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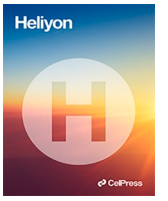

Research article

Geographically weighted regression analysis to assess hotspots of early sexual initiation and associated factors in Ethiopia

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ABSTRACT

Background: Early sexual initiation (ESI) causes unintended pregnancy, sexually transmitted infections (STI), high risk of depression and anxiety, developmental delays, lack of emotional maturity, and difficulty in pursuing education. This study aims to analyze the geographically weighted regression and associated factors of ESI of women in Ethiopia.

Methods: The study utilized data from the Ethiopian Demographic and Health Survey, 2016. It included a weighted sample of 11,775 women. Spatial regression was carried out to determine which factors are related to hotspots of ESI of women. To identify the factors associated with ESI, a multilevel Poisson regression model with robust variance was conducted. An adjusted prevalence ratio (APR) with its 95 % confidence interval was presented.

Results: The prevalence of ESI was 75.3 % (95%CI: 74.6 %, 76.1 %), showing notable spatial variation across different regions of Ethiopia. Areas of significant hotspots of ESI were identified in Western and Southern Tigray, most parts of Amhara, Southern, Central and Western Afar, Eastern Gambella, and North Western SNNPR. The significant variables for the spatial variation of ESI were; being single, rural residence, and having no formal education of the women. Factors including; wealth index, marital status, khat chewing, education level, residence, and region were associated significantly with ESI in the multilevel robust Poisson analysis.

Conclusion: A higher proportion of ESI in women was found. Public health interventions must be made by targeting hotspot areas of ESI through increasing health care access and education (specifically among rural residents), developing a comprehensive sexual education, implementing policies and laws that outlaw early marriage, and mass community-based programs to increase awareness about the importance of delaying sexual activity.

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1. Introduction

According to WHO; adolescents, who are between childhood and adulthood, are those between age 10 and 19. They constitute one-sixth of the total global population [1]. Early sexual initiation (ESI) refers to the act of involving in sexual activity before reaching 18 years of age and is usually viewed as a risky behavior due to the potential consequences that follow [2]. Most older adolescents with age of 17–19 engage in sexual activities and among teens aged 15–16, 30 % are estimated to have sex [3].

Those who are engaged in early sexual initiation are at greater risk of having many sexual partners, lower or no utilization of condoms, unintended pregnancy, sexually transmitted infections, mental health problems, and other risky behaviors including drug usage which result in long-term implications on the individual [4,5].

As stated by a data from the demographic and health surveys (DHS) conducted in developing nations, pregnancy and childbirth stand as the main factors contributing to mortality among young women 15–19 years old. An estimated one in ten young girls had become mothers by the age of 16 [6]. Every year, at least 770,000 girls aged below 15 give birth, primarily in low- and middle-income nations [1]. The major cause of maternal mortality among adolescents is abortion and 15 % of all unsafe abortions take place among those aged 15–19 [7]. In low and middle-income countries, adolescent pregnancy resulted in higher child mortality than children born to mothers who are above 20 years of age [8].

According to a qualitative study in Ghana, factors that encourage or influence adolescents to engage in sexual activity includes: the self-desire to satisfy one's curiosity through sexual activity, social fitness, financial difficulties, dysfunctional families and parenting, offensive media material, participation in social and religious rituals, and the pursuit of academic excellence [9].

Region of southeast Asia has the lowest rate of ESI whereas the Americas region has the highest rate with prevalence of 5.3 % and 18.4 %, respectively [10]. In Sub-Saharan Africa a sex-stratified analysis revealed that the percentage of ESI varied with a low of 8.6 % in Tanzania and a high of 17.7 % in Malawi [11]. The pooled prevalence of young women engaging in early sexual debut in 12 countries in East Africa was found to be 21.14 % [12]. The median age of getting married In Ethiopia is 16.5 years, which is child marriage and results in a higher magnitude of ESI. Around 25 % of Ethiopian women between the ages of 15 and 19 say they have had sex [13,14].

As per the Ethiopian Demographic and Health Survey (EDHS) conducted in 2016, the prevalence of early sexual initiation is 21.9 %. Similarly, other cross-sectional studies revealed a prevalence of 20.4 % in Ambo [15], 18.4 % in Woldiya [16], and 17.6 % in southwest Ethiopia among college students [17].

Several factors affect the initiation of sexual activity including; residence, age, parental education, religion, family income, substance use, exposure to pornographic materials, marital status, peer pressure, working status, having boy or girl friends, drinking alcohol, and low parental monitoring [18–21].

To develop effective prevention programs for ESI, potential risk factors should be identified and there have been limited research studies done in Ethiopia that investigate factors associated with early sexual initiation. As a result, we used a multilevel Poisson regression analysis with robust variance to pinpoint these determinants. Different studies conducted at a national level showed early sexual initiation varies across Ethiopian regions [22–24]. However, those studies did not address the spatially varying association between the outcome and predictors. To take into account the relationship between variables which may vary depending on the geographic location, the study employed spatial regression modeling (GWR). It reveals spatial predictors of observed hotspots in the ESI as the coefficients vary across space [25]. Identification of hotspot areas or geographical areas with a higher prevalence of ESI enables targeted interventions based on specific location. Therefore, this study is aimed at evaluating the spatial regression analysis of ESI of women and its determinants. The study is helpful in identifying the hot spot areas of ESI and its predictors to ease and prioritize interventions accordingly.

2. Methods and materials

2.1. Study setting, source of data, and design

A cross-sectional data from the 2016 EDHS, were used in this study. The data was obtained from two administrative cities and nine regions. The regions are subdivided into zones, Weredas and Kebeles. Information collected by the survey included: characteristics of households and respondents, fertility and its determinants, maternal health, family planning, women's empowerment, child health, feeding practices and supplementation, nutritional status, childhood mortality, HIV knowledge, attitude and behavior, Domestic violence and Female genital mutilation. Detail information about the DHS program is obtained from: https://www.dhsprogram.com/

2.2. Sampling and study population

The 2016 EDHS utilized a two-stage stratified sampling method. During the first stage, clusters were selected in a random manner proportional to the size of the enumeration areas (EA) and 28 households were selected from each EA in the second stage [26]. From the EDHS datasets, the individual women's data (IR) was utilized by including the weighted sample. From the total 15,683 reproductive age group women, only women who were dejure residents and have been engaged in sex were included (11,775 when weighted).

2.3. Study variables

Early sexual initiation is the dependent variable; which is a binary outcome classified as Yes or No. Women, who were sexually active prior to 18 years of age, were classified as having experienced ESI. The analysis included various independent variables at both individual and community levels. Variables at the individual-level encompassed factors such as current age, religion, khat chewing, alcohol drinking, cigarette smoking, wealth index, education level, media exposure, marital status, working status, and ever heard of STI. The community-level variables contained community-level wealth index, community-level education, community-level media exposure, region, and residence.

3. Data processing and analysis

3.1. Factors associated with early sexual initiation

The process of data extraction, cleaning, and analysis was carried out using STATA version 16 and ArcGIS version 10.7 statistical software. To make the data more representative weighted data were used. Descriptive statistics were conducted to provide a summary and description of the participants' characteristics. The hierarchical structure of the EDHS and the similarity of findings of the respondents in the same cluster make the utilization of a model that considers the clustering effect necessary. The clustering effect was measured using an Intra-class correlation coefficient (ICC) analysis and it showed a significant clustering effect with ICC exceeding 10 %. Given the cross-sectional nature of the study and the prevalence of ESI being higher than 10 %, reporting odds ratios could potentially lead to an overestimation of the relationship between the outcome and explanatory variables. Therefore, the prevalence ratio was deemed more suitable as a measure of association. Consequently, multilevel Poisson regression analysis with robust variance was employed to detect the factors associated with ESI [27].

A bi-variable multilevel Poisson regression analysis was conducted to identify predictors that would be eligible for inclusion in the subsequent multivariable analysis. Independent variables that demonstrated a p-value of less than 0.25 in the bi-variable analysis were included as part of the multivariable mixed-effect Poisson regression analysis. Four models were fitted for the multivariable analysis, including the null model (a model without independent variables), model 2 (the individual-only model), model 3 (the community-level model), and model 4 (both individual and community-level model). The model that exhibited the lowest value of deviance (-2loglikelihood) was regarded as the most suitable or best-fitting model. In the multivariable mixed-effect Poisson regression, variables with p-value below 0.05 were deemed as having a significant relationship with ESI and were reported with an Adjusted Prevalence Ratio (APR) with its 95 % confidence interval (CI).

From a total of 17 variables (5 of them are community-level variables), 11 of them had a p-value below 0.25 in bi-variable regression. They were included in the multivariable regression and among those, 6 variables had a p-value <0.05 and were significantly associated with ESI.

3.2. Spatial analysis

Global Moran's I, a measure of spatial autocorrelation was employed to identify the type of pattern of the spatial distribution of ESI as dispersed (indicated by Moran's I value close to -1), random (indicated by Moran's I value close to 0) or clustered (indicated by Moran's I value close to $+1$). The statistically significant value of Moran's I (p-value <0.05) revealed the nonrandom distribution of ESI in Ethiopia [28]. The Getis-ordGi* statistics were used for hot spot analysis in order to identify significant spatial clusters. It produces a z-score with p-value, where the z-score shows the strength of clustering, while the p-value indicates the level of statistical significance. When examining the output, the presence of significant positive and negative z-scores shows hotspots and cold spots, respectively [29].

3.3. Spatial regression analysis

Both Ordinary least squares (OLS) and Geographical weighted regression (GWR) techniques were introduced to assess the spatial relationship between ESI and its determinants making sure that there is no stationary of ESI, which was confirmed by the global spatial autocorrelation. The outcome predictor was the percentage of early sexual initiation at each EA level.

OLS is a regression model that operates on a global scale, estimating the relationship between the outcome and explanatory variables through a single equation. It assumes that each variable's coefficients are homogenous and do not vary across different locations within the study area [30]. It was applied in order to identify the variables which cause spatial heterogeneity and to select the right predictors. After fitting the OLS model the assumptions were checked and GWR was applied.

Geographically Weighted Regression investigates relationships between variables in the regression model that differ over space [31]. Even though Koenker's studentized Breusch-Pagan (BP) p-value was insignificant, we proceeded to the GWR model to examine how the association between the dependent and independent variables differs across various locations. It considers the spatial proximity of data samples and assigns different regression parameters to each observation in the study area [32].

The performance of the models was compared by corrected Akaike Information Criteria (AICc) and adjusted R^2. Lower AICc value and higher adjusted R^2 value yields better model performance. To provide the geographic weighting in the model, a spatial kernel was used. As the observations were clustered, an adaptive kernel was utilized. To make the model less complex; the AICc, which utilizes the minimized AICc value, was used to find the bandwidth [33].

4. Results

4.1. Descriptive results

The study consisted of a weighted sample of 11,775 women of reproductive age was included in the study. The majority of them (80.7 %) were residents of rural areas. More than half (59.3 %) of the women did not have a formal education. More than three-fourths of the women are followers of Orthodox Christianity (43.2 %) and Muslim (32.8 %). Most of the participants were aged 25–34. Approximately 18.9 % of women are classified in the poorest household index quintile, while 23.4 % are in the richest quintile. Only 3.3 % of them were never married (single) while 85 % are currently married. 11.6 % did not have children while 18.7 % had seven and

Table 1
Descriptive characteristics of the study participants in Ethiopia, 2016.

Variables		Weighted frequency	Percentage
Religion	Orthodox	5084	43.2 %
	Protestant	2551	21.7 %
	Muslim	3866	32.8 %
	Others	274	2.3 %
Current age	15–24	2760	23.4 %
	25–34	4873	41.4 %
	≥35	4142	35.2 %
Number of children	No child	1371	11.6 %
	1-3 Children	4803	40.8 %
	4-6 Children	3401	28.9 %
	≥7 children	2200	18.7 %
Marital status	Single	390	3.3 %
	Married	10009	85.0 %
	Widowed	415	3.5 %
	Divorced	961	8.2 %
Alcohol intake	No	7453	63.3 %
	Yes	4322	36.7 %
Chew khat	No	10090	85.7 %
	Yes	1685	14.3 %
Cigarette smoking	No	11682	99.2 %
	Yes	93	0.79 %
Education level	No education	6982	59.3 %
	Primary	3420	29.04 %
	Secondary	825	7.0 %
	Higher	548	4.7 %
Wealth index	Poorest	2228	18.9 %
	Poorer	2258	19.2 %
	Middle	2307	19.6 %
	Richer	2230	18.9 %
	Richest	2752	23.4 %
Working status	No	7723	65.6 %
	Yes	4052	34.4 %
Ever heard of STI	No	800	6.8 %
	Yes	10975	93.2 %
Media exposure	No	7430	63.1 %
	Yes	4345	36.9 %
Region	Tigray	854	7.3 %
	Afar	108	0.92 %
	Amhara	2859	24.3 %
	Oromia	4465	37.9 %
	Somali	356	3.03 %
	Benishangul	127	1.08 %
	SNNPR	2325	19.7 %
	Gambela	36	0.31 %
	Harari	30	0.25 %
	Addis Ababa	550	4.7 %
	Dire Dawa	65	0.55 %
Residence	Urban	2279	19.4 %
	Rural	9496	80.6 %
Community media exposure	No	6175	52.4 %
	Yes	5600	47.6 %
Community wealth index	Poor	6279	53.3 %
	Not poor	5496	46.7 %
Community education level	No	6834	58.0 %
	Yes	4941	42.0 %

STI: Sexually Transmitted Infections.

above children. Around 36.7 % consume alcohol, 14.3 % chew khat, and 0.79 % smoke cigarettes (Table 1).

4.2. Prevalence of early sexual initiation of women in Ethiopia

In Ethiopia, the prevalence of early sexual initiation of women was 75.3 % (95%CI: 74.6 %, 76.1 %). The region with the highest prevalence of women's ESI was Amhara, where it was recorded at 86.4 %. On the other hand, the lowest prevalence was seen in Addis Ababa, at 51.1 %.

4.3. Factors associated with early sexual initiation of women in Ethiopia

After fitting the bi-variable mixed-effect Poisson regression with robust variance to measure the relationship between the outcome and each independent variable, we fitted four models in the multivariable regression. The ICC in the null model was 11.5 % (95%CI:

Table 2
Multilevel multivariable robust Poisson regression analysis of early sexual initiation of women in Ethiopia, 2016.

Variable	Null model	Model 2 APR(95%CI)	Model 3 APR(95%CI)	Model 4 APR(95%CI)
Marital Status				
Single		1		1
Married		1.24 (1.13,1.37)		1.20 (1.09,1.33)
Widowed		1.27(1.15,1.42)		1.23(1.12,1.37)
Divorced		1.30(1.18, 1.43)		1.24(1.12,1.37)
Chew khat				
No		1		1
Yes		1.04(0.99, 1.08)		1.05(1.01,1.09)
Education level				
None		1		1
Primary		0.99(0.96, 1.01)		0.99(0.96,1.01)
Secondary		0.78(0.73, 0.83)		0.78(0.74,0.83)
Higher		0.51(0.46, 0.56)		0.52(0.47,0.57)
Wealth index				
Poorest		1		1
Poorer		1.03(0.99, 1.06)		1.03(1.00,1.07)
Middle		1.02(0.99, 1.06)		1.03(0.99,1.07)
Richer		1.03(0.98,1.07)		1.04(1.00,1.09)
Richest		0.94(0.90,0.99)		1.07(1.01,1.13)
Working status				
No		1		1
Yes		0.99(0.97, 1.02)		1.00(0.98,1.02)
Media exposure				
no media exposure		1		1
Has media exposure		0.97 (0.94,0.99)		0.98(0.96,1.01)
Region				
Tigray			1	1
Afar			1.04(0.99,1.10)	1.04(0.99,1.10)
Amhara			1.05(1.00,1.10)	1.05(1.00,1.09)
Oromia			0.95(0.90,1.00)	0.92(0.88,0.98)
Somali			0.83(0.79,0.89)	0.83(0.78,0.88)
Benishangul gumuz			0.99(0.94,1.05)	0.98(0.93,1.04)
SNNPR			0.85(0.79,0.90)	0.84(0.79,0.89)
Gambella			0.99(0.93,1.07)	1.04(0.98,1.11)
Harari			0.94(0.87,1.02)	0.93(0.86,0.99)
Addis Ababa			0.73(0.67,0.79)	0.79(0.73,0.86)
Dire Dawa			0.93(0.86,0.99)	0.90(0.84,0.96)
Residence				
Urban			1	1
Rural			1.18(1.11, 1.24)	1.08(1.02,1.15)
Community media				
Not Exposed			1	1
exposed			0.97(0.93,1.00)	0.97(0.94,1.01)
Community wealth				
Poor			1	1
Not poor			0.99(0.96,1.03)	0.98(0.95,1.03)
Community Education				
No			1	1
Yes			0.99(0.96,1.02)	1.02(0.98,1.04)
Intercept	0.75(0.74,0.77)	0.65(0.59,0.72)	0.73(0.68,0.79)	0.65(0.57,0.74)
Log-likelihood	−11327.32	−11178.41	−11221.86	−11140.54
Deviance	22654.64	22356.82	22443.72	22281.08

APR: Adjusted Prevalence Ratio.

9.9 %, 13.2 %) which shows about 12 % of the variation in ESI was due to cluster variation. The 4th model was the best-fitted model as it resulted in the highest log likelihood and lowest deviance. In the multivariable multilevel Poisson regression analysis with a robust variance; marital status, wealth index, khat chewing, education level, residence, and region were significantly associated (p-value<0.05) with women's ESI.

The prevalence of ESI in women who were married, widowed, or divorced was increased by 1.2 times (APR = 1.20, 95%CI: 1.09, 1.33), 1.23 times (APR = 1.23, 95%CI: 1.12, 1.37) and 1.24 times (APR = 1.24, 95%CI: 1.12, 1.37), respectively than single women. Women who chew khat had 1.05 times higher prevalence of ESI in comparison to those who did not chew khat (APR = 1.05, 95%CI: 1.01, 1.09). The prevalence of ESI among women who have secondary and above education was declined by 22 % (APR = 0.78, 95%CI: 0.74, 0.83) and 48 % (APR = 0.52, 95%CI: 0.47, 0.57), respectively than those without formal education. Being from the poorer, richer, and richest household wealth index has 1.03 (APR = 1.03, 95%CI: 1.00, 1.07), 1.04 (APR = 1.04, 95%CI: 1.00, 1.09) and 1.07 (APR = 1.07, 95%CI: 1.01, 1.13) times increased prevalence of ESI than those from the poorest household, respectively. The prevalence of ESI was 1.08 times (APR = 1.08, 95%CI: 1.02, 1.15) higher among women from rural residents than urban residents. Women who are from Amhara region had 1.05 (APR = 1.05, 95%CI: 1.00, 1.09) times increased prevalence of ESI, while those from Somali, Oromia, Benishangul, SNNPR, Harari, Dire Dawa, and Addis Ababa had 17 % (APR = 0.83, 95%CI: 0.78, 0.88), 8 % (APR = 0.92, 95% CI: 0.88, 0.98), 2 % (APR = 0.98, 95%CI: 0.93, 1.04), 16 % (APR = 0.84, 95%CI: 0.79, 0.89), 7 % (APR = 0.93, 95%CI: 0.86, 0.99), 10 % (APR = 0.90, 95%CI: 0.84, 0.96) and 21 % (APR = 0.79, 95%CI: 0.73, 0.86)lower prevalence of ESI, respectively as compared to Tigray region (Table 2).

4.4. Spatial distribution of early sexual initiation

Tigray, Amhara, Afar, Gambella, Beneshangul Gumuz, central parts of Oromia, and northern parts of SNNPR showed the highest prevalence of ESI (Fig. 1).

Spatial autocorrelation shows that there is a clustering effect in the distribution of ESI. The p-value of Moran's index which is 0 (<0.05) is descriptive of clustering in the distribution (Fig. 2). It has a z-score of 21.36.

Significant hotspot areas of ESI were located in Western and Southern Tigray, most parts of Amhara, Southern, central, and Western Afar, Eastern Gambella, and northwestern SNNPR. Areas exhibiting significant cold spots were spotted in Addis Ababa, Central and Eastern Oromia, Dire Dawa, Harari, and the northern part of Somalia (Fig. 3).

4.5. The ordinary least squares regression analysis

Multicollinearity between independent factors was evaluated using the mean Variance Inflation Factor (VIF) resulting from OLS. Each variable resulted in VIF<10 independently with a minimum of 1.06 and a maximum of 2.68. With an adjusted R-squared value of

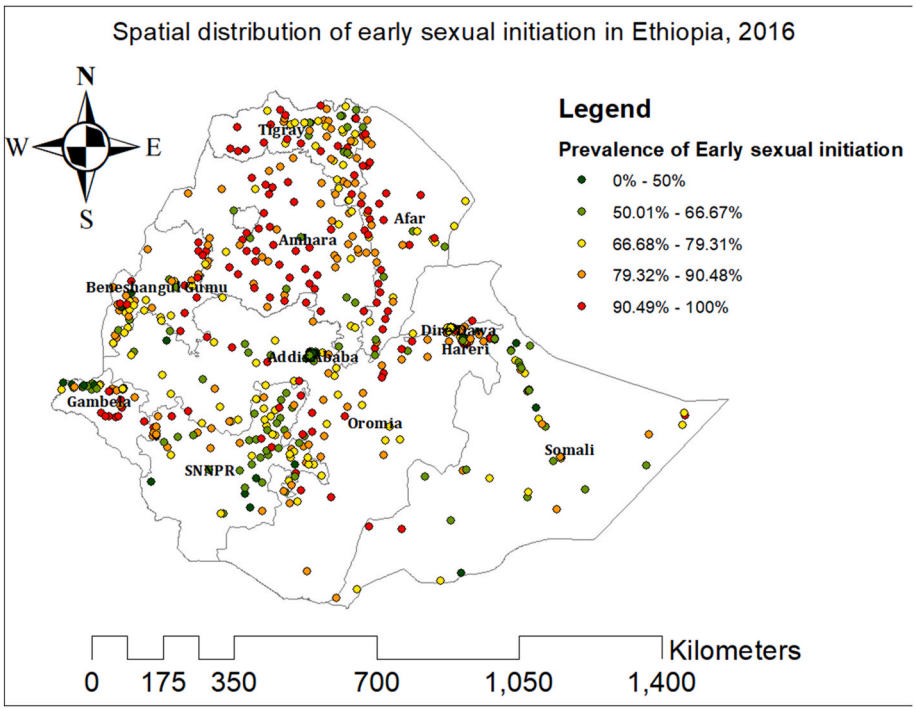

Fig. 1. The spatial distribution of early sexual initiation of women in Ethiopia, 2016.

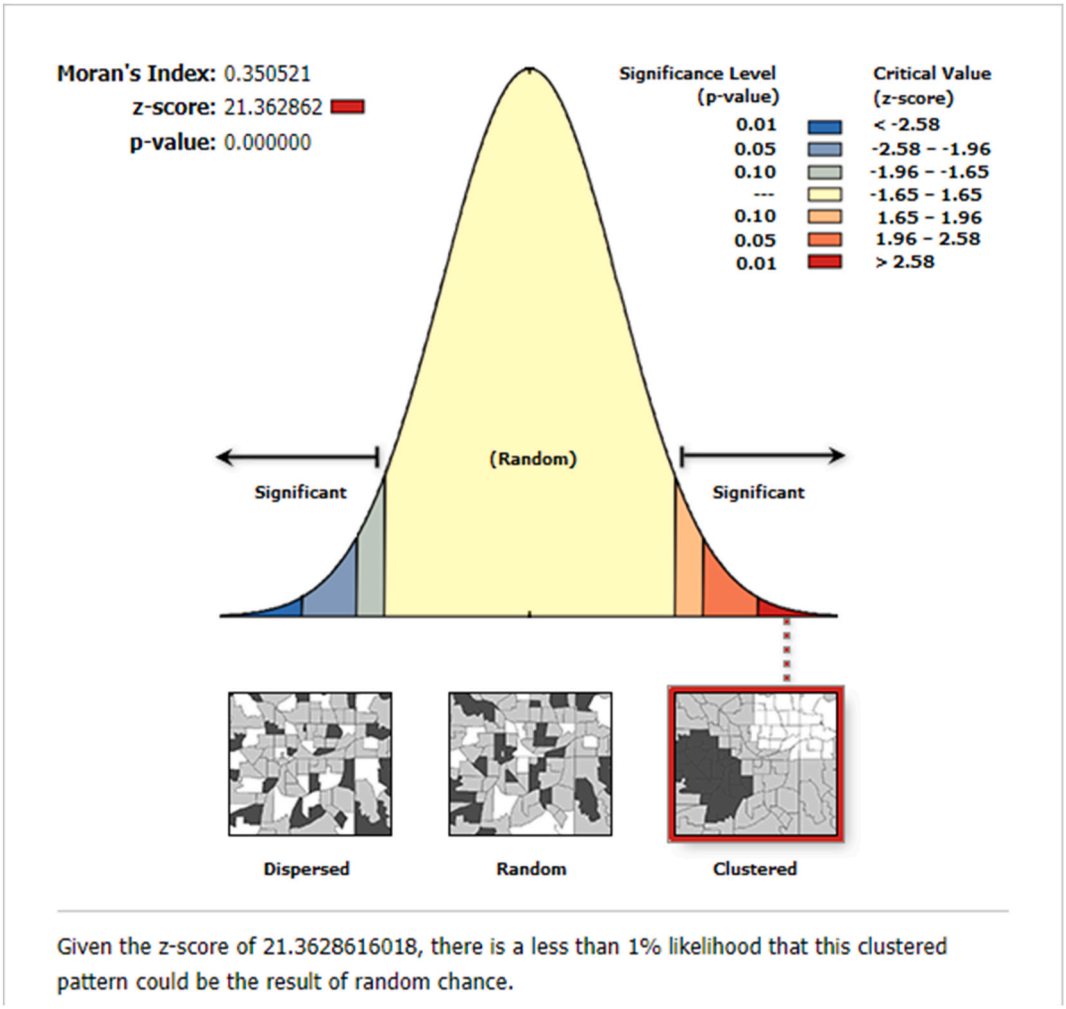

Fig. 2. The global spatial autocorrelation analysis of early sexual initiation of women in Ethiopia, 2016.

0.298, the model was able to explain approximately 29.8 % of the variation in early sexual initiation with AICc of −597.4. As the Jarque-Bera statistics become significant, it indicates that the spatial distribution of the residuals is skewed or deviates from a normal distribution. The Koenker statistics did not show any significant results which is indicative of homogeneity between the study areas. Because of the insignificant value of Koenker statistics, we will consider the joint F statistics to determine the overall model significance and it was statistically significant.

The spatial autocorrelation conducted on the regression residuals showed a statistically significant Z-score of clustering which shows a key variable is missed and the OLS model is misspecified. So we can proceed to the GWR model despite the insignificant Koenker statistics value to have a more localized insight (Table 3).

In the OLS model, there was a significant association between ESI and proportion of those who: are rural residents, single, and uneducated.

4.6. The geographically weighted regression analysis result

The GWR analysis demonstrated an enhancement in the OLS model, as evidenced by a decrease in the AICc value from −597.4 for OLS to −700.9 for GWR. The observed difference of 103.5 indicates that the GWR model provides better explanation for the spatial heterogeneity of early sexual initiation. The proportion of women of reproductive age who: are rural residents, have no formal education, and single shows statistically significant geographical variability even though Koenker's BP was statistically insignificant which implies the OLS model resulted in variables that do not vary in space. In addition to this, by utilizing GWR the model's capacity to elucidate ESI is enhanced, as evidenced by an adjusted R-squared value of 0.426. This shows the inclusion of GWR in the analysis enhanced the explanatory power of the OLS model by approximately 13 % (Table 4).

The GWR model utilized a uniform bandwidth of 619 for all covariates to simulate all processes at the same spatial scale. So, in

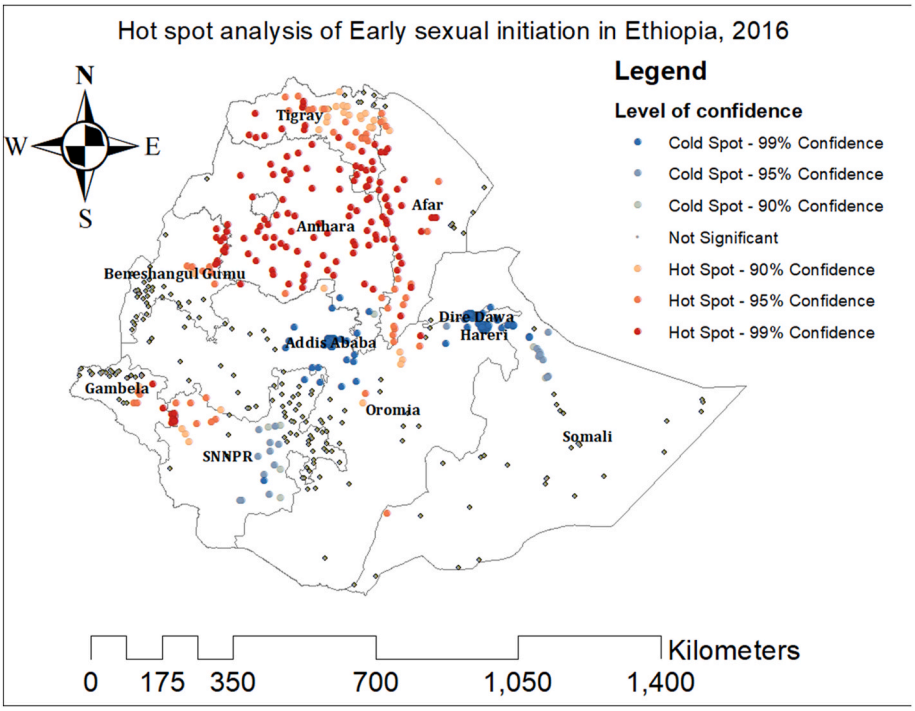

Fig. 3. The Getis-Ord Gi statistical analysis of hotspots of early sexual initiation of women in Ethiopia, 2016.

Table 3
Results of the Ordinary Least Square regression analysis.

Variable	Coefficient	Robust_SE	Robust_t statistics	Robust_probability	VIF
Intercept	0.63	0.02	33.57	0.000000[a]	–
The proportion of unmarried women	−0.31	0.07	−4.24	0.000030[a]	1.56
Proportion of Khat chewing	0.04	0.03	1.19	0.231227	1.06
Proportion of poorest wealth index	0.0019	0.02	0.09	0.931340	1.59
Proportion of rural residence	0.14	0.02	6.92	0.000000[a]	2.29
The proportion of uneducated women	0.07	0.03	2.03	0.042810[a]	2.68
OLS regression diagnostics					
Number of observations	622	Adjusted R^2			0.298
Joint F-statistics	53.9	Prob(>F), (8613) degree of freedom			0.000000[a]
Joint Wald statistics	273.9	Prob (>chi-squared) [6], degree of freedom			0.000000[a]
Koenker (BP) statistics	6.37	Prob (>chi-squared) [6], degree of freedom			0.271585
Jarque–Bera	39.5	Prob (>chi-squared) [2], degree of freedom			0.000000[a]

VIF: Variance Inflation Factor, SE: Standard Error.
[a] p-value <0.05.

Table 4
Model comparison of ordinary least square and geographic weighted regression.

Model Comparison parameter	OLS	GWR
AICc	−597.4	−700.9
Adjusted R-squared	0.298	0.426

AICc: Akaike Information Criteria.

order to inform the construction of parameter estimates in each local regression point it considers 619 nearest neighbors. Table 5 presents the summary statistics for the estimated coefficients of the local terms (GWR), along with the corresponding bandwidth.

The proportions of women who are not married have a negative relationship with the proportion of ESI. As the percentage of women who are not married increased, the occurrence of ESI decreased. Fig. 4 indicates a map of the coefficients for the marital status of being not married; showing that being not married was a negative and strong predictor of ESI in Tigray, central and western parts of Afar, northern and southern parts of Amhara, Addis Ababa, central Oromia, some parts of northern SNNPR and northern Somali. The

Table 5
Summary of the GWR model results among predictors of ESI.

Variable	Mean	STD	Min	Median	Max	Bandwidth
Intercept	−0.763	0.149	−1.184	−0.742	−0.560	619
The proportion of unmarried women	−0.418	0.043	−0.538	−0.409	−0.342	619
Proportion of Khat chewing	0.100	0.056	0.028	0.097	0.250	619
Proportion of poorest wealth index	0.054	0.067	−0.091	0.082	0.147	619
Proportion of rural residence	0.599	0.104	0.455	0.581	0.799	619
The proportion of uneducated women	0.366	0.152	0.011	0.365	0.623	619

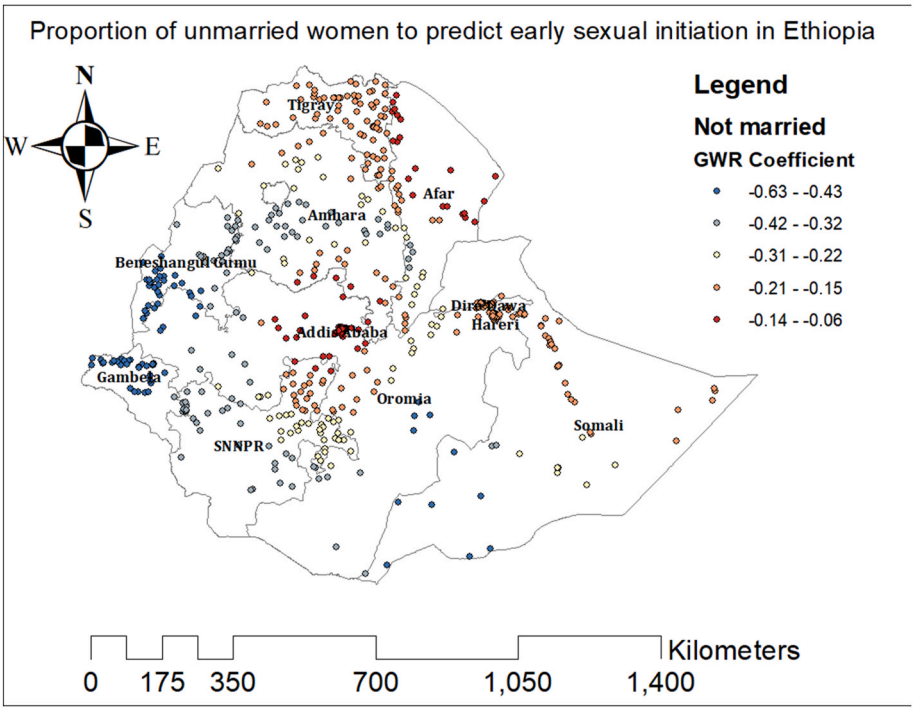

Fig. 4. Not married women GWR coefficients for predicting early sexual initiation of women in Ethiopia, 2016.

geographic region represented by the points colored in red shows the largest coefficient value for the proportion of ESI. Similarly being not married was a moderate and negative predictor of ESI in certain parts of Amhara, southern Afar, eastern Oromia, eastern SNNPR, and central Somali. At last, it was a weak and negative predictor of the outcome in Beneshangul Gumuz, Gambella, western and southeastern SNNPR, southern Somali, southern Oromia, and central Amhara.

There is a positive relationship between the proportion of women residing in rural areas and proportion of early sexual initiation (Fig. 5). When the percentage of women who are rural residents increased, the occurrence of ESI also increased. As the proportion of those who live in rural residents increased, the percentage of ESI also showed a strong increment in Addis Ababa, central Oromia, northern SNNPR, western Beneshangul Gumuz, Gambella, Somali, and southern Amhara. Living in rural areas was a moderate and positive predictor of ESI in southern Afar, southern Amhara, Dire Dawa, Harari, northern Somali, eastern and northwestern SNNPR, and southern Beneshangul Gumuz. Finally being a resident of rural areas was a weak and positive predictor of ESI in Tigray, Afar, most parts of Amhara, northeastern Beneshangul Gumuz, some parts of western Oromia, and some parts of northwestern SNNPR.

There is both a positive and negative relationship between the proportion of women without formal education and the proportion of early sexual initiation (Fig. 6). This shows when the percentage of women who have no formal education increased, the occurrence of ESI also increased for the positive relationship. For the negative relationship, when the proportion of those without formal education increased, the occurrence of ESI decreased. Strong negative correlations, where the proportion of increment of women who have no education resulted in decrement of the percentage of ESI, were observed in western Beneshangul Gumuz, most parts of Gambella, and western SNNPR. Strong positive correlations where the proportion of increment of uneducated women resulted in an increment of percentage of ESI were observed in Tigray, Amhara, Afar, Addis Ababa, some parts of eastern Oromia, and Somali. Being uneducated was a moderate and positive predictor of ESI in central Oromia, northern SNNPR, Dire Dawa, Harari, and most parts of Somalia. A value of 0 indicates being uneducated has no effect on ESI in southern Somali, southern and western Oromia, eastern SNNPR, and southern Beneshangul Gumuz.

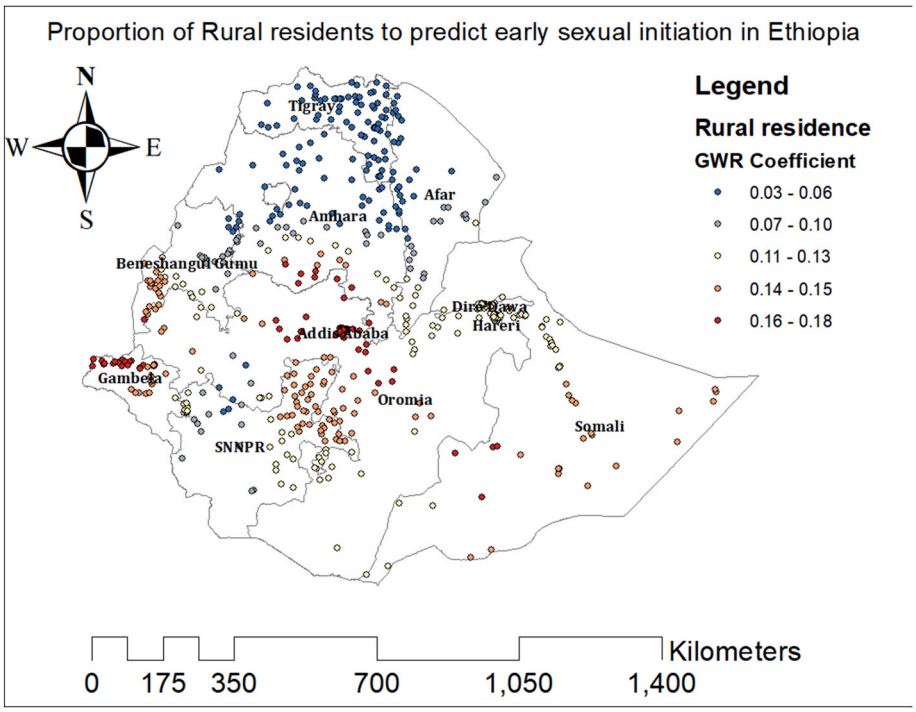

Fig. 5. Rural resident's GWR coefficients for predicting early sexual initiation of women in Ethiopia, 2016.

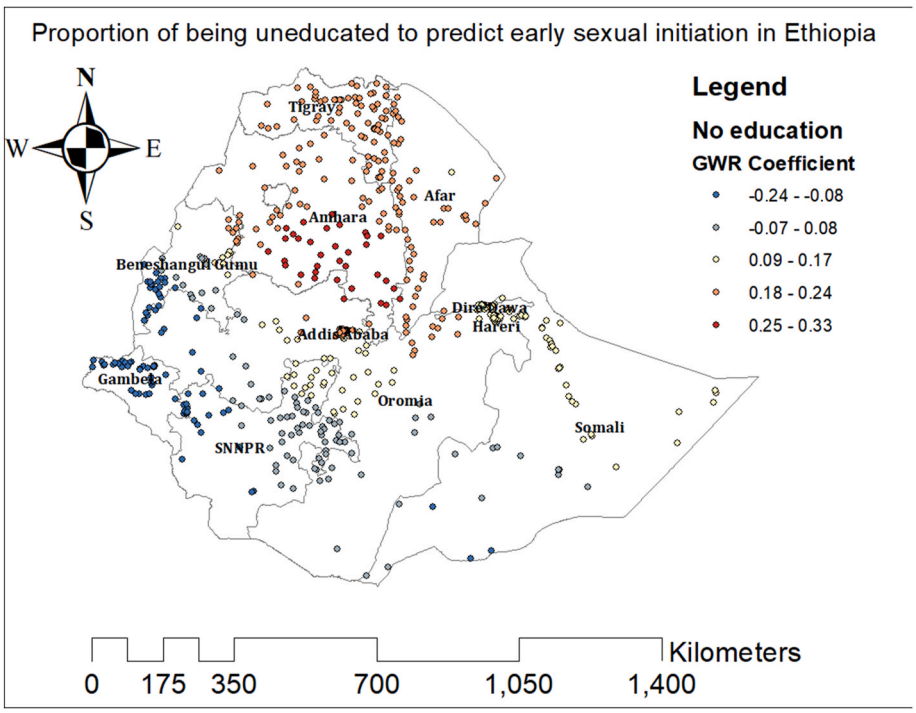

Fig. 6. Women who have no education GWR coefficients for predicting early sexual initiation of women in Ethiopia, 2016.

5. Discussion

The prevalence of ESI of women in Ethiopia was 75.3 % (95%CI: 74.6 %, 76.1 %). The possible reasons that may contribute to the higher prevalence observed are high rates of early marriage, traditional norms about gender roles and expectations, inadequate access to education and comprehensive sexual education as a result of cultural taboos that forbid discussing sexuality, gender-based violence, poverty, and limited economic opportunities.

The study determines spatial patterns and non-stationary ESI of women in Ethiopia. The spatial distribution of ESI was clustered or not random which is in line with similar research works from Ghana and Nigeria [34,35]. The hotspot areas were detected in Western and Southern Tigray, majority of the Amhara region, Southern, Central and Western Afar, Eastern Gambella, and North Western SNNPR. This is because the commonest cause of ESI in Ethiopia, that is child marriage in which girls before the age of 18 get married, is specifically clustered in the regions mentioned above. A study focused on examining the spatial distribution and factors influencing early marriage in Ethiopia [36,37] found that Amhara, Afar, Tigray, and Gambella regions had significant hotspot areas for early marriage. Amhara region accounts for the highest prevalence of child marriage, which is 48.6 %, which is considered a way of protecting a girl's honor and reputation. The most common age for a girl in the Amhara region to marry is 12 [38,39].

One of the variants of geographic weighted regression is a Multiscale Geographically Weighted Regression (MGWR) which avoids a single spatial scale and allows covariate-specific bandwidth. Standard GWR makes the assumption that processes being modeled take place at the same spatial scale by finding a "best-on-average" scale of relationship [40].

In this GWR analysis with a similar spatial scale of 619 bandwidth, factors significantly associated with hotspot areas of ESI were: being unmarried, rural residence, and having no formal education of the women. The association between unmarried women and the proportion of ESI in Tigray, central and western parts of Afar, northern and southern parts of Amhara, Addis Ababa, central Oromia, some parts of northern SNNPR, and northern Somali is negative. This is because for young people to have sexual relations, marriage is the only acceptable way by the community. Many women will be forced into marriage at a very young age which leads to early sexual initiation as they cannot decide about their sexual health [41,42]. Therefore, being unmarried decreases early sexual debut than those who are married.

As the percentage of women who live in rural residents increases, so does the proportion of early sexual initiation in Addis Ababa, central Oromia, northern SNNPR, western Beneshangul Gumuz, Gambella, Somali, and southern Amhara. This is because of lack of access to a variety of reproductive and sexual health-related information and comprehensive sex education among those residing in rural areas [43]. There is both a positive and negative relationship between being uneducated women and early sexual initiation in different geographic areas. As the number of women without an education rises in Tigray, Amhara, Afar, some areas of eastern Oromia, and Somali, there is an increment in the proportion of people who are involving in sexual relationship at young age. This can be attributed to the fact that there is a high proportion of early marriage in the above regions and if women are uneducated, they will not have the ability and skill to decide wisely regarding when and whom to marry which increases the proportion of ESI [44]. When the proportion of uneducated women increased, the percentage of ESI showed a decrement in western Beneshangul Gumuz, most parts of Gambella, and western SNNPR. This might be because school youths will be more exposed to peer pressure, substance utilization, and watching pornography than the educated ones which leads to ESI [45].

In the multivariable multilevel Poisson regression analysis with a robust variance, variables that had a significant association with ESI were; Marital status, khat chewing, education level, wealth index, region, and residence.

Women who are married, divorced, or widowed had an increased prevalence of ESI compared to single women. This is in line with studies conducted in Ethiopia [46–48]. The possible explanation is many Ethiopian girls get married earlier before turning 18 and 40 % of girls below 18 years and 14 % below the age of 15 are married [49]. Those who chew khat have an increased risk of being in ESI than those who don't chew khat. This is supported by studies from Ethiopia [2,17,50,51]. This is because as Khat is a stimulant, it results in a decrease in self-control which leads to risky sexual behaviors including ESI. Its psychoactive effect contributes to risky sexual behavior by increasing disinhibition and impulsivity which increases sexual involvement. In Ethiopia, khat is a common and also legal substance, and everyone has access to it [52,53].

The proportion of ESI was lower among women who are on secondary or higher education level than those with no formal education. This is supported by researches conducted in Ethiopia [48,54], Kenya [55], South Africa [56], Nigeria [57] and South Korea [58]. Those who are better educated have a decreased risk of ESI. That is explained by an understanding of ESI-associated risks, resisting peer pressure, making better decisions, and engaging themselves in positive relationships [59]. Compared to the Tigray region, women from the Amhara region have a higher risk of ESI; in contrast, women from Somali, Oromia, SNNPR, Harari, Dire Dawa, and Addis Ababa have a lower risk of ESI.

Rural residents have increased risk of ESI than women resided in urban. This is in accordance with some studies [48,60,61]. This might possibly be a result of a lack of access to sex education and an open discussion about sexual health. ESI has higher acceptance in rural communities which increases peer pressure and engagement in early sexual engagement. Another significant statistical relationship was also observed between the household wealth index and ESI. Women from poorer, richer, and richest households have an increased risk of ESI than the poorest ones and this is in line with a research from Peru [62].

5.1. Strengths and limitations of the study

This study utilized a nationally representative data obtained from DHS. To make generalization about the findings at the national level, a multilevel analysis was conducted. The geographically weighted regression assists policymakers in making spatial-based public health interventions. Causal inferences cannot be established as the data was cross-sectional. It was also prone to recall bias as data was

collected based on prior experience.

6. Conclusion

Ethiopia has a high rate of early sexual initiation of women and a statistically significant spatial distribution of ESI was observed across Ethiopian regions. Hotspot areas of ESI which are significant were identified in Western and Southern Tigray, most parts of Amhara, Southern, Central and Western Afar, Eastern Gambella, and North Western SNNPR. In the Geographically weighted regression; being single, rural residence, and having no formal education of the women were identified as a statistically significant explanatory variables. In the multivariable multilevel Poisson regression with a robust variance; region, residence, khat chewing, education level, wealth index, and marital status were significantly associated with ESI. Hence, the government should make interventions in public health that specifically target hotspot areas of ESI by improving access to health care services and education (specifically in rural), developing a comprehensive sexual education, implementing policies and laws that outlaw early marriage and mass community-based programs to increase awareness about the importance of delaying sexual activity.

Ethics approval and consent to participate

Since a secondary data source was used (EDHS 2016), there is no need for approval from the IRB. Participant consent is not necessary because the authors used a secondary dataset.

Consent for publication

Not Applicable.

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Availability of data and materials

Data is publicly available from the official DHS website https://www.dhsprogram.com/

CRediT authorship contribution statement

Tsion Mulat Tebeje: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Kassahun Alemu Gelaye:** Writing – review & editing, Visualization, Validation, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Yazachew Moges Chekol:** Writing – review & editing, Validation, Methodology, Investigation. **Tigabu Kidie Tesfie:** Writing – review & editing, Validation, Methodology, Investigation. **Negalgn Byadgie Gelaw:** Writing – review & editing, Validation, Methodology, Investigation. **Kusse Urmale Mare:** Writing – review & editing, Validation, Methodology, Investigation. **Beminate Lemma Seifu:** Writing – review & editing, Validation, Methodology, Investigation, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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List of abbreviations

AICc	Corrected Akaike Information Criteria
APR	Adjusted Prevalence Ratio
BP	Breusch-Pagan
CI	Confidence Interval
DHS	Demographic and Health Survey
EA	Enumeration Area
EDHS	Ethiopian Demographic and Health Survey
ESI	Early Sexual Initiation
GWR	Geographically Weighted Regression

ICC	Intra-class Correlation Coefficient
OLS	Ordinary Least Square
SNNPR	Southern Nations Nationalities and Peoples Region
STI	Sexually Transmitted Infections
VIF	Variance Inflation Factor
WHO	World Health Organization

References

[1] World Health Organization, Adolescent Health [Internet], 2022. Available from: https://www.who.int/health-topics/adolescent-health#tab=tab_1.
[2] E. Turi, B.T. Merga, G. Fekadu, A.A. Abajobir, Why too soon? Early initiation of sexual intercourse among adolescent females in Ethiopia: evidence from 2016 Ethiopian demographic andhealth survey, Int J Womens Health 12 (2020) 269–275.
[3] L.B. Finer, J.M. Philbin, Sexual initiation, contraceptive use, and pregnancy among young adolescents, Pediatrics 131 (5) (2013) 886–891.
[4] L. O'Donnell, C.R. O'Donnell, A. Stueve, Early sexual initiation and subsequent sex-related risks among urban minority youth: the reach for health study, GUTTMACHER Inst 33 (6) (2001).
[5] K.C. Kugler, S.A. Vasilenko, N.M. Butera, L. Donna, C. Hill, Long term consequences of early sexual initiation on young adult health : a causal inference approach 37 (5) (2018) 1–14.
[6] C.S. Christiansen, S. Gibbs, V. Chandra-mouli, Preventing early pregnancy and pregnancy-related mortality and morbidity in adolescents in developing countries : the place of interventions in the prepregnancy period 2013 (2013) 15–20.
[7] [Internet], Ipas. ABORTION AMONG ADOLESCENTS, 2018. Available from: https://www.ipas.org/wp-content/uploads/2020/07/CSEADG-E19.pdf.
[8] N. Noori, J.L. Proctor, Y. Efevbera, A.P. Oron, Effect of adolescent pregnancy on child mortality in 46 low and middle income countries, BMJ Glob. Health 7 (5) (2022) 1–12.
[9] W. Baba, Assessing factors influencing early sexual initiation among adolescents (13 to 19 Years) in Ghana: a qualitative study, Int J Caring Sci [Internet] 11 (1) (2021) 53–60. Available from: www.internationaljournalofcaringsciences.org.
[10] S.A. Kushal, Y.M. Amin, S. Reza, F.B. Hossain, M.S.R. Shawon, Regional and sex differences in the prevalence and correlates of early sexual initiation among adolescents aged 12–15 Years in 50 countries, J Adolesc Heal [Internet] 70 (4) (2022) 607–616, https://doi.org/10.1016/j.jadohealth.2021.10.027.
[11] I. Seff, J.J. Steiner, L. Stark, Early sexual debut: a multi-country, sex-stratified analysis in sub-Saharan Africa, Glob Public Health [Internet] 16 (7) (2021) 1046–1056, https://doi.org/10.1080/17441692.2020.1814833.
[12] S. Hailegebreal, G. Gilano, B.T. Seboka, H. Sidelil, S.M. Awol, Prevalence and associated factors of early sexual initiation among female youth in East Africa : further analysis of recent demographic and health survey, BMC Wom. Health (2022) 1–9, https://doi.org/10.1186/s12905-022-01895-8 [Internet].
[13] E.P. Marshall, M. Lyytikainen, N. Jones, Child marriage in Ethiopia, London Overseas … [Internet] (2016) (March), http://docs.dpaq.de/13055-child_marriage_in_ethiopia_evidence_review.pdf.
[14] Guttmacher Institute, Sexual and Reproductive Health of Young Women in India, vol. 19, 2014.
[15] D. Bayissa, G.B.G. Mebrahtu, Assessment of early sexual initiation and associated factors among Ambo university undergraduate students, Ambo, Ethiopia, J Reprod Heal Contracept (2016) 1–6.
[16] E. Abebe, A. Addis, A. Asmamaw, A. Addisu, B. Ayanaw, Factors associated with early sexual initiation among preparatory and high school youths in Woldia town , northeast Ethiopia : a cross-sectional study, BMC Publ. Health (2019) 1–8 [Internet], https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-019-6682-8.
[17] T. Yosef, T. Nigussie, D. Getachew, M. Tesfaye, Prevalence and factors associated with early sexual initiation among college students in southwest Ethiopia, BioMed Res. Int. 2020 (2020).
[18] W.L. Arega, T.A. Zewale, K.A. Bogale, Premarital sexual practice and associated factors among high school youths in Debretabor town , South Gondar zone , North, BMC Res. Notes (2019) 1–7, https://doi.org/10.1186/s13104-019-4348-3 [Internet].
[19] H. Bizuneh, Correlates of sexual initiation among adolescent and youth in Addis Ababa , Ethiopia : a community based cross sectional study 8 (6) (2019) 108–113.
[20] A. Girmay, T. Mariye, Risky sexual behavior practice and associated factors among secondary and preparatory school students of Aksum, BMC Res. Notes 1–7 (2019), https://doi.org/10.1186/s13104-019-4714-1 [Internet].
[21] M. Abay, S. Endgashet, B. Etana, K. Nguse, Magnitude of premarital sex and associated factors among preparatory school students in alamata town 6 (2) (2016) 1–9.
[22] B.B. Abate, A.M. Kassie, M.W. Kassaw, Prevalence and determinants of early initiation of sexual intercourse among youth girls in Ethiopia, J. Pediatr. Nurs. 55 (2020) e305–e312.
[23] M. Arefaynie, M. Yalew, Y. Damtie, B. Kefale, Determinants of early sexual initiation among female youth in Ethiopia: a multilevel analysis of 2016 Ethiopian Demographic and Health Survey, BMC Wom. Health 20 (1) (2020) 4–11.
[24] A.M. Nigatu, A.Y. Birhanu, B.F. Endehabtu, Geographical variations of early age sexual initiation among reproductive-age women in Ethiopia: evidence from EDHS 2016, Arch. Publ. Health 78 (1) (2020) 1–12.
[25] B.T. Seboka, S. Hailegebreal, T.T. Mamo, D.E. Yehualashet, G. Gilano, R.H. Kabthymer, et al., Spatial trends and projections of chronic malnutrition among children under 5 years of age in Ethiopia from 2011 to 2019: a geographically weighted regression analysis, J Heal Popul Nutr [Internet] 41 (1) (2022) 28, https://doi.org/10.1186/s41043-022-00309-7.
[26] Central Statistical Agency (CSA) and ICF, Ethiopia Demographic and Health Survey, 2016 [Internet]. Health San Francisco. Addis Ababa, Ethiopia and Rockville, CSA and ICF, Maryland, USA, 2016. https://dhsprogram.com/pubs/pdf/FR328/FR328.pdf.
[27] G.A. Tesema, Z.T. Tessema, D.A. Angaw, K.S. Tamirat, A.B. Teshale, Geographic weighted regression analysis of hot spots of anemia and its associated factors among children aged 6–59 months in Ethiopia: a geographic weighted regression analysis and multilevel robust Poisson regression analysis, PLoS One 16 (11) (2021) e0259147.
[28] O.V. Eboy, R. Dambul, Viewing preferences of TVRO users in Sabah: identification of distribution patterns using spatial statistics, Geogr Malaysian J Soc Sp 7 (4) (2011) 30–37.
[29] J. De Valck, S. Broekx, I. Liekens, L. De Nocker, J. Van Orshoven, L. Vranken, Contrasting Collective Preferences for Outdoor Recreation and Substitutability of Nature Areas Using Hot Spot Mapping, vol. 151, Landsc Urban Plan, 2016, pp. 64–78.
[30] P.M. Shrestha, Comparison of ordinary least square regression, spatial autoregression, and geographically weighted regression for modeling forest structural attributes using a geographical information system (GIS)/Remote sensing (RS) approach, Master Thesis [Internet] (2006) 204. http://people.ucalgary.ca/~mcdermid/Docs/Theses/Shrestha_2006.pdf.
[31] N. Waters, Handbook of applied spatial analysis: software tools, methods and applications, Ann. Assoc. Am. Geogr. 102 (2012) 251–253.
[32] M.S. Noresah, G. Sanjay, Geographically Weighted Regression Model: A Potential Approach for Better Management of Urban Growth, 2020, pp. 776–784.
[33] M. Charlton, A.S. Fotheringham, Geographically weighted regression, ARC GIS tutorial, Natl Cent Geocomputation Natl Univ Irel Maynooth [Internet] 27 (2009). Available from: https://www.geos.ed.ac.uk/~gisteac/fcl/gwr/gwr_arcgis/GWR_Tutorial.pdf.

[34] F. Amoako Johnson, Geographical hotspots and correlates of early sexual debut among women in Ghana, Reprod Health [Internet] 19 (1) (2022) 1–12, https://doi.org/10.1186/s12978-022-01425-7.
[35] O.A. Uthman, Geographical variations and contextual effects on age of initiation of sexual intercourse among women in Nigeria: a multilevel and spatial analysis, Int. J. Health Geogr. 7 (2008) 1–12.
[36] C.D. Agegenehu, G.A. Tesema, A.B. Teshale, A.Z. Alem, Y. Yeshaw, S.A. Kebede, et al., Spatial distribution and determinants of iron supplementation among pregnant women in Ethiopia: a spatial and multilevel analysis, Arch. Publ. Health 79 (1) (2021) 1–13.
[37] Z.T. Tessema, Spatial distribution and associated factors' of early marriage among reproductive age women in Ethiopia: a secondary data analysis of Ethiopian Demographic and Health Survey 2016, BMC Wom. Health 20 (1) (2020) 1–11, https://doi.org/10.1186/s12905-020-01103-5 [Internet].
[38] A.K. Tekile, A.A. Woya, G.W. Basha, Determinants of early marriage among female children in Amhara region, Ethiopia, Afr. Health Sci. 20 (3) (2020) 1190–1195.
[39] B. Rodgers, Child Marriage in Ethiopia and its Associated Human, vols. 11–9, 2002.
[40] A. Comber, C. Brunsdon, M. Charlton, G. Dong, R. Harris, B. Lu, et al., A route map for successful applications of geographically weighted regression, Geogr Anal [Internet] 55 (1) (2023 Jan 1) 155–178, https://doi.org/10.1111/gean.12316.
[41] UNICEF, Early marriage : child spouses, Early marriage : child spouses (7) (2001).
[42] A. Erulkar, Early marriage , marital relations and intimate partner violence in Ethiopia, Int. Perspect. Sex. Reprod. Health. (2013) 6–13.
[43] G.R. Gupta, J.O. Parkhurst, J.A. Ogden, P. Aggleton, A. Mahal, Structural approaches to HIV prevention, Lancet 372 (9640) (2008) 764–775.
[44] International Center for Research on Women. Child Marriage and Education. :1–2.
[45] M. Agajie, T. Belachew, T. Tilahun, M. Amentie, Risky sexual behavior and associated factors among high school youth in Pawe Woreda, Benishangul Gumuz Region, Sci. J. Clin. Med. 4 (4) (2015) 67–75.
[46] T.N. Digafe, Determinants of sexual debut among high school girl students in Arsi Zone, Huruta town, Ethiopia, Epidemiol. Open Access 7 (3) (2017).
[47] G. Tadesse, B. Yakob, Risky sexual behaviors among female youth in Tiss Abay, a semi-urban area of the Amhara Region, Ethiopia, PLoS One 10 (3) (2015) e0119050.
[48] F. Mazengia, A. Worku, Age at sexual initiation and factors associated with it among youths in North East Ethiopia, Ethiop. J. Health Dev. 23 (2) (2009).
[49] N. Jones, G. Emirie, B. Tefera, E. Presler-Marshall, Surprising Trends in Child Marriage in Ethiopia, London UNICEF ODI, 2016.
[50] M. Tilahun, G. Ayele, Factors associated with age at first sexual initiation among youths in Gamo Gofa, south west Ethiopia: a cross sectional study, BMC Publ. Health 13 (1) (2013) 1–6.
[51] M.T. Yigzaw, A.W. Yalew, A.B. Mesfin, A.S. Demisie, Sexual initiation and factors associated with it among Addis Ababa University undergraduate students, Addis Ababa, Ethiopia, Am. J. Health Res. 2 (5) (2014) 260–270.
[52] A. Abate, M. Tareke, M. Tirfie, A. Semachew, D. Amare, E. Ayalew, Chewing khat and risky sexual behavior among residents of Bahir Dar City administration, Northwest Ethiopia, Ann. Gen. Psychiatr. 17 (1) (2018) 1–9.
[53] R. Hoffman, M. Al'Absi, Khat use and neurobehavioral functions: suggestions for future studies, J. Ethnopharmacol. 132 (3) (2010) 554–563.
[54] D.T. Nigatu, A. Seme, S. Fituma, M.T. Segni, Sexual initiation and associated factors among young women in West Shoa, Ambo Town, Ethiopia: a community-based cross-sectional study, BMC Wom. Health 18 (2018) 1–6.
[55] C.C. Okigbo, I.S. Speizer, Determinants of sexual activity and pregnancy among unmarried young women in urban Kenya: a cross-sectional study, PLoS One 10 (6) (2015) e0129286.
[56] K. Zuma, G. Setswe, T. Ketye, T. Mzolo, T. Rehle, N. Mbelle, Age at sexual debut: a determinant of multiple partnership among South African youth, Afr. J. Reprod. Health 14 (2) (2010) 47–54.
[57] S. Aga, R. Van Rossem, A. Ankomah, Community-level influences on early sexual initiation in Nigeria, Meas Eval Work Pap Ser (2006).
[58] J.H. Yeo, H. Park, E.-Y. Kim, Predictors of the timing of sexual intercourse initiation among adolescents in South Korea, J. Community Health 44 (2019) 580–586.
[59] M.T.A. França, G.S. Frio, Factors associated with family, school and behavioral characteristics on sexual initiation: a gender analysis for Brazilian adolescents, PLoS One 13 (12) (2018) e0208542.
[60] D. Bizu, Z. Aderaw, G.M. Kassa, Assessment of early sexual initiation and associated factors among preparatory school students of FaggetaLekoma District, Awi Zone, Northwest Ethiopia, 2015, Int. J. Clin. Med. 6 (8) (2015) 521.
[61] A. Ayalew, K. Abreha, A. Shumey, K. Berhane, Magnitude and predictors of early sexual debut among high and preparatory school students in northern Ethiopia: a school-based Crosssectional study, J Heal Educ Res Dev (2015) 1–8.
[62] S. Cueto, J. Leon, Early sexual initiation among adolescents: a longitudinal analysis for 15-year-olds in Peru, Interam. J. Psychol. 50 (2) (2016).