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Spatio-Temporal Analysis of Diabetes Mellitus in Kano Metropolis, Nigeria

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Abstract
This paper focused on the spatio-temporal analysis of diabetes mellitus in Kano Metropolis, Nigeria. The study reviewed eight thousand one hundred and twenty six (8126) diabetes case folders. The study captured all the reported diabetic cases which covered ten years period from 1st January, 2005 to 31st December, 2014. Four hospitals were purposely selected for this study. They are: Murtala Muhammad Specialist Hospital, Muhammad Abdullahi Wase Specialist Hospital, Sheikh Muhammad Jidda General Hospital and Waziri Shehu Gidado General Hospital. The data collected were: date of admissionin to the hospital, gender, age and addresses. ArcGIS 10.2 and SPSS 20.0 are the software used for the analysis. The study revealed that diabetes mellitus cases varied significantly in Kano metropolis. Higher cases of diabetes were recorded in Rijiyar Lemo with 4.3% followed by Gobirawa with 3.8%while Diso, Kabuwaya and Kantudu recoded the lowest percentage of only 0.1%. Kano municipal local government area recorded the highest cases of about 16.7% this was followed by Nassarawa with about 14.6% and Gwale became third with 12.3% while Tarauni recorded the lowest with about 8.0%. The study recommended the need for mass public awareness and sensitization campaigns by the state ministry of health in collaboration with Diabetes Association of Nigeria on what the diabetes mellitus is, its causes, symptoms, preventive measures and its management.

Keywords: Spatio, Temporal, Analysis, Diabetes Mellitus

INTRODUCTION
Non-communicable diseases (NCDs) are on the rise worldwide. Studies conducted by WHO (2004) showed that four main NCDs – cardiovascular disease (CVD), cancer, chronic lung diseases, and diabetes, kill three in five people worldwide, and cause great socio-economic harm within all countries, particularly in developing nations. Diabetes Mellitus is a re-emerging disease that was once a problem in some particular regions of the World, but is now becoming a problem for a significant proportion of a population in the World (WHO, 2004). However, chronic diseases such as diabetes were traditionally more prevalent in advanced, industrial societies, it has increased in scope over the past few decades and have begun to emerge as major health problem among populations of developing countries of the World. Disease emergence is the result of changing geographies brought about by alterations in the environment, composition of the population living in that environment, or both (WHO, 2004). Positive association has been reported between the risk of diabetes and different patterns of food intake (Liese, 2009; Schulze, 2004).

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The term diabetes was coined by Apollonius Memphis around 250BC. It is derived from a Greek word "diabainein" meaning "siphon to pass through". It was in1675 that Thomas Willis added the Latin word "Mellitus" meaning "honey or sweet". This is because of the excess sugar found in the blood and urine (Ananya, 2012). Sunny, *et .al.* (2013) defined diabetes as a chronic metabolic disorder characterized by chronic hyperglycemia, caused by an absolute or relative insulin deficiency or defective action of both resulting in disorder of carbohydrate, protein and fat metabolism.

The rate of diabetic patients with complications is increasing on a daily basis, admission is made either due to diabetes or diabetes complications such as stroke, hypertension, amputation, nephropathy, neuropathy, retinopathy, cardiovascular, impotence, skin lesions (Adiseshiah, 2005).The increasing number of individuals with diabetes indicates a global epidemic. The global prevalence of the disease was estimated to be 2.8% in 2000. The world prevalence of diabetes in 2010 among adults (aged 20-79 years) was estimated at 6.4% affecting 285 million adults. By 2030 it is expected to increase to 7.7% and affecting 438 million adults. Between 2010 and 2030, there is an expected 69% increase in numbers of adults with diabetes in developing countries and a 20% increase in developed countries, 36% of the anticipated absolute global increase of 154 million people with diabetes is projected to occur in India and China alone (Shaw, Sicree and Zimmet, 2010). These predictions clearly indicate that the global burden of diabetes is growing and the greatest increase is seen particularly in low and middle-income countries (Mbanya, 2010; Whiting, *et.al* 2011).Although the prevalence of diabetes is expected to increase in all age groups, it has been estimated that there will be a greater increase in the proportion of patients with diabetes who are aged 45–64 years (Adiseshiah, 2005). Additionally, about 387 million people worldwide with the prevalence of 8.3% and 46.3% undiagnosed in the age group of 20-79 years were estimated to have diabetes International Diabetes Federation Atlas (2014).

However, the future collaborative research activities on health and diseases by Medical Geographers is likely to centre around the following areas: disease mapping with the use of Geographic Information System (GIS);disease risk assessment in particular urban risk-cell areas; global, national and even local environmental change with their human health implications; epidemiological transition including the menace of HIV and AIDS, Cancer in Sub Saharan Africa and behavioral perspectives of health seeking patterns of consumers (Iyun,1998). Therefore Medical Geographers have an important part to play in analyzing the spatial distribution and temporal variation of diabetes mellitus as well as creating awareness to communities about the menace of diabetes and the importance of good living and change in lifestyle in order to be safe from diabetes. In view of these, this study analyzed the spatio-temporal distribution of diabetes mellitus in Kano Metropolis, Nigeria.

MATERIALS AND METHODS

Study Area

The Study area (Kano Metropolis) Figure 1 which comprise Kano municipal, Gwale, Dala, Nassarawa, Kumbotso, Ungogo, Fagge and Tarauni local government area is among the fastest growing cities in Nigeria as well as the largest city in Northern Nigeria. In 1931, the population of Kano metropolis was 96,805 persons while as at 2015 this figure rose to 3,626,068 (TMTN, 2016).

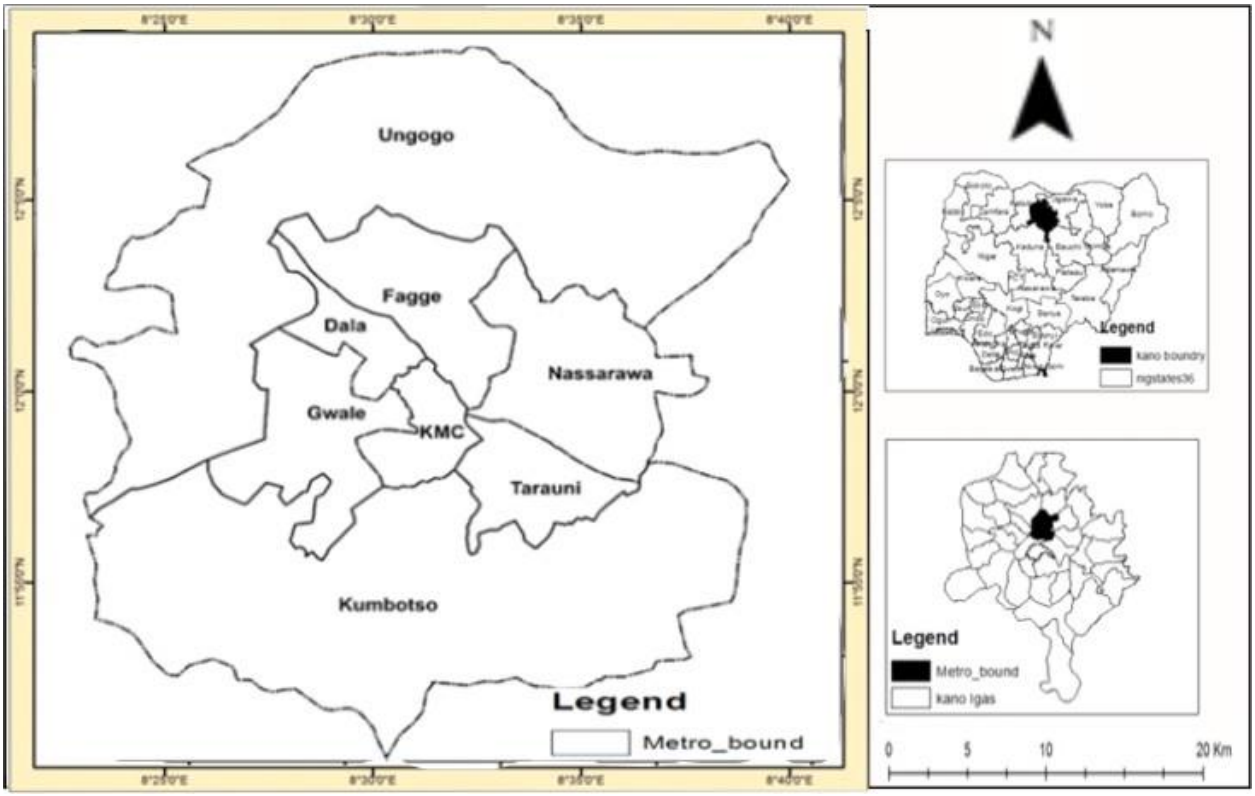

Figure 1: Kano Metropolis
Source: BUK, GIS Lab

The study area is relatively bounded by Minjibir local government area in the North East, Gezawa local government area to the East, Dawakin Kudu local government area to the South East, Madobi and Tofa local government area to the South West and finally Dawakin Tofa local government area to the North West. The area under investigation is located between Latitude 11° 52′2″ to 12° 7′41″ North of Equator and Longitude 8° 25′3″ to 8° 39′57″ East of Prime Meridian. Kano metropolis has an approximate Land area of about 499 km^2, whereby the longest distance north to south has been 26.9km while west to east about 19.5km. Considering the nature of the population of Kano metropolis how it is rapidly increasing, how the entire environment is entirely changing geographically and naturally it becomes necessary to investigate the emergence of the diabetes mellitus.

Types and Source of Data

The data used in this research is secondary data obtained from Diabetes Clinics Health Records Units of Murtala Muhammad Specialist Hospital, Muhammad Abdullahi Wase Specialist Hospital, Sheik Muhammad Jidda General Hospital and Waziri Shehu Gidado General Hospital. All reported, diagnosed and hospitalization diabetes case folders of patients in the health facility from 1st January, 2005 to 31st December, 2014 were captured to generate the required information used in the research. A total number of eight thousand one hundred and twenty six (8126) case folders were identified, reviewed and analyzed in the study.

Methods of data collection

Before collection of data for the study the research aim and objectives was defended before the research ethics committee of Kano State Hospital Management Board after which an ethical clearance (HMB/GEN/488/VOL.1) was granted. Data were then collected through checking and recording information from diabetes case folders of patients Records Units of the selected Hospitals, in some case folders address were not indicated at all while in some

age is indicated as adult (AD) all these were coded and analyzed as others. Similarly, looking at the hospitalization out comes, for example discharged home, referral, absconded, discharged against medical advice (DAMA) and died, that were diagnosed in the hospital but died at home were not considered part of the hospitalization in the analysis. This is because they were not reported back to the facility as dead. Finally, in coding addresses, some wards were merged and coded as one ward. This is because at the time of registration or diagnosis in the hospital, information on some patient's cases folders did not clearly specify their addresses.

Sampling

The study purposely selected two Specialist Hospitals and two General Hospitals (Table 1) but excluded Aminu Kano Teaching Hospital because most of the recent studies did not include either specialist hospital or general hospitals which are mostly patronized by many people with low income and patients attending teaching hospitals are probably more enlightened on health and health related issues. Some of these studies include that of; Adeleke,*et.al.*(2010) who studied childhood diabetes mellitus in Kano, north western Nigeria. The study reviewed hospital records of paediatric patients managed for diabetes mellitus at Aminu Kano Teaching Hospital between January 1999 to December 2006. Another study conducted by Ugege, *et.al* (2013) studied childhood diabetes mellitus in Sokoto, north western Nigeria: a ten year review. The study reviewed case files of children aged 15 years and below with childhood diabetes mellitus at the Usman Danfodio University Teaching Hospital (UDUTH) Sokoto, between September 2001 to December 2011. Clinical profile of childhood Type-1 diabetes in Jos was also studied by John, *et.al* (2013) the study reviewed children with diabetes in paediatric department of Jos University Teaching Hospital. This study selected these hospitals also due to the fact that, the reported cases will be higher due to the absence of consultancy fees and very little laboratory charges on glucose testing when compared with charges from University Teaching Hospitals that are high. Therefore, to the best of the researcher's knowledge, there is no known study on diabetes that used data from either specialist hospitals or general hospitals in Kano state.

Table 1: Selected Hospitals for the Study

S/N	Hospital	Location
1.	Murtala Muhammad Specialist Hospital (zone 6)	Kano Municipal Local Government Area
2.	Muhammad AbdullahiWase Specialist Hospital (zone 7)	Nassarawa Local Government Area
3.	Sheikh MuhammadJidda General Hospital (zone 8)	Fagge Local Government Area
4.	Waziri Shehu Gidado General Hospital (zone 10)	Ungogo Local Government Area

Source: Field study, 2015.

Data Analysis

To achieve the objective of this study, ArcGIS 10.2 software was used for the spatial analysis. To do that, the diabetes cases data collected for the period of ten years (2005-2014) and the geographical coordinate points of the 77 ward addresses of the cases which were considered as mapping units were entered into Microsoft excel application 2007 as a data base,. The wards are as follow:- Challawa, Gwagwarwa, Chedi, Rangaza, Danbare, Adakawa, Naibawa, Kofar Mazugal, Gwale, Mandawari, Chiranchi, Daurawa, Rijiyar Zaki, Kaura Goje, Fagge, Jakara, Kawaji, Bakin Ruwa, Gyadi Gyadi, Tudun Wuzurchi, Sharada, Hotoro, Babban Giji, Gawuna, Zango (Ugg), Tudun Fulani, Gurin Gawa, Sani Mainagge, Panshekara, Mariri, Danmaliki,

Giginyu, Kankarofi, Dandago, Ungogo, Unguwa Uku Cikin Gari, Gandu, Sheshe, Tudun Wada, Zaitawa, Dakata, Gama, Kofar Ruwa, Dorayi, Darmanawa, Tudun Murtala, Gobirawa, Gwammaja, Goron Dutse, Dan Agundi, Dala, Bachirawa, Sabon Gari, Yalwa, Kabuga, Rijiyar Lemo, Yakasai, Zango (KMC), Shahuchi, Fanisau, Gayawa, Yadakunya, Kadawa, Kwachiri, Yan Mata, Tudun Nufawa, Kumbotso, Unguwar Rimi, Tarauni, Diso, Gyaranya, Galadanchi, Dogon Nama, Kabuwaya, Kantudu and Madigawa.

The data from the Microsoft excel were imported into ArcMap environment as attribute tables and then converted to shape file for the analysis. The data were subjected to inverse distance interpolation method where choropleth map was produced for spatial distribution of the diseases in the area. The result of the analysis from ArcGIS environment was then exported as DBS to Microsoft Excel environment for the construction of charts which depicts the spatial distribution of the disease by local government areas and by wards.

RESULTS AND DISCUSSION

Spatial Distribution of Diabetes Mellitus by wards in Kano Metropolis 2005-2014

The result as presented in Figure 2 shows that there are high cases of diabetes in some wards while low cases in other wards in the study area. Highest is recorded in Rijiyar Lemo with 4.3% followed by Gobirawa with 3.8% while Diso, Kabuwaya and Kantudu recoded the lowest with only 0.1%, each.

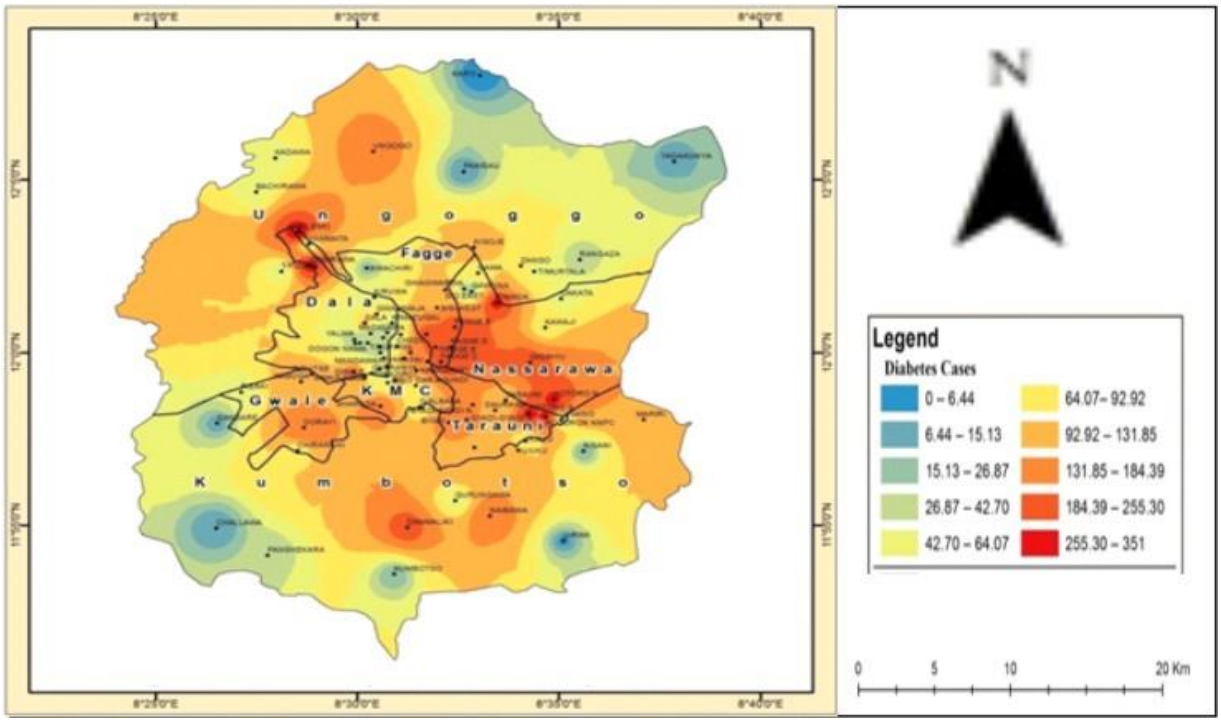

Figure 2: Spatial Distribution of cases by ward in Kano Metropolis 2005-2014
Source: Data Analysis, 2015

The result as shown in the figure further revealed that, diabetes cases are higher in the densely populated areas of the core city of Metropolitan Kano than in other areas within the same core city of the metropolitan Kano and periphery areas of Metropolitan Kano. This is attributed to the sedentary nature of their occupation, in the sense that most of them engage in trading activities living in one place (house shop or market) while the people living in the periphery

of the city mainly engage in activities that involve hand work or movement from one place to another such as farming and trading that have to do with moving from one locality to another.

Spatio-temporal Distribution of Diabetes Mellitus Cases by Local Governments Areas 2005-2014

The distribution of Diabetes Mellitus in the study area as shown in Table 2 revealed that, there is a variation between local government areas for instance; Kano municipal local government area recorded the highest cases of about 16.7% this was followed by Nassarawa with about 14.6% and Gwale became third with 12.3% while Tarauni recorded the lowest with about 8.0%.

Table 2: Spatio-Temporal Distribution of Cases by Local Governments 2005-2014

YEAR	GWALE	DALA	FAGGE	KMC	KUMBOTSO	NASSARAWA	TARAUNI	UNGOGO	OTHERS	TOTAL
	%	%	%	%	%	%	%	%	%	%
2005	1.2	1.0	1.0	1.5	.8	1.6	.8	1.0	1.0	9.9
2006	.7	.5	.4	1.4	.9	1.1	1.0	.5	.5	6.9
2007	1.6	1.5	1.2	2.3	1.1	2.4	1.1	.6	1.3	13.1
2008	1.5	.9	1.1	2.2	.8	1.7	.8	.5	1.4	10.8
2009	1.8	1.3	1.0	2.0	1.0	1.8	.9	1.2	1.5	12.5
2010	1.3	1.1	1.1	1.9	.9	1.4	.8	1.1	1.5	11.2
2011	1.2	1.0	.9	1.2	.7	1.3	.6	1.0	1.4	9.2
2012	1.1	.8	.9	1.6	.7	1.1	.8	.9	1.3	9.2
2013	.9	.8	.9	1.3	.8	1.1	.6	.8	1.0	8.3
2014	1.0	.8	.8	1.3	.8	1.3	.7	1.1	1.1	9.0
TOTAL	**12.3**	**9.6**	**9.3**	**16.7**	**8.6**	**14.6**	**8.0**	**8.8**	**12.0**	**100**

Source: Data analysis (2015)

However, looking at the trend in the table from 2005-2014 there have been fluctuations in the number of reported or diagnosed cases but sharp increase in diabetes cases were recorded in 2007 and 2009 while approximately uniform increase of 9.2% were recorded in 2011 and 2012 respectively. Probably this difference is attributed to more affluent life style of people in the core city. This variation could probably be explained by the difference in the duration of clinical manifestation of the diabetes complications because the onset of these complications varies from time to time and from one's individual exposed risk factors to another. This therefore makes the onset of the disease to vary. This conforms to the finding of Maigeng *et al*, (2015) that reported higher cases of diabetes in urban areas than in rural area of China. Additionally, the decrease from core city to periphery is likely to arise from the complex diabetes risk factors which include dietary pattern, obesity, smoking and sedentary nature of urban life (Jones, 2008).

Temporal Variation of Diabetes Mellitus Cases in Kano Metropolis from Year 2005-2014

The temporal Variation of Diabetes Mellitus Cases in Kano Metropolis within the study periods (Figure 3) revealed that, the highest cases of diagnosed amounted to 1066 were recorded in 2007; this was followed by 1014 cases in 2009while 2006 recorded the least of about 558 cases.

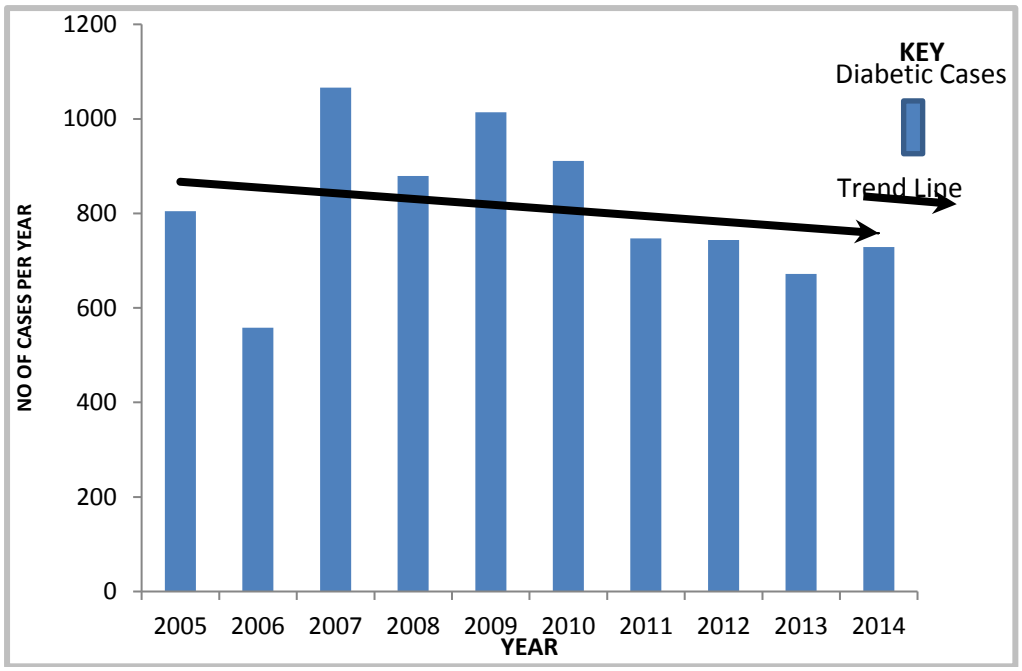

Figure 3: Diabetes temporal trends from 2005 to 2014
Source: Data Analysis (2015)

However, looking at the trend from 2005 to 2014 there is fluctuation in the number of diagnosed cases of diabetes mellitus. The trend line on the bar graph indicates a significant decrease in the number diagnosed cases from 2005 to 2014. Additionally, the figure shows a trend indicating a sharp decline in the number of reported and diagnosed cases from 2010 to 2014 and fluctuation between 2007 and 2010. Probably, this variation occurs because of the difference in the duration of clinical manifestation of the diabetes complications because the onset of these complications varies from time to time and from one individual's exposed risk factors to another. This therefore makes the onset of the disease to vary.

CONCLUSION

Based on the findings of the study, it is therefore concluded that, there is significant difference in the number of diabetes mellitus cases between the metropolitan wards whereby highest cases are seen in core city wards. It is also concluded that, there is variation of diabetes case between local government areas whereby Kano municipal local government area recorded the highest cases of about 16.7%, Nassarawa with about 14.6%, this was followed by Gwale with12.3% while Tarauni recorded the lowest with about 8.0%. It is also concluded that, there is significant difference in the number of diabetes mellitus cases between years whereby in the 2007 the highest cases of diagnosed amounted to 1066 which fall to 1014 cases in 2009while 2006 recorded the least of about 558 cases as revealed using descriptive statistics. It is also concluded from the analysis of this study that GIS is powerful technology for health cases related analysis. Based on the finding of this research, the study recommends the establishment of diabetes testing and counseling units in all the sixty nine primary health care facilities in Kano metropolis by the state ministry of health in collaboration with federal ministry of health. The study also recommends annual mass public awareness campaigns by State Ministry of Health and Diabetes Association of Nigeria (DAN) in collaboration with Ministry of Information and private radio and television stations, about diabetes, risk factors complication and morbidity.

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