# healthGIS

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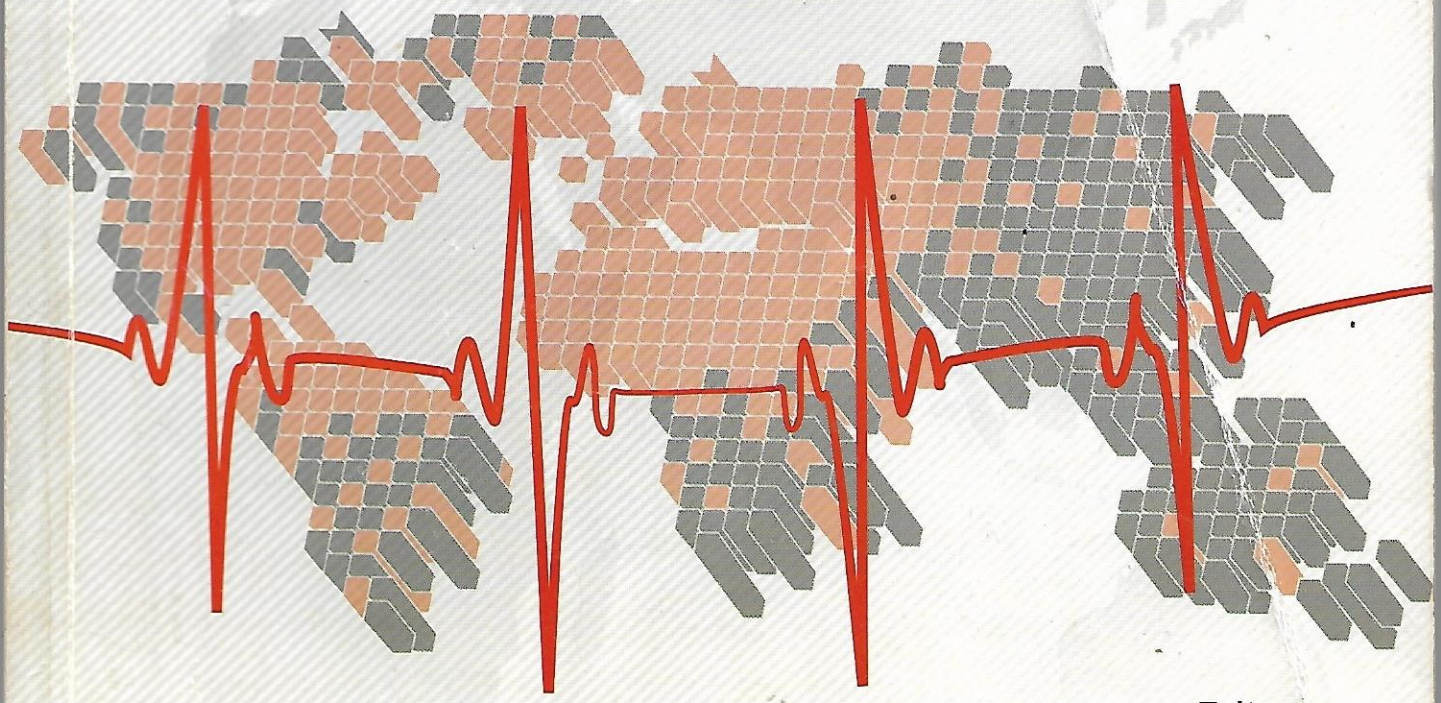

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Hamid Mehmood

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For any general queries, please contact publisher at:

**Geoinformatics International**
165/520 Moo 5, Tiwanon Road, Muang
Pathumthani, 12000, Thailand
Phone: +66-2-963-9148, Fax: +66-501-1677
E-mail: progeoinfo@gmail.com / nitiporn.ijg@gmail.com

# Content

# SPATIAL PATTERN OF MENINGOCOCCAL MENINGITIS IN KADUNA METROPOLIS

**Umaru Emmanuel Tanko[1], Ahmad Muhammad Nazri bin Ludin[1], Soheil Sabri[1] and Francis A. Adesina[2]**
Department of Urban and Regional Planning, Faculty of Built Environment, Universiti Teknologi, Malaysia[1]
Department of Geography, Obafemi Awolowo University, Ile Ife Nigeria[2]
E-mail: eumaru2001@yahoo.com

**ABSTRACT**
Meningococcal meningitis is an airborne disease that has been a threat to human life for over a century now. Countries within the West Africa meningitis belt are the worst hit. Kaduna metropolis, a town within northern Nigeria falls within the African meningitis belt. In spite of some of the government and non-governmental efforts in combating the menace; they don't seem to be winning the battle. The study seeks to investigate the spatial pattern of the spread and also to identify those locations that have high occurrence of the disease. Point data on Meningococcal meningitis (2007 to 2011) were used for the study. Getis and ord's local gi* statistics was used to evaluate the local spatial pattern of the disease. The result of the study revealed that neighborhoods that have high clusters with high Z scores includes Tudun wada, Tudun nupawa Kabala, Anguwan Mu'azu, Anguwan sanusi, Sabon gari, Anguwan mu'azu 1, Kudandan, Nasarawa industry, Polytechnic, Nasarawa village and Kurmin gbagyi. The other neighborhoods that have lower Z scores include Kawo extension, Kawo, Kawo GRA Airforce base and Agric center. The study discovered that there was a consistent spread of the disease in Kabala, Anguwan Mu'azu, Anguwan sanusi, Sabon gari, Anguwan mu'azu 1, Kudandan, Nasarawa industry, Polytechnic, Nasarawa village and Kurmin gbagyi neighborhoods for the period of five years which indicates strongly that the disease is more dominant in those locations.

**KEY WORDS:** Meningococcal meningitis, Spatial, Cluster, Outlier

## 1. INTRODUCTION

### 1.1 Background Study

Meningococcal meningitis is an infectious disease that meningococus (Neisseria meningitides) bacteria cause (Organization, 1998). It is a major cause of many deaths in the world especially in Africa. Meningococcal meningitis is usually referred to as cerebrospinal meningitis and it is the only bacterial meningitis that has the capacity to cause epidemics. Epidemics of meningococcal meningitis can occur anywhere in the world, but the greatest epidemics occurs specifically in the sub Saharan African which is referred to as the African "meningitis belt"(WHO, 2003). The disease occurs all over the world with variations in some seasons which is as a result of the changeable distribution of the endemic meningitis. Apart from the epidemics, the World Health Organisation (WHO) has discovered that over 1.1 million bacterial meningitis incidences manifest every year and about 130,000 cases are disastrous. Out of 450,000 people that are attacked by the disease over 55,000 are impaired and less than 65,000 casualties are as a result of *N. meningitidis*. From the records, there over 26,000 people that died (Tikhomirov, Santamaria, & Esteves, 1997) while 16,000 (6.4%) were incapacitated 10,000 (4%) had problems with hearing (Hodgson et al., 2001), and from Africa. Despite the fact the potent and non-harmful and affordable drugs are available globally, the disease is still linked to loss of lives and continual hearing defects mostly in children between the ages of 1 to 12 years (Tikhomirov et al., 1997). Variations in weather elements like temperature, humidity, and rainfall have effect on the occurrence and severity of the epidemic (Besancenot, Boko, & Oke, 1997; Cuevas et al., 2007; Stanwell-Smith et al., 1994; Tobías, Cayla, Pey, Alastuey, & Querol, 2011). A study carried out by (Molesworth, Cuevas, Connor, Morse, & Thomson, 2003) shows that high temperatures and low humidity influence the spread of meningitis.

Socio- economic factors affect the occurrence and intensity of the outbreaks. People in the middle and upper strata of the society, are rarely affected by the disease,(Moore, Harrison, Telzak, Ajello, & Broome, 1988; Olowokure, Onions, Patel, Hoosen, & O'Neill, 2006). Some studies that have been carried out have shown consistent evidence that meningococcal disease has a direct relationship with poor housing condition and household overcrowding (Fone, Harries, Lester, & Nehaul,

2003; Micheal Baker, Fafphm, Anne Mcnicholas, Mph, Nicholas Garret Ms, Nicholas Jones Fafphm, Joanna Stewart, Msc, Vivien Koberstein and Diana Lennon, 2000; Stuart et al., 1987). Other Studies by (Burgess, Frei, Lewis Ii, Fiebelkorn, & Jorgensen, 2007; Rosenstein et al., 1999) have also shown that low income level, low maternal education and other negative social characteristics were closely linked with increased risk of the disease. The age and sex is another major factor in the spread of meningococcal disease. Studies have shown that the attack is much more common in some particular age target and at the same time some authors proposed that the attack rate is not same for both sexes. A study in Mali, West Africa by (Imperato, 1983) revealed that boys that are within the age bracket of 5 to 15 years are more vulnerable to the disease due to some of their habits. Boys in Mali sleep beside each other, and the nocturnal closeness facilitates the spread of the disease within them. Studies by (Joachim & Nadel, 2011; Panjarathinam & Shah, 1993) indicated that age bracket of 5 to 15 years are more vulnerable to the disease.

Social behavior is another factor that influences the spread meningococcal disease. The social behaviors that are influencing the spread are smoking, clubbing, intimate kissing and sexual activity (Kriz, Bobak, & Kriz, 2000). Other studies by (Hodgson et al., 2001; Honish, Soskolne, Senthilselvan, & Houston, 2008; Mutonga et al., 2009; Stanwell-Smith R EStuart & Hughes, 1994) confirmed this.

Another study show that movement and large gatherings of people is another factor that influences the spread (Moore et al., 1988) of the disease.

Most of the studies that have been carried out about the spatial spread of Meningococcal meningitis have been on a large scale in which the relationship is assumed to be spatially constant across the whole study area, (Molesworth et al., 2003; Yaka et al., 2008), thus ignoring the local variations. Doing this is very inappropriate due to the fact that there could be a positively or negatively correlation of some other local factors that aids in the spread of the disease. The study aims at evaluating the spatial pattern of meningococcal meningitis in Kaduna metropolis.

## 2. METHODS

Reported cases of meningococcal meningitis from all the hospitals within the metropolis, both the public and private were used for the study. Both the public and private hospitals are expected to report any case of the disease to the health department of the local government, and the health department forwards the summaries to the epidemiology unit of Kaduna state ministry of health for proper documentation. For the purpose of this study, the case files for each patient were picked out and evaluated. Some vital information was extracted from the records. It includes name, address, date, age, sex, and occupation, level of income and status of survival. Spatial statics tool in ArcGIS 10.1 was used for the spatial statistical analysis.

Precisely, Getis and Ord (Gi) statistics was used for the analysis because of its capability to show the level of significance of the clusters of the meningococcal meningitis disease. Database design was made and all the spatial data which includes the neighborhood boundaries for Kaduna metropolis and also the attribute data which also includes name, address, date, age, sex, and occupation, level of income and status of survival.

### 2.1 Study Area

The Kaduna City Region is located in an ecological zone generally described as the northern Guinea Savanna Zone. It has been traditionally characterized by a mono-modal rainfall system and a growing period of 150-180 days (Max lock, 2010). It lies between latitudes 10 and 11 degrees north and longitude 7 and 8 degrees east. Its central location renders communications with the rest of the country relatively easy and facilitates the flow of agricultural inputs and produce. Kaduna City at an altitude of 645m above sea level is the capital of Kaduna State of Nigeria which itself is richly endowed with natural resources and a strong agricultural industry. A report by (Consultants, 2010) points that Kaduna Urban Area (KUA) is gazette 52km by 30km lying roughly Northeast/Southwest with Kaduna in its center. The UN estimates the population for the Kaduna urban agglomeration (based on Federal Government estimates) in 2010 at 1,561,000, (UN, 2009) by this estimate it is Nigeria's fifth largest city

## 3. RESULTS

### 3.1 Spatial Pattern

Hotspot analysis (Getis- ord local Gi Statistics) was conducted for each of the years, 2007 to 2011. This was done to be able to identify the clusters of hotspot and cold spot of the meningococcal meningitis spread in Kaduna metropolis and also for all the years to be compared to visualize the spatial processes that occurs within those years as regards to the spread of the disease.

Figure 1 shows the result of the hotspot analysis for the year 2007. It reveals that some neighborhood like Rigasa, Anguwan mua'zu, Kabala west, Anguwan mu'azu1 and Kudandan have the highest Z score of >2.58 Std. Dev. It indicates that the spread of the meningococcal meningitis was highest

in those neighborhoods. It was followed by those neighborhoods that have a Z score of 1.96-2.58 Std. Dev., the neighborhoods are Badiko, Anguwan sanusi, Polytechnic Qtrs., Tudun nupawa, Sabongari, Tudun wada, Magajin gari, Stadium, Anguwan mu'azu 2, Kudandan extension and Nasarawa industry. It implies that meningococcal meningitis spread in those neighborhoods is significant. In Nasarawa village and Kurmin gbagyi,

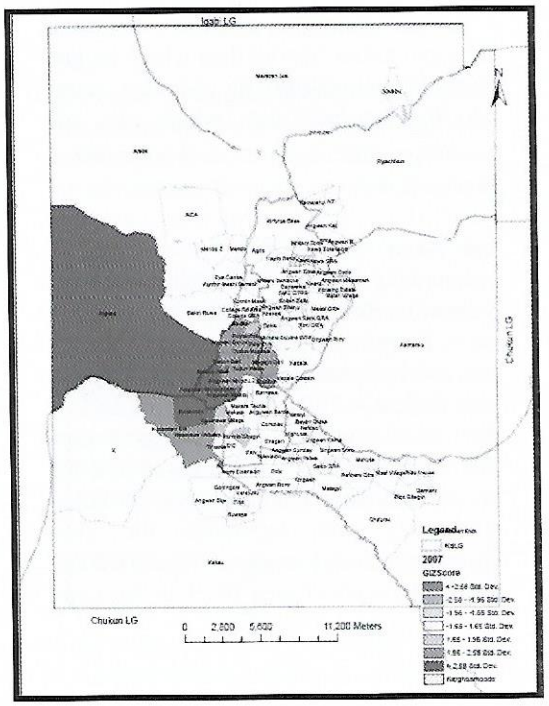



Figure 1: Hotspot analysis for year 2007

the Z score is 1.65-1.96 Std. Dev., indicating that the disease level is significant. Kawo neighborhood has a Z score of -1.96 to -1.65 indicating that it has the lowest Z score for the year 2007. It implies that the spread of the disease in Kawo is the lowest.

Figure 2 showed that Anguwan mu'azu 2, Anguwan mu'azu 1 and Kabala west have the highest Z score of 2.58 Std. Dev. It implies that the spread of meningococcal meningitis is highest in the three neighborhoods in year 2008. It was followed by those neighborhoods that have the Z score of 1.96-2.58 Std. Dev. They include Kudandan extension, Kudandan, Nasarawa industry, Tirkania, Nasarawa village, Anguwan mu'azu low, Sabongari, Polytechnic, Poly Qtrs, Tudun nupawa, Tudun wada, Magajin gari, Kabala costain, Makera, Kurmin gbagyi, Kakuri, Television and Shagari.

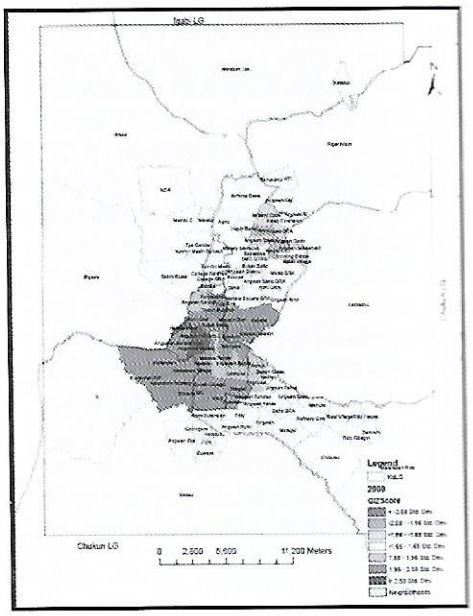
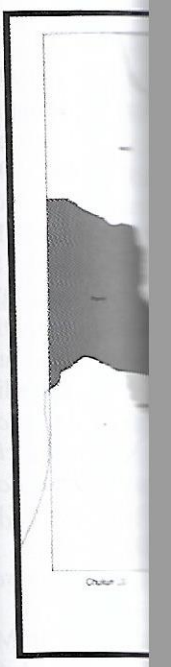



Figure 2: Hotspot analysis for year 2008

Neighborhoods like Badiko, Anguwan sanusi, Makera Textile, Anguwan Barde, Complex, Narayo and Complex had a Z score of 1.65-1.96 Std. Dev. It implies that the spread of meningococcal meningitis in the eight neighborhoods was also significant. Lower z score was observed in Kawo, Anguwan gado, Kwaru, Anguwan maisamari, Military zone, Kawo GRA, Anguwan dosa and Malali village all ranging from -2.58 to -1.65 Std. Dev. This indicates that there is a very low concentration of clusters of the disease spreading those neighborhoods especially Kawo, Anguwan gado, Kwaru and Anguwan maisamri because they have the lowest Z scores.

Figure 3 is the result of hotspot analysis for the year 2009. It showed that Rigasa, Kabala, , Anguwan Mu'azu and Polytechnic have the highest Z score of >2.58 Std. Dev.
It is followed by those neighborhoods that have a Z score of 1.96-2.58 Std. Dev., they include Poly Qtrs, Anguwan sanusi, Sabon gari, Anguwan mu'azu 1, Kudandan, Nasarawa industry. Seven other neighborhoods which include Badiko, Badiko barracks, Tudun nupawa, Anguwan Mu'azu 2, Kudandan extension, Nasarawa village, Kurmin gbagyi and DIC have a Z score ranging from 1.65-1.96 Std. Dev. This indicates that the spread of the meningococcal meningitis disease is very high on those neighborhoods that have Z score >2.58 Std. Dev., followed by those ones with 1.96-2.58 Std. Dev. and the ones with 1.65-1.96 Std. Dev.



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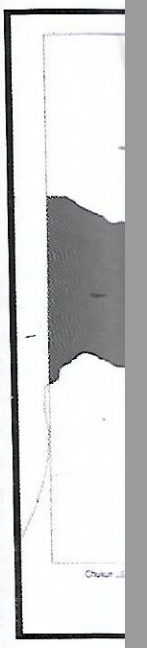

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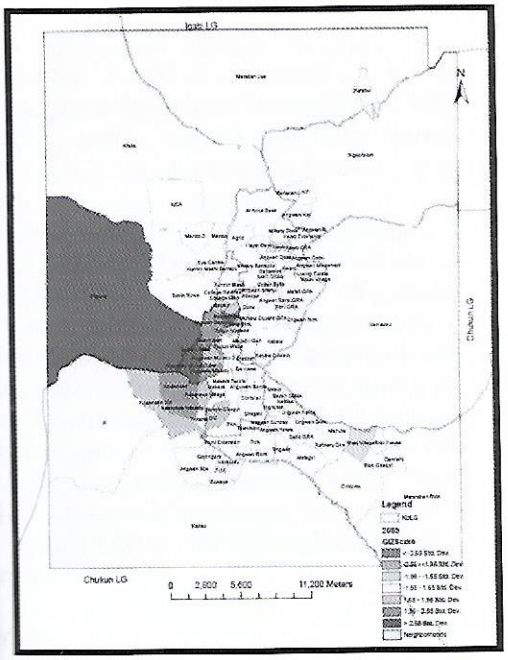


Figure 3: Hotspot analysis for year 2009

The result of the hotspot analysis showed that Kawo and Nissi village neighborhood have the lowest Z score of -1.96 to-1.65 Std. Dev. This indicates that the cluster of the meningococcal meningitis disease is lowest in those neighborhoods.

Figure 4 is the hotspot analysis for the year 2010. The result shows that only Rigasa neighborhood got the highest Z score of > 2.58 Std. Dev.

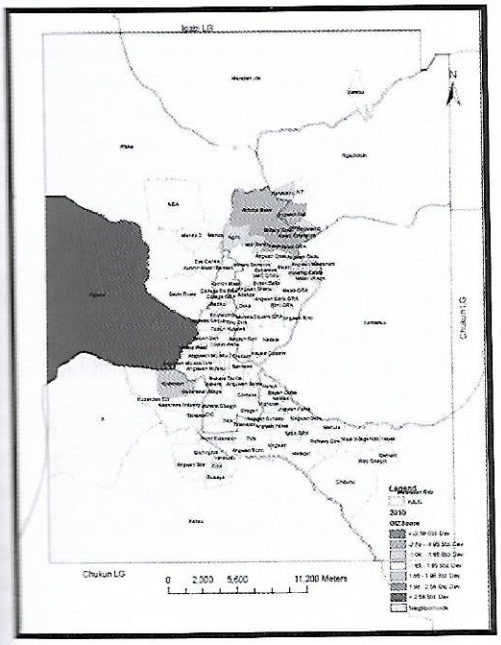


Figure 4: Hotspot analysis for year 2010

It is followed by Kudandan that had a Z score of 1.65-1.96 Std. Dev. This indicates that the cluster of meningococcal meningitis disease was very high in Rigasa in year 2010 with Kudandan neighborhood following. Low clusters of meningococcal meningitis were observed on these following neighborhoods and with a Z score of -2.58 to-1.96 Std. Dev., they are Airforce base, Anguwan Kaji, Military zone, Kawo extension, Kawo and Kawo GRA. It is followed by these neighborhoods having a Z score of -1.96 to-1.65 Std. Dev., they are Hayin bank, Barkalahu, Agric, Housing estate and Angwan b. It implies that those neighborhoods that are having a Z score of -2.58 to -1.96 Std. Dev. Have the lowest cases of the spread of the disease followed by those ones with -1.96 to -1.65 Std. Dev.

Figure 5 is the hotspot analysis conducted for the spread of meningococcal meningitis in 2011. It shows that there was Z score of 1.96-2.58 Std. Dev.

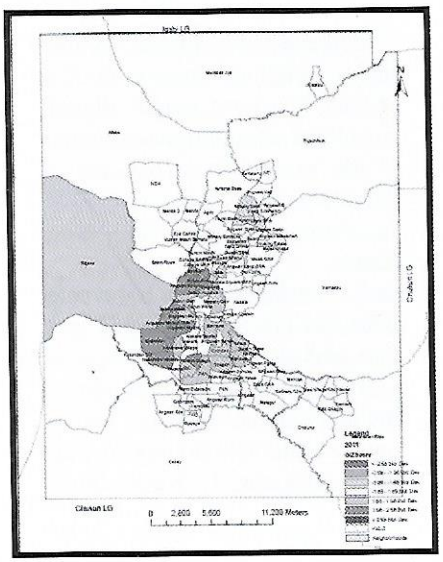


Figure 5: Hotspot analysis for year 2011

On neighborhoods like Polytechnic, Poly Qtrs, Kabala west, Anguwan mu'azu low, Anguwan mu'azu 1, Nasarawa industry, Nasarawa village, DIC, Kurmin gbagyi, PAN, Complex, Shagari, Highcost and Narayi. Other neighborhoods like Badiko, Anguwan sanusi, Doka, Tudun nupawa, Magajin gari, Sabon gari, Kabala, Kabala costain, Anguwan mu'azu 2, Makera, Makera textile, Barnawa and Anguwan barde have a Z score of 1.65-1.96 Std. Dev. It implies that those neighborhoods having the Z score ranging from 1.96-2.58 Std. Dev. have the highest clusters of the disease spread followed by the neighborhoods that have 1.65-1.96 Std. Dev. Those neighborhoods with

low Z score include Military zone, Kawo and Kawo GRA all having a Z score of -1.96 to -1.65 Std. Dev.. It indicates that these neighborhoods have the lowest clusters of the disease spread.

### 3.2 Temporal Pattern

Comparing the results of the hotspot analysis for those five years reveals that there is a trend in the spread of the meningococcal meningitis. There are some neighborhoods that the spread of the disease has been dominant over the five year period, like Kabala, Anguwan Mu'azu, Anguwan sanusi, Sabon gari, Anguwan mu'azu 1, Kudandan, Nasarawa industry Polytechnic, Nasarawa village and Kurmin gbagyi. And some neighborhoods showed a consistent low cluster of the meningococcal meningitis spread like Kawo extension, Kawo, Kawo GRA Airforce base and Agric center. Many other neighborhoods did not have any significance in the spread of the disease either on the high side or the low side. It is very likely that those factors that facilitate in the spread of the disease are very active in in the neighborhoods that have had a consistent dominance of the disease spread. While it is less active in those neighborhoods with low level of significance and for those neighborhoods that did not show any level of significance may mean that the factors are present but they are not strong enough to facilitate the spread.

### 4.0 Discussion

The spatial analysis has revealed those neighborhoods that are more affected by the spread of the disease and also those ones that are affected very little. Those neighborhoods that are more affected inclide Tudun wada, Tudun nupawa Kabala, Anguwan Mu'azu, Anguwan sanusi, Sabon gari, Anguwan mu'azu 1, Kudandan, Nasarawa industry Polytechnic, Nasarawa village and Kurmin gbagyi. Those neighborhoods that are less affected are Kawo extension, Kawo, Kawo GRA Airforce base and Agric center. This indicates that there could be some factors within those neighborhoods that are facilitating the spread of the disease.

## 5. CONCLUSION

The study was aimed at identifying those neighborhoods that have high clusters and low clusters of the disease spread. It was able to detect those neighborhoods with the high cluster and also the low clusters. It is very likely that there are some underlying factors that are facilitating the spread of the disease in those high clusters neighborhoods. The study suggests that researches in the future should be focused on identifying those factors that are responsible for the spread of the disease.

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