SPATIAL ANALYSIS OF MATERNAL MORTALITY IN SOUTHERN SENATORIAL DISTRICT OF EDO STATE, NIGERIA

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Abstract

Nigeria accounts for high percentage of global maternal deaths and most studies on maternal mortality has been tied to hospital data that capture only the percentage of women that finally receive care from any of the existing orthodox health facilities. A population-based research on maternal death offers a more prospective approach at identifying areas of challenges. This research seeks to investigate spatial variations of maternal deaths in Southern Senatorial District of Edo State, Nigeria. Community-based survey design was employed to investigate the level of maternal mortality. To examine significance and spatial relationship, measurement of total fertility rate, maternal mortality ratio, lifetime risk and proportion of maternal death, descriptive statistical and cartographic methods were used. Data was collected from 2100 respondents using the indirect sisterhood method. The findings show that Total Fertility Rate for the study area was 4.605 and the maternal mortality ratio (MMR) calculated from the lifetime risk was 3877 per 100, 000 live births. Comparative analysis showed the period and place of maternal death was during /after delivery at health facilities in the study area. Most maternal deaths in the study area were between the age groups of 25–29 and 30–34 years occurring more amongst married women. Spatial variation of maternal mortality levels between urban areas and rural areas was (3806 and 4041) per 100,000 live births, respectively. With increased maternal risk across the study area, there is need for policies and actions that will accelerate the progress needed to achieve the SDG 3.1 goal by 2030.

Keywords: Indirect sisterhood, Lifetime risk, Maternal mortality, Total fertility ratio

INTRODUCTION

Maternal mortality has received greater worldwide focus as one of the public health problems but, skeletal facts exist on maternal mortality and morbidity causes across geographical space especially in the developing world. This is occasioned by the fact that most women who died from maternal causes occur where there are no vital registrations of maternal deaths, and accessing health care is not paramount to countless number of sick women (Filippi, Chou, Ronsmans, Graham & Say, 2016). One main challenge faced in managing the situation is the accurate measurement of maternal mortality levels. There is need to improve on the inequalities among sub-populations due to the innumerable maternal deaths. This is also a problem even in countries that have low maternal mortality levels. As the Millennium Development Goals era ended by 2015 and now the Sustainable Development Goals era has begun, maternal mortality information is vital to identify the various challenges and make reproductive women health care in this era a top priority (Langer, Horton & Chalamilla, 2013).

Countries in Sub-Saharan Africa and South of Asia have about ninety (90) percent of global maternal mortality. Maternal mortality ratio of 546 per 100,000 live births is recorded for countries in the Sub-Saharan of Africa; with yearly maternal death of about 201,000. The region has more than 65 percent of total universal maternal mortality yearly. Next to this region is South Asia, with maternal mortality ratio of more than 180 or yearly mortality figures of 66,000 which accounts for about 20 percent of global maternal deaths (World Health Organization [WHO], 2015). The high number and associated problems of maternal and child deaths necessitated the focus across geographical space on countries with more than sixty-nine percent of maternal mortality worldwide by United States Agency for International Development (USAID, 2O15). This includes countries in Africa, Asia, Middle East and Latin America with more focus on the African continent than any other continent in the world. The continent records the highest maternal deaths with high number of indirect cause of deaths related to AIDS amongst sub-Saharan Africa adults of reproductive age 15-49 years. This age bracket constitutes 5 percent HIV prevalence rate (WHO, 2015).

. Developing countries have the most maternal deaths while developed countries record about one percent of deaths (Bhutta, Darmstadt, Hasan & Haws, 2005; WHO, 2015). Studies have shown great

differences in equity between inter-state and intra-state, with increasing number of maternal mortality observed in poor clan communities (Banerjee, John, & Singh, 2013; Subha Sri & Khanna, 2014; Montgomery, Ram, Kumar & Jha, 2014; Okigbo, Adegoke & Olorunsaiye, 2017; Anastasi, Ekanem, Hill, Adebayo Oluwakemi, Abayomi, & Bernasconi, 2017). In 2015, countries like Nigeria and India recorded about 33 percent of the global maternal mortality worldwide which is approximately 58,000 and 45,000 maternal deaths respectively (WHO, 2015). In 2000, Millennium Development Goals (MDGs) was adopted globally and maternal health was listed as one of its goals. Countries were committed to the Millennium Development Goals 5, which was to reduce the number of maternal death by the year 2015. Countries like Nigeria, Central African Republic, Congo, Cameroon, Gambia and Mauritania made no progress, while India, Sierra Leone, Ghana, Chad, Liberia and Niger made inadequate progress toward achieving the MDG 5 goal (WHO, 2015). Nigeria is not on track towards achieving MDG 5 targets in 2015. In Nigeria, Oyibo, Watt & Weller (2017) showed that maternal mortality is a major challenge in the reproductive health arena.

Studies on circumstances surrounding maternal deaths and complications are mostly hospital based data sources from hospital/clinical records, interviews and observations (Hussein et al., 2016). Cham, Sundby, and Vangen (2005) in a qualitative study of rural Gambia state that a site-specific data might be vital for modifying existing policy and implementation, even though it is a known fact on the universal causes of continued high maternal mortality rates. Several other studies in Africa have sued for more apt data on the level, trend and factors responsible for maternal mortality across geographical space that have importance on the poor, those in rural areas/districts and urban slums in developing countries (Bougangue, 2010; Mohammed, Elnour, Mohammed, Ahmed, and Abdelfattah, 2011; Garenne, Kahn, Collinson, Gómez-Olivé, & Tollman, 2013).

In Nigeria, studies' utilizing geospatial techniques and approaches in analysing maternal mortality from data collected with health facility records was carried out (Kolo, Adamu, Mairiga and Chutiyami, 2017; Uriri 2015). Kolo et.al. (2017) reported temporal and spatial pattern of antenatal care, hospital deliveries and maternal deaths from 2001 to 2010 in Borno State. The state recorded maternal death ratio of 3448 per 100, 000 live births with Northern Borno recording highest ratio of 1373 per 100,000 live births and the least in Southern Borno (894 per 100,000 live births). In Delta State, the temporal and spatial distribution/pattern of factors of maternal death, and mortality from 2003-2010 was analyzed in the context of human development indicators (Uriri, 2015). These studies added baseline data at local specific level across their respective state.

STATEMENT OF THE PROBLEM

Globally, among all areas of human development, maternal death and pregnancy complications have been less successful. Child bearing results in severe health challenge for women in reproductive age. On average, over 800 women die daily from pregnancy and childbirth complications, maternal deaths were more in sub-Saharan Africa (550) and South Asia (180) (WHO, 2015). In transiting from the Millennium Development Goal to the Sustainable Development Goal era, maternal deaths seem quite extreme in this age (Global Burden of Disease, 2015). With global regional progress achieved, there are still reports of alarming levels of maternal deaths in sub-Saharan Africa region. Most maternal mortality is preventable as evidently proven from records depicting vast differences amongst the richest and poorest countries. Maternal mortality lifetime risk is 1 in 3,300 in developed nations when compared to 1 in 41 in developing countries (WHO, 2015).

In developing countries, maternal deaths have not been critically examined which is evident from the few studies carried out in the areas (Chung, 2003). The patterns of maternal mortality reveal large levels of inequity between and within countries. In most developing countries, there is lack of quality records on maternal deaths and with the application of different research methodologies for measuring trends and level as well as causes of maternal mortality create a difficult situation in evaluating observed trends across nations (Hakkert, 2001; Hill, Abouzahr, & Wardlaw, 2001). A study in Brazil showed the utility of the spatial analysis of temporal evolution and distribution of maternal mortality that were above WHO recommended values as well as depicting regions with highest mortality (Carreno, Bonilh & Dias da Costa, 2014).

Records of high maternal mortality figures in the northern part of Nigeria have been documented, maternal mortality ratio of 2,420; 1,549 and 1,100 per 100,000 live births respectively (Adamu, Salihu, Sathiakumar & Alexander, 2003; National Population Commission [NPC], 2004; Kolo et al., 2017). In South Western region, community-based studies of maternal mortality conducted gave a maternal mortality ratio of 7,778 and 1,050 per 100,000 live births. These cross-sectional household surveys reiterate the crucial need to obtain information from underprivileged, rural

dwellers, and those living in un-accessible areas with a view to ascertaining areas in need of more resources for timely interventions. It validates the significance of sub-regional, differential data among the underprivileged, distant and vulnerable people at risk of dying (Adegoke, Campbell, Ogundeji, Lawoyin & Thomson, 2013; Anastatsi et al., 2017). In Lagos State, it was discovered that there is poor recording of information, scanty health services and lack of centralized data on maternal death (Mojekwu & Ibekwe, 2014). Rural communities in Nigeria report increasing maternal which is as a result of the high level of poverty among such rural reproductive women Harrison study (as cited by Okeh, 2009).

Health facilities studies records high maternal mortality ratio of 518, 2,278, 10,118, 405 and 313 per 100, 000 live births across the South-South region of Nigeria amongst pregnant women who die from pregnancy and childbirth complications especially deaths occurring from unbooked mothers (Eghe & Omo-Aghoja, 2008; Omo-Aghoja, Aisien, Akuse, Bergstrom & Okonofua, 2010, Uzoigwe, (nd); Uriri, 2015; Saving Mother Giving Life, 2016). This region is perceived as having fewer maternal deaths and records show they also have the least number of births per woman in the country. The need to understand the reason behind this upsurge in deaths among women age 15–49 is crucial. The South-South region of Nigeria records 4.3 births per woman, the index is higher in the North West (6.7), North East (6.3) and also in the North Central (5.3) (Nigeria Demographic and Health Survey [NDHS], 2013). This clearly indicates that overtime the measures put in place to curb and help reduce these ratio across geographical areas have been ineffective even in areas seemingly to be more educated with low fertility rate and high reproductive health care utilization. Accessibility to quality health care services at health facilities depicts a glooming picture to meet the increasing need for maternal health care delivery system in the country.

Although a vast number of facility-based statistics on maternal mortality exist in developing countries such as Nigeria, they may not reflect the actual state of health of community or local women. It has been suggested that the status of women's health is better captured by population based studies, which are very scarce (Gulmezoglu, Say, Betran, Villar & Piaggio, 2004). Evidence from studies in Edo State employ individual facility data on maternal death and no dependable community estimate of maternal deaths in the state (Eghe, Lawrence & Omo-Aghoja, 2008; Doctor, Findley & Afenyadu, 2012; Agbonkhese, 2014; Agofure & Olarniregun, 2017; Agan, Monjok, Akpan, Omoronyia & Ekabua, 2018). Successful planning and implementation for safe motherhood program would be difficult with the obvious lack of dependable state-level data. These studies concentrated on maternal mortality and morbidity in different population and they hardly utilize spatial geographical techniques. This paves the way for this study to have recent data, spatial analysis of the increasing risk to women in our society during their child bearing period. This will also depict the true state of maternal mortality between urban and rural reproductive women in the study area utilizing the indirect sisterhood techniques to estimate maternal mortality ratio.

JUSTIFICATION FOR THE STUDY

The lack of vital registration system on birth and death has left many developing regions without credible data about the populace. Based on the poor performance of Nigeria on the Millennium Development Goals for maternal health, maternal mortality requires reliable regional information to guide policy makers on the best possible strategy to curb geographic difference especially among the worse disadvantaged groups of women to lower maternal deaths in the country. Recent high maternal death records from a government tertiary health facility in the state is of grave concern, as most cases are referrals from private clinic and health centers across the state. There is need to identify the demographic distribution and spatial locations of areas with high mortality and morbidity. The choice of communities and grass-root population studies is needed to boost inter/intra-regional planning and policy implementation scheme of safe motherhood on maternal mortality. Also, the application of indirect sisterhood method in reporting maternal death within geographic areas in the country would explain the situation on ground much when human health issues are addressed. The application of the spatial techniques will aid government on effective strategies and interventions on combatting maternal death within identified communities with the highest maternal mortality. This specific target identification will aid reduction on maternal death which is geared toward achieving the Sustainable Development Goal 3.1 in the state.

MATERIALS AND METHODS

Study Area

Edo South Senatorial District is one of the three senatorial districts in the state. It is located between latitude 5º44'N and 6º 87'N and Longitude 5º 00' E and 6º 43'E of the equator. The district comprises seven (7)

Local Government Areas that include: Oredo, Ikpoba-okha, Egor, Ovia North-East, Ovia South-West, Orhionmwon and Uhunmwode which makes up the study area (Figure 1). The total land area of the senatorial district is 10835.37 km^2 (NPC, 2010).Community based survey design was employed to investigate the level of maternal mortality in seven Local Government Areas of Edo South Senatorial District. Households in the selected areas/wards were visited and enquiries made regarding maternal deaths from 2008–2017.This study adopted the indirect sisterhood method in estimating maternal death in the study area. This is because, most studies that are population based still use the indirect method for estimating maternal death (Oye-adeniran et al., 2011; Adegoke et al., 2013; Mgawadere et al., 2017). The method was developed by Graham (1989) in which adult respondents report on sisters born to the same mother survival has been applied effectively in many household surveys (Olsen et al., 2000). In this part of the world, the extended family system is practiced; therefore emphasis is on sisters born to the same mother.

A structured questionnaire was administered on 2100 adult men and women of reproductive age (15–49 years), one from each household in the selected communities. Respondents provided information on the proportion of their sisters dying during pregnancy, delivery, or post-partum (after six weeks of delivery). This study applied the multi-stage stratified random sampling design where twenty-nine communities were selected within the study area; Table 1 depicts all the communities. With the use of a Geographic Positioning System (GPS) device, coordinates of the various respondents household within the study area were collected to produce a geo-referenced map of the study area using ArcGIS 10.4. The following relevant indicators of mortality among reproductive women aged 15–49 were calculated: lifetime risk, maternal mortality ratio, total fertility rate, sampling error for maternal mortality, and proportion of maternal death.

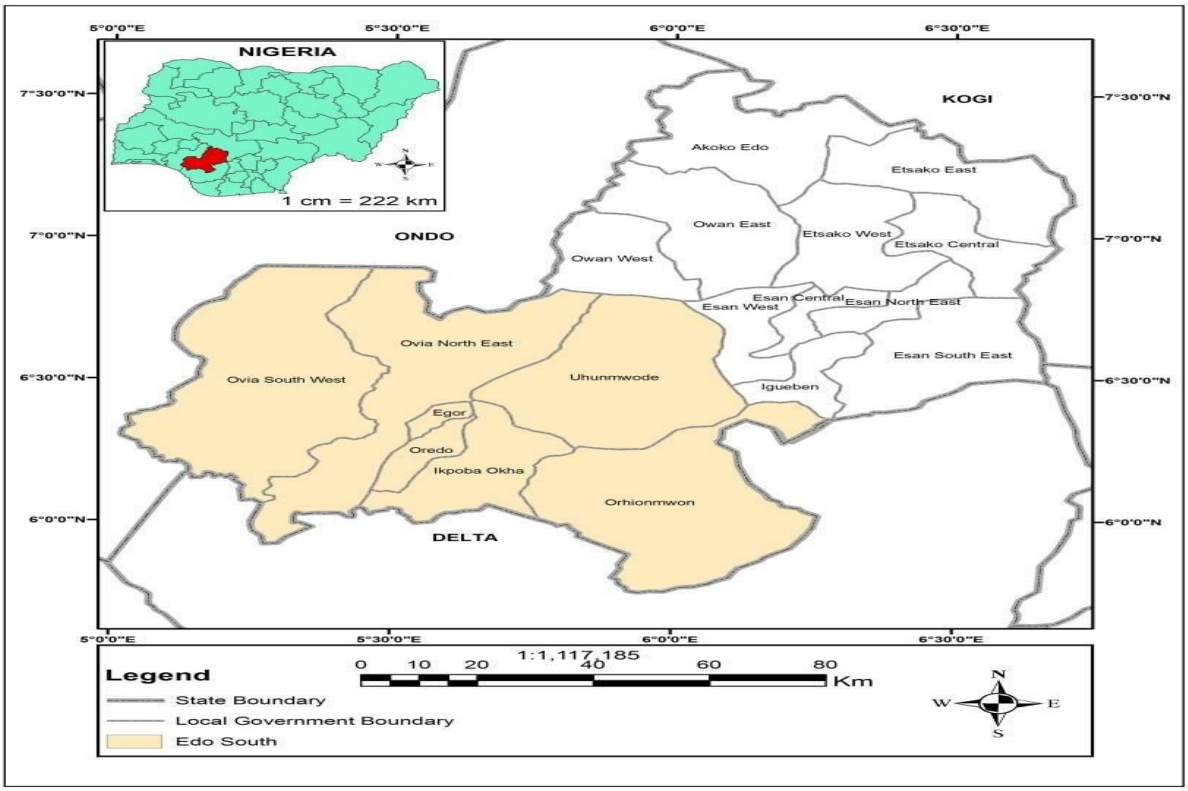

Figure 1 Edo South Senatorial District (Inset Nigeria)

Table 1 Selected Communities in Edo South Senatorial District

S/N	Local Government Area	Selected Urban Areas	Selected Rural Areas
1	Egor	Uselu, Ugbowo	Evbuotubu, Egor
2	Ikpoba-Okha	Idogbo, Gorretti	Ologbo and Obanyantor
3	Oredo	Ogbe quarters, Oredo urban (New Benin)	*Urhegin/Okua and Ekae*
4	Orhionmwon	Abiokunla1(Abudu), Urhonigbe	Ugu and Igbanke west
5	Ovia North East	Okada, Ekiadolor	Utoka and Iwu
6	Ovia South West	Iguobazuwa, Usen	Udo and Siluko
7	Uhunmwonde	Ehor, Umagbae South	*Ohuan, Orhua.*

Source: Authors' Fieldwork, 2018

The following are standard formulae for analyzing maternal mortality.

The formula for estimating **lifetime risk** of dying of maternal causes is given as:

$$Q = \Sigma ri/\Sigma Bi \quad (1)$$

Where
Q = Lifetime risk
ri = number of maternal mortality
Bi = i "sister units of risk of exposure
The adjustment factor is a constant, reported in the standard guidelines for the sisterhood method calculations.

The inverse of the lifetime risk of dying was used to calculate the probability of survival.

$$\text{Probability of survival} = 1-Q \quad (2)$$

$$\text{Where: } Q = \Sigma ri/\Sigma Bi \quad (3)$$

The maternal mortality ratio (MMR) was calculated from:

$$MMR = 1- (\text{probability of survival})\ 1/TFR \quad (4)$$

$$\text{Thus: } MMR = Q/TFR \quad (5)$$

The sampling error for maternal mortality is calculated as:

$$SE(MMR)=1-MMR/TFR\{(1-P/BP)+[\log(P)]2\ Var(TFR)/TFR2\ \}0.5 \quad (6)$$

The Upper and Lower confidence limits are calculated using the formula:

$$MMR_U=MMR+Z[SE(MMR)] \quad (7)$$

$$MMR_L=MMR-Z[SE(MMR)] \quad (8)$$

where Z is 1.96

This formula shows the relationship between the risk of death from pregnancy (obstetric risk) and the number of pregnancies per woman (total fertility rate).

Total fertility Rate combines all births per women of specific ages (five year age group)

TFR = Age specific fertility rate *5 (derived from NDHS, 2013 for the State) (9)

Proportion of maternal death = number of maternal death / All female death at ages 15–49 (10)

RESULTS AND DISCUSSION

The respondents reported a total numbers of 4287 sisters, out of which 4036 were those sister aged 15–49 years (Table 2). Of these numbers, three thousand five hundred and ninety-three (3593) were those sisters alive as at the time of data collection and 443 were recorded as dead. Table 3 clearly shows the number of dead sisters by their local government areas. Deduced from respondents' information, there are a total of four hundred and forty-three (443) dead sisters, of which three hundred and fifty-four (354) are reported cases of death due to pregnancy, childbirth and immediate postpartum period. The percentage of sisters who had died from maternal causes was much higher in Oredo, Ikpoba-Okha and Egor with 77%.

Table 2 Age group of respondents by number of sister born of the same mother

Age Group of Respondent	Number of Sisters born of same Mother											Total No. of Respondents	Total No. of Respondent Sisters	Total No. of Respondent Sisters age 15–49
	0	1	2	3	4	5	6	7	8	9	10			
15-19	10	19	32	16	11	0	1	0	0	0	0	89	181	168
20-24	16	62	65	44	26	5	4	3	1	0	0	226	506	477
25-29	64	155	150	76	30	14	1	2	3	0	0	495	917	853
30-34	50	126	133	71	28	9	7	3	3	0	1	431	859	817
35-39	48	108	108	86	37	14	5	2	3	1	0	412	877	823
40-44	24	79	62	46	21	10	6	0	1	0	0	249	519	496
45-49	23	49	54	39	17	12	2	2	0	0	0	198	428	402
Total Number of Respondents	235	598	604	378	170	64	26	12	11	1	1	2100		
Total Number of Respondents Sisters		598	1208	1134	680	320	156	84	88	9	10		4287	
Total Number of Respondents Sisters age 15-49		581	1186	1071	608	275	132	84	80	9	10			4036

Source: Authors' Fieldwork, 2018

Table 3 Number of dead sisters from maternal causes by local government areas

Number of Sisters Born of Same Mother	Local Government Areas							Total
	Egor	Ikpoba Okha	Oredo	Orhion mwon	Ovia North East	Ovia South West	Uhun mwode	
Alive	808	855	958	195	228	265	284	3593
	91.3%	88.7%	86.6%	89.9%	86.4%	92.7%	90.1%	89%
Dead from Maternal Causes	53	97	121	21	29	17	16	354
	6%	10%	11%	9.7%	10.9%	5.9%	5.1%	8.8%
Dead from other Causes	24	12	26	1	7	4	15	89
	2.7%	1.3%	2.4	0.4%	2.7%	1.4%	4.8%	2.2%
Total	885	964	1105	217	264	286	315	4036
	100%	100%	100%	100%	100%	100%	100%	100%

Source: Authors' Fieldwork, 2018

Figure 2 depicts maternal mortality among reported sisters in respect to the period it occurred (pregnancy, childbirth and immediate postpartum). There was spatial variation in the period by which these maternal deaths occurred within the study area. A total of (45) deaths occurred at pregnancy in Egor, Ovia North-East and Ovia South-West LGAs at pregnancy when compared with (21) dead sisters at the immediate postpartum while Ikpoba-Okha, Oredo, Orhionmwon and Uhunmwonde LGAs recorded (105) deaths at Childbirth. Overall, the number of deaths due to obstetric causes occurred more in childbirth (138) and closely followed by pregnancy period with (115) and immediate postpartum period (101) deaths.

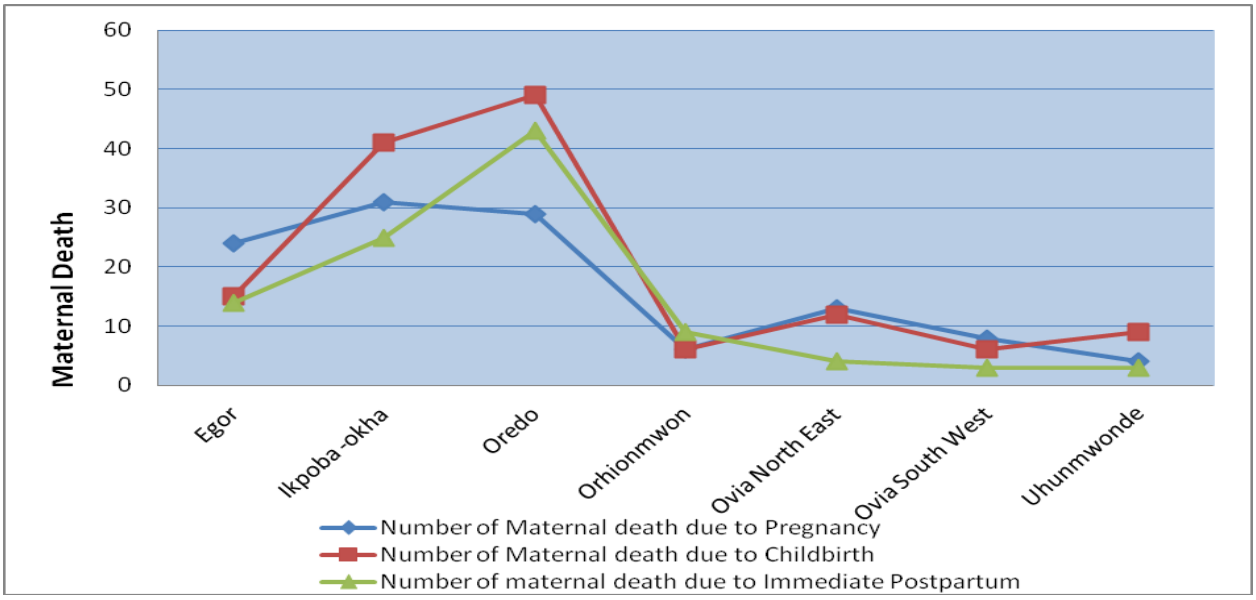

Figure 2 Numbers of dead sisters due to obstetric causes in the study area
Source: Authors' Fieldwork

Maternal death among the different age groups of dead sisters is depicted in Table 4. There was high mortality among the age groups of 25–29 years (n=86) and 30–34 years (n= 84) for dead sisters. Next to these age group were sisters 20–24 years (n=59). The spatial analysis of the percentage shows that Oredo has 28% and Ikpoba–Okha has 24% of maternal deaths among age groups 25–29 years. Oredo and Orhionmwon were the two highest local government areas with maternal deaths from age group 30–34 years with 30% and 28%

respectively. Table 5 shows the information on dead sisters' marital status. There are over seventy-seven percent of married dead sisters with Oredo having eighty-six percent of these deaths within the LGAs, while there are twenty-two percent of Unmarried (single person) dead sisters mostly from Ovia North-East and Ovia South-West LGAs.

Table 4 Age group of dead sisters (maternal deaths) in Edo South Senatorial District

Age Group of Dead Sisters	Local Government Areas							
	Egor	Ikpoba Okha	Oredo	Orhionmwon	Ovia North East	Ovia South west	Uhunmwode	Total
15–19	7	11	9	2	5	3	1	38
Number Percentage	13.2%	11.3%	7.4%	9.5%	17.2%	17.6%	6.2%	10.7%
20–24	9	20	7	5	8	6	4	59
Number Percentage	17.0%	20.6%	5.8%	23.8%	27.6%	35.3%	25.0%	16.7%
25–29	13	24	34	5	5	3	2	86
Number Percentage	24.5%	24.7%	28.1%	23.8%	17.2%	17.6%	12.5%	24.3%
30–34	9	21	37	6	6	2	3	84
Number Percentage	17.0%	21.6%	30.6%	28.6%	20.7%	11.8%	18.8%	23.7%
35–39	9	11	19	2	3	0	3	47
Number Percentage	17.0%	11.3%	15.7%	9.5%	10.3%	.0%	18.8%	13.3%
40–44	4	8	8	0	1	3	1	25
Number Percentage	7.5%	8.2%	6.6%	0%	3.4%	17.6%	6.2%	7.1%
45–49	2	2	7	1	1	0	2	15
Number Percentage	3.8%	2.1%	5.8%	4.8%	3.4%	.0%	12.5%	4.2%
Total	53	97	121	21	29	17	16	354
Number Percentage	100%	100%	100%	100%	100%	100%	100%	100%

Source: Authors' Fieldwork

The Total Fertility Rate (TFR) was calculated using data on age group (15–49), number of births and of women in that age group as shown in Table 6. The total fertility rate calculated was utilized to determine the maternal mortality rate for the study area. The number of respondent sisters' age 15–49 from 2008–2017 was used in the calculation of subtotal and total fertility rates. The group specific fertility subtotal (W*P) gave the TFR. The Total Fertility Rate is 4.605 with an estimated variance of 0.0235, at 95% Confidence Interval.

Table 5 Marital status of dead sisters in Edo South Senatorial District

Marital Status of Dead Sisters	Local Government Areas							Total
	Egor	Ikpoba Okha	Oredo	Orhionmwon	Ovia North East	Ovia South west	Uhunmwode	
Single	12	26	16	4	11	6	3	78
Number Percentage	22.6%	26.8%	13.2%	19.0%	37.9%	35.3%	18.8%	22.0%
Married	41	71	104	17	18	11	13	275
Number Percentage	77.4%	73.2%	86.0%	81.0%	62.1%	64.7%	81.2%	77.7%
Separated	0	0	1	0	0	0	0	1
Number Percentage	.0%	.0%	.8%	.0%	.0%	.0%	.0%	.3%
Total	53	97	121	21	29	17	16	354
Number Percentage	100%	100%	100%	100%	100%	100%	100%	100%

Source: Authors' Fieldwork, 2018

Table 6 Analytical framework for estimating total fertility rate

Column 1 Age group of Respondents	Column 2 No. of births (2008–2017)	Column 3 No. of Ever married women	Column 4 Births per woman-year	Column 5 Births over w years	Column 6 Var[P]	Column 7 Var[w*P]
W=5	Y	N	P=y/n*T	w*p	p*(1-p) /n*T	W2>* Var[p]
15-19	117	168	0.069	0.345	0.000590	0.014810
20-24	357	477	0.075	0.375	0.000015	0.000375
25-29	1075	853	0.126	0.630	0.000120	0.002884
30-34	1071	817	0.131	0.655	0.000014	0.003408
35-39	1297	823	0.158	0.790	0.000016	0.000404
40-44	962	496	0.194	0.970	0.000032	0.000788
45-49	674	402	0.168	0.840	0.000035	0.000869
Total	5553	4036		4.605 TFR		0.023538 Var TFR

Source: Deduced from Hanley et. al. (1996) Table A2.
*T= Time span from 2008-2017
*Standard Error (SE) of total fertility Rate =square root of 0.0235= 0.153
*95% confidence interval: 4.605±1.96 (0.153) or (4.91, 4.31)

The maternal mortality was estimated from the responses collected from two thousand one hundred respondents as shown in Table 7. The number of sister of reproductive age (15–49) years are those who are at risk of a maternal death. The maternal mortality ratio was calculated from the lifetime risk:

MMR= 1- [(probability of survival) 1/TFR] (11)

The Total Fertility Rate (TFR) in Table 6, it is a vital factor in computing the Maternal Mortality Ratio (MMR). The lifetime risk of dying from maternal causes is presented in Table 7. The indirect sisterhood method was used to estimate the MMR for 2008-2017.

The TFR for this study is 4.605 and the maternal mortality ratio (MMR) calculated from the lifetime risk of 0.1664 is 3877 per 100, 000 live births. Since TFR is an estimated value, Hanley et.al. (1996) deduced that the lower and upper limits may be subject to sampling error (SE), and therefore the following equation was used to calculate the limits:

$$SE[MMR]=1\text{-}MMR/TFR\sqrt{1\text{-}P/B*P + [Log\ \{p\}]^2 Var\ \{TFR\}/\ TFR^2} \qquad (12)$$

Table 7 Analytical framework for estimating maternal mortality ratio

Col 1 Age group of Respondents	Col 2 Number of Respondents	Col 3 Total Number of Sisters	Col 4 Number of dead Sisters	Col 5 Number of Maternal Deaths	Col 6 Adjustment Factors (I)	Col 7 Sister-units of exposure	Col 8 Lifetime Risk of dying of maternal causes	Col 9 Proportion of dead sisters dying of maternal causes
						Col 3* Col 6	Col 5/ Col 7	Col 5/Col 4
15-19	89	168	43	38	0.107	18	2.1111	0.8837
20-24	226	477	64	59	0.206	98	0.6020	0.9219
25-29	495	853	105	86	0.343	293	0.2935	0.8190
30-34	431	817	93	84	0.503	411	0.2044	0.9032
35-39	412	823	76	47	0.664	547	0.0859	0.6184
40-44	249	496	29	25	0.802	398	0.0628	0.8621
45-49	198	402	33	15	0.900	362	0.0414	0.4545
	2100	4036	443	354		2127	0.1664	0.7991

Source: Deduced from Hagen (1995)
*Col means Column
* Estimated Total Fertility Rate (TFR) is 4.605
* Variance of Total Fertility Rate (Var TFR) is 0.02358
* Maternal Mortality Ratio (MMR) from respondents = $(1- 0.83357)^{0.2172}$ = 0.03877, that means the (MMR) is 3877 per 100,000 live births
* Standard Error Maternal Mortality Ratio [SE (MMR)] is 0.00209.
At 95% the confidence interval (Cl) ±1.96 (0.00209) is = 3466 to 4287
*Life Time Risk (LTR) which is Q =Σri/ΣBi = (354/2127) = 0.1664, thus one divided by 0.1664 is equal to one in every six women has the probability of dying a maternal death.

According to Table 7, a total of forty-three sisters died but only thirty-eight were reported to be related to maternal causes for age group 15-19. Graham et. al. (1989) adjustment factor for the different age groups was multiplied to the number of sister to deduced sisters exposed to maternal mortality. The lifetime risk (LTR) depicts the risk of dying from maternal causes among women in different reproductive age groups. In the study area, 1 in 6 women have a chance of maternal death during her lifetime.

One key factor and highly sensitive to ascertaining the maternal mortality ratio is the total fertility rate. Other studies have applied estimated TFR for the country, state or district in their analysis. This study also modeled various TFRs published to estimate the effect of variance of TFR on MMR within the senatorial district in Table 8. This study used TFR of 5.5 and 5.8 which was the TFR for Nigeria in 2015 and 2016 (National Bureau of Statistics [NBS], 2018) to model the MMR, which was (3255 and 3089) per 100, 000 live births. Also modeled was the TFR of 4.4 for Edo State (NDHS 2013) which gave an MMR of 4053 per 100, 000 live births and that for the state by (NBS, 2018) was 4678 per 100, 000 live births. Across

the study area, the MMR increase from the lowest TFR to the highest.

Table 8 Estimated maternal mortality rate using various total fertility rates

TOTAL FERTILITY RATE	MATERNAL MORTALITY RATIO	STANDARD ERROR OF MATERNAL MORTALITY	UPPER CONFIDENCE LIMITS	LOWER CONFIDENCE LIMITS
3.8 (NBS, 2018)	4678	0.00256	5179	4176
4.4 (NDHS, 2013)	4053	0.00219	4483	3622
5.5(NDHS, 2013)	3255	0.00175	3598	2912
5.8 (NBS, 2018)	3089	0.00165	3413	2764
4.6 (THIS STUDY)	3877	0.00209	4287	3466

Maternal mortality Ratio was estimated for urban and rural areas in Table 9 based on the TFR of 4.605 from this study. The MMR for the Urban area is 3806 per 100,000 live births with confidence intervals of (3325, 4287) while the MMR in the rural area is 4041 per 100,000 live births with confidence intervals of (3291, 4790). The maternal mortality ratio is higher for both area but much higher in the rural areas than in the urban areas of this senatorial district. The lifetime risk is high with one in every six women likely to die from maternal causes. This also depicts the statistical analysis of maternal mortality ratio across the seven local government areas in Edo South senatorial district. The least maternal mortality ratio (MMR) of 2164 per 100 000 live births was estimated in Uhunmwonde local government area; the next was in Egor local government area with MMR of 2588 per 100 000 live births. Ovia South-West local government area has an estimated MMR of 2597 per 100 000 live births which is lower when compared with the MMR of 4281 per 100 000 live births for Orhionwon LGA. The highest MMR were recorded in Ovia North-East, Oredo and Ikpoba-Okha LGA with their MMR as: 4995, 4936, and 4507 per 100 000 live births respectively. There were observed spatial variation on the pattern of maternal mortality across the study area as depicted by Figures 3 to 6.

Table 9 Summary of maternal mortality in Edo South Senatorial District

Local Government Areas	MMR	TFR	SEMMR	MMR^U	MMR^L	LTR
Egor	2588	4.605	0.00352	3279	1896	1 in 8
Ikpoba-Okha	4507	4.605	0.00452	5394	3620	1 in 5
Oredo	4936	4.605	0.00444	5806	4066	1 in 5
Ovia North-East	4995	4.605	0.00908	6776	3214	1 in 5
Ovia South-West	2597	4.605	0.00623	3818	1376	1 in 9
Orhionmwon	4288	4.605	0.00918	6776	3214	1 in 6
Uhunmwonde	2164	4.605	0.00536	3215	1113	1 in 10
Urban Areas	3806	4.605	0.00245	4287	3325	1 in 6
Rural Areas	4041	4.605	0.00382	4790	3291	1 in 6

- *MMR=Maternal Mortality Ratio; TFR= Total Fertility Rate; SEMMR =Standard Error of MMR*
- *MMR^U = Maternal Mortality Ratio Upper limit; MMR^L = Maternal Mortality Ratio Lower limit*

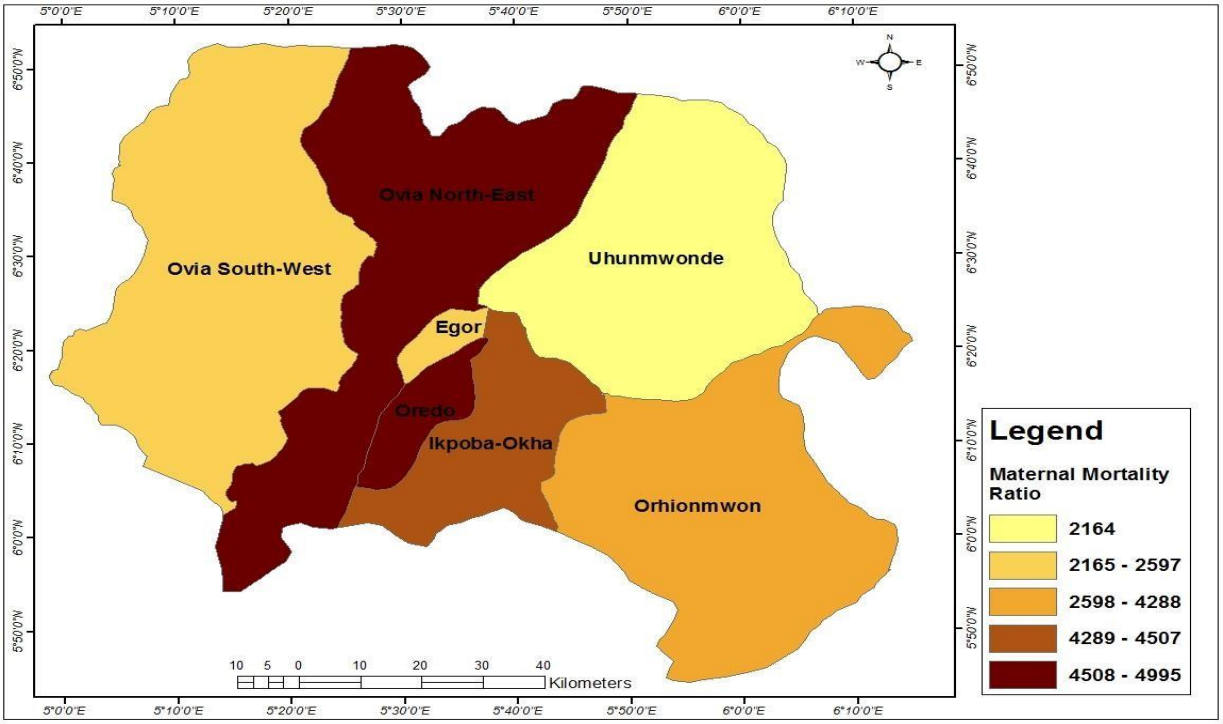

Figure 3 Maternal Mortality Ratio in Edo South
Source: Authors' Fieldwork, 2018

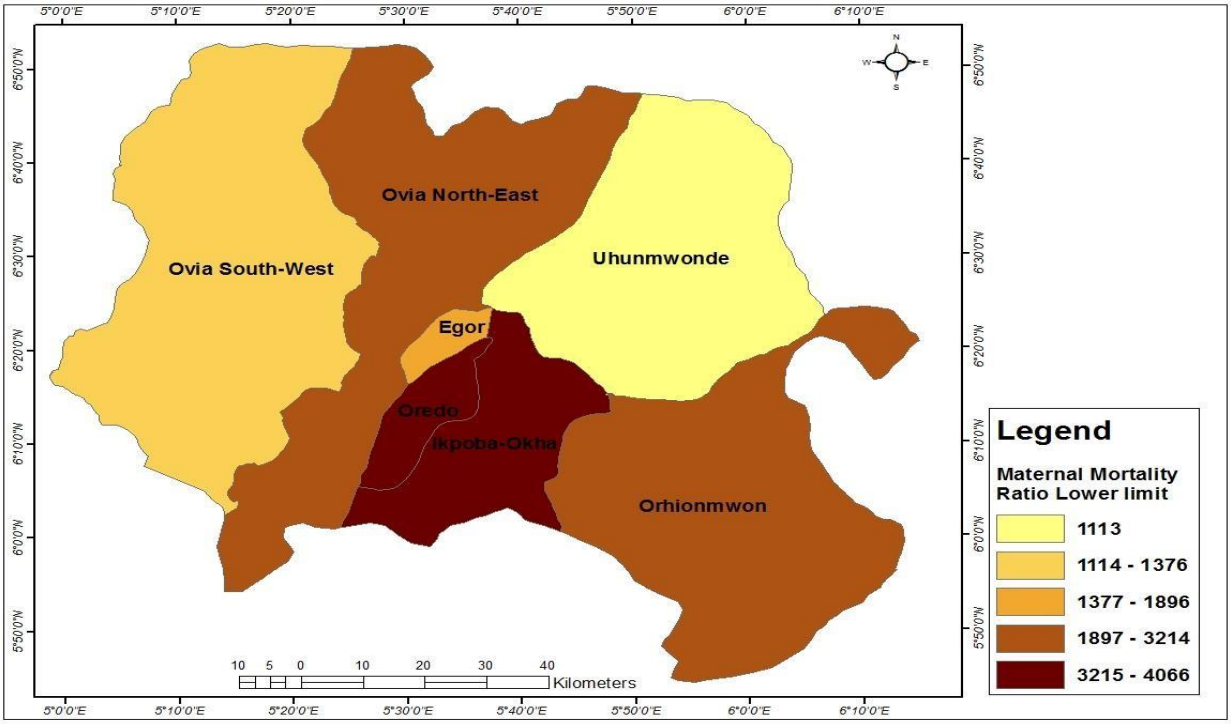

Figure 4 Maternal Mortality Ratio (Lower Limit) in Edo South
Source: Authors' Fieldwork, 2018

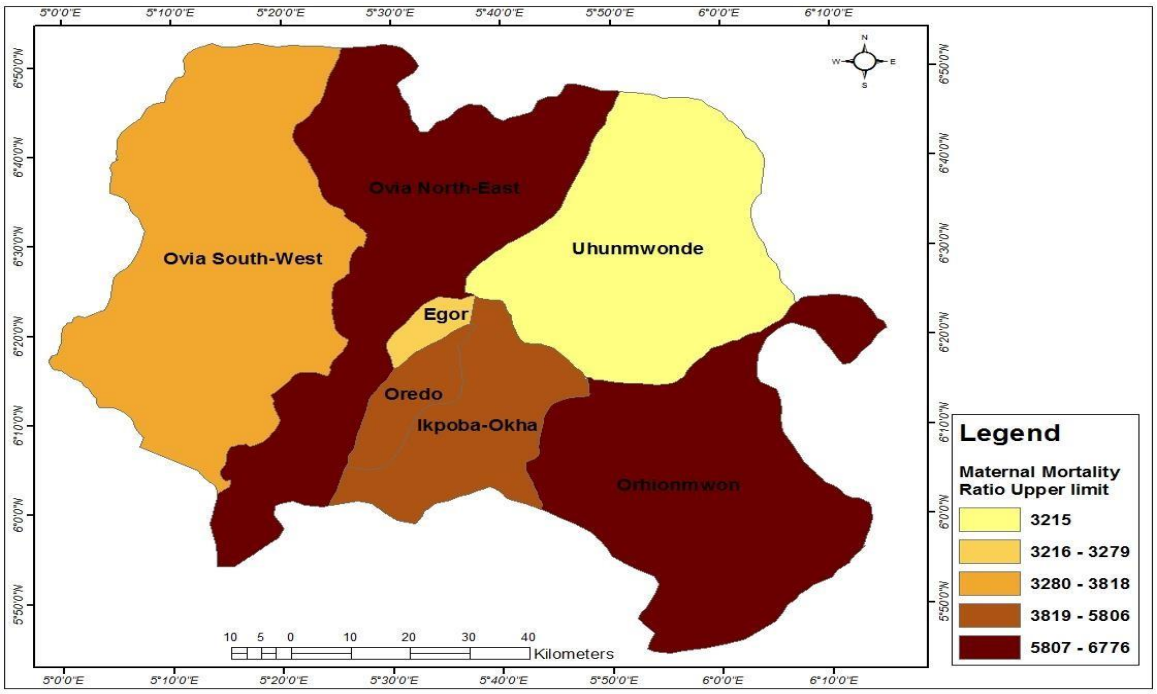

Figure 5 Maternal Mortality Ratio (Upper Limit) in Edo South
Source: Authors' Fieldwork, 2018

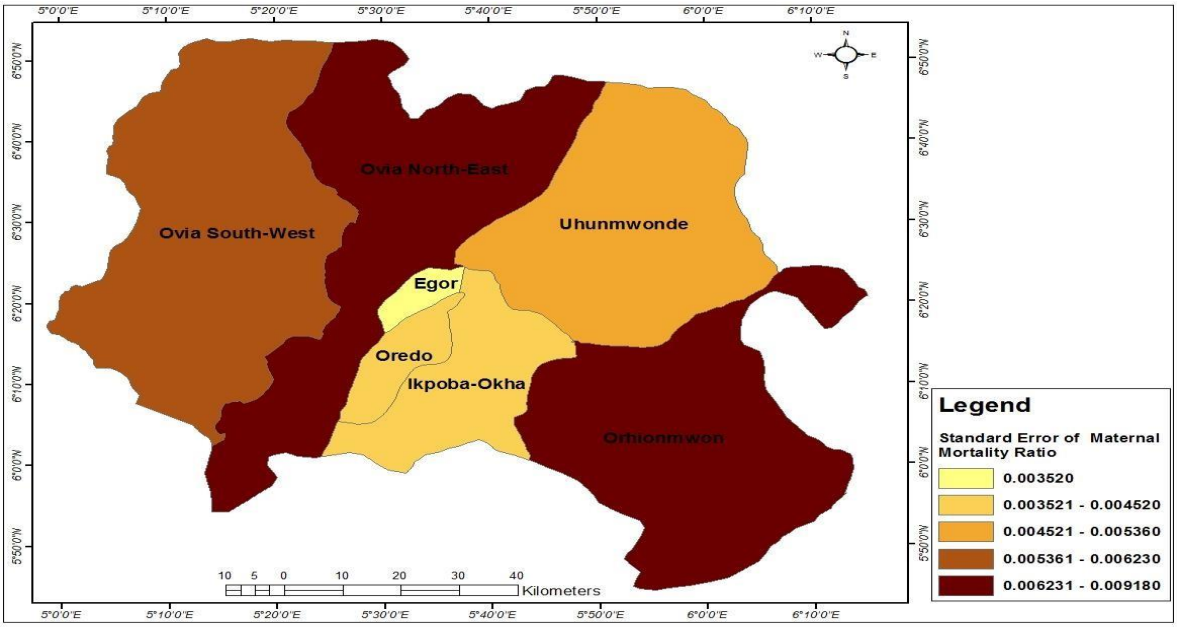

Figure 6 Standard Error of Maternal Mortality Ratio in Edo South
Source: Authors' Fieldwork, 2018

Maternal death was high among the age groups of 25–29 years and 30–34 years. This concurs with findings from (Bankole et al., 2009; Omo-Aghoja, et al., 2010; Doctor et al., 2012; and Adegoke et al., 2013). Maternal deaths in Oredo and Ikpoba-Okha LGAs were higher among age groups between 25–29 years. Oredo and Orhionmwon local government areas had more maternal deaths from age group between 30–34 years. The least number of maternal deaths was among age groups 40–49 as affirmed by (NDHS, 2013). The married/unmarried (single) dead sisters recorded 77% and 22% of obstetric cause of deaths. This is not surprising as maternal deaths are identified with

cohabitation and marriage being the principal risk factors in pregnancy and associated complications in Nigeria (NPC, 2004).

The numbers of maternal deaths was high among first time pregnant women and were found in Ovia North-East, Ovia South-West, Uhunmwonde, and Ikpoba-Okha. Parity gave rise to the high percentage of maternal mortality within the LGAs. As parity increases, the percentage of maternal deaths reduces. This agrees with Okeh (2009) and Yarzever (2014) findings that higher parity increases the chance of a maternal death. Maternal deaths interval occurred at health facilities in Oredo, Ikpoba-Okha and Egor LGAs. The time of labour, delivery and after delivery records the most maternal deaths. This negates finding from Oye-Adeniran et.al. (2014) which found more deaths occurring in pregnancy and affirms Ghebrehiwot, (2004) finding that most deaths occurred during delivery and postpartum periods. In this study the TFR is 4.605 with an estimated variance of 0.0235, at 95% Confidence Interval (CI). This was slightly higher than the estimated TFR of 4.4 for Edo State reported by (NDHS, 2013). The rate is quite high when compared to the TFR by (NBS, 2018).

The estimated maternal mortality ratio was 3877 per 100, 000 live births. The upper and lower limit at 95% confidence interval (CI) was 4287 and 3466. The 2018 NBS TFR gave an MMR of 3089 and (CI) of 3413 and 2764 while the 2013 NBS TFR of 5.5 gave a (CI) of 3598 and 2912, deduced from maternal mortality ratio of 3255 per 100, 000 live births. Edo State TFR of 4.4 by NDHS (2013) produced MMR of 4053 per 100, 000 live births and (CI) between 4483 and 3622. The 2018 computed TFR for the State by NBS produced a maternal mortality ratio of 4678 per 100, 000 live births and (CI) between 5179 and 4176. Within the study area, the MMR increase from the highest TFR to the lowest with (CI) levels ranging from 2764 to 5176.

Studies conducted across the state, reported MMR range from 322, 518, 700 to 2,282 per 100, 000 live births (Eghe & Omo-Aghoja, 2008; ESMOH, 2009; Omo-Aghoja et al., 2010; Agofure & Olaniregun, 2017). These estimated MMRs are deduced from health facilities records and reported only the percentage of pregnant women seeking health care service, this implies delays in accessing maternal health services from by most pregnant women from ante-natal to post-natal periods. About fifty percent of mothers' patronize health facilities for delivery and quite a large number do not access health facilities within the South South region. Among the states comprising the South South region, Edo State hold the highest percentage that patronize health facilities however, a wide margin still exists that do not use health facilities especially in rural areas(NDHS, 2013).

CONCLUSION

Various models of TFRs were used to ascertain the MMR in the study area. The rural areas had higher estimated MMR than the urban areas. In each local government area, maternal mortality ratio was calculated to depict the LGAs with the highest and least maternal mortality ratio. Comparative analysis was done to show the periods of maternal death incidences among dead sisters. There were observed spatial variations on the pattern of maternal mortality measures of 3877 per 100, 000 live births across the study area. With the high record of maternal deaths occurring from the survey, it suggests a gap exists in available services and care received from existing health facilities and could be a function of any of the established delays in accessing health services. With over 55% increase in maternal mortality level compared to set SGD 3.1 targets, there is need to turn government, non-government organization and policy makers to the plight of the less privilege pregnant women especially in rural areas. To urgently address the current challenge, specific targeted goals such as quality reproductive health services (maternal health care services, family planning and excellent referral networking system); upgrading dilapidated and non-functioning health facilities and effective emergency obstetric services at the grassroot will save maternal lives.

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