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Geographic patterns and determinants of family planning satisfaction among women of reproductive age in Ethiopia

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Abstract

Introduction While studies in Ethiopia have explored family planning use and contraceptive determinants, limited research examines the spatial variation and predictors of satisfaction with family planning methods. This study addresses this gap using geographically weighted regression (GWR) analysis to assess spatial patterns and determinants of satisfaction with family planning methods among reproductive-age women. Utilizing nationally representative 2021 Performance Monitoring for Action Ethiopia (PMA-ET) data, the study aims to provide targeted insights for improving family planning services.

Methods A weighted sample of 1,456 reproductive-age women was analyzed. Spatial analysis was conducted using ArcGIS 10.7 and SaTScan 9.6. Hotspot detection, ordinary least squares (OLS) regression, and geographically weighted regression (GWR) were applied. The Bernoulli model was used to identify spatial clusters of satisfaction. Associations between satisfaction and explanatory variables were assessed using OLS and GWR, with statistical significance set at P < 0.05.

Results The overall satisfaction rate with current family planning methods was 84.1% (95% CI: 82.12, 85.97). Satisfaction levels exhibited a clustered spatial distribution. High-satisfaction hotspots were detected in Addis Ababa, most parts of Amhara, and some areas of Benishangul-Gumuz. SaTScan identified a primary spatial cluster (RR = 1.19, P < 0.001) in Addis Ababa, northern southwestern Ethiopia, and eastern Gambela, and a secondary cluster (RR = 1.18, P < 0.001) in northern Addis Ababa and southern Amhara. GWR analysis revealed that younger women (15–24 years), those with poor wealth status, and urban residents were significant spatial predictors of satisfaction.

Conclusion The study revealed that satisfaction with the current use of family planning methods among reproductive-age women in Ethiopia exhibits regional variations. Statistically significant clusters of higher satisfaction were identified in Addis Ababa, most parts of Amhara, and some parts of Benishangul-Gumuz. Geographically Weighted Regression (GWR) analysis indicated that women aged 15–24, those with poor wealth status, and urban residents were significant spatial predictors of satisfaction at the local level. These findings suggest the need for

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targeted regional strategies to improve satisfaction with family planning services. Interventions should prioritize high-satisfaction areas to sustain progress while addressing disparities in underserved regions. Policymakers should focus on enhancing equitable access, strengthening awareness campaigns, and mitigating socioeconomic barriers to improve satisfaction with family planning.

Keywords Satisfaction, Spatial analysis, Family planning method, Ethiopia

Introduction

Satisfaction with family planning methods is a key indicator of service quality and influences contraceptive continuation and effectiveness [1]. Globally, an estimated 214 million women have an unmet need for family planning, and discontinuation rates remain high. In Africa, only 33% of women use modern contraceptive methods, with sub-Saharan Africa reporting a contraceptive prevalence rate of 23% and an unmet need of 24% [2-4]. In Ethiopia, the contraceptive prevalence rate is 36%, while 22% of women have an unmet need for family planning [5]. Despite efforts to improve access, little is known about women's satisfaction with their current contraceptive methods. Low satisfaction may contribute to inconsistent use, leading to unintended pregnancies, unsafe abortions, maternal and child health risks, and broader socio-economic consequences such as poverty, reduced educational opportunities, and limited healthcare access [6, 7].

As indicated in previous studies, age, educational status, wealth status, media exposure, residence, marital status, and other related factors were significant factors for satisfaction with the current use of family planning methods among reproductive-age women [8-10].

While studies in Ethiopia have examined family planning use and contraceptive determinants, little research has explored the spatial variation and predictors of satisfaction with family planning methods. To address this gap, this study applies geographically weighted regression analysis to provide nuanced insights. Using nationally representative data from the 2021 Performance Monitoring for Action Ethiopia (PMA-ET), it examines spatial patterns in satisfaction, enabling targeted interventions in regions with lower satisfaction rates. This study aims to comprehensively analyze the geographic patterns and determinants of family planning satisfaction among reproductive-age women in Ethiopia.

Materials and methods

Study design, study area, and data source

In the PMA-ET 2021 study, a community-based crosssectional design employed a two-stage cluster approach with residential areas (urban and rural) and sub-regions as strata, ensuring representation across all 12 geographic regions in Ethiopia. The study divided each region into urban and rural zones, resulting in 321 sampling strata. Households were then systematically selected through random sampling. Eligible participants included all women of reproductive age who were regular members of the chosen households or who stayed overnight in the household before the survey. Notably, 95% of the target population, women aged 15-49 years, resides in four key regions: Addis Ababa, Amhara, Oromia, and SNNP. To address regions with less than 5% of the target population, a sixth synthetic region, denoted as "other," was created. Due to population distribution and resource constraints, regional representative samples were taken exclusively in the four major regions. The sampling design, comprising 321 Enumeration Areas, aims to achieve a national-level margin of error below 2%, below 3% for urban and rural estimates, and below 5% at each of the four regional levels, ensuring robust and precise estimates of male involvement in family planning decisionmaking among reproductive-age women. The secondary data for this analysis were obtained from PMA-ET of 2021 which was found in the PMA portal (https://www.p madata.org/ _ 2021) (Fig. 1).

Population

The study population comprised all reproductive-age women surveyed in Ethiopia. A weighted total sample of 1,456 women of reproductive age were included in the analysis, encompassing all variables of interest. Women with missing responses on satisfaction were excluded, particularly those from enumeration areas with zero coordinates, as their geographic information was incomplete, preventing accurate spatial analysis. the Performance Monitoring for Action Ethiopia (PMA-ET) dataset follows standardized data collection protocols, including interviewer training, supervision, and real-time data validation to ensure accuracy and reliability.

Study variables

Dependent variable

The proportion of respondents at the cluster level who report satisfaction with their current family planning method. This is calculated by dividing the number of satisfied respondents by the total number of respondents in each cluster.

Independent variables

Women's age (aggregated proportion of 15–24, aggregated proportion of 25–34, and aggregated proportion of 35–49), Women's education status (aggregated

Legend Tigray Legend Ethiopia Ethiopia Afar other Africa Amhara Benishangul Gumz Dire Dawa Addis Ababa Harahi Gambelia Oromia Somali South West Ethiopia Sidama SNNP 3,550 7,100 14,200 Kilometers 0

Map of the study Area

Fig. 1 Map of the study area (Ethiopia) Shapefile source: CSA, 2013; URL: https://africaopendata.org/dataset/ethiopia- shapefiles

proportion of no education, aggregated proportion of primary education, aggregated proportion of secondary education, and aggregated proportion of higher education), residence (aggregated proportion of urban or rural), marital status (aggregated proportion of single, married, divorced/separated, and widowed), and wealth index (aggregated proportion of poor, middle and rich) of current use of any type of family planning method.

Operational definition

Family planning satisfaction

"satisfaction" with family planning methods is operationally defined as women's self-reported contentment with their current contraceptive method, based on their responses in the 2021 PMA-ET survey, where those expressing approval were classified as satisfied, while those indicating dissatisfaction or uncertainty were considered unsatisfied.

Data management and statistical analysis Spatial autocorrelation analysis

The spatial autocorrelation analysis aims to examine the degree of similarity between nearby locations in spatial data, helping identify spatial patterns and potential clustering, thus informing targeted interventions and policy decisions. The data underwent cleaning using STATA version 17.0 software and Microsoft Excel. For data analysis, Arc GIS 10.7 and SaTScan 9.6 were utilized. To assess the spatial distribution of satisfaction towards the current use of family planning methods in Ethiopia, the Global Moran's I statistic was employed. A Moran's I value nearing – 1 indicates dispersed satisfaction, close to + 1 suggests clustering and a value of zero signifies a random distribution, and if Moran's I value zero shows randomly distributed and a statistically significant Moran's I (p < 0.05) leads to rejection of the hypothesis [11].

Incremental autocorrelation analysis

To assess spatial autocorrelation across a range of distances, a line graph depicting these distances and their corresponding Z-scores was created. The Z-scores



Fig. 2 Incremental spatial autocorrelation of satisfaction towards current use of family planning method among reproductive-age women in Ethiopia using 2021 PMA-ET

indicate both the degree of spatial clustering and statistical significance. Peaks in Z-scores highlight distances where spatial processes fostering clustering are most prominent. These peak distances serve as valuable references for tools incorporating Distance Band or Distance Radius parameters. Utilizing this information aids in selecting an optimal distance threshold or radius for tools that employ such parameters, including those used in hotspot analysis [12].

Hotspot and cold spot analysis

Hotspot and cold spot analysis, commonly used in spatial epidemiology and public health, helps identify areas with statistically significant clusters of high or low values, respectively, guiding resource allocation and intervention strategies for disease prevention and control. The study employed Gettis-Ord Gi* statistics to assess spatial autocorrelation differences in the study location for each area, particularly focusing on satisfaction with the current use of the family planning method. Gettis-Ord Gi* statistics were utilized to identify hotspot areas, signifying pronounced spatial clustering. The z-score was computed to validate the statistical significance of clustering, and the p-value was determined at p-value < 0.05 with 90%, 95%, and 99% confidence intervals. A z-score less than -1.68, -1.96, and -2.58 designates a cold spot, while a z-score greater than +1.68, +1.96, and +2.58 indicates hotspot areas [3, 13, 14].

Spatial interpolation

The spatial interpolation technique is used to predict satisfaction with the current use of the family planning method for unsampled areas based on sampled clusters [15]. Deterministic and geostatistical interpolation methods were applied in this study. To evaluate these interpolation methods, a geostatistical analysis, identifying the technique with the lowest mean predicted error (MPE) and root mean square predicted error (RMSPE) as the most fitting for predicting satisfaction towards the current use of the family planning method. Smaller MPE and RMSPE values suggest a closer alignment between predicted and observed values, indicating the precision and efficacy of the selected interpolation technique [16].

Spatial scan statistics

This study employed Bernoulli-based spatial Kuldorff's Scan statistics within SaTScan version 9.6.1 software to identify the geographical locations with statistically significant spatial windows for satisfaction towards the current use of the family planning method [17]. The outcome variable has a Bernoulli distribution, so the Bernoulli model was employed using Kuldorff's method for purely spatial analysis.

The scanning window, moving across the study area, identified cases with satisfaction towards the current use of family planning method as well as controls dissatisfaction towards the current use of family planning method,

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fitting the Bernoulli model. The default maximum spatial cluster size, set at <50% of the population, served as an upper limit. Identification of the most likely clusters relied on p-values and likelihood ratio tests derived from 999 Monte Carlo replications. Secondary clusters were generated using non-overlapping options in SaTScan version 9.6.1, and the mapping of clusters and attributes of satisfaction towards the current use of the family planning method, produced by SaTScan, was accomplished using ArcGIS software version 10.7.

Spatial regression

Exploratory Regression was employed to identify a model adhering to the assumptions of the Ordinary Least Squares (OLS) method, focusing on models with high Adjusted R2 values. The Ordinary Least Square regression model, being global, estimates a single coefficient per explanatory variable across the entire study region. We utilized explanatory regression to verify the assumptions of spatial regression, incorporating specific tests. The Jarque-Bera test assessed normality assumptions for residuals, and the statistically significant Koenker (BP) statistic indicated inconsistencies in the modeled relationships, possibly attributable to non-stationarity or heteroscedasticity. Multicollinearity, assessed through the Variance Inflation Factor, ensured the absence of

Table 1	Socio-demographic characteristics and proportion
of satisfa	ction towards current use of family planning method
among r	eproductive-age women in Ethiopia using 2021 PMA-E

Variables	categories	Weighted	Weighted per-				
		frequency(<i>n</i>)	centage (%)				
Age	15–24	378	25.97				
	25-34	648	44.50				
	35–49	430	29.54				
Residence	Urban	595	40.85				
	Rural	861	59.15				
Educational	no educated	381	26.19				
status	primary education	610	41.86				
	secondary education	285	19.58				
	higher education	180	12.36				
	Wealth status						
Wealth	Poor	418	28.72				
status	Middle	249	17.10				
	Rich	789	54.18				
marital	Single	39	2.69				
status	Married	1375	94.46				
	divorced/separated	34	2.33				
	Widowed	8	0.52				
satisfaction	No	232	15.90				
towards the	Yes	1224	84.10				
current use			(82.12,85.97)				
of family							
method							

redundancy among predictor variables, with coefficients displaying the expected sign and statistical significance, along with robust Adjusted R2 values.

A geographically weighted regression model gives local parameter estimates to reflect variations over space in the association between the current use of family planning methods and predictor variables [18]. The geographically weighted regression model utilized the aggregated proportion of satisfaction towards the current use of the family planning method and all relevant predictor variables for each cluster.

The evaluation of geographical heterogeneity for each coefficient involved comparing the AICc between the GWR model and the global OLS regression model. Model comparison, utilizing the corrected Akaike Information Criteria (AIC) and Adjusted R-squared, was performed for both the OLS (global model) and GWR (local) model. The determination of the best-fit model for local parameter estimates hinged on selecting the model with the lowest AICc value and a higher adjusted R-squared. The comparison between the OLS and GWR models was based on robust statistical metrics, including the corrected Akaike Information Criteria (AICc) and Adjusted R-squared. By evaluating geographical heterogeneity through these measures, we aimed to demonstrate how the GWR model captures spatial variability more effectively than the OLS model. The GWR model's superiority lies in its ability to account for spatial heterogeneity by allowing coefficients to vary across different locations, unlike the OLS model, which assumes spatial homogeneity. By comparing AICc values and adjusted R-squared between the two models, we identified the GWR model as providing a better fit for capturing the spatial nuances inherent in our dataset.

Findings

Socio-demographic characteristics and proportion of satisfaction towards current use of family planning method

A weighted total of 1,456 reproductive age group women were included in the study. Approximately half of the participants, constituting 648 (44.50%) women, fell within the age range of 25–34 years. The majority of the participants resided in rural areas, accounting for 861 (59.15%). Regarding educational background, 610 (41.86%) had primary education, and rich (54.18%) belonged to the rich wealth status category. The majority of the study participants, 1,375 (94.46%) were married women. The overall proportion of satisfaction towards the current use of family planning methods among reproductive-age women in Ethiopia was 84.10% (82.12, 85.97) (Table 1).

Spatial analysis result

Spatial autocorrelation (Global Moran's I) and incremental Spatial autocorrelation analysis

At a distance threshold of 229,712 m, statistically significant z-scores suggest that spatial factors contribute to clustering patterns. The incremental spatial autocorrelation analysis, beginning at 18,385.7 m, identified ten distance bands with significant clustering (Fig. 2). The spatial distribution of satisfaction with current family planning use among reproductive-age women demonstrated a non-random clustering pattern at the regional level. The Global Moran's I index was 0.308358 (p-value < 0.001), indicating a moderate but statistically significant level of spatial clustering. The Z-score of 7.1 suggests that there is less than a 1% probability that the observed clustering occurred by random chance (Fig. 3).

Hotspot and cold spot regions for satisfaction with current use of family planning methods

Hotspot analysis identifies statistically significant regions with either high (hot spots) or low (cold spots) levels of satisfaction with current family planning use. The results indicate that regions with higher satisfaction levels (hot spots) were detected in Addis Ababa, most parts of Amhara, and some areas of Benishangul-Gumuz. Conversely, lower satisfaction levels (cold spots) were found in Harari, Dire Dawa, parts of Oromia, sections of Gambela, and some areas within Benishangul-Gumuz and Somali regions (Fig. 4).

Spatial interpolation

The Ordinary Kriging spatial interpolation method was used to predict satisfaction with the current use of family planning methods in unobserved areas, with mean predicted error (MPE) and Root Mean Square Predicted Error (RMSP) used for comparison. Among the interpolation methods evaluated, Disjunctive Kriging was identified as the most suitable, yielding the lowest MPE (-0.02669) and RMSP (0.56540). The analysis, based on the 2021 PMA-ET dataset, indicated regional variations in predicted satisfaction, with a transition from red (lower predicted satisfaction) to green (higher predicted satisfaction) areas (Table 2). Illustrate that Addis Ababa and some parts of the Amhara region were predicted as areas with higher satisfaction towards the current use of family planning methods compared to other regions (Fig. 5).



Global Moran's I Summary

Fig. 3 Spatial autocorrelation of satisfaction towards current use of family planning method among reproductive-age women in Ethiopia using 2021 PMA-ET



Fig. 4 Hot spot analysis of satisfaction towards current use of family planning method among reproductive-age women in Ethiopia using 2021 PMA-ET

Spatial scan statistics

The Kulldorff's Spatial Scan analysis identified seven spatial clusters, of which two were statistically significant at p < 0.05. The primary cluster, represented by a green-colored ring, was predominantly located in central Ethiopia,

Table 2Interpolation method comparison for satisfactiontowards current use of family planning method amongreproductive-age women PMA-ET 2021

Interpolation n	nethod	Parameters			
		Mean error (ME)	Root-mean- square error (RMSE)		
Deterministic Inverse distance interpolation weighted method		-1.30322	1.338025		
geostatistical	Ordinary kriging	-2.94570	1.15671		
interpolation	Simple kriging	1.56219	1.08135		
methods	Universal kriging	2.94570	1.15671		
	Disjunctive kriging	-0.02669	0.56540		
	Probability kriging	0.02447	0.56375		
	Indicator kriging	1.56219	1.08135		

covering Addis Ababa, the northern part of southwestern Ethiopia, and the eastern part of Gambela (Fig. 6). This spatial window, centered at 9.954596°N, 38.209724°E, had a 73.07 km radius, a Log-Likelihood Ratio (LLR) of 13.21, and a relative risk (RR) of 1.19 at p < 0.001, indicating that women within this area were 1.19 times more likely to report satisfaction with the current use of family planning methods compared to those outside the cluster. The secondary cluster, marked by a tourmaline blue ring, covered northern Addis Ababa and the southern part of the Amhara region, with a center at 8.011829°N, 35.638621°E, a 113.07 km radius, an LLR of 8.4, and an RR of 1.18 at p < 0.001, suggesting that women within this cluster had 1.18 times higher satisfaction than those outside it (Table 3).

Spatial regression analysis

The spatial regression analysis assessed factors influencing spatial variations in satisfaction with the current use of family planning methods using the Ordinary Least Squares (OLS) model, which explained 71.0% of



Interpolation of satisfaction towards current use of family planning method

Fig. 5 Interpolation of satisfaction towards current use of family planning method use among Reproductive-age Women PMA-ET 2021

the variation (Adjusted $R^2 = 0.71$), meeting all model assumptions. The coefficients indicated the strength and direction of each explanatory variable's effect, with statistical significance confirmed using robust probability estimates. The Koenker (BP) statistic was significant (Koenker BP = 24.65, p < 0.001), suggesting that the relationships between explanatory variables and satisfaction with family planning use varied across locations. The Joint Wald statistic confirmed the overall model significance (p < 0.01), while Variance Inflation Factor (VIF) values < 7.5 indicated no multicollinearity issues. Additionally, the Jarque-Bera test was non-significant, confirming that model residuals followed a normal distribution. Given the significant Koenker test result, the analysis suggests that relationships between some explanatory variables and satisfaction with family planning use are non-stationary across different geographic areas, warranting the application of Geographically Weighted Regression (GWR) for a more localized assessment (Table 4).

Geographically weighted regression (GWR) analysis

The Geographically Weighted Regression (GWR) analysis identified women aged 15–24, poor wealth status, and urban residence as significant spatial predictors of satisfaction with the current use of family planning methods among reproductive-age women in Ethiopia. The effect of age (15–24 years) on satisfaction exhibited spatial variation, with coefficients ranging from 1.062880 to 1.062969, indicating a consistent positive influence across different geographic areas. Notably, regions such as Addis Ababa, Amhara, Oromia, SNNP, northwest Ethiopia, Gambela, and Afar demonstrated a particularly strong and positive association between younger women (15–24 years old) and higher satisfaction with family planning use (Fig. 7).

The Geographically Weighted Regression (GWR) analysis also revealed that the statistical significance



Spatial SaTScan analysis of satisfaction towards current use of family planning method

Fig. 6 Spatial SaTScan analysis of satisfaction towards current use of family planning method among reproductive-age women, PMA-ET 2021

Table 3	Significant clusters of satisfaction towards current use of family planning method among reproductive-age women, P	'MA-ET
2021		

Type of cluster	#cluster location	#pop	# case	RR	LLR	Coordinate/radius	<i>p</i> -value
Primary cluster	7	79	679	1.19	13.207192	9.954596 N, 38.209724 E) / 73.07 km	< 0.001
Secondary cluster 1	6	51	51	1.18	8.428470	8.011829 N, 35.638621 E) / 113.07 km	< 0.001

of poor wealth status varied across different regions of Ethiopia. The coefficients associated with women with media exposure exhibited spatial variation, ranging from 0.733614 to 0.733722, indicating a positive spatial effect of poor wealth status on satisfaction with the current use of family planning methods. This relationship was particularly strong and positive in Oromia and some parts of the Afar region (Fig. 8).

The Geographically Weighted Regression (GWR) analysis further indicated that the statistical significance of women's residence in urban areas varied across different regions of Ethiopia. The coefficients associated with urban residence exhibited spatial variation, ranging from 0.418157 to 0.418243, suggesting a positive spatial

effect on satisfaction with the current use of family planning methods. This relationship was particularly strong and positive in Harari, Dire Dawa, and some parts of the Amhara and Oromia regions (Fig. 9).

In comparing the Ordinary Least Squares (OLS) and Geographically Weighted Regression (GWR) models, the corrected Akaike Information Criterion (AICc) and adjusted R^2 were used as evaluation metrics. Both models exhibited a similar AICc value of 953.11, indicating comparable model fit. However, the GWR model demonstrated a superior explanatory power, achieving an adjusted R^2 of 73.0%, compared to 71.0% in the OLS model (Table 4 and Table 5).

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Table 4 Global beta coefficients of the ordinary least squaremodel summary and diagnostics for satisfaction towards currentuse of family planning method among reproductive-age women,PMA-ET 2021

Variable	Coefficient	Std. error	Probability	Robust probability	VIF
Intercept	1.50	0.338	0.000023	0.00000	
Age(15-24)	1.06	0.11	0.00000	0.0000	1.33
Poor wealth status	0.73	0.06	0.0000	0.00000	1.33
Urban	0.41	0.56	0.0000	0.00000	1.36
OLS Diagnos	tic				
Diagnostic criteria	Magnitude	p-valı	ıe		
AICc	953.11				
R squared	0.71				
Adjusted R squared	0.71				
Joint F-Statistics	149.98	0.0000*			
Joint Wald Statistics	272.80	0.0000*			
Koenker (BP) Statistics	24.65	0.00002*			
Jarque-Bera Statistics	173.60	0.0826			

Discussion

This study aimed to explore the spatial variation and predictors of satisfaction with the current use of family planning methods among reproductive-age women in Ethiopia using data from the 2021 Performance Monitoring for Action Ethiopia (PMA-ET). The findings revealed that 84.10% (82.12-85.97) of reproductive-age women in Ethiopia were satisfied with their current family planning methods.). his result is consistent with a study conducted in Nigeria, which reported a similar satisfaction rate of 83.5% among women of reproductive age [19]. However, findings from Ghana indicated a lower satisfaction level of 71% [20]. while a study in the Philippines reported a significantly higher satisfaction rate of 92% [21]. These variations across countries may be attributed to differences in healthcare accessibility, quality of family planning services, cultural perceptions, and socioeconomic factors. For instance, Ghana's lower satisfaction rate may reflect barriers to service access, limited contraceptive choices, or provider biases, whereas the Philippines' higher satisfaction rate could result from well-established family planning programs, extensive community outreach, and improved service delivery. Unexpectedly, despite Ethiopia's relatively lower contraceptive prevalence rate (36%) and persistent unmet need for family planning (22%), satisfaction levels were relatively high. This may indicate that women who do access family planning services generally find them acceptable. Additionally, variations in spatial clusters suggest that local healthcare infrastructure, provider-client interactions, and regional socio-cultural factors play a role in shaping women's satisfaction levels, warranting further qualitative exploration.

The Getis-Ord Gi* hotspot analysis identified significant hotspots, indicating hotspot (high satisfaction) regions for satisfaction towards the current use of family planning method were detected in Addis Ababa, most parts of Amhara, and some parts of Benshangul-Gumz. The spatial Kuldorff's Scan analysis is statistically significant at a P-value < 0.05 in Addis Ababa, the north part of southwestern Ethiopia, the south part of Amhara, and the east part of Gambela. A study conducted in Nigeria used spatial analysis to identify hotspots of contraceptive use and satisfaction with family planning services [22]. The study found significant hotspots of high satisfaction in urban areas, while rural areas showed lower satisfaction levels. This contrasts with the findings in Ethiopia, where hotspots were identified in both urban (Addis Ababa) and rural (Amhara and Benshangul-Gumz) areas. In another study conducted in Kenya, spatial analysis was used to assess the geographical disparities in satisfaction with family planning services. The results revealed hotspots of high satisfaction in the coastal region and parts of the Rift Valley [23]. This differs from the Ethiopian findings, where hotspots were identified in Addis Ababa and various regions across the country. The discrepancy in contraceptive use satisfaction between women of reproductive age may be due to variations in access to a wide range of contraceptive methods, quality of family planning services, cultural attitudes towards contraception, and the availability of information and education on contraceptive options.

The significant hotspots identified by the Getis-Ord Gi* and spatial Kuldorff's Scan analyses offer insights into regional disparities in family planning satisfaction. Targeted interventions can prioritize areas with high satisfaction, like Addis Ababa and parts of Amhara, while addressing lower satisfaction levels in other regions, aiding policy development for equitable service delivery.

Furthermore, a global study employed spatial analysis to examine regional disparities in family planning satisfaction across multiple countries. The study identified hotspots of high satisfaction in urban areas of low-income countries, while rural areas showed lower satisfaction levels [24]. This aligns with the Ethiopian findings, where hotspots were detected in both urban and rural areas.

The geographically weighted regression model revealed that predictor variables women aged of 15–24, poor wealth status, and women who reside in urban areas were statistically significant predictors spatially for satisfaction towards the current use of family planning methods among reproductive-age women in Ethiopia. Previous



Geographically varying values of coefficients per cluster for predictor women who had age 15-24

Fig. 7 Geographically varying values of coefficients per cluster for predictor women who had age 15–24, PMA-ET 2021

studies conducted in various African countries have also explored the factors influencing satisfaction towards the current use of family planning methods among reproductive-age women. For instance, a study conducted in Nigeria found that age, education level, and socioeconomic status were significant predictors of satisfaction with family planning methods [25]. Similarly, a study in Kenya revealed that urban residence and higher education levels were associated with higher levels of satisfaction [26]. This consistency across different studies suggests that these factors play a crucial role in determining women's satisfaction with family planning services. In Ethiopia's socio-cultural context, women aged 15-24 may show higher satisfaction due to better exposure to education, health campaigns, and proactive use of modern family planning methods. Urban residents benefit from easier access to healthcare facilities, diverse contraceptive options, and community-level awareness initiatives. Conversely, women with poor wealth status may face challenges such as limited access to quality services or financial barriers, impacting their satisfaction. These findings reflect how socio-economic disparities and urban-rural divides influence family planning satisfaction in Ethiopia.

Strengths and limitations of study

This study's strength lies in its use of geographically weighted regression (GWR), which provides detailed spatial insights into factors influencing family planning satisfaction across Ethiopia. The large sample size and nationwide scope enhance the generalizability of findings, while the identification of specific predictors offers valuable data for region-specific interventions. However, limitations include the cross-sectional nature of the study, which precludes causal inferences, and the exclusive focus on family planning users, excluding non-users who could provide insights into barriers to access and dissatisfaction. Additionally, reliance on secondary data limits the scope of examined variables, potentially omitting important cultural, provider-related, or behavioral factors. Spatial analysis assumptions and potential model limitations may also affect interpretation, requiring



Geographically varying values of coefficients per cluster for predictor women who had poor wealth status

Fig. 8 Geographically varying values of coefficients per cluster for predictor women had poor wealth status, PMA-ET 2021

caution when generalizing results. Future research should consider longitudinal designs and a broader population to provide a more comprehensive understanding of family planning satisfaction dynamics in Ethiopia.

Practical policy implications

The findings highlight the need for region-specific policy interventions to improve family planning satisfaction in Ethiopia. Policymakers should focus on expanding access to quality family planning services in underserved areas, particularly for younger women, those with poor wealth status, and urban residents. Tailored outreach programs addressing financial and social barriers can enhance satisfaction and service utilization. Additionally, strengthening infrastructure and service delivery in identified hot spots, such as Addis Ababa, Amhara, and Benishangul-Gumuz, can sustain high satisfaction levels and guide similar efforts in other regions.

Conclusion

The study revealed that satisfaction with the current use of family planning methods among reproductive-age women in Ethiopia exhibits regional variations. Statistically significant clusters of higher satisfaction were identified in Addis Ababa, most parts of Amhara, and some parts of Benishangul-Gumuz. Geographically Weighted Regression (GWR) analysis indicated that women aged 15-24, those with poor wealth status, and urban residents were significant spatial predictors of satisfaction at the local level. These findings suggest the need for targeted regional strategies to improve satisfaction with family planning services. Interventions should prioritize high-satisfaction areas to sustain progress while addressing disparities in underserved regions. Policymakers should focus on enhancing equitable access, strengthening awareness campaigns, and mitigating socioeconomic barriers to improve satisfaction with family planning.



Geographically varying values of coefficients per cluster for predictor women who were urban residence

Fig. 9 Geographically varying values of coefficients per cluster for predictor women residence in urban, PMA-ET 2021

 Table 5
 Geographic weighted regression (GWR) model for satisfaction towards current use of family planning method among reproductive-age women, PMA-ET 2021

Explanatory Variable	Age (15–24), wealth status (poor wealth status) and residence (urban)		
Residual square	1850.70		
Effective number	4.00		
Sigma	3.2		
AICc	953.11		
Multiple R square	0.73		
Adjusted R square	0.72		

Abbreviations

 AOR
 Adjusted Odds Ratio

 EAs
 Enumeration Areas

 MPE
 Mean Predicted Error

 SNNP
 South Nation and Nationalities People

 RMSPE
 Root Mean Square Predicted Error

 PMA-ET
 Performance Monitoring for Action Ethiopia

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Author contributions

All authors contribute to the Conceptualizations of the study, Methodology, and, Statistical analysis. The author(s) read and approved the manuscript.

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Data availability

All the necessary data are included in the manuscript. The detailed information was found within the PMA report and the data set was by requesting permission through the website https://datalab.pmadata.org/dash board?check_logged_in=1.

Declarations

Ethical approval

was secured from the Performance Monitoring for Action Ethiopia (PMA-ET) organization dataset for research. The nationally representative survey, conducted by the Addis Ababa University School of Public Health and the Bill & Melinda Gates Institute for Population and Reproductive Health at the Johns Hopkins Bloomberg School of Public Health, provided data accessible

through the website https://datalab.pmadata.org/dataset. Authorization was obtained via an approval letter, and the data were used exclusively for this study, maintaining confidentiality and adhering to IRB-approved procedures. No personal or household identifiers were disclosed, and ethical guidelines were strictly followed, as outlined in the PMA report. Permission was sought from all levels for the study involving individuals under 18 years old. Caretakers received comprehensive information about the study's purpose. data collection procedures, and potential risks/benefits. Informed written consent was obtained from caretakers, representing each reproductive age women's family. A child participated only with caretaker agreement, and if a child opted out, their decision was respected, irrespective of caretaker consent. Informed consent was obtained from each study participant before the commencement of data collection. Confidentiality of information was received from the study participants maintained by using codes rather than the names of participants during data collection procedures. Participants were informed that participation was voluntary. All methods and materials were carried out under relevant guidelines and regulations.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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References

- Suranga MS, De Silva WI, Kumarasinghe M. Family Planning and Contraception. Sri Lankan Youth; Sexual and Reproductive Health-Profile, Knowledge, Attitudes & Behaviour, Child Fund Sri Lanka. 2020;161–75.
- Nations U. Department of Economic and Social Affairs. Population Division. 2015.
- Muche A, Melaku MS, Amsalu ET, Adane M. Using geographically weighted regression analysis to cluster under-nutrition and its predictors among under-five children in Ethiopia: evidence from demographic and health survey. PLoS ONE. 2021;16(5):e0248156.
- Darroch JE, Sully E, Biddlecom A. Adding it up: investing in contraception and maternal and newborn health, 2017—supplementary tables. New York, NY: The Guttmacher Institute; 2017.
- Ababa A, Calverton E. Central statistical agency (Ethiopia) and ICF international. Volume 14. Ethiopia and Calverton: Ethiopia Demographic and Health Survey; 2011.
- Tusa BS, Weldesenbet AB, Kebede SA. Spatial distribution and associated factors of underweight in Ethiopia: an analysis of Ethiopian demographic and health survey, 2016. PLoS ONE. 2020;15(12):e0242744.
- Bulto GA, Zewdie TA, Beyen TK. Demand for long acting and permanent contraceptive methods and associated factors among married women of

reproductive age group in Debre Markos town, North West Ethiopia. BMC Womens Health. 2014;14:1–12.

- Chen S, Guilkey DK. Determinants of contraceptive method choice in rural Tanzania between 1991 and 1999. Wiley Online Library; 2003.
- 9. Burgard S. Factors associated with contraceptive use in late-and post-apartheid South Africa. Stud Fam Plann. 2004;35(2):91–104.
- Sedgh G, Hussain R, Bankole A, Singh S. Women with an unmet need for contraception in developing countries and their reasons for not using a method. Occasional Rep. 2007;37:5–40.
- 11. Tsai P-J, Lin M-L, Chu C-M, Perng C-H. Spatial autocorrelation analysis of health care hotspots in Taiwan in 2006. BMC Public Health. 2009;9:1–13.
- Waldhör T. The Spatial autocorrelation coefficient Moran's I under heteroscedasticity. Stat Med. 1996;15(7–9):887–92.
- Wulder M, Boots B. Local Spatial autocorrelation characteristics of remotely sensed imagery assessed with the Getis statistic. Int J Remote Sens. 1998;19(11):2223–31.
- De Valck J, Broekx S, Liekens I, De Nocker L, Van Orshoven J, Vranken L. Contrasting collective preferences for outdoor recreation and substitutability of nature areas using hot spot mapping. Landsc Urban Plann. 2016;151:64–78.
- Krivoruchko K. Empirical bayesian kriging. ESRI: Redlands, CA. California: USA. Available online at: http://www.esri.com/news/arcuser ….
- Gia Pham T, Kappas M, Van Huynh C, Hoang Khanh Nguyen L. Application of ordinary kriging and regression kriging method for soil properties mapping in hilly region of central Vietnam. ISPRS Int J Geo-Information. 2019;8(3):147.
- 17. Kulldorff M. A Spatial scan statistic. Commun Statistics-Theory Methods. 1997;26(6):1481–96.
- Fotheringham AS, Brunsdon C, Charlton M. Geographically weighted regression: the analysis of spatially varying relationships. Wiley; 2003.
- Anate BC, Balogun MR, Olubodun T, Adejimi AA. Knowledge and utilization of family planning among rural postpartum women in Southwest Nigeria. J Family Med Prim Care. 2021;10(2):730.
- 20. Abekah-Nkrumah G, Ottie-Boakye D, Owusu R, Ermel J, Issiaka S, Baku AAA. Process of use of evidence products by frontline maternal, newborn and child health staff at the facility level in Ghana. MedRxiv. 2023;202309:24–23296046.
- Lopez LM, Grey TW, Chen M, Hiller JE. Strategies for improving postpartum contraceptive use: evidence from non-randomized studies. Cochrane Database Syst Reviews. 2014(11).
- Merid MW, Kibret AA, Alem AZ, Asratie MH, Aragaw FM, Chilot D, Belay DG. Spatial variations and multi-level determinants of modern contraceptive utilization among young women (15–24 years) in Ethiopia: Spatial and multilevel analysis of mini-EDHS 2019. Contracept Reproductive Med. 2023;8(1):26.
- Okigbo CC, Speizer IS, Corroon M, Gueye A. Exposure to family planning messages and modern contraceptive use among men in urban Kenya, Nigeria, and Senegal: a cross-sectional study. Reproductive Health. 2015;12(1):1–11.
- 24. Mumah J, Machiyama K, Kabiru CW, Odwe G, Obare F, Huda FA et al. Reasons for unmet need for family planning, with attention to the measurement of fertility preferences in Kenya and Bangladesh. 2017.
- Alo OD, Daini BO, Omisile OK, Ubah EJ, Adelusi OE, Idoko-Asuelimhen O. Factors influencing the use of modern contraceptive in Nigeria: a multilevel logistic analysis using linked data from performance monitoring and accountability 2020. BMC Womens Health. 2020;20(1):1–9.
- Ochako R, Fotso J-C, Ikamari L, Khasakhala A. Utilization of maternal health services among young women in Kenya: insights from the Kenya demographic and health survey, 2003. BMC Pregnancy Childbirth. 2011;11(1):1–9.

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