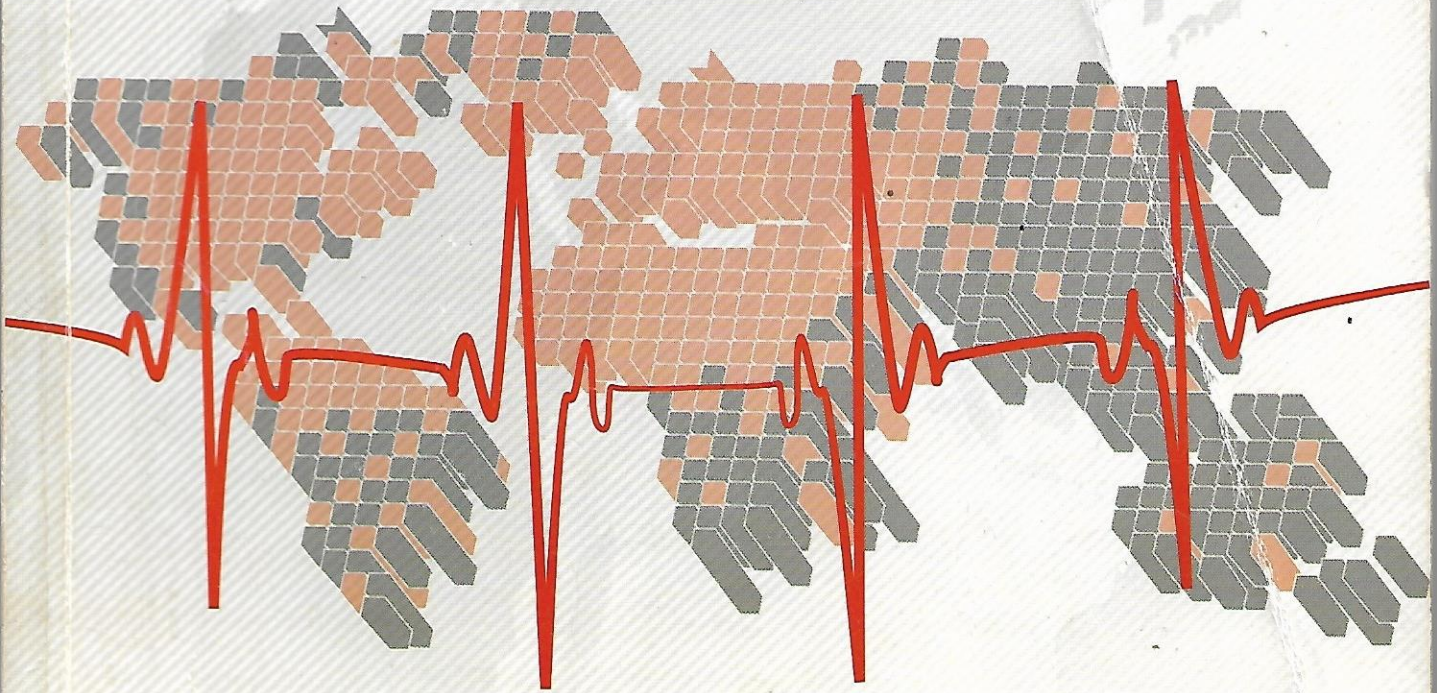


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Content

Foreword	C
Keynote Session	F
Technical Session	
Technical Session 1	1
Technical Session 2	15
Technical Session 3	46
Technical Session 4	83
Technical Session 5	97
Technical Session 6	119
Technical Session 7	132
Technical Session 8	178
Poster Session	243
Author Index	256

SPATIAL PATTERN OF MENINGOCOCCAL MENINGITIS IN KADUNA METROPOLIS

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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. Past data on Meningococcal meningitis (2007 to 2011) were used for the study. Getis and Ord's local G* 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 meningococcus (*Neisseria meningitidis*) 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 epidemics (Besancenot, Boko, & Oke, 1997; Cuevas et al., 2007; Stanwell-Smith et al., 1994; Tobias, 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, Hooson, & 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, Mph, Nicholas, Joanna Stewart, Lennon, 2000; Burgess, Frei, 2007; Rosenstem, low income level, negative social, with increased, is another, meningococcal, attack is much, target and at the, that the attack, study in Mali, revealed that, 5 to 15 years, to some of their, each other, and, the spread of the, (Joachim & Nade, 1993) indicated, more vulnerable, Social behavior, spread meningoc, that are influen, clubbing, intimate, Bobak, & Kriz, 2001; Hom, Houston, 2008, Smith R E Stuart &

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2. METHODS

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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 every 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 statistics 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 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'azul 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,

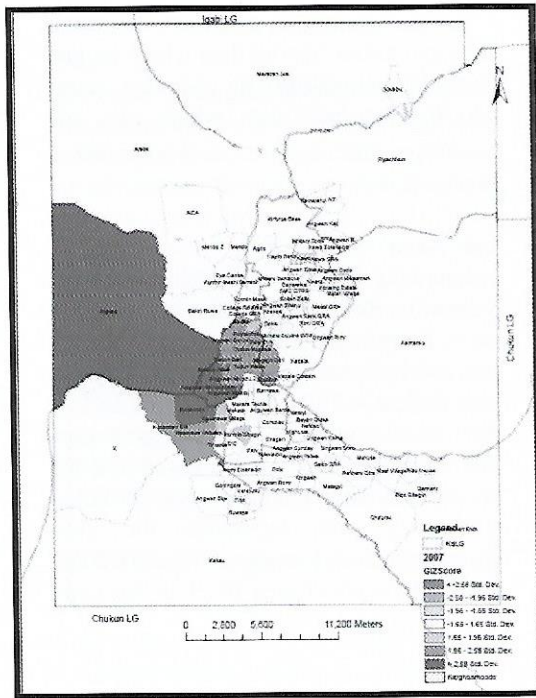


Figure 1: Hotspot analysis for year 2007

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.

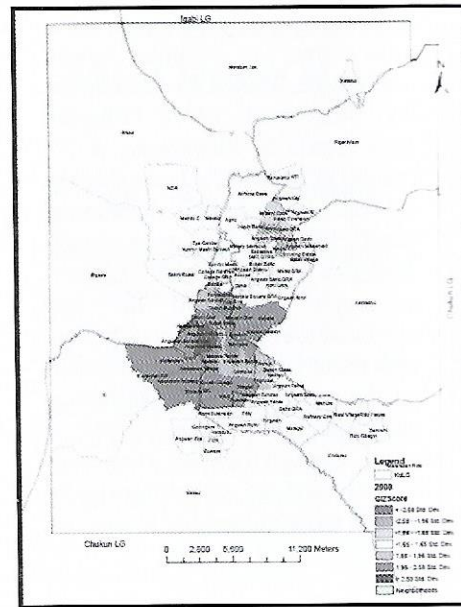


Figure 2: Hotspot analysis for year 2008

Neighborhoods like Badiko, Anguwan sanusi, Makera Textile, Anguwan Barde, Complex, Narawa 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.

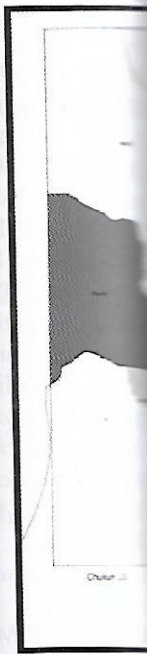


Figure 3

The result of the and Nissi village score of -1.96 to the cluster of the is lowest in those

Figure 4 is the The result show the highest Z score



Figure 4

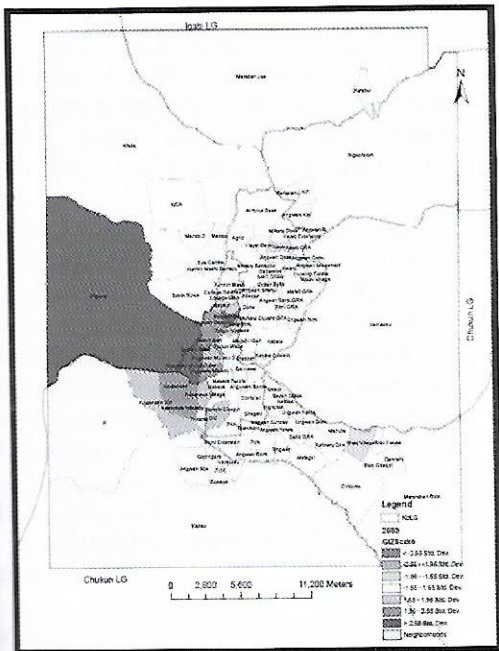


Figure 3: Hotspot analysis for year 2009

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.

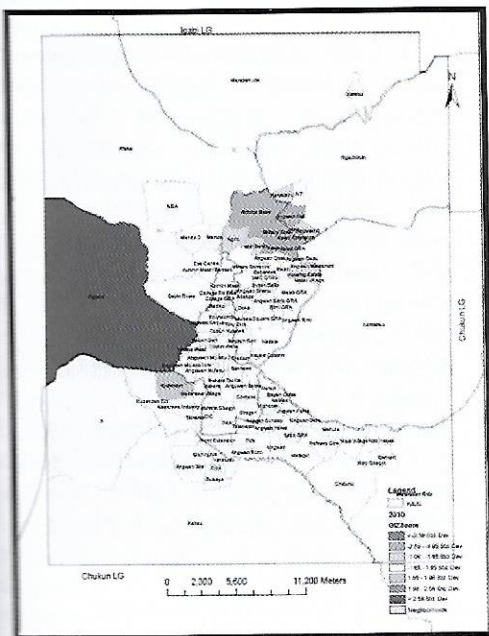


Figure 4: Hotspot analysis for year 2010

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.

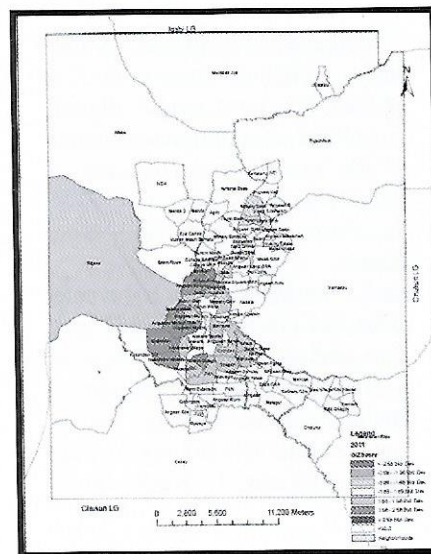


Figure 5: Hotspot analysis for year 2011

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 include 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.

REFERENCES

- Besancenot, J. P., Boko, M., & Oke, P. C. (1997). Weather conditions and cerebrospinal meningitis in Benin (Gulf of Guinea, West Africa). *European journal of epidemiology*, 13(7), 807-15. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/9384271>
- Burgess, D. S., Frei, C. R., Lewis Li, J. S., Fiebelkorn, K. R., & Jorgensen, J. H. (2007). The contribution of pharmacokinetic-pharmacodynamic modelling with Monte Carlo simulation to the development of susceptibility breakpoints for *Neisseria meningitidis*. *Clinical microbiology and infection: the official publication of the European Society of Clinical Microbiology and Infectious Diseases*, 13(1), 33-9. doi:10.1111/j.1469-0691.2006.01617.x
- Consultants, M. L. (2010). *The Master Plan Revised 2010* (p. 348). Kaduna.
- Cuevas, L. E., Jeanne, I., Molesworth, A., Bell, M., Savory, E. C., Connor, S. J., & Thomson, M. C. (2007). Risk mapping and early warning systems for the control of meningitis in Africa. *Vaccine*, 25(1), 12-17. doi:10.1016/j.vaccine.2007.04.034
- Fone, D. L., Harries, J. M., Lester, N., & Nehaul, L. (2003). Meningococcal disease and social deprivation: a small area geographical study in Gwent, UK. *Epidemiology and infection*, 130(1), 53-8. Retrieved from <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2869938&tool=pmcentrez&rendering=abstract>
- Hodgson, a, Smith, T., Gagneux, S., Adjuik, M., Pluschke, G., Mensah, N. K., Binka, F., et al. (2001). Risk factors for meningococcal meningitis in northern Ghana. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 95(5), 477-80. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/11706652>
- Honish, L., Soskolne, C. L., Senthilselvan, A., & Houston, S. (2008). Modifiable risk factors for invasive meningococcal disease during an Edmonton, Alberta outbreak, 1999-2002. *Canadian journal of public health. Revue canadienne de santé publique*, 99(1), 46-51. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/18435340>
- Imperato, P. J. (1983). Epidemic meningococcal meningitis: the case of Mali. *Bulletin of the New York Academy of Medicine*, 59(9), 818-22. Retrieved from <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1911698&tool=pmcentrez&rendering=abstract>
- ...achim, C., & ... meningococcal ... Health, doi:10.1016/j.jpa...
- ...Kriz, P., Bobak, ... smoking, social ... invasive mening ... population base ... Disease Child ... Michael Baker, ... Nicholas Garner, ... Joanna Stewart, ... Diana Lennon, ... Major Risk Fac ... Disease in ... Infectious Disea ... Molesworth, A. M. ... Morse, A. P., ... Environmental ... Africa. *Emerg ...* 1287-93. doi:10.1016/j.jpa...
- ...Moore, P. S., Har ... G. W., & Ba ... meningococcal ... from Saudi Ar ... American Med ... 9. <http://www.ncbi.nlm.nih.gov/pubmed/11706652>
- ...Mutonga, D. M., ... C., Mutiso, J., ... (2009). Epide ... serogroup X ... an outbreak in ... American Jour ... Hygiene, 80(4), 477-80. <http://www.ncbi.nlm.nih.gov/pubmed/1911698>
- ...Olowokure, B., O ... O'Neill, P., ... socioeconomic ... disease: a rural ... of infe ... doi:10.1016/j.jpa...
- ...Organization, W. ... meningococcal ... guidelines. 2nd ... Panjarathinam, R. ... meningitis in ... Pediatrics, doi:10.1007/B...
- ...Rosenstein, N. E. ... Lefkowitz, L. ... Cieslak, P., ... epidemiology ... United State ... infectious ... doi:10.1086/3...

- Joachim, C., & Nadel, S. (2011). Management of meningococcal disease. *Paediatrics and Child Health*, 21(4), 153–158. doi:10.1016/j.paed.2010.09.001
- Kriz, P., Bobak, M., & Kriz, B. (2000). Parental smoking, socioeconomic factors, and risk of invasive meningococcal disease in children: a population based case-control study. *Archives Disease Child Journal*, 83, 117–121.
- Micheal Baker, Fafphm, Anne McNicholas, Mph, Nicholas Garret Ms, Nicholas Jones Fafphm, Joanna Stewart, Msc, Vivien Koberstein and Diana Lennon, F. (2000). Household Crowding a Major Risk Factor for Epidemic Meningococcal Disease in Auckland Children. *Pediatric Infectious Disease Journal*, 19(10), 983–990.
- Molesworth, A. M., Cuevas, L. E., Connor, S. J., Morse, A. P., & Thomson, M. C. (2003). Environmental risk and meningitis epidemics in Africa. *Emerging infectious diseases*, 9(10), 1287–93. doi:10.3201/eid0910.030182
- Moore, P. S., Harrison, L. H., Telzak, E. E., Ajello, G. W., & Broome, C. V. (1988). Group A meningococcal carriage in travelers returning from Saudi Arabia. *JAMA: the journal of the American Medical Association*, 260(18), 2686–9. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/3184335>
- Mutonga, D. M., Pimentel, G., Muindi, J., Nzioka, C., Mutiso, J., Klena, J. D., Morcos, M., et al. (2009). Epidemiology and risk factors for serogroup X meningococcal meningitis during an outbreak in western Kenya, 2005–2006. *The American Journal of Tropical Medicine and Hygiene*, 80(4), 619–624. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/19346388>
- Olowokure, B., Onions, H., Patel, D., Hooson, J., & O'Neill, P. (2006). Geographic and socioeconomic variation in meningococcal disease: a rural/urban comparison. *The Journal of Infection*, 52(1), 61–6. doi:10.1016/j.jinf.2005.01.013
- Organization, W. H. (1998). Control of epidemic meningococcal disease, WHO practical guidelines. 2nd edition.
- Panjarathinam, R., & Shah, R. K. (1993). Pyogenic meningitis in Ahmedabad. *The Indian Journal of Pediatrics*, 60(5), 669–673. doi:10.1007/BF02821730
- Rosenstein, N. E., Perkins, B. a, Stephens, D. S., Lefkowitz, L., Cartter, M. L., Danila, R., Cieslak, P., et al. (1999). The changing epidemiology of meningococcal disease in the United States, 1992–1996. *The Journal of infectious diseases*, 180(6), 1894–901. doi:10.1086/315158
- Stanwell-Smith R EStuart, J. M., & Hughes, A. R. P. G. M. B. C. K. (1994). Smoking, the environment and meningococcal disease: a case control study. *Epidemiologic Journal*, 112(January 1988), 315–328.
- Stanwell-Smith, R. E., Stuart, J. M., Hughes, A. O., Robinson, P., Griffin, M. B., & Cartwright, K. (1994). Smoking, the environment and meningococcal disease: a case control study. *Epidemiology and Infection*, 112(2), 315–28. Retrieved from <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2271460&tool=pmcentrez&rendertype=abstract>
- Stuart, J. M., Cartwright, K. A. V., Jones, D. M., Noah, N. D., Wall, R. J., Blackwell, C. C., Jephcott, A. E., et al. (1987). An outbreak of meningococcal disease in Stonehouse: planning and execution of a large-scale survey. *Epidemiology and Infection*, 99(03), 579–589. Retrieved from http://journals.cambridge.org/abstract_S0950268800066437
- Tikhomirov, E., Santamaria, M., & Esteves, K. (1997). Meningococcal disease: public health burden and control. *World health statistics quarterly. Rapport trimestriel de statistiques sanitaires mondiales*, 50(3-4), 170–7. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/9477545>
- Tobías, A., Caylà, J. a, Pey, J., Alastuey, A., & Querol, X. (2011). Are Saharan dust intrusions increasing the risk of meningococcal meningitis? *International journal of infectious diseases: IJID: official publication of the International Society for Infectious Diseases*, 15(7), e503. doi:10.1016/j.ijid.2011.03.008
- WHO. (2003). World Health Organisation. WHO. Retrieved November 13, 2012, from <http://www.who.int/about/definition/en/print.htm>
- Yaka, P., Sultan, B., Broutin, H., Janicot, S., Philippon, S., & Fourquet, N. (2008). Relationships between climate and year-to-year variability in meningitis outbreaks: A case study in Burkina Faso and Niger. *International Journal of Health Geographics*, 135, 1–13. doi:10.1186/1476-072X-7-34

Author Index

Ahmad Ali Hanafi-Bojd	47	Haoran Zhang	254
Ahmad Muhammad Nazri bin Lud	201	Hasan Raja Naqvi	128
Ajay Sharma	103	Hasan Raza	129
Akbar Khan	129	Hazrin Hashim	14, 109
Albina Apriadsa	3	Helga Fogstad	48
Alexia Joachim	179	Hidayatulfathi Othman	14
Ali Reza Rabet	63	Iqbal, M.C.M.	4
Allisyn Moran	48	Iskandar Muda Purwaamijaya	28
AL-Shameri	180	Jagdish Mahanta	40
Ameneh Karimi	47	James Campbell	48
Amonrat Sonsa	57	Janak Kumar Thapa	177
Anawat Phalee	250	Jeni Rajbamshi	162
Andrew J. Tatem	48	Jenjira Tanleng	68
Aparna R. Phalke	207	Jonathan Inbaraj Doss	214
Ash Pachauri	35	K M Srinath	138
Ashish Upadhyay	166, 255	Karen Corson	131
Atiqur Rahman	128, 129	Karin Stenberg	48
Ayesha De Costa	166, 167	Karuthan Chinna	214
Ayesha Sulthana	180	Khandoker Tamirul Islam	120
Ayumi Arai	196	Khathawut Panboon	250
Azharul Islam Khan	120	Kongjak Jaidee	94, 95, 96
Aziz Shafie	2, 150, 214	Kristi Sidney	167
B Madhu	138	Kusumawathi, P.H.D.	4
Balasubramanian, S.	3, 138, 180, 186, 192	Kyle Hathaway	131
Banchob Sripa	94, 95, 96	Lakes, T.	4
Barandi Sapta Widartono	3, 39	Lalitha Vadrevu	113
Barun Kanjilal	113	Latha K. C.	186
Bidisha Chattopadhyay	231	Laxman Sharma	124
Bijoy K. Handique	40	Liesl Zühlke	179
Bongani Mayosi	179	Lutfie Ara	120
Bowo Susilo	3	M. Harun-Or- Rasid	10
Bruce Wilcox	94, 95	M. Selvaraj	9
C.K.M. Deheragoda	2	Madhav Chaulagain	162
Chalermchai Pawattana	71	Maduni Madanayake	4
Chalobol Wongsawad	250	Mamatha Guruprasad	23
Chanthana Wech-O-Sodsak	84	Manandhar, P	177
Chatree Krabuanrat	144	Manasi Bawdekar	98
Chatupon Manetab	68	Manoj Das	129
Choosak Nithikathkul	57, 221, 237, 250	Manoj K. Das	128
Chris Chiesa	131	Marc Souris	242
Christina Kim	96	Maria Guerra-Arias	48
Christina Sunyoung Kim	95	Maria Loureiro	9
Chua Kek Heng	150	Marilyn O'Hara Ruiz	2
Debjani Barman	113	Mark Daniel	128
Dileep Mavalankar	166	Mark Engel	179
Dylan Barth	179	Martya Rahmaniati Makful	17, 133
Ekkarat	254	Mayur Vaswani	128, 129
Elsa Herdiana	39	Mazrura Sahani	14
Eric Daudé	3	Md. Abu Saeid	10
Fadhli Yusof	109	Md. Akramul Islam	10
Fifi Amoako Johnson	48	Milima Singh Dangol	162
Francis A. Adesina	201	Mohamad Naim Mohamad Rasidi	14
Govindaraju Munisamy	9	Mohammad Moktadir Kabir	10
Gunatilake, J.	4	Mohsen Ahadnejad Reveshty	63
H.M. Prabath Jayantha	2	Motaher Ali Al-Shameri	186

Murtaza Ali	130	Sharma N	177
N C Ashok	138	Shashidhar Thatikonda	9
Nakarín Chaikaew	125	Shikha Dixit	128, 129
Narayan Chandra Jana	156	Shridhar R	192
Narendra Arora	129	Singuluri Sudhakar	40
Narendra K. Arora	128	Siraj Ahmed Khan	40
Narueset Prasertsri	84	Siriwan Hassarangsee	242
Nasrin Nari	63	Soheil Sabri	201
Natapol Pumipuntu	64	Sompong Jarungjitanuson	237
Natasha J. Howard	128	Somsak Sripakdee	237
Navamon Sinlabud	68	Somsakun Maneerat	3
Nitchanan Phisaphab,	68	Somu, G.	169
Nitin K. Tripathi	207, 225, 242, 254	Songkran Nakbun	221
Nivedita Nukavarapu	16	Sridhar R	23
Norzawati Yeop	14	Srisaang Koajarem	254
Orasa Suksawang	144	Steeve Ebener	48
P. Kumar	9	Sudhakar Kantipudi	169
P. Suganthi	9	Sukhum Keerativittayanun	68
Parichat Saenna	94, 95	Sulistyawati	39
Patsy Bailey	48	Suneerat Yangyuen	84
Pattamapond Limpanopas	68	Sung-Jong Hong	221
Phaisam Jeefoo	71, 125	Sunil Sisodia	129
Pipat Reungsang	57, 221	Supachai Nakapan	125
Pissamai Homchampa	237	Surachet Chaiprapathong	250
Pitpassorn Chansawang	68	Surya Durbha	16
Pradip Kumar Bardhan	120	Suwimon Songklang	84
Prakash M. Nimbalkar	207	Swati Trehan	35
Prasanta Kumar Ghosh	156	Tahir Aris	14, 109
Prem Singh	124	Taravudh Tipdecho	242, 254
Prima Widayani	3	Teerayut Horanont	196
Priyanka Kamble	98	Thanachai Supphanam	68
Promote Thongkrajai	221	Thidharat Somdee	84
Punsa Pungkhom	244	Thitiworn Choosong	68
R Sridhar	138	Toshikazu Nakamura	196
Rajeev Gera	124	Udomsak Mahaweerawat	84
Rakesh Singh	129	Umaru Emmanuel Tanko	201
Rama Tammu	9	Veena Iyer	166
Ramya Rathan	23	Vishal Diwan	167
Ramya Rathan	192	Vivarad Phonekeo	225
Raphael Duboz	254	Wanida Jinsart	244
Ratchaphon Samphutthano	213	Wijesundara, S.	4
Raymond Stiff	131	Wirasiri Waseeweerasi	250
Reid Porter	48	Worapol Aengwanich	64
Rina Marina Masri	28	Worapong Sirofjanawong	225
Romano Ngui	150	Wutjanun Muttitanon	75
Rozita Hod	14	Yogesh Sabde	167
Ryosuke Shibasaki	196	Yusrin	17
Sabrina Che Soh	214	Yvonne Ai Lian Lim	150
SadhanaTayade	98	Zainudin Mohd Ali	14
Sarah Neal	48	Zoe Matthews	48
Sarawut Jampapunt	237	Monika Setia	255
Sarawut Ninsawat	225, 254	Paresh Chaudhary	255
Sauerborn, R	4	Ritu Rana	255
Shaharudin Idrus	14	Jitendra D Gajjar	255
Shahidul Islam Laskar	10	Dileep Mavalankar	255
Shamsun Naher	10		