



## *RESEARCH ARTICLE*

### **GEO-SPATIAL ANALYSIS OF THE CLUSTERS OF NEONATAL MORTALITY FROM 2009-2019 IN IMO STATE, NIGERIA**

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#### **ABSTRACT**

Neonatal mortality is a major contributor to Under-five mortality. This corollary is predicated on socio-economic and demographic factors. This study adopted the integration of descriptive survey and GIS to geo-spatially analyze the clusters of neonatal mortality from 2009-2019 in Imo State, Southeastern Nigeria. Data acquisition involved the collection of data from the selected local government areas in Imo state's Public Hospitals' records of neonates who were delivered, admitted and died within 28 days after birth from the year 2009 – 2019 in the study area. The study population included the twenty seven local government areas and the seventeen Public Hospitals in the study area. The analysis of spatial autocorrelation was carried out using Moran's local indicator (Moran I) of spatial autocorrelation (LISA) in Arc-GIS 10.4, in order to facilitate the identification of area clusters with significant patterns of spatial association. The result shows a statistically significant positive Local Moran's I index (LMiIndex) of 0.226715 which confirms that there is a positive autocorrelation of Neonatal mortalities in Okigwe local government area. It can be concluded that there is a high clustering of Neonatal mortality in Okigwe local government area. The study therefore proffers: governmental execution of infrastructural developments, strategic methodology and blue-prints, and refurbishment of the existing public hospitals in the mitigation of neonatal mortality in the study area.

Keywords: Cluster, neonatal, mortality, geo-spatial, study area.

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## **1.0. INTRODUCTION**

Neonatal mortality refers to the death of new borns within the ages of 0-28 days. It is a core indicator for neonatal health and wellbeing, and is becoming a prominent component of overall under-five mortality. According to You, Hug, Ejdemyr, et al. (2015), they asserted that it's garnering spectacular attention from Health authorities. Globally, the neonatal mortality rate only fell by 39% in consonance with the under-five mortality rate which dropped by 47% (from 9.9 million to 5.6 million children) from 2000 to 2016 (Sustainable Development, 2015). Liu, Oza, Hogan, et al., (2015) added that out of the 5.9 million under five deaths reported in 2015, 2.7 million died during the neonatal period.

In 2013, sub-Saharan Africa orchestrated approximately half of the global under-five mortality records, largely predicated on contagious illnesses (Liu, Oza, Hogan, et al., 2016). Additionally, in Sub-Saharan Africa and South Asia, 27/1000 live births were attributed to neonatal mortality in 2017 (Andegiorgish, Andemariam, Temesghen, Ogbai, Ogbe and Zeng, 2020). Susceptibility to neonatal mortality was nine times higher for a child born from this region than a child from a high income country (Andegiorgish, et al., 2020).

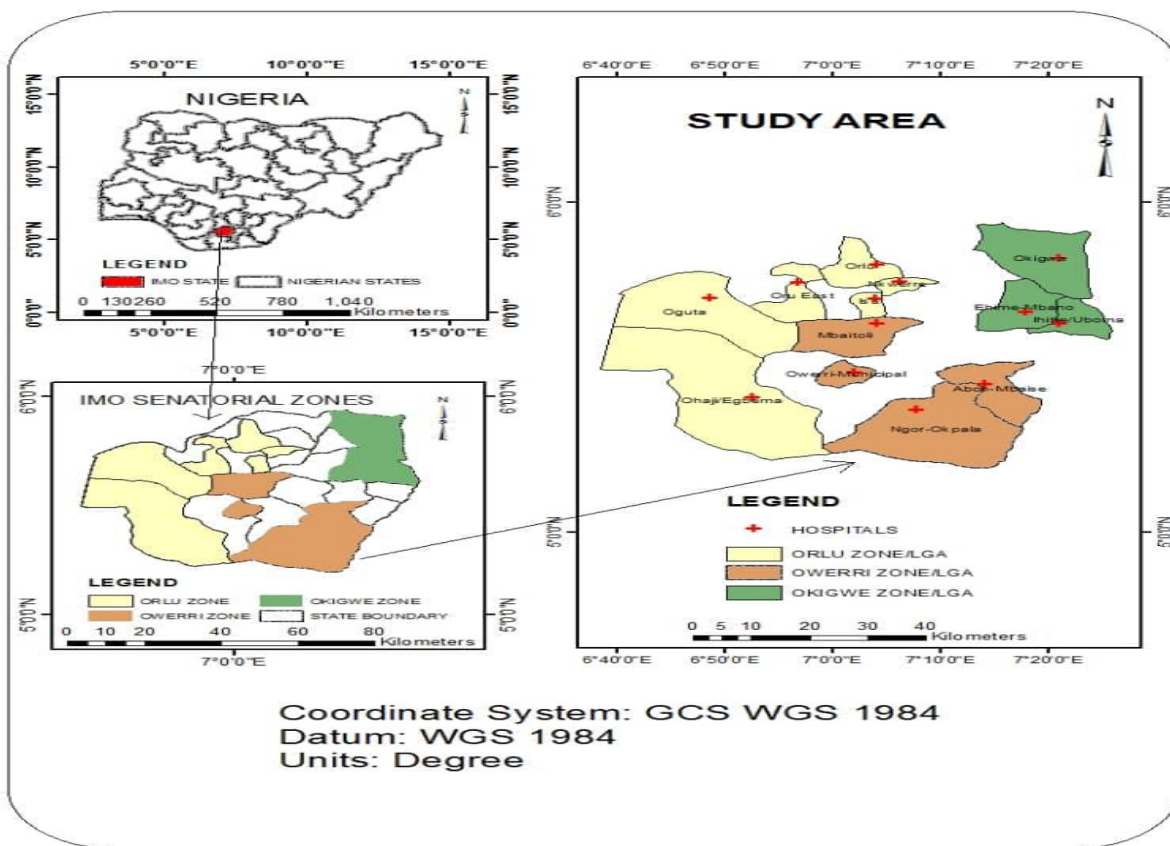
Many studies such as You, et al., (2015), Liu, et al., (2015), etc. have been done on Child Mortality. Conversely, Andegiorgish, et al., (2020) examined Neonatal Mortality and Associated Factors in the Specialized Neonatal Care Unit, Asmara, Eritrea. However, not much work has been done in Neonatal Mortality in Imo State, Southeastern, Nigeria.

Subsequently, this study sets out to geo-spatially analyze the clusters of neonatal mortality from 2009-2019 in the study area with the view of mitigating it in the area.



## 2.0. DESCRIPTION OF THE STUDY AREA

Imo state lies within latitudes  $4^{\circ}45'N$  and  $7^{\circ}15'N$  and longitudes  $6^{\circ}50'E$  and  $7^{\circ}25'E$ . It occupies the area between the lower part of River Niger and the Upper and middle of Imo River from which it derives its name (Okoro, Uzoukwu and Chimezie, 2014). It is bounded on the east by Abia state, on the west by the River Niger and Delta state, on the north by Anambra state while it is bounded on the south by Rivers state (fig. 1). More so, the selected local government areas and the public hospitals in the study area are shown in fig 1 below.



**Fig 1: Map of the Study Area**

**Source:** Federal Ministry of Land, Housing and Urban Development (2020).



### 3.0. METHODOLOGY

This study adopted the integration of descriptive survey and GIS to quantitatively analyze and examine the geo-spatially analyze the clusters of neonatal mortality from 2009-2019 in the study area. Data acquisition involved the collection of data from the selected local government areas in Imo state's Public Hospitals' records of neonates who were delivered, admitted and died within 28 days after birth from the year 2009 – 2019 in the study area.

The study population included the twenty seven local government areas and the seventeen Public Hospitals in the study area as shown in Table 1 and 2 below. But, from our reconnaissance survey, it was ascertained that there are no Public hospitals in fourteen of the local government areas in the study area (Table 1). Consequently, only the thirteen local government areas where the public hospitals are sited were also taken into cognizance in this study as shown in Table 8.

Simple random sampling technique was leveraged in this study, to sample 13 out of the 27 local government areas and 13 out of the 17 Public hospitals in the study area as shown in Table 1 and 2 respectively. This proposition is premised on our deductions from our reconnaissance survey which unraveled, that the seventeen public hospitals in the study area are sited only in the thirteen sampled study locations of the study area (Table 2). But, the other local government areas were not taken into cognizance because they only have private hospitals which are outside the target population of this study.

**Table 1: Selection of Local Government Areas (L.G.As) in the Study Area**

S/N	Zones	Selected L.G.As	Data	
			Population	Sample
1	Okigwe	3	6	3
2	Orlu	6	12	6
3	Owerri	4	9	4
<b>Total</b>		<b>13</b>	<b>27</b>	<b>13</b>

**Source:** Author's Field Studies (2020).



**Table 2: Selection of Public Hospitals in the Study Area**

S/N	L.G.A	Selected Hospital	Location		Data	
			Latitude	Longitude	Population	Sample
1	Okigwe	1	5°49'14.51"N	7°21'12.11"E	1	1
2	Ehime Mbano	1	5°40'11.11"N	7°17'52.11"E	1	1
3	Ihitte Uboma	1	5°37'58.11"N	7°21'11.11"E	1	1
4	Orlu	1	5°48'38.11"N	7°4'01.11"E	1	1
5	Nkwerre	1	5°45'33.11"N	7°6'13.11"E	1	1
6	Isu	1	5°42'29.11"N	7°3'56.11"E	2	1
7	Oru East	1	5°45'24.11"N	6°56'46.11"E	1	1
8	Oguta	1	5°42'37.11"N	6°48'33.11"E	1	1
9	Ohaji/Egbema	1	5°24'30.11"N	6°52'31.11"E	1	1
10	Mbaitoli	1	5°37'59.11"N	7°4'00.11"E	2	1
11	Owerri Municipal	1	5°29'01.11"N	7°01'59.11"E	2	1
12	Aboh Mbaise	1	5°27'0.48.11"N	7°14'00.11"E	2	1
13	Ngor Okpala	1	5°22'14.11"N	7°7'45.11"E	1	1
<b>Total</b>		<b>13</b>			<b>17</b>	<b>13</b>

**Source:** Author's Field Studies (2020).

Arc GIS version 10.4 was used in this study for the analysis and mapping of the clusters of Neonatal mortality. Microsoft Excel (2013) and SPSS (20.0) were used for statistical analysis and creating of charts and graphs while hand held GPS and Google Earth were used for measurement and referencing purposes.

Data for this study were collected from both primary and secondary sources. The shape files of Imo state were sourced from the National Centre for Remote Sensing, Jos, for the years (2009-2019) in order to delineate the study areas while other primary data were also retrieved from the Hospitals' (public owned) based records on Neonatal mortalities in the study area for the study period (2009 to 2019), photo documentation, maps, Global Positioning System for the collection of the location points of the Hospitals (public owned), and Google Earth for the extraction of the various imageries from the study area. In addition, secondary data were sourced from base maps



and relevant literature, Ministry of Lands and Survey, libraries, and internet, in order to explain the objectives.

The analysis of spatial autocorrelation was carried out using Moran's local indicator (Moran I) of spatial autocorrelation (LISA) in Arc-GIS 10.4, in order to facilitate the identification of area clusters with significant patterns of spatial association. This analysis made it possible to identify and compare the values of each district in the study area with the value of neighboring districts within the same study area.

The result of the analysis were maps and analysis reports of cluster/outlier between a statistically significant cluster of high values (HH), cluster of low values (LL), outlier in which a high value is surrounded primarily by low values (HL), and outlier in which a low value is surrounded primarily by high values (LH). Statistical significance is set at the 95% confidence level. A positive value for  $I$  indicate that a feature has neighboring features with similarly high or low attributes values; this feature is part of a cluster. A negative value for  $I$  indicates that a feature has neighboring features with dissimilar values; this feature is an outlier.

#### **4.0. PRESENTATION OF RESULTS AND DISCUSSIONS**

##### **Presentation and Analysis of Public Hospitals' Neonatal Admissions' and Mortalities Data**

This section puts on view the presentation of the public hospitals' neonatal admissions and mortalities from 2009-2019 in the study area in consonance with the results of the analyses carried out in this research and their associated discussions. It encompasses the results of identifying and mapping the clusters of neonatal mortalities in the study area from 2009-2019. The presentation of neonatal admissions and mortalities from 2009-2019 in the study area from the public hospitals are clearly depicted in Tables 3 and 4.





**Table 3: Selected Public Hospitals' Neonatal Admissions from 2009-2019 in the Area**

Zones	L.G.As/Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total
Okigwe	Okigwe	34	41	20	29	15	19	21	11	17	20	13	240
	Ehime Mbano	26	32	14	18	31	12	7	0	11	9	15	175
	Ihitte Uboma	15	10	6	10	8	0	10	3	1	12	7	82
Owerri	Mbaitoli	11	4	3	12	4	15	0	13	3	4	6	75
	Owerri Muni.	8	25	18	8	0	9	5	7	0	10	1	91
	Aboh Mbaise	17	21	20	16	10	5	11	0	2	3	4	109
	Ngor Okpala	9	9	4	0	7	0	0	0	0	0	0	29
Orlu	Orlu	2	5	1	10	12	7	13	4	1	10	8	73
	Nkwerre	5	0	2	5	3	0	7	1	10	7	3	43
	Isu	12	5	8	23	8	5	0	2	3	4	5	75
	Oru East	9	0	6	19	5	3	2	15	7	6	9	81
	Oguta	4	1	5	2	9	5	0	5	13	9	12	65
	Ohaji/Egbema	10	7	3	0	7	11	4	8	6	5	3	64
	<b>Total</b>	162	160	110	152	119	91	80	69	74	99	86	<b>1202</b>

**Source:** Author's Field Studies (2021).

Table 3 shows the selected public hospitals' neonatal admissions from 2009-2019 in the area. Among the thirteen local government areas examined in the study, eleven had high values and consequently upward trends of neonatal admissions though with differing records. The other two; Nkwerre and Ngor Okpala had low values implying downward trends. Okigwe possesses the highest value of 240 among the areas with high cases probably due to the low intra-household decision power to seek both curative and preventive health care to neonatal emergencies such as severe neonatal jaundice (a liver condition that causes yellowing of a newborn baby's skin and eyes), sepsis (a potentially life-threatening condition that occurs when the body's response to an infection damages its own tissues), perinatal asphyxia (This refers to a lack of blood flow or gas exchange to or from the fetus in the period immediately before, during, or after the birth process) and neonatal tetanus (This occurs when a neonate with the normal ability to suck and cry during the first two days of life, and between three and twenty eight days



of age cannot suck normally and becomes stiff or has spasms) in Okigwe zone. This delay in decision to seek health care may have been orchestrated by the poverty indices of the different.

**Table 4:** Neonatal Mortality Cases from 2009 - 2019 in the Selected Public Hospitals

Zones	L.G.As/Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total
Okigwe	Okigwe	21	17	12	8	2	13	7	4	6	12	9	111
	Ehime Mbano	15	18	9	10	6	8	4	0	8	5	9	92
	Ihitte Uboma	9	8	2	5	4	0	7	2	0	9	4	50
Owerri	Mbaitoli	7	3	1	4	1	0	0	5	1	0	1	23
	Owerri Muni.	2	0	3	0	0	4	0	0	0	2	1	12
	Aboh Mbaise	7	10	2	5	4	1	4	0	1	0	1	35
	Ngor Okpala	4	3	0	0	2	0	0	0	0	0	0	9
Orlu	Orlu	0	3	0	4	7	3	9	2	0	6	5	39
	Nkwerre	3	0	0	3	1	0	3	0	2	1	3	16
	Isu	0	1	5	11	6	3	0	0	1	3	2	32
	Oru East	2	0	4	7	3	1	0	0	2	2	7	28
	Oguta	0	1	1	0	5	3	0	0	7	4	8	29
	Ohaji/Egbema	7	5	0	0	4	7	3	1	2	2	0	31
	<b>Total</b>	77	69	39	57	45	43	37	14	30	46	50	<b>507</b>

Source: Author's Fieldwork (2021).

However, Nkwerre had 43 as the highest among those with low cases of neonatal admissions over the study period. On the other hand, Ohaji/Egbema had the lowest value of 64 for the increased cases of neonatal admissions over the study period while 29 cases were recorded in Ngor Okpala as the lowest for the areas with low cases probably due to reduced neonatal emergencies in the public hospitals.

An examination of Table 4 reveals the neonatal mortality cases from 2009-2019 in the study area. From the table, all but two out of the thirteen areas examined possessed low values of neonatal mortality. It is only Okigwe, and Ehime Mbano local government areas that recorded high values thus implying upward trends in their neonatal mortality cases probably due to poor access to education, low income, poor obstetrics assistance, infections (including

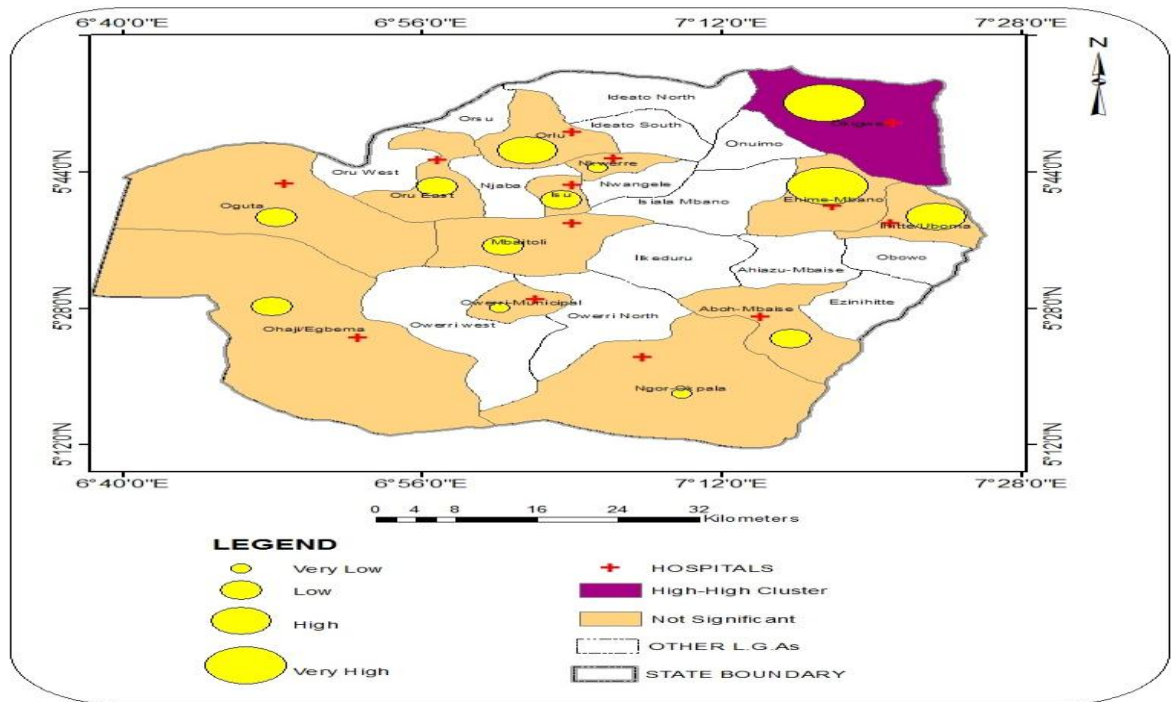




sepsis/pneumonia, tetanus and diarrhea), intra-partum related conditions (the time period spanning childbirth, from the onset of labour through delivery of the placenta); birth asphyxia (this occurs when a baby doesn't receive enough oxygen before, during or just after birth) and multiple pregnancies which result in preterm births (a phenomenon that occurs when babies are born too early before 37 weeks of pregnancy are completed) in the areas. Put differently, the other areas are experiencing a decrease in their cases probably due to changing patterns in reproductive health, socioeconomic progress and the quality of obstetric and neonatal care in their health facilities. The cases are generally low, except for Okigwe and Ehime Mbano with 111 and 92 cases respectively while Owerri Municipal and Ngor Okpala each recorded the least cases of only 12 and 9 respectively as well.

A juxtaposition of both tables unravels that among the 1202 neonates admitted in the public hospitals (Table 3), 507 neonates died (Table 4) in the study area from 2009-2019. This implies that 42.3% of the neonates that were admitted in the public hospitals died over the study period. Therefore, 42.3% (507) was used in further analysis.

More so, the clusters of the neonatal mortalities from 2009-2019 in the Study Area is depicted below (Figure 2).



**Fig. 2: Map of Imo state showing the cluster for neonatal mortality from 2009-2019**  
**Source: Researcher's Data Results, (2021)**

From figure 2 above, it was observed that using the Local indicators of spatial association analysis (LISA), there was significant “High-High” correlation in Okigwe local government area and “Not Significant” correlation in the rest of the local government areas. The High-High correlation indicates that Okigwe local government area has a high coefficient and is surrounded by neighboring local government areas with the same high characteristics. Justifying the result of the analysis, Appendix 1 shows a statistically significant positive Local Moran’s I index (LMiIndex) of 0.226715 which confirms there is a positive autocorrelation of Neonatal mortalities in Okigwe local government area. It can be concluded that there is a high clustering of Neonatal mortality in Okigwe local government area. The cluster outlier type (CO type) shows that there are High mortality values in Okigwe. The z-score of 2.857524 which is the



standard deviation shows a P-value of 0.00427 which gives us a Confidence Interval (CI) of 99 percent.

## **5.0. CONCLUSIONS AND RECOMMENDATIONS**

Sustainable research on neonatal mortality must recognize the geo-spatial information on its clusters. Detailed knowledge of the clusters of neonatal mortality is useful for designing and evaluating the effectiveness of intervention programs aimed at its reduction. From the research results obtained from the geo-spatial analysis of the clusters of neonatal mortality in the study area, this study therefore proffers: governmental execution of infrastructural developments, strategic methodology and blue-prints, and refurbishment of the existing public hospitals in the mitigation of neonatal mortality in the study area. Subsequently, these recommendations were further elucidated sequentially thus:

**Governmental execution of infrastructural developments:** Table 2 ascertained the existence of only one public hospital each in Okigwe, Ehime Mbano, Ihitte Uboma (Okigwe zone), Oru East, Oguta, Ohaji Egbema, Orlu, Nkwerre (Orlu zone) and Ngor Okpala, (Owerri zone) in the study area. Hence, it is expedient that the community leaders of the aforementioned local government areas should draw the attention of the State government through their respective State House of Assembly Members to the infrastructural deficits with reference to the health sectors in the study area.

**Strategic Methodology and Blue-prints:** Efficient execution of infrastructural developments, entails that the State government should strategize on the methodology and blue-prints for equipping the prospective public hospitals for the provision of health care services by prioritizing and ensuring the adequacy of staff, staff competency, and availability of equipment, supplies and adequate management in the aforementioned nine local government areas of the study location where there are only a public hospital each.



**Refurbishment of the Existing Public Hospitals:** More so, the already existing seventeen public hospitals in the thirteen local government areas of the study area (Table 2) should be refurbished and maintained for the maximization of their functionality in the area. This will enhance the survival chances of the neonates in the study area.

### Competing Interest

The author have declared that no competing interest exist this paper.

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## Appendix

### Appendix 1: Local Moran's I analysis

HH	
SOURCE ID	1
sumof_cases	507
LMIndex IDW 19273	0.226715
LMZScore IDW 19273	2.857524
LMIPValue IDW 19273	0.00427
COType IDW 19273	HH

Source: Researcher's Data Result, (2021)