### RESEARCH

Spatial variations and determinants of modern contraceptive utilization among sexually active rural women in Ethiopia using mini EDHS 2019 data: spatial and multilevel analysis

Chilot Kassa Mekonnen<sup>1\*</sup>, Zerko Wako Beko<sup>1</sup>, Gashaw Adane Nega<sup>2</sup> and Hailemichael Kindie Abate<sup>1</sup>

### Abstract

**Background** Modern contraceptive prevents unwanted pregnancy and play a paramount role in birth spacing and improving health care costs for the individual, family, community, and the country at large. However, there is limited evidence on the modern contraceptive utilization of rural women in Ethiopia. Hence, this study aimed to assess the spatial distributions and determinants of modern contraceptive utilization of rural women in Ethiopia.

**Method** Data was drawn from the 2019 Ethiopian mini-demographic health survey. Total weighted samples of 5934 mothers who were sexually active in the last five years preceding the survey were included. STATA version 14 was used to clean and analyze the data. The Arc GIS version 10.7 and Sat Scan version 10.1 were used for the spatial analysis to locate hot and cold spot areas in modern family planning among rural Ethiopian women. Multilevel multivariable logistic regression was employed to identify factors associated with modern family planning utilization in Ethiopia. In the multivariable analysis, an adjusted odd ratio with a 95% confidence level indicated a statistical association with the outcome variable at a P- value < 0.05.

**Result** The overall prevalence of modern family planning utilization was 23.00% [95%Cl (21.92–24.06)] among reproductive age (15–49) year-old Ethiopian rural women. Those women whose age 25–34 was [AOR = 0.79,95%Cl(0.64, 0.98)], age of 35–49 years [AOR = 0.39,95%Cl(0.03, 0.49)], being catholic[AOR = 1.46, 95%Cl (1.18, 4.03)], not married[AOR = 0.05, 95%Cl(0.04, 0.07)], having formal education[AOR = 1.59,95%Cl(1.34, 1.88)], being primi-para[AOR = 2.27,95%Cl(1.23, 9.33)], being multi-para[AOR = 2.43, 95%Cl(1.94, 3.03)], house hold seize 11–24[AOR = 1.89,95%Cl(1.38, 4.84)], having sons [AOR = 2.03,95%Cl(1.67, 3.84)], having daughters[AOR = 1.55,95%Cl(1.19, 2.33)], being middle wealth status[AOR = 1.22,95%Cl(1.01, 1.47)], and having high level community literacy were [AOR = 1.99, 95%Cl(1.43, 2.79)] times to utilize modern. In this study, the spatial analysis

\*Correspondence: Chilot Kassa Mekonnen chilotkassa.m@gmail.com

Full list of author information is available at the end of the article







revealed that SNNPR and Amhara regions have had a high modern contraceptive utilization rate. Whereas, the clusters with low utilization rates were located in Somalia and Afar regions of Ethiopia.

**Conclusion** Less than a quarter of reproductive-age rural women used modern contraceptives in Ethiopia. The study revealed that there were considerable variations in utilizing modern contraceptives across rural areas in the regions of Ethiopia. Hence, the clusters with cold spots shall be emphasized beefing up the services.

Keywords Modern contraceptive, Sexually active, Rural women, Ethiopia

### Introduction

Contraceptive is a means of controlling fertility using different techniques either traditional or modern type [1]. Modern contraceptives are a medicine or medical treatment that prevents unwanted pregnancy in sexually active women [2]. It includes oral, injectable, transdermal, vaginal ring, implant and intrauterine device (IUD) [3]. Modern contraceptives are crucial for maternal and child health by preventing unintended pregnancy, abortion, and birth with no spacing [4]. According to a central statistics agency report Ethiopia is one of the most populated nations in Africa, with 115 million in 2020 and this number will be projected to 145 million in 2030 [5]. This number indicates that Ethiopia is one of the most fertile nations in Africa and is a populous nation that has an impact on the human development index such as life expectancy, education and economic level of the [6].

Hence, modern contraceptive has an integral role in decreasing maternal and child mortality, and improving healthcare costs thereby improving maternal and child health [7, 8]. In addition, it is so essential to have the right number of children and child spacing, to reduce the high risk of unintended pregnancy and its related negative health consequences [9]. Modern contraceptive utilization increased in many parts of the world particularly in Asia and Latin America, from (54-57%) but was reported low in sub-Saharan Africa 23.6–28.5% [10]. Worldwide, modern method contraceptives are utilized by 58% of married or in-union women of reproductive age group [11]. Similarly, the prevalence of modern contraceptive utilization was reported as 21- 89.8% in Ghana [12, 13], and 58.9% in Cameroon [14]. However, the overall modern contraceptive utilization was 20.42% and 28% in 2016 and 2019 respectively [15, 16] in Ethiopia. Similarly, one study reported a 45.8% prevalence of modern contraceptive use among lactating rural mothers in Ethiopia [17]. Modern family planning method utilization has benefits such as women's empowerment, maternal and child health, economic growth and education [18]. Furthermore, it plays an essential role in reducing unwanted pregnancies, delaying births and improving neonatal and child survival rates because there will be more time for good partnering child health [19]. Evidence showed that the use of modern contraceptives could be affected by the age of respondents, level of education, a discussion between the couple about family planning, husband's permission for using of contraceptive, number of children, planned number of children, residency, religion, knowledge and attitude religious and traditional influence [20–23]. Although there is an investment in modern family planning programs and education, unmet needs remain high among reproductive-age women in low and middle-income countries, increasing the risk for unintended pregnancies and adverse social and reproductive health outcomes [24, 25]. Previous estimates, of family planning indicators have mainly been limited to married or in-union women of reproductive age 15-49 years, and unmarried women of reproductive age 15-49 years have not been paid adequate attention [26]. However, very recently changes the international MFP has been refocused attention toward all women of reproductive age 15-49 years, regardless of marital status [27]. However, recent studies regarding modern family planning focused on married women only and overlooked the sexually active unmarried women who may be imposed by an unmet need for family planning in Ethiopia.

In Ethiopia, studies were conducted on the overall prevalence and associated factors of modern contraceptive Utilization [28, 29] but none of these studies has tried to show the spatial distribution of modern contraceptive utilization among rural reproductive-age women. Moreover, unmarried women who are at a high risk of unintended pregnancy are frequently overlooked in researches which tend to focus on married women.

Therefore, this study aimed to investigate the prevalence and spatial distribution of modern contraceptive utilization among all reproductive age (15–49) years rural women in Ethiopia based on weighted 2019 mini EDHS data. Thus, the identification of significant hotspot areas with a low prevalence of modern contraceptive use plays an integral role in designing targeted effective public health interventions to enhance its uptake. Thereby, reducing maternal death, the cost of the family, and the country at large.

### Methods

### Study setting and data source

The study used the Ethiopia Mini Data Health Survey (EMDHS) 2019 which is a nationally collected household survey of data collected every five years. The objective

of EMDHS is to provide up-to-date information on key demographics and health indicators [30]. Ethiopia is located in the horn of Africa 3° to 14° N and 33° to 48° E. The EDHS 2019 was the second mini-demographic survey conducted in Ethiopia. In Ethiopia, there are nine administrative regions which include Tigray, Afar, Amhara, Oromia, Benishangul-Gumuz, Gambela, South Nation Nationalities and People's Region, Harari, Somali and two city administrations. A pre-tested and standardized questionnaire was used to collect data from the EDHS survey. The questionnaire was conceptualized based on the context for our setup and the data was collected by trained data collectors. The data set was obtained from the measure of the EDHS program [31]. A total weighted sample of 5934 rural women was included in the study. In the emerging regions of the country, there is a pretty sizeable health care services inaccessibility, inadequate infrastructure, drought and poverty whereas, the developed Regions such as Amhara, Oromia, South Nation Nationalities and people's region, and the city administration characterized accessibility of health care services, adequate infrastructure, denser population and better education service.

### Source of population and study population

In this study, data was restricted to reproductive-age rural women in Ethiopia and based on this criterion the study sample was drawn. Therefore, all reproductive-age rural women were the source population; whereas those selected reproductive-age rural women were the study population.

### Sampling, data collection tools and procedures

The data for this particular study were obtained from the Ethiopian Mini Demographic and Health Survey of 2019 after the online request of the Demographic and Health Survey (DHS) database www.measuredhs.com and the online authorization was given through addressing the ultimate purpose of the study. The DHS is a large nationally representative survey which conducted through a face-to-face interview on a wider population. The sample was stratified and selected into two stages. The first stage is the random selection of the enumeration areas (EA). The second stage is a selection of the households with the listing operation in all selected EAS. After dropping the urban residency reproductive-age women in all regions of Ethiopia, we have done individual sample weighting for rural women by dividing the cluster number by million (v005/1000000) to get a representative estimate. After dropping urban and weighting the sample for rural reproductive-age women was 5934. All rural women aged 15-49 who were either permanent residents of the selected households or visitors who slept in the night before the survey were eligible to be interviewed. The data collector interviewed only pre-selected households that were allowed in the implementing stage to prevent selection bias. Further, a detailed explanation of the sampling processes is presented on the measure DHS website (https://dhsprogram.com).

### Variables of the study Dependent variable

The dependent variable in this study was modern contraceptive use among sexually active rural women categorized as (Yes, No). Modern contraceptive includes the emergency contraceptive pill, IUD, injections, diaphragm, male or female condom, male or female sterilization, implant, lactation amenorrhea, and standard days method [32]. However, those women who had had a folkloric traditional method or those who did not use any were considered traditional contraceptive utilizers (nonusers of modern contraceptives).

### Independent variable

Based on the standard EMDHS 2019 dataset, it includes both individual and community variables. The individual-level variables include; maternal age, sex, religion, educational status, wealth status, current marital status and number of children. The community-level variable includes; region, community literacy, and community poverty.

## Community level variables (community literacy, and community poverty)

In the first place those reproductive age women having a minimum of primary school level of education was generated from the data based on the participants' levels of education. Then after, it was categorized as per the national mean value after computation of Crosstabulations of the individual level of women's education with cluster number (V001). Hence, the community level women's literacy ( $\geq$  50% national mean value categorized as high community level literacy, < 50% of the national mean value as low community level literacy.) Besides, the community level poverty was categories as rich and middle wealth. After generating the cross-tabulation of individual-level wealth status combined with the cluster number (V001), it was then classified using the national mean value of the wealth index: low community-level poverty (communities with  $\geq$  50% of the national mean value of the wealth index) and high community-level poverty (community with <50% of the national mean value of the community wealth index. Then they were dichotomized as low or high depending on the distribution of computed proportion values from the existing aggregated individual-level characters.

### Inclusion and exclusion criteria

All reproductive-age (15–49 years old) rural women were the source population; whereas those selected reproductive-age rural women were the study population.

### Data management analysis

The data were cleaned, recorded and analyzed using STATA version 14/MP. Sample weighting was done before analyzing to ensure the representativeness of the data DHS sample and to get reliable estimates and standard errors [33].

Descriptive data were presented using tables to describe modern contraceptive utilization by Sociodemographic factors and maternal characteristics. A multilevel analysis was used after checking the assumptions. The multilevel model eligibility was assessed by calculating the Intra-class Correlation Coefficient (ICC) and a model for greater than 10%. In this study, the ICC was 0.24 which showed there existed an intra-class correlation. Since the hierarchical nature of DHS data of women, the two-level logistic regression model was fitted to estimate the individual and community level variables on the modern contraceptive utilization status of rural women. Four models were fitted: the null model (models without independent variables), model I (models with individual-level variables), model II (models including community-level variables), and model III (models with both individual and community-level variables). Deviance was used to assess model fitness since these models were nested. Model III, which includes both individual-level and community-level variables, was selected as the bestfitted model since it had a low deviance value. Bivariable and multivariable analysis was conducted. The results of the random effect were estimated using different methods such as intra-class correlation (ICC), median odds ratio (MOR), and proportional change in variance (PCV) and deviance. Finally, a fixed effect model with a p-value less than 0.05 with an Adjusted Odds Ratio (AOR) with a 95% Confidence Interval (CI) was used to estimate the association of individual and community-level factors with modern contraceptive utilization status of rural women. The random effect variations between clusters were reported using ICC and proportional change in variance (PCV).

### Spatial analysis

The Geographic Information System (GIS) was used in the spatial analysis to locate geographic variations of modern contraceptive utilization among rural women in Ethiopia. The shape files were obtained from the DHS office upon request and the proportion of modern contraceptive utilizers was calculated for every cluster in the survey. The X-Y coordinates of selected clusters were appended about the latitude and longitude. Before conducting the hot spot analysis the spatial autocorrelation statistics (Global Moran's I) were performed to identify the presence of dispersed, clustered, or perhaps randomly distributed outcome variables (modern contraceptive use). The Moran's I value close to -1 indicates scattered modern contraceptive utilization status of rural women which is dispersed, whereas close to +1 indicates clustered, and Moran's I value of zero indicates randomly distributed [33, 34]. Moran's I with statistically significant p values (p < 0.05) had a chance to reject the null hypothesis which indicates the presence of special autocorrelation. In this regard, the actual p-value was (p < 0.001)which shows there is significant clustering. Hot spot analysis (Getis-Ord statistic) z-scores with p-values gave the features with either hot spot or cold spot values for the clusters spatially. Spatial interpolation statistics were used to predict the lack of or scattered uses of modern contraceptive utilization status of rural women the study participants for the un-sampled area of the country. The geo-statistical Empirical Bayesian Kriging spatial ArcGIS 10.7 version 10 software was used for the prediction of un-sampled EAs The weight of the new simulated semivariogram was estimated by Bayer's rule [35]. Spatial scan statistics were employed to determine the geographical locations' statistically significant clusters for the lack of modern contraceptive utilization status of rural women using Kul-dorff's SaTScan version 9.6 software [36].

To fit the Bernoulli model, the lack of modern contraceptive utilization status of rural women was taken as cases and those taking of modern contraceptive utilization status of rural women were taken as controls. The maximum spatial cluster size of less than 50% of the population allows both small and large clusters to be detected and removed clusters more than the maximum limit with the cluster shape of the window. Most probably clusters are detected by using p-value and log-likelihood ratio test.

### **Ethics consideration**

The data set was obtained from the DHS website after a formal request and permission from the major DHS. All methods were performed per the Demographic and Health Surveys (DHS) program's relevant guidelines and regulations. The dataset was not allowed to be shared with other organizations and has remained confidential.

### Result

### Socio-demographic characteristics

From the total of 5934 weighted sample, about 2388 (40.3%) were aged between 15 and 24 years, 2564 (43.21%) were Muslim by faith, 3030 (51.06%) had no formal education, 4090 (68.92%) were married, 2241 (37.77%) were multipara, 3141 (52.93%) were with one to five live children, 3372 (56.83%) had sons at home, 3214

Variables	Categories	Weighted fre-	Per-
	5	quency (n)	cent-
			age
Ade	15-24	2388	40.24
/igc	25-34	1974	32.42
	35-49	1622	27 33
Religion	Orthodox	1971	27.55
nengion	Catholic	60	1 01
	Protestant	1259	21.22
	Muslim	2564	43.21
	Others	80	13.21
Educational level	No formal	3030	51.06
Educationaliever	Formal	2904	48.94
Marital status	Married	4090	68.92
Marital Status	No married	1844	31.08
Parity	No parity	1736	29.26
Turty	Primi nara	654	11.02
	Multi para	22/1	37.77
	Grand para	1303	21.96
Number of live	No	1790	30.17
children	1 5	31/1	52.03
	6 14	1003	16.00
Sons at homo	0-14 No	2562	10.90
Sours at nonne	Voc	2302	56.83
Daughtors at homo	No	2720	15.84
Daughters at nome	Voc	2720	4J.04 54.16
Ever been married or	No	1284	72.70
lived in a union	No Ever married	1204	72.79
	Lived in union	70	1 / 8
Wealth index	Livea in anion	2100	4.40 52.50
Wealth Index	Middle	1200	20.22
	Rich	1554	20.22
Say of boursehold	Malo	1554	77.04
head	Fomalo	1300	22.06
Household size	1 5	2751	22.00 46.36
TIOUSETIOIU SIZE	6 10	2731	40.30 50.34
	11 24	106	2 20
Community level va	riables	190	5.50
Community level Va literacy	Low	2876	48.47
	Hiah	3058	51 53
Community poverty	low	2933	49.43
community porcity	High	3001	50.57
Region	Tigray	563	949
negion	Afar	515	8.68
	Amhara	810	13.65
	Oromia	868	14.63
	Somalia	487	8 2 1
	Benshangul	637	10.73
	SNNPR	921	15.52
	Gambella	564	9.50
	Harari	285	2.50 4.80
		200	0U

Table 1	Socio-demographic characteristics of respondents in
the 2019	mini EDHS survey

(54.16%) had a daughter at home, 1284 (72.79%) had never been married or lived in the union, 3180 (53.59%) were in poor wealth index category, 4625 (77.94%) house-hold head was male, 2987(50.34%) were with a household size of six to ten, and 921 (15.52%) were from SNNPR. (Table 1)

# Prevalence and frequency distribution of modern contraceptive utilization among rural women in Ethiopia

The prevalence of modern contraceptive utilization was 23.00% [95%CI (21.92–24.06)] among reproductive age (15–49) year-old Ethiopian rural mothers.

In this study, there were significant variations in modern contraceptive utilization across individual as well as community variables in which 31.29% of the women aged 25–34 years utilized modern contraceptives as compared to 16.50% among those aged 15–24 years. Furthermore, 31.70% of married women used modern contraceptives whereas only 4.99% of unmarried women utilized the method so far. Regarding religion, 31.20% of Orthodox followers utilized the modern contraceptive method, but the lowest was seen among Muslim followers in which only 14% used the family planning methods. Nearly 40% of the primi para rural women utilized modern contraceptives Table 2.

### Random effect and model comparison

As indicated in Table 3, the ICC in the null model was 0.24, which means that about 24% of the variations in modern family planning utilization among study participants were attributed to the difference at the cluster level but the other 76% were attributed to individual women's factors.

Furthermore, the PCV value, 0.314, in the final model indicates that about 31.4% of the variations in modern family planning utilization among study participants were attributed to individual and community-level factors. Regarding model comparison and fitness, deviance was used. The model with the lowest deviance was the best-fitted model, model four (5580) (Table 3).

**Spatial autocorrelation of modern contraceptive utilization** The study showed that modern contraceptive utilization among rural women in Ethiopia was clustered.

The autocorrelation analysis result interpretation (Moran's I = 0.292771, p-value < 0.001) revealed that clustering plays a significant role in variation (Fig. 1).

# Spatial distribution and hotspot analysis of modern contraceptive utilization in Ethiopian rural women

The analysis with Getis-Ord GI\* statistics located the hot and cold spot areas of modern contraceptive utilization among rural women across the regions of Ethiopia. The red colour showed significant hotspot areas where

Variables	Categories	Modern contracepti	ive	Total weighted frequency (%)		
		No n=4570(77.01%)	Yes (%) n = 1364(22.99)			
Age of women	15–24	1994(83.5)	394(16.50)	2388(40.42)		
	25–34	1322(68.71)	602(31.29)	1924(32.42)		
	> 35	1254(77.3)	368(22.69)	1622(27.33)		
Marital status	Married	2818(68.90)	1272(31.70)	4090(68.92)		
	Not married	1752(95.01)	92(4.99)	1844(31.08)		
Religious	Orthodox	1356(68.80)	615(31.20)	1971(33.22)		
	Catholic	42(70.00)	18(30.00)	60(1.01)		
	Protestant	902(71.64)	357(28.36)	1259(21.22)		
	Muslim	2205(86.00)	359(14.00)	2564(43.21)		
	Others	65(81.25)	15(18.75)	80(1.35)		
Parity	No parity	1620(93.32)	116(6.68)	1738(29.26)		
	Primi para	398(60.86)	256(39.14)	654(11.02)		
	Multi para	1524(68.01)	717(31.99)	2241(37.77)		
	Grand para	1028(78.89)	275(21.11)	1303(21.96)		
Women education status	No education	2398(79.01)	632(20.86)	3030(51.01)		
	Formal education	2172(74.79)	732(25.21)	2904(48.94)		
Number of the live child	No	1666(93.07)	124(6.93)	1790(30.17)		
	1–5	2117(67.40)	1024(32.60)	3141(52.93)		
	6–14	787(78.46)	21621.54)	1003(16.90)		
Sons at home	No	2181(85.13)	381(14.87)	2562(43.17)		
	Yes	2389(70.85)	983(29.15)	3372(56.83)		
Daughters at home	No	2303(84.67)	417(15.33)	2720(45.84)		
	Yes	2267(70.54)	947(29.46)	3214(54.16)		
Wealth index	Poor	2645(83.18)	535(16.82)	3180(53.59)		
	Middle	847(70.58)	353(29.42)	1200(20.22)		
	Rich	1078(69.37)	476(30.63)	1554(26.19)		
Household size	1–5	1996(72.56)	755(27.44)	2751(46.36)		
	6–10	2045(80.52)	582(14.48)	2987(50.34)		
	>10	169(86.22)	27(13.78)	196(3.30)		
Sex of household head	Male	3420(73.95)	1205(26.03)	4625(77.94)		
	Female	1150(87.83)	159(12.15)	1309(22.06)		
Number of children under five at home	No	1786(83.61)	350(16.39)	2136(36.00)		
	1–2	2439(71.59)	968(28.41)	3407(57.41)		
	3–5	345(88.24)	46(11.76)	391(6.59)		
Community level variables						
Region	Tigray	431(76.55)	132(23.45)	663(9.49)		
	Afar	478(92.82)	37(7.18)	515(8.68)		
	Amhara	554(67.1)	264(32.59)	810(13.65)		
	Oromia	633(72.93)	235(27.07)	868(14.63)		
	Somalia	480(98.56)	7(1.44)	487(8.21)		
	Benshangul	462(72.53)	175(27.47)	637(10.73)		
	SNNPR	635(68.95)	286(31.05)	921(15.52)		
	Gambella	418(74.15)	146(25.89)	564(9.50)		
	Harari	243(85.26)	42(14 74)	285(4.80)		

### Table 2 Utilization of modern contraceptives among rural women in Ethiopia

SNNPR: Southern Nations, Nationalities and Peoples Representatives

modern contraceptive was utilized by Ethiopian rural women. In contrast, the blue colour showed significant cold spot areas where modern contraceptive use was low. In this study, the highest proportion of modern contraceptive utilization among rural women was indicated in SNNPR, central Amhara, and Oromia regions respectively. On the other hand, the cold spot areas for utilizing modern contraceptives among rural women were most parts of Somali and Harari, the Eastern part of Tigray and

Table 5	Model fittless and fand	om enect measures				
Random e	effect					
	VA	0.86		0.75	0.67	0.59
	ICC	0.24		0.19	0.17	0.15
	MOR	2.41		2.27	2.18	2.08
	PCV (%)	-		12.79%	22.1%	31.4%
Model co	mparison					
	Deviance		6680	6480	6350	5580
	VIE		_	1 73	5 36	2.89

### Table 3 Model fitness and random effect measures

ICC = Inter cluster correlation coefficient, MOR = Median odds ratio, PCV = proportional change in variance, VA = Area level variance, VIF = Variance inflation factor



### **Spatial Autocorrelation Report**

# Given the z-score of 6.92717931041, there is less than <u>a 1</u>% likelihood that this clustered pattern could be the result of random chance.

Fig. 1 Spatial Autocorrelation Analysis of modern contraceptive utilization

Gambella, and the southern part of Afar regions of Ethiopia (Fig. 2).

# The spatial interpolation or the prediction of modern contraceptive utilization

In this study, the spatial interpolation analysis depicts the predicted proportion of modern contraceptive utilization for unsampled areas of the regions based on the sampled areas of the region in Ethiopia. An ordinary Kriging method of analysis was employed. The areas in red color on the map showed the high predicted proportion of modern contraceptive use in that region of the country. In the interpolation analysis, the area colour change from red to green revealed that the predicted modern contraceptive utilization declined over that particular area. As shown in the result, a high proportion



### Source: Shape file, CSA Ethiopia, 2013

Fig. 2 Hotspot analysis of modern contraceptive utilization in rural Ethiopia women; Shape file source; (Central Statistical agency, Ethiopia, 2013. (URL:h ttps://africaopendata.org/dataset/ethiopia-shapefiles). Map output: Own analysis using Arc Map 10.7 software

of modern contraceptive utilization was indicated in the western part of SNNPR, the southern part of Gambella, the Northeast and the Southern Amhara, the southern parts of Oromia, and the Western Tigray regions of Ethiopia. However, a low proportion of modern contraceptive utilization was found in most parts of Somalia, Eastern Tigray and Gambella, and the northern part of the Afar regions of the country (Fig. 3).

### The spatial SaTScan statistical analysis

Among the clusters located, 91 were most likely significant clusters of modern contraceptive non-utilizers. The spatial SaTScan analysis depicted that women living inside the spatial SaTScan window were less likely to utilize modern contraceptives compared to those residing outside of the SaTScan window (Fig. 4).

Among these, 38 clusters were the first most significant primary clusters located in the entire SNNPR, some parts of Tigray, southern Gambella and Oromia regions centred at 4.495034 N, 36.230625 E with 378.22Km radius, relative risk(RR) = 1.83, log-likelihood ratio(LLR) = 63.16, p-value < 0.001. The second 51 most likely significant clusters were identified in the entire Amhara and western Beshangul-Gumaz centred at 10.555963 N, 37.646893 E with 274.74Km radius, relative risk(RR) = 1.55, loglikelihood ratio(LLR) = 36.24, p-value less than 0.001. The third significant clusters were found in some parts of Oromia and Beshangul-Gumaz, southern Tigray, and northwest Afar centred at 8.313592 N, 40.103390 E with



Fig. 3 Interpolation analysis of modern contraceptive utilization in rural women in Ethiopia; Shape file source (Central Statistical agency, Ethiopia; URL:h ttps://africaopendata.org/dataset/ethiopia-shapefiles) Map output: own analysis using Arc Map 10.7 software

56.98 km radius, relative risk(RR) = 2.33, log-likelihood ratio(LLR) = 10.82, p-value less than 0.003 (Table 4).

### Multivariable analysis of factors associated with modern contraceptive utilization among reproductive-age women of rural Ethiopia

Those women aged 25-34 were 21% [AOR = 0.79, 95%CI(0.64,0.98)] less likely to utilize modern contraceptives as compared to those aged 15-24, being in the age of 35-49 years was 61%[AOR=0.39, 95%CI(0.03, 0.49)] less likely to utilize modern contraceptive as compared to the age of 15-24 years. Regarding religion being catholic was 1.46[AOR=1.46, 95%CI (1.18, 4.03)] times more to utilize modern contraceptives as compared to their counterparts. Whereas, being protestant was 47% [AOR=0.53, 95%CI (0.32, 0.92)] less likely to utilize modern contraceptives compared to their counterparts. Those who had not married were 95% [AOR = 0.05, 95%CI (0.04, 0.07) less likely to utilize family planning methods compared to their counterparts. Having formal education was 1.59[AOR = 1.59, 95%CI (1.34, 1.88)] times more likely to utilize modern family planning methods compared to no formal education. Parity was a significant predictor of modern contraceptive use in which being primi para and multipara were 2.27[AOR = 2.2,95%CI(1.23,9.33)], and 2.43[AOR = 2.43, 95%CI(1.94, 3.03)] to use modern contraceptives as compared to no para at all. Having, an 11-24 household size was 1.89[AOR = 1.89,95%CI(1.38, 4.84)] times more likely to utilize modern contraceptives compared to a 1-5 household size. Those having sons at home were two times [AOR = 2.03, 95%CI(1.67, 3.84)] more likely to use modern family planning methods as compared to their counterparts. Those who had daughters at home were also 55% [AOR = 1.55, 95% CI(1.19, 2.33)] more likely to use modern family planning methods compared to their counterparts. Regarding the wealth index, those in the middle classes were 22% [AOR = 1.22, 95%CI (1.01, 1.47)] more to utilize compared to the lowest classes. Those having high community literacy levels were nearly two times [AOR = 1.99, 95%CI (1.43, 2.79)] more likely to use modern family planning methods as compared to low community literacy levels. Regarding the regions, Afar was found 64%[AOR = 0.28,95%CI(0.06,0.87)] less likely



Fig. 4 SaTScan analysis of modern contraceptive utilization among rural Ethiopian women: Shape file source: (Central Statistical agency, Ethiopia; URL:h ttps://africaopendata.org/dataset/ethiopia-shapefiles) Map output: own analysis using Kul-dorff's SaTScan version 9.6 software

**Table 4** Statistical significant clusters for the study modern contraceptive utilization among sexually active rural women in Ethiopia using 2019 mini EDHS data

Clus-	Significant Enumeration Areas (clusters) detected	Coordinate/radius	Рор	Cases	RR	LLR	P-
ter							val-
type							ue
1	193, 202, 192, 199, 196, 198, 216, 197, 188, 215, 200, 191, 204, 201, 190, 195, 115, 223, 224, 222, 189, 227, 228, 221, 226, 182, 225, 194,113, 96, 184, 186, 178, 181, 180, 183, 185, 187, 183, 185, 187	(4.495034 N, 36.230625 E) / 378.22 km	1074	393	1.83	63.16	0.001
2	72, 76, 70, 71, 73, 77, 119, 79, 80, 81, 60, 75, 99, 100, 59, 74, 65, 58, 57, 163, 162, 165, 164, 98,67, 166, 61, 63, 66, 83, 82, 84, 167, 161, 168, 112, 158, 93, 62, 78, 169, 160, 64, 68, 69, 174, 56, 101, 159, 92, 120	(10.555963 N, 37.646893 E) / 274.74 km	1459	457	1.55	36.24	0.001
3	102, 105	(8.313592 N, 40.103390 E) / 56.98 km	51	27	2.33	10.82	0.003

Abbreviations: E; EAST, N; North, Km; Kilometer, Pop; Population, LLR; Log likelihood ratio, RR; Relative risk

to utilize modern family planning methods compared to the Tigray region. Furthermore, the Somalia region was 93% [AOR = 0.07,95%CI(0.01,0.47)] less to utilize modern family planning methods compared to the Tigray region. On the other hand, Benshangul was 54% [AOR = 1.54, 95%CI(1.17,9.68)] more to use modern family planning methods. Besides, the region of SNNPR was nearly two times [AOR = 1.86,95%CI(1.46, 8.79)] more to utilize modern family planning methods compared to the region of Tigray.

Furthermore, the Gambela region was 66% [AOR = 1.66, 95%CI(1.08,4.59)] more to utilize modern family planning methods as compared to its counterparts (Table 5).

### Discussion

In this study, the spatial distribution of modern contraceptive utilization among rural Ethiopian women was addressed. Moreover, the individual and community level factors were also identified as per the availability of the data from the Ethiopian mini-EDHS, 2019. The spatial analysis result depicted that there were significant variations in utilizing modern contraceptives across the regions of Ethiopia. The nationwide overall prevalence of modern contraceptive utilization among rural women aged 15-49 years was 23.00% [95%CI (21.92-24.06)]. In this study, the highest proportion of modern contraceptive utilization was mapped in the SNNPR region followed by the Amhara region. The possible explanation might be attributed to the difference in sociodemographics such as information access about family planning and cultural variations across the regions of Ethiopia. This finding was in line with the study conducted in Kenya [37] in which 23.2% of participants utilized the modern family planning method. However, the current study finding was higher than the previous studies with modern family planning use of 18.4% and 20% in Ethiopia [38, 39], 8.8% in Zambia [40], only 4.46% in Mali [41], 10.3% and 14.8% in Nigeria [42, 43], 12.6% in Burkina Faso and 16.8% in Myanmar [44]. The possible explanation of the variation between the current study and the studies [38, 39] in Ethiopia was the sample size difference in which the current study had large national data whereas the previous studies were conducted at the regional level. Besides, the possible explanation for the variation between the current study and other national studies might be the time gap and the sociocultural difference of the sampled population.

Furthermore, the study in Zambia included only married women and that of Myanmar among youth reproductive-age females. On the other hand, the current study findings were lower than the previous study conducted in Ethiopia with 31.7% of rural women using modern family planning methods [45] and 45.8% of rural lactating women [17]. The possible reason for this discrepancy might be the previous studies did not include all regions and all reproductive-age women. Furthermore, women in rural areas might have limited awareness of modern contraceptives, for instance, they might overestimate the side effects rather than its benefits [46].

It was also lower than the other previous studies with 35.2% in Ethiopia [47], 42.7% in Tanzania [48], 43% in Zambia [49], 32.8% in Yemen [50], and 32.5% and 45.3% in Nigeria [51, 52]. The reason for the variation between the current study and the previous study in Ethiopia might be the time gap from 2000 to 2016, sampled population difference in which the current study included only rural and sexually active women aged 15-49 years. Whereas, that of 2000 and 2016 included only married rural, but not all reproductive-age (married and unmarried) women in Ethiopia. Besides, the variation between the current study findings with that of Tanzania was conducted in one district of the country, but not nationwide. Moreover, the variation between current study findings in Zambia might be the time gap, the sample population difference, and socio-demographic and socio-cultural variations across the nations. Besides, the study in Yemen included all urban and rural women and the studies in Nigeria were conducted among unmarried women. Furthermore, the current study result was lower than the study in Rwanda [53] in which 52.4% of reproductiveage women utilized modern family planning. The discrepancy might be unlike the current study, the study in Rwanda included both rural and urban reproductive-age women.

The current finding is also lower than the studies in Jordan, where 42.3% utilize modern contraceptive methods [54] and in Senegal, 26.3% utilized modern contraceptives [55]. The difference might be due to the sample population difference, as that of Senegal covered married women only and the study in Jordan was all reproductiveage women. However, this was not the case in our study since it included all reproductive-age women living in rural Ethiopia. In the current study age, educational status, religion, marital status, parity, household size, having sons and daughters at home, wealth index, and community literacy level were significant predictors of modern contraceptive utilization among rural Ethiopian women.

In this regard, women aged 25–34 were 21% less likely to utilize modern contraceptives as compared to those aged 15–24, and the aged 35–49 years were 61% less likely to utilize modern contraceptives as compared to those aged 15–24 years. The result revealed that as age increases, the probability of using contraceptives decreases since nature will be against fertility then as the women reach menopause. It was consistent with the study conducted in Ethiopia [56] and supported by data from the 2006–2010 National Survey of Family Growth 
 Table 5
 Multilevel multivariable analysis of factors associated with modern contraceptive utilization among rural Ethiopian

 reproductive age (15–49 years) women, Mini, EDHS 2019

Variables	Categories	Null model	Model I	Model II	Model III
	-		AOR [95% CI]	AOR [95% CI]	AOR [95% CI]
Age	15–24	-	1.00	-	1.00
	25-34	-	0.67[0.53, 0.84]	-	0.79[0.64,0.98]*
	35–49	-	0.39[0.29,0.52]*	-	0.39[0.03,0.49]*
Religion	Orthodox	-	1.00	-	1.00
	Catholic	-	1.54[1.26, 3.74]*	-	1.46[1.18,4.03]*
	Protestant	-	0.65[0.49,0.87]*	-	0.53[0.32,0.92]*
	Muslim	-	0.32[0.23, 0.44]*	-	0.44[0.28,1.89]
	Others		0.48[0.25,0.94]	-	0.37[0.28,2.22]
Marital status	Married	-	1.00	-	1.00
	Not married	-	0.10[0.08,0.14]*	-	0.05[0.04,0.07]*
Educational status	No formal	-	1.00	-	1.00
	Formal	-	1.86[1.57,2.22]*	-	1.59[1.34,1.88]*
Parity	No parity	-	1.00	-	1.00
	Primi para	-	4.79[3.35,6.88]*		2.66[1.23,9.35]*
	Multi para	-	4.67[3.05,7.15]*		2.43[1.94,3.03]*
	Grand para	-	3.05[1.88,4.95]*		1.57[0.67,6.78]
Sex of household head	Male	-	1.00	-	1.00
	Female	-	0.91[0.69, 1.18]	-	1.32[0.89, 2.11]
Household size	1–5	-	1.00	-	1.00
	6–10	-	1.13[0.95, 1.35]	-	1.06[0.58, 1.76]
	11-24	-	2.07[1.27, 3.34]*	-	1.89[1.38, 4.84]*
Live children in the home	No	-	1.00	-	1.00
	1–5	-	3.02[0.67,1.34]	-	2.66[0.91, 5.27]
	6-14	-	2.81[0.97, 8.44]	-	2.65[0.87, 6.73]
Sons at home	No	-	1.00	-	1.00
	Yes	-	1.89[1.51, 2.36]*	-	2.03[1.67, 3.84]*
Daughters at home	No	-	1.00	-	1.00
	Yes	-	1.32[1.07, 1.63]*	-	1.55[1.19, 2.33]*
Wealth index	Poor	-	1.00	-	1.00
	Middle	-	1.31[1.08, 1.58]*	-	1.22[1.01, 1.47]*
	Rich	-	1.31[1.06.1.61]*	-	1.15[0.94, 1.41]
Community level variable	25				
Community literacy	low	-		1	1
	High	-		1 64(1 22 2 21)	1 99(1 43 2 79)
Community poverty	low	-		1	1
community porcity	High	-		1.06(0.79, 1.42)	1 59(0 23 1 63)
Region	Tigrav	-	-	1	1
negion	Afar	-	-	0.49[0.08.2.99]	0.28[0.06_0.87]*
	Amhara	-	-	3 80 [1 86 10 82]*	2 15[0.88, 9 37]
	Oromia	-	-	181[041 800]	1 77[0.69 8 74]
	Somalia	-	-	0.08[0.01.0.52]*	0.07[0.01 0.47]*
	Benshangul	-	-	2 42[0 55 10 23]	1 54[1 17 9 68]*
	Snnpr	-	-	2.44[1.75 10.74]	1.86[1.46_8.79]*
	Gambella	-	-	1.95[1.27 13.62]*	1.66[1.08 4.59]*
	Harari	-	-	0.66 [0.32, 6.93]	0.58 [0.42, 7.04]

\* = P-value < 0.05, \*\* = Pvalue < 0.01, \*\*\* = Pvalue < 0.001

AOR = adjusted odds ratio; CI = confidence interval

[57]. This might be because when people's ages decline, they use contemporary contraceptives more frequently. Those who have a plan to have more children report difficulties in getting pregnant among older women. Religion, being catholic and protestant were 1.46 and 1.47 times more to utilize modern contraceptives as compared to their counterparts. This is supported by the study conducted in western Ethiopia, orthodox Christians utilize more [58]. On the other hand, being Muslim is reported as an inhibiting factor [59]. Those who had not married were 95% less likely to utilize modern contraceptives as compared to their counterparts. This was supported by a study [56] as being single and widowed favours two times of using modern contraceptive methods compared to being married. This could be due to fear of unwanted pregnancy and its consequences, STIs, stigma and discrimination. On the contrary, married women tend to use it more frequently for birth spacing [60]. Having formal education was 1.59 times more likely to utilize modern contraceptives as compared to no formal education. This finding was supported by studies [56], Metekel Zone North West Ethiopia [61] and Oromia region [59]. This could be due to being knowledgeable will favour the use of modern contraceptive methods among women concerning their preference, perceived benefits and consequences of the contraceptive. Being prime para was 2.66 times more likely to use modern contraceptives as compared to no para at all. This was because having one healthy growing child is enough till they plan for the next birth including birth spacing. Moreover, being multipara was 2.43 times more likely to use modern family planning methods compared to nulliparous. The possible reason might be having more children could probably have an economic impact so that they might determine to use either spacing or permanent birth control by using modern contraceptive methods. This is consistent with a study in Eritrea [62].

Having a household size of 11-24 household sizes was nearly two times more likely to utilize modern contraceptives as compared to 1-5 household sizes. This is supported by studies in Nigeria [63], Senegal [64] and Ethiopia [59]. This could be because having a large household size significantly increased the likelihood of using any method, and the presence of multiple wives significantly reduced the use of any method of contraception. Those having sons at home were two times more likely to use modern contraceptives as compared to their counterparts. This was supported by the study in Bangladesh that focused on the influence of male sex preference [65]. This could be due to the custom or belief that the male child is the physical shield for the house and indeed the symbol of pride and respect within the community. Furthermore, the current study stipulated that those who had daughters at home were also 1.55 times more likely to use modern contraceptives as compared to their counterparts.

Regarding the wealth index, those in the middle classes had 1.22 times more to utilize compared to the lowest classes. This could be due to socioeconomic status played a significant role in family spacing which was supported by the study conducted in Uganda [66]. Those with high community literacy were nearly two times more likely to use modern family planning. This is because having adequate knowledge and information through various means could probably help them to know more about the advantages of modern contraceptives compared to low-level community literacy. This was supported by the study conducted in Senegal [67].

Regarding the regions Afar was found 72% less likely to utilize modern contraceptives compared to the Tigray region. Furthermore, the Somalia region was 92% less likely to use modern contraceptives compared to the Tigray region. On the other hand, Benshangul was 54% more likely to use modern contraceptives. Besides, the region of SNNPR was 86% more likely to utilize modern family planning methods compared to the region of Tigray. Moreover, the region of Gambela was 66% more likely to utilize modern family planning methods compared to the region of Tigray. This could be because, in the Afar and Somalia regions, the majority were Muslim by faith. Supported by the findings from Nepal [68]. However, there are other factors like availability, affordability and accessibility of family planning.

Therefore, we forwarded a recommendation to the planners and policymakers of both governmental and non-governmental firms having a job done on family planning to enhance the dissemination of information to the target population. The concerned bodies in the cold spotted regions shall work on awaring the community about the advantages of modern contraceptives over traditional.

### Implication of the study

This study finding will provide an opportunity to understand modern contraceptive utilization among sexually active women of reproductive age living in rural Ethiopia. Particularly, for those directly involved in family planning in Ethiopia. It also sheds light on family planning program managers about individual, household and community-level factors that influence a woman's modern contraceptive utilization. Moreover, the spatial distribution that locates areas where existing modern contraceptive use is above or below expectation through cold and hot spot prevalence clusters in the country. Hence, areas with higher than expected may be good practice examples on which care providers and policymakers take a lesson to improve policy and utilization, and set targets of intervention in lower utilization areas(cold spots). Furthermore, it is used to identify and develop strategies for reaching more rural women and attaining the health sector plan of the country, understanding factors that positively influence the use of modern contraceptives among all reproductive-age women will give policymakers the needed information to strengthen or reshape the existing family planning programs and let them design appropriate policies. It also gives rooms for researchers based on the geographical variations of modern family planning use to explore contextual factors that could contribute to the hotspot and cold spot clusters.

### Limitations and strengths of the study

This study used large national database with standardized analyses methods and tried to see spatial variation of modern contraceptive utilization across the rural regions of Ethiopia. It has been done using the nationally representative DHS data with weighted and a multilevel model fitted to strengthen the generalizability of the findings to the national community. This study has paramount significance for the policy makers to take remedies to beef up modern contraceptive utilization by giving more emphasis to cold spot regions of the country. However, the study has had limitation in which it lacks some variables such as media exposure, husband educational level, maternal working status, and husband occupation. This was because the mini-Ethiopian EDHS 2019 did not have the aforementioned variables.

### Conclusion

Less than a quarter of reproductive-age rural women used modern contraceptives in Ethiopia. However, there was a significant distributional variation of modern contraceptive utilization in this segment population. Highly significant hot spot areas were found in the West, South and Southwest areas of the country so far. This signals more has to be done to increase awareness to minimize unnecessary pregnancy and its related risk for the mother and the child so far. Age, educational status, religion, marital status, parity, household size, having sons and daughters at home, and wealth index were significant predictors of modern contraceptive utilization among rural Ethiopian women.

Therefore, the policymakers and programmers better intervene in targeting those very hot spot areas by strengthening health education.

### Abbreviations

- Adjusted Odds Ratio AOR
- CL Confidence Interval
- COR Crude Odds Ratio
- Central Statistical Agency CSA DHS
- Demographic and Health Survey
- ICC Intraclass Correlation Coefficient IR
- Individual Record
- IUD Intrauterine Device

- Log Likelihood Ratio LLR
- MOR Median Odds Ratio
- PCV Proportion of Change in Variance
- VA Variance of the Area Level VIF
- Variance Inflation Factors

### Acknowledgements

Our pleasure has gone to MEASURE DHS for granting access to the EDHS data sets.

### Author contributions

Conceptualization: Chilot Kassa Mekonnen, Zerko Wako Beko, Hailemichael Kindie Abate. Data curation: Chilot Kassa Mekonnen and Hailemichael Kindie Abate. Formal analysis: Chilot Kassa Mekonnen and Hailemichael Kindie Abate. Investigation: Chilot Kassa Mekonnen, Zerko Wako Beko, and Hailemichael Kindie Abate. Methodology: Chilot Kassa Mekonnen, Gashaw Adane Nega and Zerko Wako Beko. Software: Chilot Kassa Mekonnen, Gashaw Adane Nega and Hailemichael Kindie Abate. Validation: Chilot Kassa Mekonnen, Zerko Wako Beko, and Hailemichael Kindie Abate. Visualization: Chilot Kassa Mekonnen, Zerko Wako Beko, Gashaw Adane Nega and Hailemichael Kindie Abate. Writing - original draft: Chilot Kassa Mekonnen, Gashaw Adane Nega and Hailemichael Kindie Abate. Writing - review and editing: Chilot Kassa Mekonnen, Zerko Wako Beko, Gashaw Adane Nega and Hailemi-chael Kindie Abate.

### Funding

The authors received no specific funding for this work.

### Data availability

Data is provided within the manuscript or supplementary information files.

### Declarations

#### Ethics approval and consent to participate

The data set was obtained from the DHS website after formal request. All methods were performed in accordance with the relevant guidelines and regulations.

#### **Consent for publication**

Not applicable.

### **Competing interests**

The authors declare no competing interests.

#### Author details

<sup>1</sup>Department of Medical Nursing, School of Nursing, College of Medicine and Health Sciences, University of Gondar, P.O. Box 196, Gondar, Ethiopia <sup>2</sup>Department of Immunology and Molecular Biology, School of Biomedical and Laboratory Science, College of Medicine and Health Science, University of Gondar, P.O. Box 196, Gondar, Ethiopia

### Received: 22 April 2024 / Accepted: 22 April 2025 Published online: 10 May 2025

### References

- Jain R, Muralidhar S. Contraceptive methods: needs, options and utilization. J 1. Obstet Gynecol India. 2011;61:626-34.
- 2. Hubacher D, Trussell J. A definition of modern contraceptive methods. Contraception. 2015;92(5):420-1
- 3. Festin MPR. Overview of modern contraception. Best Pract Res Clin Obstet Gynecol. 2020;66:4-14.
- Aviisah PA et al. Modern contraceptive use among women of reproductive age in 4. Ghana: analysis of the 2003–2014 Ghana Demographic and Health Surveys. BMC women's health, 2018. 18: pp. 1-10.
  - Lakew ABaY. Population estimates and projection of Ethiopia. 2023.
- Shah S. Determinants of human development index: A cross-country empirical 6. analysis. 2016.
- Winikoff B, Sullivan M. Assessing the role of family planning in reducing 7. maternal mortality. Stud Fam Plann. 1987;18(3):128-43.

- Rahman M, DaVanzo J, Razzaque A. Do better family planning services reduce abortion in Bangladesh? Lancet. 2001;358(9287):1051–6.
- Abate MG, Tareke AA. Individual and community level associates of contraceptive use in Ethiopia: a multilevel mixed effects analysis. Archives Public Health. 2019;77(1):1–12.
- Asaolu I, et al. Healthcare system indicators associated with modern contraceptive use in Ghana, Kenya, and Nigeria: evidence from the performance monitoring and accountability 2020 data. Reproductive Health. 2019;16(1):1–10.
- DESA, U., World Family Planning 2017: Highlights. 2017, New York: United Nations. http://www.un.org/en/development/desa/population&#8230.
- 12. Afriyie P, Tarkang EE. Factors influencing use of modern contraception among married women in Ho West district, Ghana: descriptive cross-sectional study. Pan Afr Med J, 2019. 33(1).
- 13. Ochako R, et al. Modern contraceptive use among migrant and non-migrant women in Kenya. Reproductive Health. 2016;13:1–8.
- Njotang PN, et al. Determinants of modern contraceptive practice in Yaoundé-Cameroon: a community based cross sectional study. BMC Res Notes. 2017;10:1–6.
- Beyene KM, Bekele SA, Abu MK. Factors affecting utilization of modern contraceptive methods among women of reproductive age in Ethiopia. PLoS ONE. 2023;18(11):e0294444.
- Gebre MN, Edossa ZK. Modern contraceptive utilization and associated factors among reproductive-age women in Ethiopia: evidence from 2016 Ethiopia demographic and health survey. BMC Womens Health. 2020;20(1):61.
- Derso T, et al. Prevalence and determinants of modern contraceptive utilization among rural lactating mothers: findings from the primary health care project in two Northwest Ethiopian districts. BMC Womens Health. 2020;20(1):67.
- Hirshberg A, Srinivas SK. Epidemiology of maternal morbidity and mortality. In Seminars In perinatology. Elsevier; 2017.
- Kuvatova J, Seiitov T. This review has been possible thanks to the technical support from the United Nations Population Fund.<sup>©</sup> UNFPA 2021. All rights reserved. The publication is available at the UNFPA website (www.unfpa.org. kg). The United Nations Population Fund, Kyrgyz Republic 720040, Bishkek, 160 Chuy Avenue, Tel:+ 997312611211.
- Lwelamira J, Mnyamagola G, Msaki M. Knowledge, attitude and practice (KAP) towards modern contraceptives among married women of reproductive age in Mpwapwa district, central Tanzania. Curr Res J Social Sci. 2012;4(3):235–45.
- Hagos G, et al. Family planning utilization and factors associated among women receiving abortion services in health facilities of central zone towns of Tigray, Northern Ethiopia: a cross sectional study. BMC Womens Health. 2018;18(1):1–8.
- 22. Assefa Y, et al. Primary health care contributions to universal health coverage, Ethiopia. Bull World Health Organ. 2020;98(12):894.
- Austin PC, et al. Measures of clustering and heterogeneity in multilevel P Oisson regression analyses of rates/count data. Stat Med. 2018;37(4):572–89.
- Wasiyhun TS, Geda NR. Inequalities in the demand and unmet need for contraception among women in four regions of Ethiopia. PLoS ONE. 2024;19(9):e0308476.
- Alem AZ, Agegnehu CD. Magnitude and associated factors of unmet need for family planning among rural women in Ethiopia: a multilevel crosssectional analysis. 2021. 11(4): p. e044060.
- Tadesse D, et al. Unmet need for family planning among rural married women in Ethiopia: what is the role of the health extension program in reducing unmet need? Reprod Health. 2022;19(1):15.
- Kantorová V, Wheldon MC. Estimating progress towards meeting women's contraceptive needs in 185 countries: A Bayesian hierarchical modelling study. 2020. 17(2): p. e1003026.
- Fenta SM, Gebremichael SG. Predictors of modern contraceptive usage among sexually active rural women in Ethiopia: A multi-level analysis. Arch Public Health. 2021;79(1):93.
- Tekelab T, Melka AS, Wirtu D. Predictors of modern contraceptive methods use among married women of reproductive age groups in Western Ethiopia: a community based cross-sectional study. BMC Womens Health. 2015;15:1–8.
- 30. Csa I. Central statistical agency (CSA)[Ethiopia] and ICF. Ethiopia demographic and health survey, addis Ababa. Central Statistical Agency; 2016.
- 31. Othieno CJ, et al. Depression among university students in Kenya: prevalence and sociodemographic correlates. J Affect Disord. 2014;165:120–5.
- 32. Croft TN, et al. Guide to DHS statistics. Rockville: ICF; 2018. p. 645.
- 33. Croft T, Marshall A, Allen C. Guide to DHS statistics. Rockville: ICF; 2018. 2018.

- Charlton M, Fotheringham S, Brunsdon C. *Geographically weighted regression*. White paper. National centre for geocomputation. National University of Ireland Maynooth; 2009. p. 2.
- Krivoruchko K, Gribov A. Evaluation of empirical bayesian kriging. Spat Stat. 2019;32:100368.
- Kulldorff M. A Spatial scan statistic. Commun Statistics-Theory Methods. 1997;26(6):1481–96.
- Orwa J, Gatimu SM. Factors associated with use of long-acting reversible and permanent contraceptives among married women in rural Kenya: A community-based cross-sectional study in Kisii and Kilifi counties. 2022. 17(10): p. e0275575.
- Fenta SM, Gebremichael SG. Predictors of modern contraceptive usage among sexually active rural women in Ethiopia: a multi-level analysis. Archives Public Health. 2021;79(1):93.
- Mulatu T, et al. Modern family planning utilization and its associated factors among currently married women in rural Eastern Ethiopia: A Community-Based study. Volume 2020. BioMed research international; 2020. p. 6096280.
   1.
- Mangimela-Mulundano A, Black KI, Cheney K. A cross-sectional study of women's autonomy and modern contraception use in Zambia. BMC Womens Health. 2022;22(1):550.
- 41. Whidden C, et al. Women's empowerment, intrahousehold influences, and health system design on modern contraceptive use in rural Mali: a multilevel analysis of cross-sectional survey data. Reprod Health. 2021;18(1):55.
- OlaOlorun FM, Tsui AO. Effect of community health workers' visits on uptake of modern contraception among rural women of reproductive age in Nigeria. Afr J Reprod Health. 2020;24(3):108–17.
- Johnson OE. Determinants of modern contraceptive uptake among Nigerian women: evidence from the National demographic and health survey. Afr J Reprod Health. 2017;21(3):89–95.
- Lun CN, Aung T, Mya KS. Utilization of modern contraceptive methods and its determinants among youth in Myanmar: analysis of Myanmar demographic and health survey (2015–2016). PLoS ONE. 2021;16(10):e0258142.
- 45. Debebe S, Limenih MA, Biadgo B. Modern contraceptive methods utilization and associated factors among reproductive aged women in rural Dembia district, Northwest Ethiopia: community based cross-sectional study. Int J Reprod Biomed. 2017;15(6):367–74.
- Schrumpf LA, et al. Side effect concerns and their impact on women's uptake of modern family planning methods in rural Ghana: a mixed methods study. BMC Womens Health. 2020;20(1):57.
- Meselu W, et al. Trends and predictors of modern contraceptive use among married women: analysis of 2000–2016 Ethiopian demographic and health surveys. Public Health Pract. 2022;3:100243.
- Martin V, et al. Prevalence and determinants of modern contraceptive methods use among women of reproductive age (15–49 years) in rural setting: a case of Kishapu district, Shinyanga region. Adv Sex Med. 2019;9(4):53–66.
- Lasong J, et al. Determinants of modern contraceptive use among married women of reproductive age: a cross-sectional study in rural Zambia. BMJ Open. 2020;10(3):e030980.
- Boah M, Adokiya MN. Prevalence and factors associated with the utilisation of modern contraceptive methods among married women of childbearing age in Yemen: a secondary analysis of national survey data. 2023. 13(6): p. e071936.
- Ozumba BC, Obi SN, Ijioma NN. Knowledge, attitude and practice of modern contraception among single women in a rural and urban community in Southeast Nigeria. J Obstet Gynaecol. 2005;25(3):292–5.
- Crawford EE, et al. Modern contraceptive use among unmarried girls aged 15–19 years in South Western Nigeria: results from a cross-sectional baseline survey for the adolescent 360 (A360) impact evaluation. Reprod Health. 2021;18(1):6.
- Kalinda C, et al. Trends and socio-demographic components of modern contraceptive use among sexually active women in Rwanda: a multivariate decomposition analysis. Reprod Health. 2022;19(1):226.
- Almalik M, Mosleh S, Almasarweh I. Are users of modern and traditional contraceptive methods in Jordan different. East Mediterr Health J. 2018;24(4):377–84.
- Zegeye B, et al. Modern contraceptive utilization and its associated factors among married women in Senegal: a multilevel analysis. BMC Public Health. 2021;21(1):231.
- Zeleke GT, Zemedu TG. Modern contraception utilization and associated factors among all women aged 15–49 in Ethiopia: evidence from the 2019 Ethiopian Mini demographic and health survey. BMC Womens Health. 2023;23(1):51.

- 57. Pazol K, et al. Sporadic contraceptive use and nonuse: age-specific prevalence and associated factors. Am J Obstet Gynecol. 2015;212(3):e3241–8.
- Tigabu S, et al. Socioeconomic and religious differentials in contraceptive uptake in Western Ethiopia: a mixed-methods phenomenological study. BMC Womens Health. 2018;18(1):85.
- Abiye AA, et al. Modern contraceptive use and associated factors among reproductive age group women in three Peri-Urban communities in central Ethiopia. J Drug Delivery Ther. 2019;9(6–s):93–102.
- 60. Mankelkl G, Kinfe B. Spatial variations and multilevel mixed effect analysis on determinants factors of modern contraceptive utilization among reproductive age women in Ethiopia; proven by Ethiopian mini demographic health survey 2019. BMC Womens Health. 2023;23(1):77.
- Adane AA, Bekele YA. Modern Contraceptive Utilization and Associated Factors among Married Gumuz Women in Metekel Zone North West Ethiopia. 2020. 2020: p. 8010327.
- 62. Idris I, Idris I. Factors influencing contraception usage: A cross-sectional study among mothers receiving abortion services in Orotta maternity hospital, Eritrea. Int J Sex Reprod Health Care. 2020;3:070–4.
- 63. Fadeyibi O, et al. Household structure and contraceptive use in Nigeria. Frontiers in Global Women's Health; 2022. p. 3.

- 64. Zegeye B, et al. Modern contraceptive utilization and its associated factors among married women in Senegal: a multilevel analysis. BMC Public Health. 2021;21(1):1–13.
- Hoq MN. Influence of the preference for sons on contraceptive use in Bangladesh: A multivariate analysis. Heliyon. 2020;6(10):e05120.
- Makumbi FE, et al. Socio-economic and education related inequities in use of modern contraceptive in seven sub-regions in Uganda. BMC Health Serv Res. 2023;23(1):201.
- 67. Zegeye B et al. Modern contraceptive utilization and its associated factors among married women in Senegal: a multilevel analysis. 2021. 21(1): p. 231.
- Thakuri DS, et al. Knowledge and practices of modern contraceptives among religious minority (Muslim) women: A cross-sectional study from Southern Nepal. PLoS ONE. 2022;17(12):e0278899.

### **Publisher's note**

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.