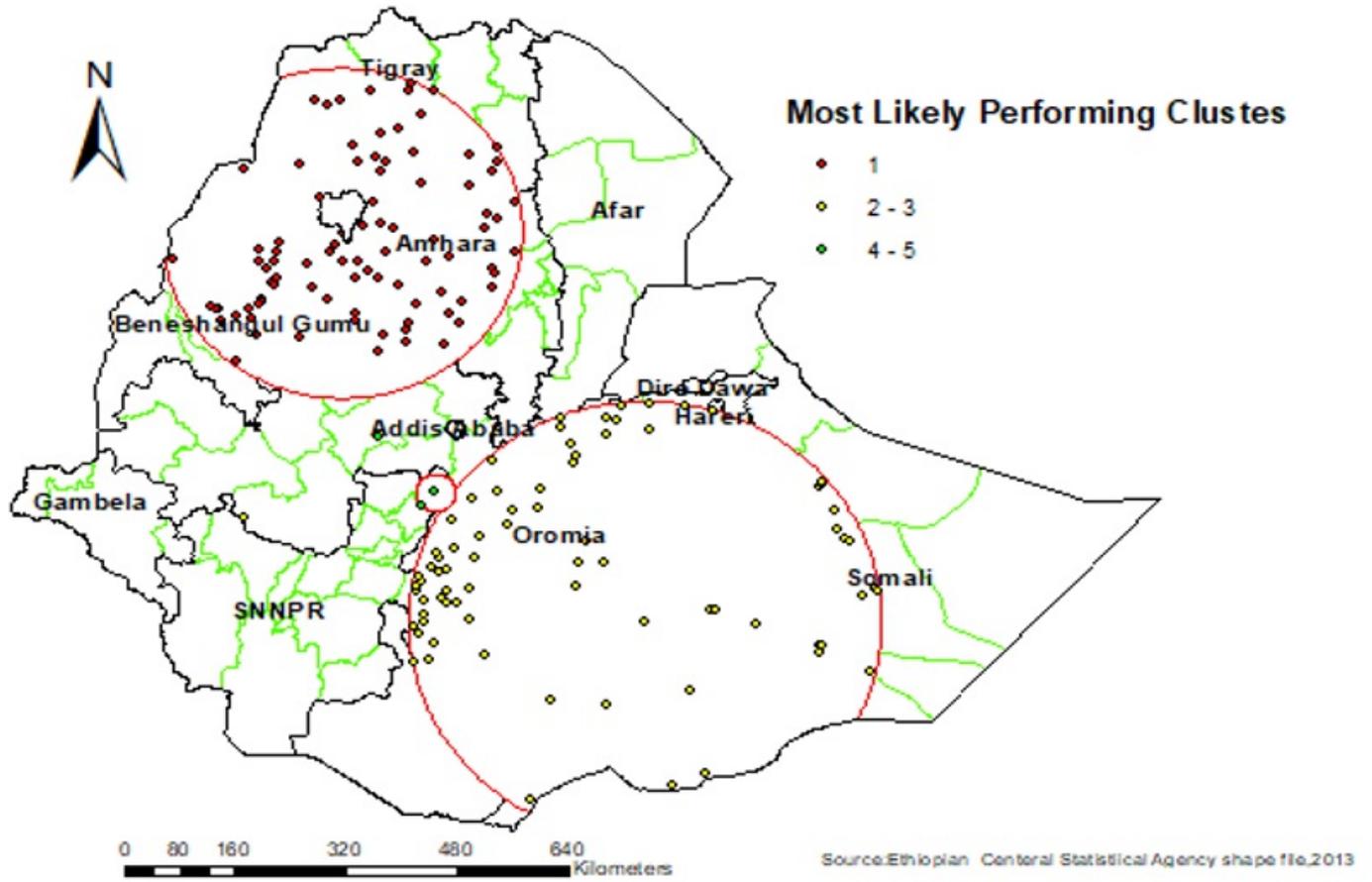


Figure 5

SatTscan analysis result of Early marriage among Reproductive age women in Ethiopia EDHS 2016

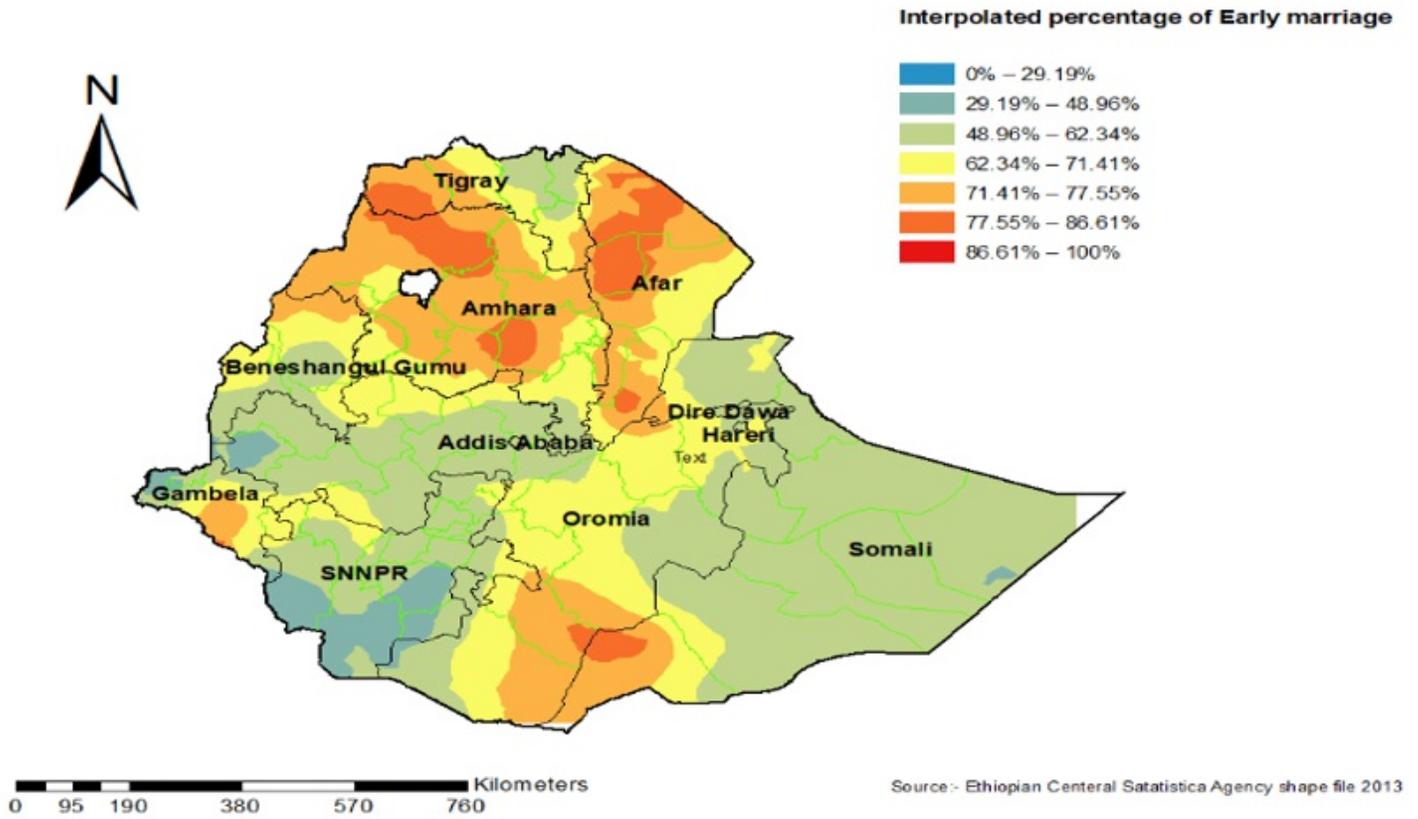


Figure 6

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