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Original Research

Geospatial Distribution, Accessibility and Utilization of Basic Emergency Obstetric and New-born Care in Jigawa State, Northwest Nigeria.

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Abstract

Background: High maternal mortality has remained a problem, especially in developing countries. Ensuring availability and utilization of Basic Emergency Obstetric and Newborn Care services (BEmONC) reduce maternal morbidity and mortality. The study aimed to determine the geospatial distribution, accessibility and utilization of BEmONC services in Jigawa State.

Methodology: A cross-sectional study was conducted using the WHO "30 by 7" cluster sampling technique and two-stage sampling to select 630 women and 15 Primary Health Care facilities (PHCFs) respectively. The Geo coordinates of the PHCFs and households of respondents were taken using the global positioning system (GPS) on Android devices. Data were analysed using IBM SPSS version 25 and Arc GIS version 10.6.

Results: A dispersed distribution was observed for the BEmONC facilities in two LGAs and majority of the respondents (71.9%) fall within 5 Km radius to a BEmONC facility. Only 27% of the respondents utilized BEmONC services for obstetric complications. Predictors of utilization of BEmONC were living within 5 Km to the nearest BEmONC (aOR=3.3; 95% CI=1.565 – 6.822), use of bicycle (aOR=1.930; 95% CI=1.012 – 3.679), cars (aOR=1.838; 95% CI=1.127 – 2.998), and tricycles (aOR=1.833; 95% CI=1.017 – 3.309) as means of transportation to PHCs.

Conclusions: A dispersed distribution and good physical accessibility to BEmONC facilities were found, however, utilization was poor. Distance and mode of transportation were predictors of utilization of BEmONC services. Jigawa State Government should intensify awareness campaigns to improve the utilization of BEmONC services and provide emergency transport schemes for women with obstetric complications.

Keywords: Geospatial Distribution; Accessibility; Utilization; Basic Emergency Obstetric; Newborn Care.

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Introduction

Maternal mortality has remained a problem in developing countries where women continue to die from pregnancy and childbirth related complications. In sub-Saharan Africa, the danger of death during pregnancy or childbirth is 175 times higher when compared to other developed nations of the world.[1]Nigeria alone accounts for 19.5% of the global maternal mortality burden.[2] Regional variations in the maternal mortality figures in Nigeria shows that women in rural areas and/or from the northern part of Nigeria are at higher risk of maternal death compared to those in urban areas and/or from the southern part of the country.[2]

Most maternal deaths occur from direct obstetric complications like postpartum haemorrhage, sepsis, obstructed labour, toxaemia of pregnancy and complications of abortion. These complications occur suddenly often without warning and can be fatal unless treated promptly.[3]These can be averted through improving the availability, accessibility and quality of Emergency Obstetric and new-born Care (EmONC) services.[4] The 2009 WHO guidelines recommended that for every 500,000 people there should be four Basic Emergency Obstetric and New-born Care (BEmONC) facilities and one Comprehensive Emergency Obstetric and New-born Care (CEmONC) facility.[5] Lack of timely and quality EmONC has contributed significantly to maternal morbidity and mortality in developing countries.[6]According to the Nigerian National Demographic and Health Survey, 25% of women have problems of geographic accessibility to a health facility including BEmONCservices.[7]

Studies from Nigeria have shown clustered pattern of distribution of the health facilities around main towns and roads, with majority of the facilities located in Urban areas around the metropolis.[8,9]Most of the studies that described physical accessibility to health facilities in Nigeria relied on the estimated distance as reported by the respondents or employed the use of travel time as a proxy to physical accessibility, however, this study used GIS technology to measure precise location of the health facilities and the houses of the women, thereby providing the exact physical accessibility of BEmONC to the women who need them. Hence the assessment produces evidence that could be used to strengthen health systems, improve physical access to EmONC, and save the lives of mothers and new-borns in Jigawa State.[5]

Materials and Methods

Ethical considerations and confidentiality

Ethical approval for this study was obtained from the Health Research Ethics Committee of the Ahmadu Bello University Teaching Hospital with reference number ABUTHZ/HREC/W23/2021. Informed consent was obtained from every study participant at the time of recruitment. Confidentiality and anonymity of data collected was ensured.

Study area

The study was conducted in Jigawa State, Nigeria which is made up of twenty-seven Local Government Areas (LGAs) and 287 wards with Dutse as the State capital. It has a 2023 projected population of 5,590,272 out of which 49% are females. There are two tertiary health facilities in the State and 10 General Hospitals.[9] The 27 Local Government Areas are charged with the provision of primary level of health care services, which are essentially promotive, preventive and curative. Jigawa State has 120

functional Primary Health Care (PHC) Centres that provide delivery services, which is expected to include BEmONCservices.[9]

Study population

Study population included Public PHC facilities that provide delivery services, as well as mothers of children under the age of 5 years. The study excluded the Public PHC facilities that commence the provision of delivery services for less than three months prior to this study and mothers of children under the age of five who were not permanent residents of the selected communities.

Study design

It was a cross-sectional descriptive study.

Sample size estimation

For the health facility component of the survey, all the 15PHC facilities that provide delivery services in the selected LGAs were recruited into the study. The WHO "30 by 7" cluster survey method was used to select 630 mothers of children under the age 5 years (210 from each of the 3 selected LGAs).[10]

Sampling technique

For the health facility component, a two-stage sampling technique was used. One LGA was selected using simple random sample from each of the three senatorial districts in the State (Dutse, Hadejia and Kazaure LGAs were selected). Then total population survey was conducted to include all the public PHC centres in the selected LGAs that meet the inclusion criteria. For the community component, the WHO 30 by 7" cluster survey method was used to select mothers of children under the age of 5 years.[10]

Data collection tool

Data was collected using Interviewer-administered semi-structured electronic questionnaire adapted from international budget partnership questionnaire on maternal health services.[11] and a health facility checklist. The Geo coordinates (latitude and longitude) of the PHC centres and households of interviewed mothers were taken using the global positioning system.

Data analysis

Data was analysed using IBM SPSS version 25 and Arc GIS version 10.6.

At univariate level, frequency of socio-demographics, reproductive profile, utilization of maternal health and BEmONC services and accessibility of the health facilities were reported with their percentages. Mean age, number of children, duration of marriage, average household income and number of visits to maternal health services were reported with their standard deviations; data to be presented in tables and charts.

At the bivariate level, Chi-square and Fisher's exact tests were performed to assess for the existence of association between socio demographic, reproductive profiles with the utilization of BEmONC services. Level of significance (α) was set at 0.05.

At multivariate level, factors found to be significantly associated with utilization in bivariate analysis were subjected to binary logistic regression model to determine the predictors of utilization of BEmONC services. The regression analyses were presented in tables with adjusted Odds Ratio (aOR), Confidence Interval (CI) and their *P*- values. The maximum margin for error was set at 5%.

To determine the geospatial distribution and accessibility of BEmONC facilities, the point locations and attributes of the health care facilities were imported into the ArcGIS 10.6 environment and overlaid on a geo-referenced base map of Jigawa State. The average nearest neighbourhood analysis was carried out in the ArcGIS 10.6 environment to compute the mean distance between the BEmONC facilities to determine the pattern of distribution of the facilities. An index (Average Nearest Neighbour ratio) less than one, signified clustering of the health facilities. Index greater than one, meant dispersed pattern of distribution. A buffer analysis in ArcGIS 10.6 was used to determine the level of accessibility of each Primary Health Centre in the study area. The Buffer analysis function was utilized to create a radius of 5 km around the facilities. The region within the stipulated radius was considered to have the facilities accessible to them, while those outside the radius were considered not to have access to the facilities.

Moran's I analysis on the Arc GIS 10.6 was employed to check for spatial autocorrelation in the utilization of BEmONC services. Clustering or otherwise of the utilizers and non-utilizers of the BEmONC was shown in relation to distance of to the nearest BEmONC facility. Moran's, I have a value from -1 to 1. Negative values signify dispersion, with a value of -1 signifying perfect clustering of dissimilar values (or perfect dispersion). 0 indicates no autocorrelation (perfect randomness) while positive values indicate clustering of cases, with 1 indicating perfect clustering of similar values.

Results

Socio-demographic characteristics and reproductive profile of Respondents

Table 1: Socio-demographic characteristics and reproductive profile of respondents

Variable	Frequency (n=630)	Percentage
Age (years)		
15-24	119	18.9
25-34	326	51.7
35-44	172	27.3
45 and above	13	2.1
Marital status		
Married	591	98.2
Unmarried	39	6.2

Highest level of education		
No formal	208	30.0
Primary	158	25.1
Secondary	200	31.7
Tertiary	64	10.2
Tribe		
Hausa	562	88.9
Others	70	11.1
Religion		
Islam	622	98.7
Christianity	8	1.3
Occupation		
Business	42	6.7
Civil servant	44	7.0
Farmer	21	3.3
Petty trader	364	57.8
Not gainfully employed	140	22.2
Others	19	3.0
Household average monthly income (Naira)		
<50,000	518	82.3
50,000 and above	112	17.8
Time taken to closest BEmONC facility		
Less than 30 mins	358	56.8
30 mins to 1 hour	213	33.8
1hour to 1.5 hours	47	7.5

1.5 to 2 hours	11	1.7
Greater than 2 hours	1	0.2
Distance from closest BEmONC facility (Km)		
<5	453	71.9
5-10	53	8.4
>10	124	19.7
Mode of transportation		
Bicycle	58	9.2
Car	147	23.3
Donkey	10	1.6
Tricycle	86	13.7
Walking	269	42.7
Others (eg Horses, animal driven carts	60	9.5
Waiting time to see health care provider		
Less than 30 mins	201	31.9
30 mins to 1 hour	278	44.1
1 hour to 1.5 hours	88	14.0
1.5 hours to 2 hours	43	6.8
Greater than 2 hours	19	3.0
15-24	561	89.0
25-34	15	2.4
35 and above	3	0.5
Number of living children		
1-4	355	56.3
5-9	259	41.1

10+	16	2.6
Duration of marriage (Years)		
< 5 years	79	12.5
5-9	162	25.7
10-14	179	28.4
15-19	112	17.8
20 and above	98	15.6
Last childbirth (months)		
0-11	219	34.8
12-23	176	27.9
24-35	136	21.6
36-47	74	11.7
48-59	25	4.0

A total of 630 respondents were interviewed. The mean age of the respondents was found to be 29.9 ± 6.4 years, and the majority of the respondents were aged 25 -34 years. Over 98% of the respondents were married and 30% of them had no formal education. Petty traders constituted the majority (57.8%) of the respondents. About 82.3% of the respondents earn less than 50,000 naira per month. The median household monthly income was 30,000 naira. Concerning the time taken to access the health facility and the means of transport, 56% of the respondents travel less than 30 minutes to the nearest BEmONC facility, while 33.8% of the respondents are within 30 minutes to one-hour travel time to the closest BEmONC facility. Forty-two percent of the respondents reported walking to the health facility to access care with only 23.3% using cars as means of transportation.

The respondent's mean age at first marriage was 18.14 ± 0.03. The majority (89%) of respondents' age at first marriage was between 15-24 years. The mean number of children alive was 4.4 ± 2.5 with 56.3% of the respondents having between 0-4 living children. Median duration of marriage of the respondents was found to be 11.0 years and 28.4% of them have been married for 10-14 years. The median time of last childbirth was 18.3 months. About 34% of the respondents had their last childbirth between 0-11 months ago.

Geospatial distribution and accessibility to BEmONC Facilities

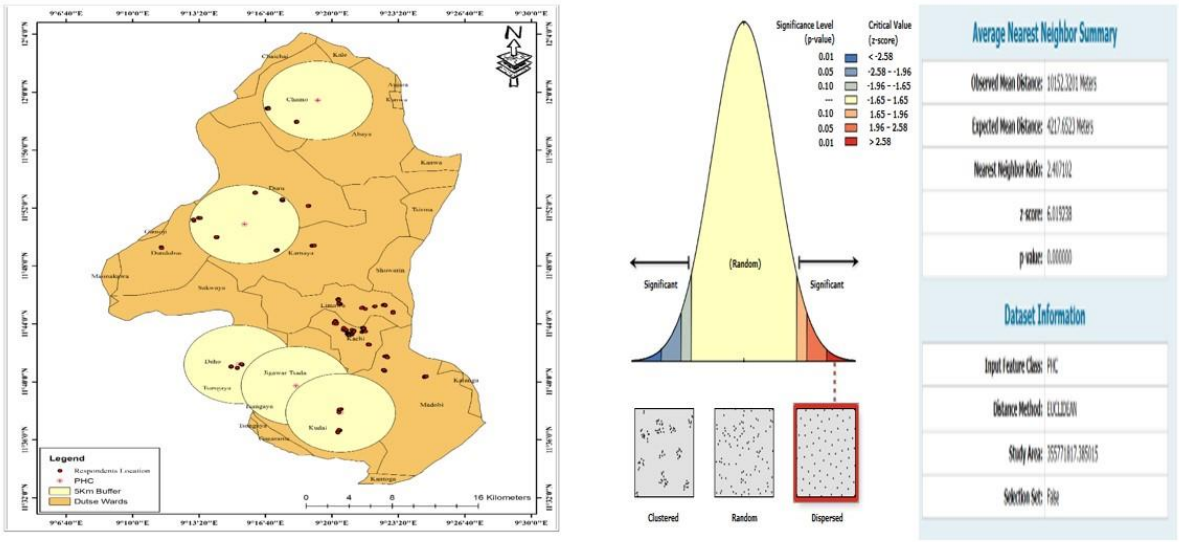

Figure 1: Five-kilometer radius buffer analysis and Nearest Neighbor analysis of BEmONC facilities in Dutse LGA

Nearest neighbour analysis revealed that the BEmONC facilities were dispersed in Dutse LGA (NNR=2.41) with 84(40%) falling within the 5-Kilometer radius of a BEmONC facility.

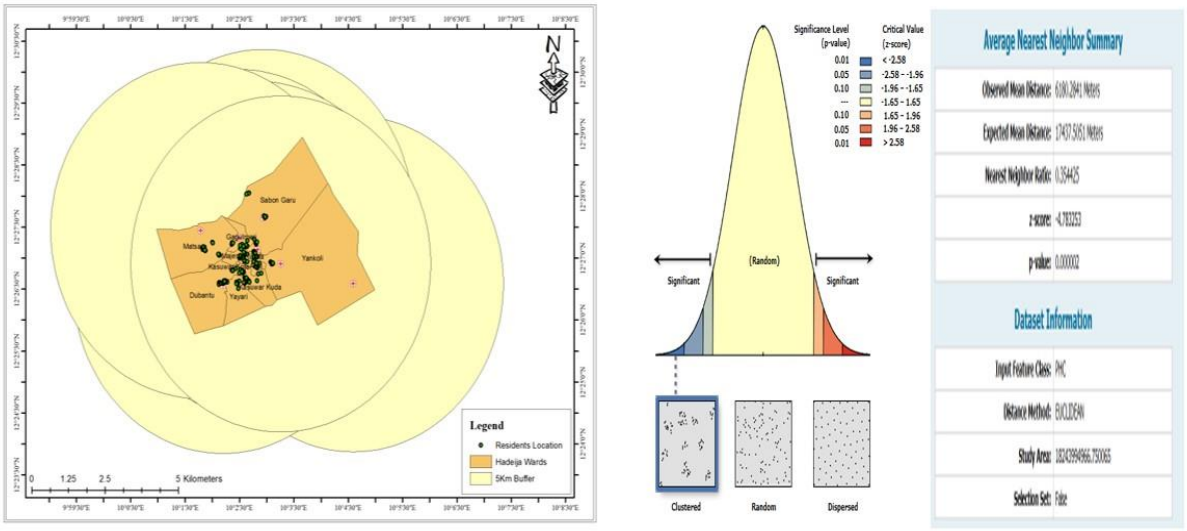

Figure 2: Five-kilometer radius buffer analysis and Nearest Neighbor analysis of BEmONC facilities in Hadeija LGA

In Hadejia LGA, the BEmONC facilities had a clustered pattern of distribution (NNR=0.35) and all the 210 respondents (100%) in Hadejia LGA fall within 5km radius of a BEmONC facility.

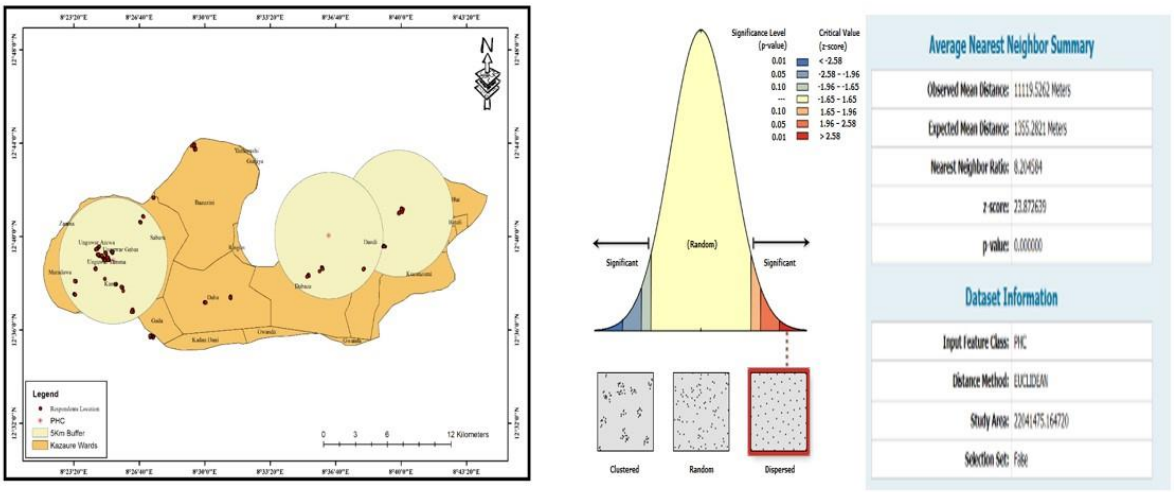

Figure 3: Five-kilometer radius buffer analysis and Nearest Neighbor analysis of BEmONC facilities in Kazaure LGA

For Kazaure LGA, the BEmONC facilities were also dispersed (NNR=8.21) and 159 (75.7%) of the respondents in Kazaure LGA fall within 5Km radius to a BEmONC facility.

Table 2: Summary of buffer analysis using a 5km radius in the three selected LGAs

LGA	Total Number of respondents	Respondents within 5 Km buffer	Respondents outside the 5km buffer
	F	F (%)	F (%)
Dutse	210	84(40%)	126(60%)
Hadejia	210	210(100%)	0(0%)
Kazaure	210	159(75.7%)	51(24.3%)
Jigawa State	**630**	**453(71.9%)**	**177(28.1%)**

A total of 453 respondents (71.9%) of all the respondents fall within the 5 Km radius to a BEmONC facility in the three selected LGAs in Jigawa State. The median distance to the closest BEmONC facility was 4.28Km.

Utilization of BEmONC Services in the PHC facilitiesamong Respondents

Table 3: Experience of direct obstetric complications and utilization of BEmONC services

Variable	Frequency (n=630)	Percentage
Had direct obstetric complications	**205**	**32.5**
Obstetric haemorrhage	106	16.8
Fever	89	14.1
Severe Headache	54	8.6
Leg swelling	35	5.6
Obstructed labour	18	2.9
Weakness	16	2.5
Blurring of vision	15	2.4
Eclampsia/preeclampsia	12	1.9
Complications of abortion	9	1.4
Infection/sepsis	5	0.8
Others	3	0.5
Utilized BEmONC	**175**	**27.8**
Parenteral antibiotics	141	22.3
Parenteral Oxytocics	76	12.1
Parenteral anticonvulsants	12	2.0
Neonatal resuscitation	10	1.6
Removal of retained products	9	1.4
Manual removal of placenta	8	1.3
Assisted vaginal delivery	0	0
Others	17	2.7

Thirty-two percent of the respondents experienced direct obstetric complications during their most recent pregnancies. The most common complications reported was obstetric hemorrhage as experienced by about 16.8% of the respondents. About 27.8% of the respondents have utilized BEmONC services for treatment of the complications. Twenty-two percent of the respondents had parenteral antibiotics given. None of the respondents had assisted vaginal delivery.

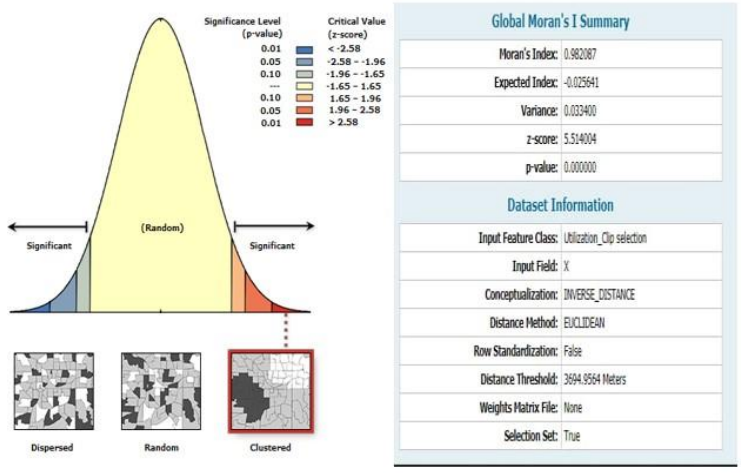

Figure 4: Moran's I analysis showing clustering pattern of utilization of BEmONC care in the 3 selected LGAs in Jigawa state

Utilizers of BEmONC services were shown to be clustered around areas closer to the BEmONC facilities (Moran's I value=0.982).

Determinants of Utilization of BEmONC Services

Table 4: Factors that affect utilization of BEmONC services in Jigawa State

Variable	Utilize BEmONC services		*P*-Value/test statistic
	Yes	No	
	F (%)	F (%)	
Age group (Years)			
15-24	37(5.9)	82(13.0)	X^2=0.852
25-34	91(14.4)	235(37.3)	*P* =0.845
35-44	46(7.3)	126(20.0)	
45 and above	3(0.5)	10(1.6)	
Tribe			
Hausa	154(24.4)	408(64.8)	Fischer Exact = 3.619

Others	23(3.7)	45(7.1)	P = 0.287
Religion			
Islam	175(27.7)	447(71.0)	Fischer Exact = 2.723
Christianity	6(0.9)	2(0.4)	P = 0.335
Marital Status			
Married	161(25.5)	430(68.0)	Fischer Exact = 4.807
Unmarried	16(2.5)	23(3.5)	P = 0.181
Highest Level of education			
No formal education	61(9.7)	147(23.3)	X^2 =0.252
Primary	43(6.8)	115(18.3)	P =0.969
Secondary	55(8.7)	145(23.0)	
Tertiary	18(2.8)	46(7.3)	
Occupation			
None	30(4.8)	110(17.5)	X^2 =10.164
Business	12(1.9)	30(4.8)	***P* =0.049**
Civil servant	14(2.2)	30(4.8)	
Farmer	6(0.9)	15(2.4)	
Petty trader	114(18.1)	250(39.7)	
Others	1(0.2)	18(2.8)	
Household monthly income (Naira)			
<50,000	148(23.5)	370(58.8)	X^2 =0.347
50,000 and above	29(4.6)	83(13.2)	
Distance to nearest BEmONC facility (Km)			
<5	90(14.3)	262(41.6)	X^2 =12.748
5-10	26(4.1)	27(4.2)	***P* =0.002**

>10	61(9.7)	164(26.0)	
Time taken to nearest PHC			
<30 minutes	106(16.8)	252(40.0)	Fischer's Exact =5.568
30 mins to 1 hour	50(7.9)	163(25.9)	*P* =0.210
1 hour -1.5 hours	18(2.9)	29(4.6)	
1.5 hours-2 hours	3(0.5)	8(1.3)	
> 2 hours	0(0.0)	1(0.2)	
Mode of transportation to health facility			
Bicycle	22(3.5)	36(5.7)	$X^2 = 9.808$
Car	49(7.8)	98(15.6)	***P* =0.039**
Donkey/Cart	4(0.6)	6(1.0)	
Tricycle	26(4.1)	60(9.5)	
Walking	63(10.0)	206(32.7)	
Others	13(2.1)	47(7.5)	
Average waiting time to see medical staff			
<30 minutes	72(11.4)	129(20.5)	X^2 =9.808
30 mins to 1 hour	73(11.6)	205(32.5)	***P* =0.033**
1 hour -1.5 hours	22(3.5)	66(10.5)	
1.5 hours-2 hours	7(1.1)	36(5.7)	
> 2 hours	3(0.5)	16(2.5)	
Age at marriage (Years)			
<15	18(2.9)	33(5.2)	Fischer Exact = *2.458*
15-24	154(24.4)	407(64.6)	*P* = 0.428
25-34	5(0.8)	10(1.6)	

35 and above	0(0.0)	3(0.5)	
Number of living children			
0-4	99(15.7)	256(40.6)	X^2 =0.795
5-9	75(12.0)	184(29.2)	*P* = 0.672
10 and above	3(0.5)	13(2.1)	
Duration of marriage (In years)			
<5	28(4.4)	51(8.1)	X^2 =5.093
5-9	38(6.0)	124(19.7)	*P* =0.279
10-14	55(8.7)	124(19.7)	
15-19	32(5.1)	80(12.7)	
20 and above	24(3.8)	74(11.7)	
Last childbirth (months)			
0-11	66(10.5)	153(24.2)	X^2 =5.788
12-23	44(7.0)	132(21.0)	*P* =0.674
24-35	38(6.0)	98(15.6)	
36-47	24(3.8)	50(7.9)	
48-59	5(0.8)	20(3.2)	

X^2= Pearson's Chi-square test

Respondent's occupation (*P* =0.049), distance to the nearest BEmONC facility (*P* =0.002), average waiting time to see a medical staff (*P* =0.033) and mode of transportation (p=0.039) were found to be significantly associated with utilization of BEmONC.

None of the reproductive health factors were significantly associated with utilization of BEmONC services.

Table 5: Predictors of utilization of BEmONC services

Variable	aOR	95 % CI for OR	*P* - value
		Upper-Lower	
Distance to nearest BEmONC facility (Km)			
< 5	3.30	1.57 – 6.82	**0.002**
5 – 10	0.96	0.63 – 1.47	0.856
>10	1.00		
Occupation			
Petty trader	1.00		
Business	0.86	0.39 -1.86	0.698
Civil servant	0.91	0.42 – 1.94	0.797
Farmer	0.69	0.23 - 2.08	0.511
None	0.64	0.39 – 1.05	0.075
Others	0.13	0.02 – 1.01	0.051
Mode of transportation			
Walking	1.00		
Bicycle	1.93	1.01 – 3.68	**0.046**
Car	1.84	1.13 – 2.99	**0.015**
Donkey/cart	2.74	0.67 – 11.27	0.163
Tricycle	1.83	1.02 – 3.31	**0.044**
Others	0.88	0.40 – 1.89	0.735
Average amount of time spent to see a medical staff			
Less than 30 minutes	1.00		
30 mins to 1 hour	0.73	0.39 – 1.33	0.298

1 hour to 1.5 hours	0.49	0.19 – 1.25	0.136
1.5 hours to 2 hours	0.88	0.23 – 6.35	0.332
>2 hours	0.78	0.50 – 1.21	0.265

aOR=Adjusted odds ratio **CI**= Confidence interval

Respondents who live within 5 Km to the nearest BEmONC facility are more than three times more likely to utilize BEmONC care services than those who live more than 10Km away for the BEmONC facilities (aOR=3.3; 95% CI=1.565 – 6.822; *P*=0.02). Respondents who use bicycle as a mode of transportation were almost twice more likely to utilize BEmONC services than those who walk to the facilities (aOR=1.930; 95% CI=1.012 – 3.679; *P*=0.046). Those who use cars for transportation to health facility were almost twice more likely to utilize BEmONC than those who walk (aOR=1.838; 95% CI=1.127 – 2.998; *P* =0.015). Similarly, those who use tricycles as means of transportation of health facilities were almost twice more likely to utilize BEmONC services than those who walk to the health facilities (aOR=1.833; 95% CI=1.017 – 3.309; *P*=0.044

Discussion

The study assessed geospatial distribution, accessibility and utilization of BEmONC services in Jigawa State. Overall, the study found the facilities mostly had a dispersed pattern of distribution across the selected LGAs, signifying equity in terms of physical location of the health care facilities. Similarly, a study from Nigeria which assessed spatial pattern of facilities using GIS data revealed that PHCs in Babura, had a dispersed pattern of distribution.[9] In addition, a cross-sectional study in Madhya Pradesh in India reported that the BEmONC facilities were dispersed throughout the district.[12] Contrarily, a cross sectional studies from Kano and Oyo States Nigeria reported clustering of the facilities around urban areas.[8,9] Studies from Tanzania and Ghana all revealed that there is significant inequality in the distribution of the BEmONC facilities as most were clustered around urban areas.[13,14,15,16]The reason for the difference seen with these studies could be because they were conducted in large metropolitan States with significant proportion of urban populations while this study was conducted in Jigawa State which is 90% rural,[17] hence the typical urban rural distribution preferences may not be manifest.

This study also found that majority of the respondents fall within 5Km distance to the closest BEmONC facility while almost one fifth of the respondents are more than 10Km away from the closest BEmONC facility. It is recommended that the health facilities should be within 5Km distance to all people to ensure physical accessibility. Similarly, a study from Kano revealed that majority of the respondents live within 5Km to health facilities. Even though findings from this study implies that majority of the respondents in this study had a good physical accessibility to the health facilities, as many as a fifth of them will have to travel more than 10kilometres to the nearest health facility. Distance of more than 10Km is a serious challenge especially in the predominantly rural setting of Jigawa State, where adequate mode of transportation is a big challenge**.** Other studies have reported poor physical accessibility to emergency obstetric care facilities. A study in Zambia found that less than 39% of the population live within 15Km to the closest health facility.[18] Another study from Kenya reported that the average distance toa Basic emergency obstetric care facility was 30Km.[19] Additionally, a study from Ghana revealed that up to 34% of the women live beyond the clinically significant distance to the closest emergency obstetric care facility.[16]

About one third of the respondents in this study reported to have experienced one or more of direct obstetric complications during the last pregnancy. This is higher than the estimated 15% of all pregnancies expected to have direct obstetric complications.[3] The higher figure observed in this study could be because of the poor health seeking behaviour during pregnancy and harmful traditional practices in the State. As expected, obstetric haemorrhages were the most common complications experienced by the women. WHO had estimated that about one third of all obstetric complications are from obstetric haemorrhages.[20]

This study found that respondent's occupation, distance from nearest BEmONC facility, mode of transport and average waiting time in health facility were associated with utilization of the BEmONC services. A similar study from Nigeria also found that occupations of women and were associated with utilization of obstetric services.[21] Additionally, studies in Cross rivers State Nigeria.[22]and Haiti found that distance to health facility is an important factor in utilization of emergency obstetric service.[23]Also, a systemic review in Sub Saharan Africa reported that distance to health facilities and transportation were among factors associated with utilization of emergency obstetric care services.[24]It found that those within 5km to health facility are almost twice as likely to utilize emergency obstetric care services as those more than 5km from the facilities.[23] Another similar finding was reported from a study in Pakistan, which reported that income was significantly associated with utilization of emergency obstetric care.[25]

Contrary findings were reported from a study in Tanzania which found that wealth index was associated with utilization.[26] Additionally, a study from Kenya found that health decision making at the family level, insecurity at night, cost of health services, inhospitable formal service providers and poorly equipped health facilities were identified as factors that hinder the utilization of obstetric care services.[27] A different finding was also reported from a study from developing countries which found that in Malawi, younger age, being married, attending up to four or more antenatal visits, and being a Christian or Muslim were significantly associated with greater odds of utilization of emergency obstetric care facilities for delivery, whereas wealth quintile was associated with lesser odds.[23]In addition, a prospective cohort study among 9,576 women from Bangladesh reported that socio-economic factors such as living in a household from the highest wealth quartile, women's literacy, and women's employment were significantly associated with seeking care for emergency services for obstetric complications.[28]A major strength of this study is the application of geographical information (GIS) technology to measure precise locations of BEmONC facilities and location of respondents as well as providing a spatial representation of the health facilities and the respondents on geo referenced maps. It also measured accurate distances of respondents to health facilities as against estimates from respondent's experiences. It equally has an added strength in the use of total population survey of the health facilities that provide delivery services in the selected LGAs to assess availability of services. The study, however, did not answer the questions of availability and quality of the BEmONC services in the health facilities. Future research directions could focus on the availability and quality of BEmONC services in Jigawa state.

In view of the above findings, the Jigawa State government in collaboration with religious and community leaders should engage in awareness campaigns on the need to utilize health facilities for treatment of obstetric complications. Also, the non-governmental organizations in collaboration with the Jigawa State government should scale up and sustain the emergency transport scheme for pregnant women since mode of transportation with cars and tricycles have been shown to be predictors of utilization of BEmONC services.

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