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Analysis of the Spatial Pattern of HIV-AIDS Patients in Adamawa State, Nigeria

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Abstract

The aim of this study is to map and analyze the spatial pattern of Human Immunodeficiency Virus (HIV) patients in Adamawa State, Nigeria. Data for this research covering the period October, 2018- October, 2019 were obtained from the records of the General Hospitals in Michika, Mubi, Yola, Garkida, and Numan. The data were analyzed using the Geographic Information System (GIS) Software (ARC GIS 9.3a). A total of two thousand, eight hundred and thirteen (2813) people were diagnosed with HIV/AIDS during the study period. The results showed how HIV data can be mapped and manipulated for easy retrieval and for aiding decision making. The results revealed that Michika has the highest recorded cases of HIV at the time of data collection while Toungo has the least number of HIV cases. 55% of the H IV/AIDS positive persons were within the age group 20-34 years. HIV/AIDS varied significantly by age. Prevalence rate by sex revealed that more females (68%) than males (32%) were infected and that majority were married (70%). The research suggests the need to leverage on the GIS platform to refocus the strategies of curbing the menace of HIV/AIDS.

Keywords: HIV; AIDS; GIS; mapping; spatial pattern; Analysis

Introduction

Recent epidemiological report indicates that Human Immunodeficiency / Acquired Immune Virus (HIV / AIDS) is still a public health issue that persistently drains many sectors of our economy having claimed more than 25 million lives over the last thirty years (WHO,2014). Overall, the estimated number of - people living with HIV (PLWHIV) by the end of 2014 was about 36.9 41 million. Sub-Saharan Africa was the most affected region, having approximately 28 million PLWHIV and 66% of all PLWHIV in Africa (Awofala & Ogundele, 2018). Of all people living with HIV globally, 9% of them live in Nigeria (Levi et al., 2016). The country already challenged by political instability and poor health care system (Dalhatu et al., 2016). Notwithstanding the progress in institutional reforms and political commitment to tackle the disease, the country has seen more citizens placed on life saving medication of active antiretroviral therapy (AART) to increase the survival of such HIV seropositive individuals (Awofala & Ogundele, 2018).

The HIV epidemic is one of the greatest global public health challenge in recent years because of its significant growth in its spread, it has generated - much interest among scholars (Mahmoudi, Dehdari, Shojaeezadeh, & Abbasian, 2015). However, little attention has been paid with regards its spatial analysis (Mabayoje & Akinleye, 2016; Rangel, Gavin, Reed, Fowler, & Lee, 2006). It also has been revealed by Laah (2010) that despite increased efforts to control the epidemic, by 2006 it was estimated that just ten percent of HIV-infected women and men were receiving antiretroviral treatment. This resulted into incomplete data and posed a great constraint to the perfection of this work.

The spatial aspects of HIV could be employed in preventive interventions in particular, and health care in general (Richardson et al., 2013). Geographic Information Systems (GIS) is an instrument that can be utilized to analyze the factors associated with spatial patterns and data management for policy and decision making (Cromley & McLafferty, 2012). GIS technology can also be used to generate, analyze and design health information system. One of the most common and longstanding use of GIS in public health, is for disease surveillance which is the compilation and tracking of information on the incidence, prevalence, and spread of disease (Rushton, 1998).

There are two interrelated components of disease surveillance; disease mapping and disease modeling. Disease mapping is used to understand the geographical distribution and spread of disease in the past, or present (M. F. Myers, Rogers, Cox, Flahault, & Hay, 2000). Disease modeling is closely related to risk analysis and is used to forecast future disease spread, or epidemic outbreaks and to identify those factors that may foster, or inhibit disease transmission (N. Myers, Mittermeier, Mittermeier, Da Fonseca, & Kent, 2000). The characteristics of a place, including its demography (Population characteristics) and environment are critical factors in determining the origin and the spread of a disease and may offer insight in to its prevention and control. With GIS, it is possible to 'point' at a location, object, or area on the screen and retrieve HIV information about it from off-screen files. GIS can query the status of the area in relation to other areas. This kind of analytical function allows for drawing conclusion about the area. It also enhances work efficiency and reduces the cost implications.

Spatial analysis, is one of the routes of studying the dynamics of disease-related events. It has proven imperative because there is a growing body of evidence arguing that GIS and the resulting data in a spatial environment are essential elements in monitoring and predicting the spread of pandemics (Parr, 2004), and that is why GIS is enjoying a growing popularity. It is now been used to study the geographic changes of HIV towards the implementation of effective preventive programs and treatments (Djukpen, 2012; Martinez et al., 2014). Extant literature suggests, spatial data can be used for simulating HIV transmission routes locally (Mehta et al., 2015), and displaying the spatial clusters of diseases (Heimer, Barbour, Shaboltas, Hoffman, & Kozlov, 2008). Given the aforementioned about the application of GIS as well as the high rates of community level transmission of HIV, the aim of the present study is to map the spatial distribution pattern of HIV in Adamawa State, Nigeria.

The research is mainly concerned with the analysis of the spatial patterns of PLWHIV diagnosed in the study area. The age, sex, marital status, and occupation of patients were determined and analyzed.

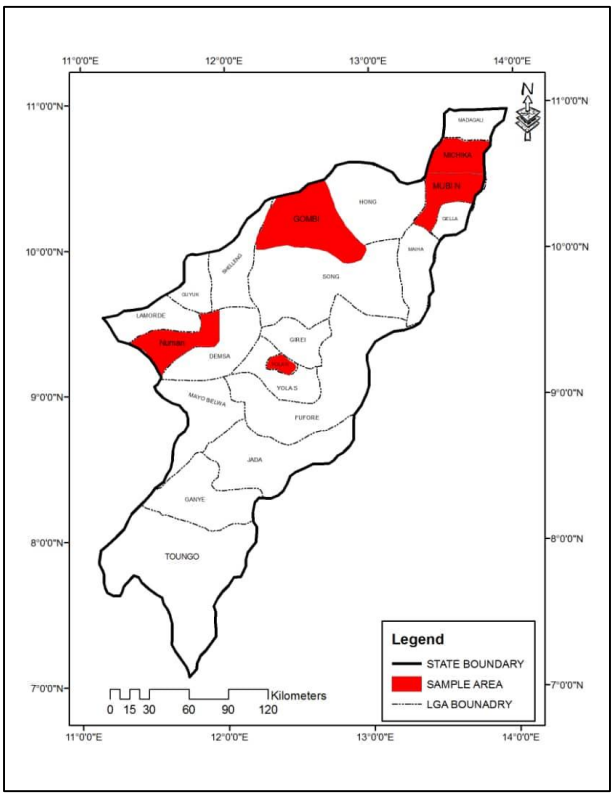


Figure 1: The Study Area

The Study Area

Adamawa State is located in the North Eastern part of Nigeria. It lies between latitude 7^0 and 11^0 North of the equator, and longitude 11^0 and 14^0E of the Greenwich Meridian. It shares common boundaries with Taraba State in the South and the West, Gombe State in its Northwest, and Borno to the North. Adamawa State has an international boundary with the Cameroun Republic along its eastern border (Figure 1). The State covers a land area of about 38,741 km Adamawa State consists of 21 Local Government Areas and covers the total area of about 38,741 Km2. It is on this land that exists a population of about 3,168,101 persons (Centre & Group, 2006). This gives the population density of about 82 persons per sq Km. According to the National Population Census conducted in 2006, out of the total population, 49.3% are females while 50.7% are males (Amadi, Nwagboso and Uyanga,1999).

Materials and Methods

This chapter is concerned with the method employed in the database creation and demographic study of HIV/AIDS disease. It describes the strategies that were used in collecting the data, the approaches adopted in the analysis for actualizing the GIS application. An overview of the method used is illustrated in figure 1 below:

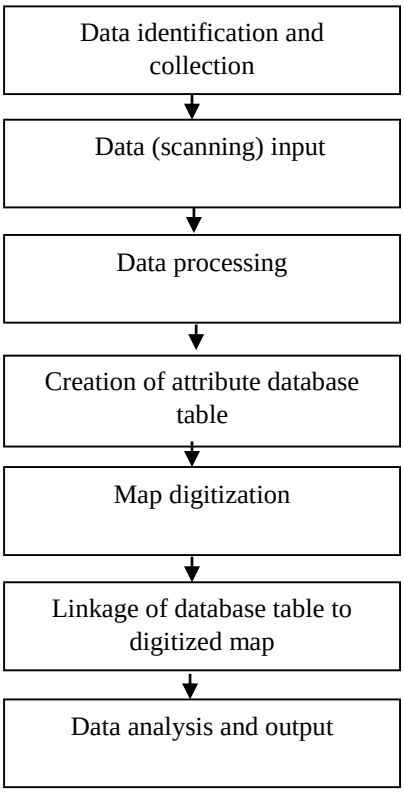


Figure 2: Flow chart

The research work employed two (2) types of data for analysis of the socio-demographic characteristics of HIV/AIDS patients in Adamawa State. These included the primary data and the secondary data. The primary data sources used for this study were the data on HIV/AIDS Patients obtained from the Hospital record book. The concept, idea, empirical issues for this research was obtained from the text books, related research projects, journals internet, documentations, Topographical and Administrative maps of Adamawa state on the scale 1:25,000 produced by the Directorate of oversees survey 1967, was used as a base map for this research. The map was used to ascertain the location of the study area, location of patients and their attributes. The idea sourced out from these data was applied in literature review, data interpretation and analysis.

Development of Database on Demographic characteristics of HIV/AIDS Patients in Adamawa State

HIV/AIDS occurrence data from 2018 to 2019 of patients diagnosed in Adamawa State were obtained from the General Hospitals offering ART Services within the State. This centres include the General Hospitals in Michika, Mubi, Garkida, Yola, and Numan. The purpose was to generate information on patients' location, age, sex, occupation and marital status.

A Database is a collection of facts from which conclusions could be drawn. The HIV/AIDS database of Patients in Adamawa State, 2018-2019. Was developed by obtaining the raw data of the demographic characteristics of the patients (attributes) which include the; age, sex, marital status, occupation and code of Patients. Location of patients was also necessary for geo-spatial reference as well as representation on the map. The database was created in the Arc Map 9.3 software by creating a database table in the arc catalogue environment before adding it into the already created shape file in the arc map where the map of Adamawa was digitized. The dots on the map were thrown with respect to the number of patients in each local government area. These dots (patients)were given code number each which tallies with the same code entered into the database table and it was joined so that the dots (patients) in the map were linked to the database by joining the coded patients shape file to the database so that a dot will bear the attributes of a patient.

Equipment and Materials

Hardware and Software components of the GIS were used in this study. The Hardware used for this research comprises of Host computer which was used for data and software storage data processing and manipulation overall system control, digitizer used for data digitization in the vector format, digital plotter used for output of hardcopy graphics, and the printer used to print report and table output.

Software is a set of instructions (programs) that a computer can carry out. GIS software has different modules. When purchasing GIS software, one should be able to understand these modules and know the specifics that are required. There are many GIS software that can handle data relating to the HIV. Among these include, Arc view, Arcinfo, Idrisi, Ilwis etc. but for the purpose of this research, the ARC GIS9.3 was used in the processing of data and display of final results in form of tables, maps and graphs. A photo plus was used to scan the administrative map of Adamawa State and to convert it from hard to soft copy. Corel draw software was used to capture the scanned image.

Data Processing

Data encoding for this research involved geo-referencing, digitizing and layering the final map product. It was done using a laptop and GIS software (ArcGIS 9.3). The administrative map of Adamawa State was scanned into the CorelDraw software and converted into the Tagged Image File Format (TIFF) then exported into the GIS software for geo-referencing, resampling, digitizing, analysis and presentation of results, respectively.

Data Analysis

The descriptive statistics were applied using ARC GIS 9.3 so as to calculate the means, and the sums in variation for the data set. Maps were used to describe the level of occurrence of the HIV/AIDS for each sex, age group, marital status, occupation and location. Spatial analysis involved the use of query function in ArcGis 9.3 was adopted to show patient with file number106, patients between 0 and 15 years of age (under care), patients diagnosed in General Hospital Mubi, male patients, widowed patients

Data Output

A critical component of GIS is its ability to produce graphics on the screen or on paper that conveys the results of analysis to people who make decisions about resources. Graphical, digital and statistical information as well as maps can be generated thereby allowing the viewer to visualize and understand the results of analysis, or simulations of special events. The data on HIV/AIDS patients in the entire study area were represented on the map produced which included the map of Adamawa State showing the demographic characteristics of patients. Graduated colored map was used to show Local government areas according to the number of patients The local government areas with greater number of patients is represented with the darkest colour and the darkness of the colour reduces as the number of patients keeps reducing with respect to their local government areas. Essential map details such as the title, the north arrow, the scale, grid lines,

frame and the legends were added for easy interpretation of the final map.

Query tool is a GIS package used for selecting the data subset from the attribute database table to display either on map, graph, or table. was done by opening the map, or the database and clicking on the SQL column from the options and issuing a command of what needed to be queried and the item(s) were automatically be selected. The demonstration of query of patients diagnosed in Mubi, male patients widowed patients and under care patients are shown in Figures to 4-9

Results and Discussion

This research was set to analyze the characteristics of HIV/AIDS Patients in Adamawa State. To achieve this objective the data were sourced from five general hospitals, anti-retroviral therapy Service Centres including Michika, Mubi, Garkida, Yola, and Numan. The data generated are presented on figure5 below. The total population of HIV/AIDS Patients in each local government areas of the State is shown on Figure 5.

Representation of HIV/AIDS Database on map and some GIS manipulations

One of the objectives of this research is to represent HIV/AIDS patients' database on the map. In this regard, database was created for all the Patients. The data were linked and thrown on the map to show the Spatial distribution of the Patients in the State as presented in Fig 6 below.

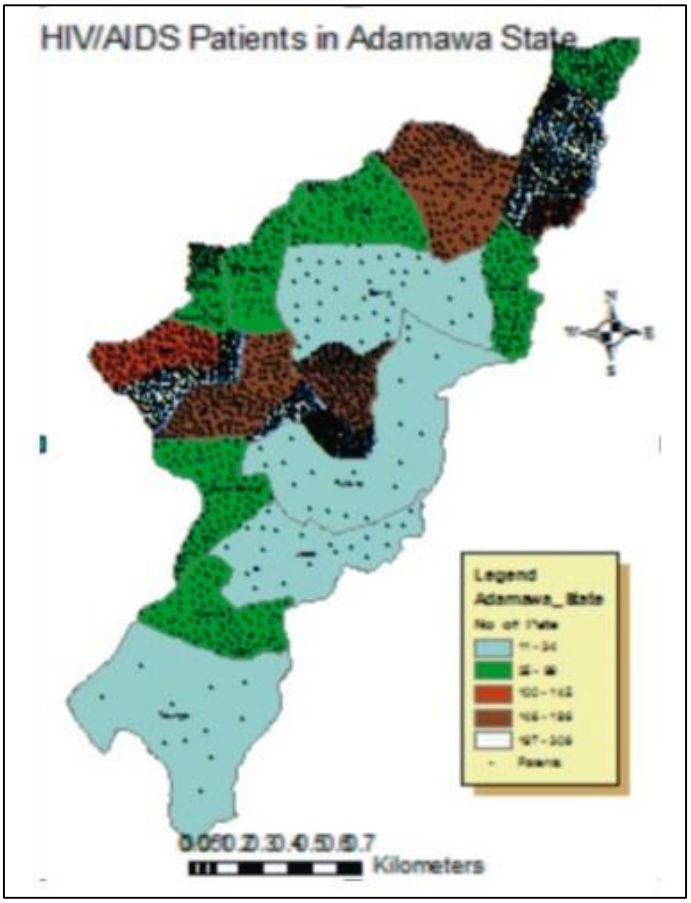


Figure 3: Spatial Distribution of HIV Patients diagnosed in Adamawa State from October, 2018 –October, 2019.

Figure 3 shows the distribution of all the two thousand eight hundred and thirteen (2,813) HIV/AIDS patients in Adamawa State. Each Patient is represented with a dot with respect to his/her local government area of residence. Each dot is linked to a particular patient in the statistical database with a code number. The preceding map above clearly reveals that there is disparity in the distribution of AIDS Patients in Adamawa State. Some local governments such as Toungo, Jada and Fufore have sparse populations of AIDS Patients represented by fewer dots on the map but other local government

areas such as Yola North, and South, Michika, Mubi North, and South, have high concentrations of the epidemic as represented by clustered dots .This reveals that in Adamawa State, there is less concentration of HIV/AIDS Patients in the rural local government areas, while the Patients are highly concentrated in the Urban than in the Rural local government areas. This might be due to the distance to the sources of medical care centres where data for this research was obtained, negligence or due to the high level of social interaction in the Urban Centres. The information in the database can be displayed for perusal. This is done by highlighting the code number of a patient and click then the database table appears as shown in the Figure 7as follows:

Use of identifier Tool

Identifier tool is a GIS package that was used for selecting a representation on map to reveal the attributes of the selected item on the map as entered into the database table. This was done by picking the identifier tool from the menu bar and clicking on the feature of interest on the map and the attributes of that feature were automatically displayed on the screen.

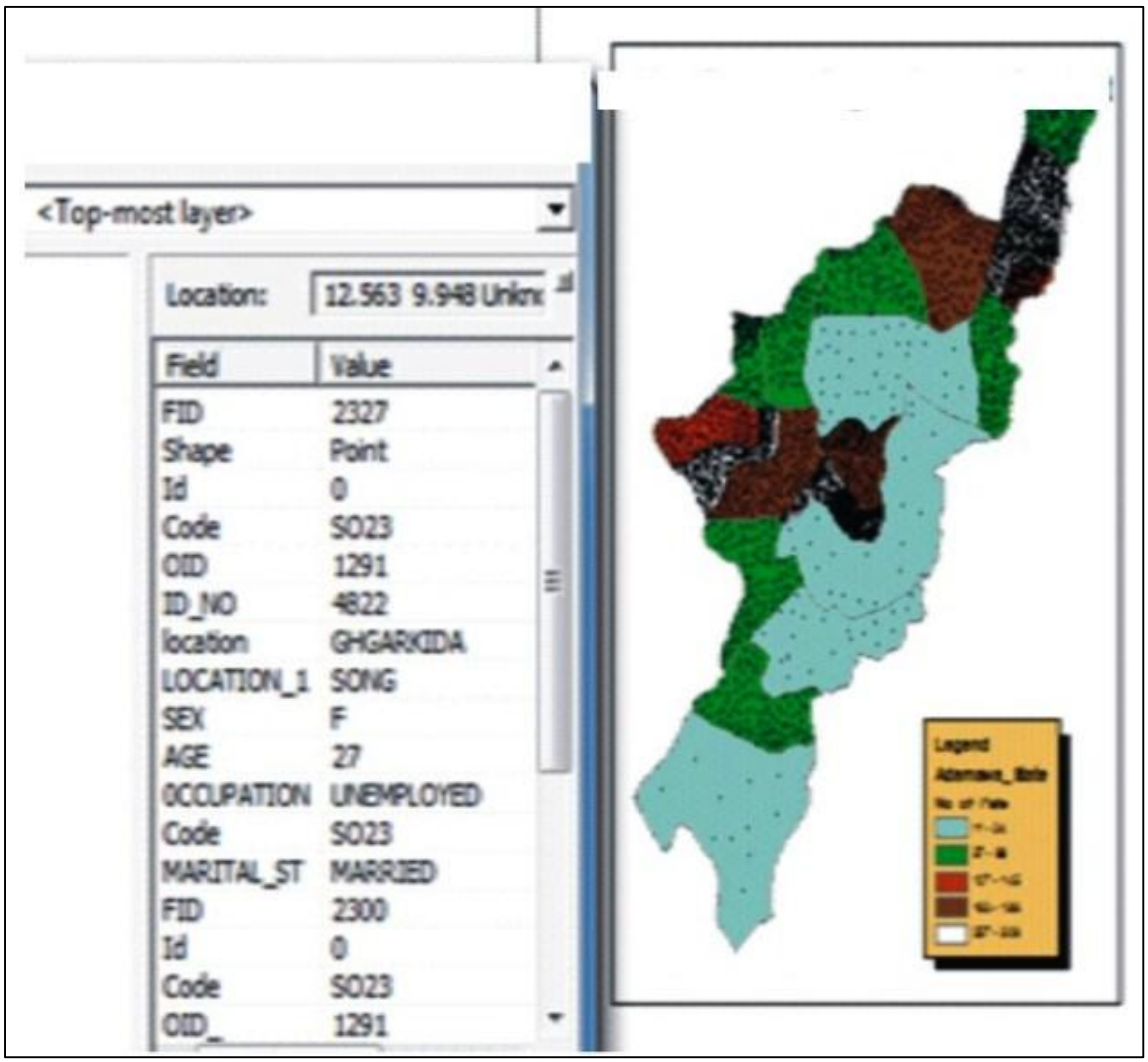
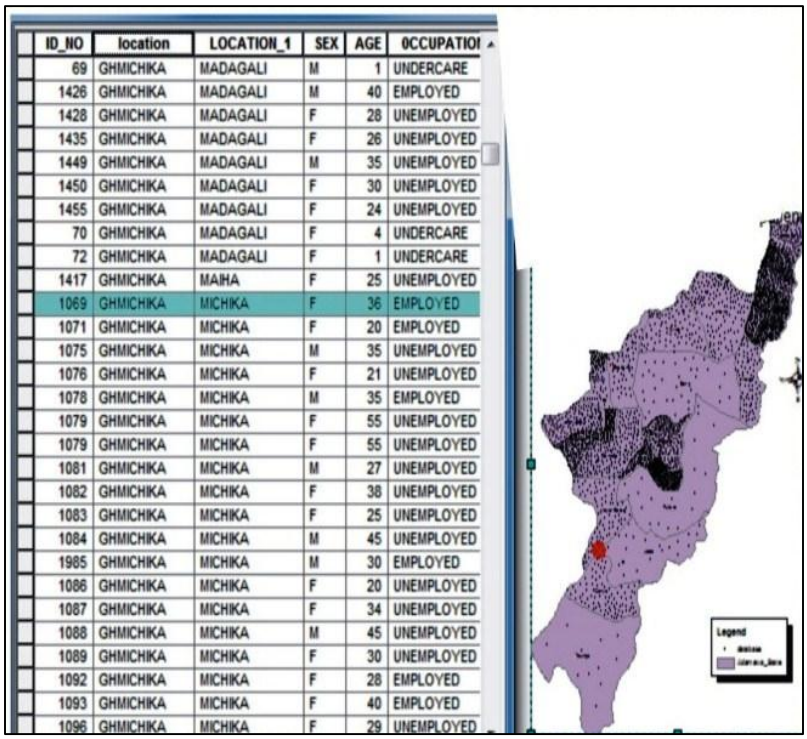


Figure4: Use of Identifier Tool.

Querying Attribute Data of HIV/AIDS Patient

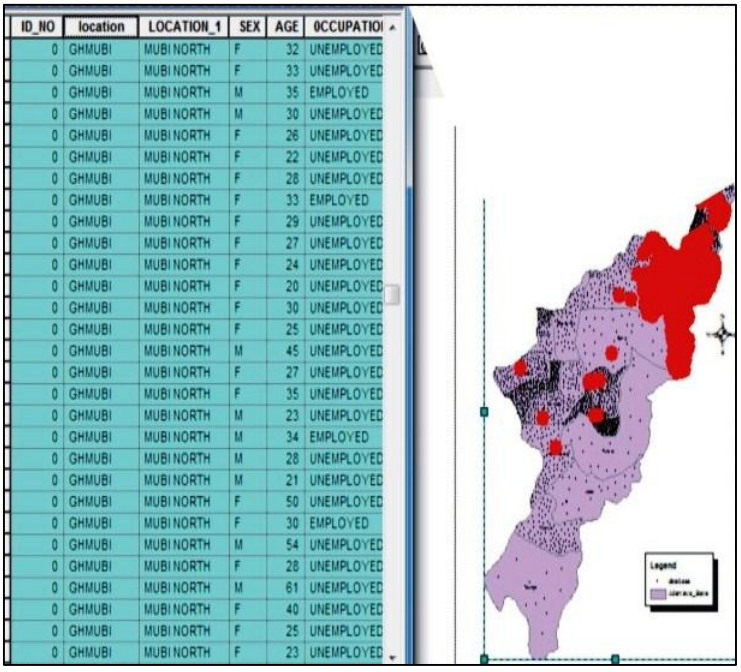
GIS query tool was used to explore the attribute data of a feature from the statistical database as shown in Figure 8:



ID_NO	location	LOCATION_1	SEX	AGE	0CCUPATIOI
69	GHMICHIKA	MADAGALI	M	1	UNDERCARE
1426	GHMICHIKA	MADAGALI	M	40	EMPLOYED
1428	GHMICHIKA	MADAGALI	F	28	UNEMPLOYED
1435	GHMICHIKA	MADAGALI	F	26	UNEMPLOYED
1449	GHMICHIKA	MADAGALI	M	35	UNEMPLOYED
1450	GHMICHIKA	MADAGALI	F	30	UNEMPLOYED
1455	GHMICHIKA	MADAGALI	F	24	UNEMPLOYED
70	GHMICHIKA	MADAGALI	F	4	UNDERCARE
72	GHMICHIKA	MADAGALI	F	1	UNDERCARE
1417	GHMICHIKA	MAIHA	F	25	UNEMPLOYED
1069	GHMICHIKA	MICHIKA	F	36	EMPLOYED
1071	GHMICHIKA	MICHIKA	F	20	EMPLOYED
1075	GHMICHIKA	MICHIKA	M	35	UNEMPLOYED
1076	GHMICHIKA	MICHIKA	F	21	UNEMPLOYED
1078	GHMICHIKA	MICHIKA	M	35	EMPLOYED
1079	GHMICHIKA	MICHIKA	F	55	UNEMPLOYED
1079	GHMICHIKA	MICHIKA	F	55	UNEMPLOYED
1081	GHMICHIKA	MICHIKA	M	27	UNEMPLOYED
1082	GHMICHIKA	MICHIKA	F	38	UNEMPLOYED
1083	GHMICHIKA	MICHIKA	F	25	UNEMPLOYED
1084	GHMICHIKA	MICHIKA	M	45	UNEMPLOYED
1985	GHMICHIKA	MICHIKA	M	30	EMPLOYED
1086	GHMICHIKA	MICHIKA	F	20	UNEMPLOYED
1087	GHMICHIKA	MICHIKA	F	34	UNEMPLOYED
1088	GHMICHIKA	MICHIKA	M	45	UNEMPLOYED
1089	GHMICHIKA	MICHIKA	F	30	UNEMPLOYED
1092	GHMICHIKA	MICHIKA	F	28	EMPLOYED
1093	GHMICHIKA	MICHIKA	F	40	EMPLOYED
1096	GHMICHIKA	MICHIKA	F	29	UNEMPLOYED

Figure 5: Query of Attribute of HIV/AIDS Patient October, 2018 –October, 2019.

Figure 4 preceded demonstrates how the patient with file number 1069 represented with a dot on the map was highlighted, clicked and automatically, its attributes as entered into the database, was displayed. This is a GIS manipulation system used for perusal and subsequent updating of information on the statistical database table.



ID_NO	location	LOCATION_1	SEX	AGE	0CCUPATIOI
0	GHMUBI	MUBI NORTH	F	32	UNEMPLOYED
0	GHMUBI	MUBI NORTH	F	33	UNEMPLOYED
0	GHMUBI	MUBI NORTH	M	35	EMPLOYED
0	GHMUBI	MUBI NORTH	M	30	UNEMPLOYED
0	GHMUBI	MUBI NORTH	F	26	UNEMPLOYED
0	GHMUBI	MUBI NORTH	F	22	UNEMPLOYED
0	GHMUBI	MUBI NORTH	F	28	UNEMPLOYED
0	GHMUBI	MUBI NORTH	F	33	EMPLOYED
0	GHMUBI	MUBI NORTH	F	29	UNEMPLOYED
0	GHMUBI	MUBI NORTH	F	27	UNEMPLOYED
0	GHMUBI	MUBI NORTH	F	24	UNEMPLOYED
0	GHMUBI	MUBI NORTH	F	20	UNEMPLOYED
0	GHMUBI	MUBI NORTH	F	30	UNEMPLOYED
0	GHMUBI	MUBI NORTH	F	25	UNEMPLOYED
0	GHMUBI	MUBI NORTH	M	45	UNEMPLOYED
0	GHMUBI	MUBI NORTH	F	27	UNEMPLOYED
0	GHMUBI	MUBI NORTH	F	35	UNEMPLOYED
0	GHMUBI	MUBI NORTH	M	23	UNEMPLOYED
0	GHMUBI	MUBI NORTH	M	34	EMPLOYED
0	GHMUBI	MUBI NORTH	M	28	UNEMPLOYED
0	GHMUBI	MUBI NORTH	M	21	UNEMPLOYED
0	GHMUBI	MUBI NORTH	F	50	UNEMPLOYED
0	GHMUBI	MUBI NORTH	F	30	EMPLOYED
0	GHMUBI	MUBI NORTH	M	54	UNEMPLOYED
0	GHMUBI	MUBI NORTH	F	28	UNEMPLOYED
0	GHMUBI	MUBI NORTH	M	61	UNEMPLOYED
0	GHMUBI	MUBI NORTH	F	40	UNEMPLOYED
0	GHMUBI	MUBI NORTH	F	25	UNEMPLOYED
0	GHMUBI	MUBI NORTH	F	23	UNEMPLOYED

Figure 6: Database of HIV/AIDS Patients diagnosed in Mubi Adamawa State from October, 2018 –October,2019.

Figure 6 reveals query of all the patients on medication in Mubi in the database and the map by highlighting in green and red colours, respectively. This analysis shows that six hundred and fifty-six (656) patients were diagnosed between October, 2018 and October, 2019 in Mubi.

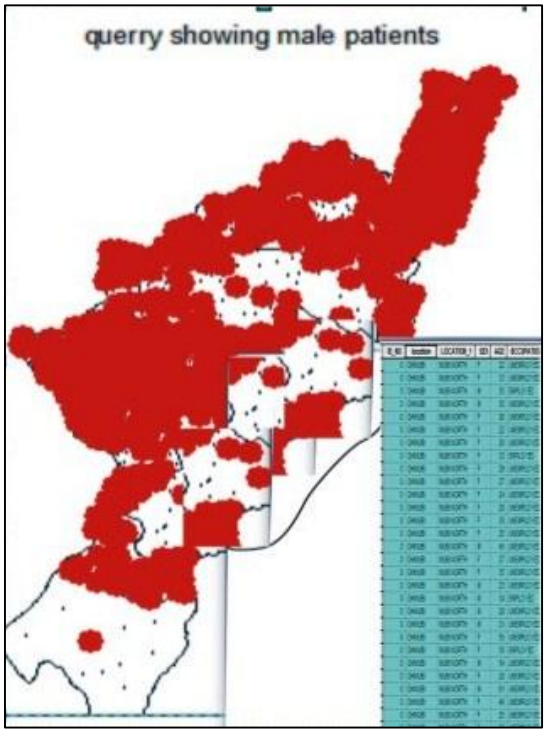
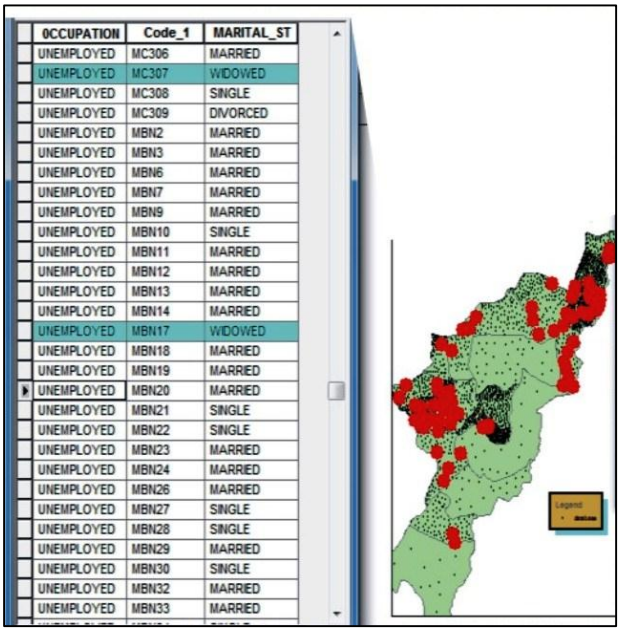


Figure 7: Database of HIV/AIDS male patients diagnosed in Adamawa State October, 2018 –October, 2019.

Figure 7 highlights all the male patients in the database in green colour showing all their geo-spatial attributes and also selecting them on the map in red colour through query. The age frequency distribution on the map reveals that the minimum age of male patients is zero (0), while the maximum age is eighty-two (82) and their mean age is thirty-five years (35) with age the group between 30 and 40, having the highest number of patients.



OCCUPATION	Code_1	MARITAL_ST
UNEMPLOYED	MC306	MARRIED
UNEMPLOYED	MC307	WIDOWED
UNEMPLOYED	MC308	SINGLE
UNEMPLOYED	MC309	DIVORCED
UNEMPLOYED	MBN2	MARRIED
UNEMPLOYED	MBN3	MARRIED
UNEMPLOYED	MBN6	MARRIED
UNEMPLOYED	MBN7	MARRIED
UNEMPLOYED	MBN9	MARRIED
UNEMPLOYED	MBN10	SINGLE
UNEMPLOYED	MBN11	MARRIED
UNEMPLOYED	MBN12	MARRIED
UNEMPLOYED	MBN13	MARRIED
UNEMPLOYED	MBN14	MARRIED
UNEMPLOYED	MBN17	WIDOWED
UNEMPLOYED	MBN18	MARRIED
UNEMPLOYED	MBN19	MARRIED
UNEMPLOYED	MBN20	MARRIED
UNEMPLOYED	MBN21	SINGLE
UNEMPLOYED	MBN22	SINGLE
UNEMPLOYED	MBN23	MARRIED
UNEMPLOYED	MBN24	MARRIED
UNEMPLOYED	MBN26	MARRIED
UNEMPLOYED	MBN27	SINGLE
UNEMPLOYED	MBN28	SINGLE
UNEMPLOYED	MBN29	MARRIED
UNEMPLOYED	MBN30	SINGLE
UNEMPLOYED	MBN32	MARRIED
UNEMPLOYED	MBN33	MARRIED

Figure 8: Query of Widowed Patients Diagnosed in Adamawa State from October, 2018 –October, 2019.

Figure 8 highlights all the seventy-three (73) widowed patients in the database in green colour showing all their geo-spatial attributes and also selecting them on the map in red colour through query. The age frequency distribution on the map reveals that the minimum age of the widowed patient is seventeen (17), while the maximum age is seventy-five (75) and the mean age is forty-one (41) with age 35 to 45, having the highest number of widowed patients.

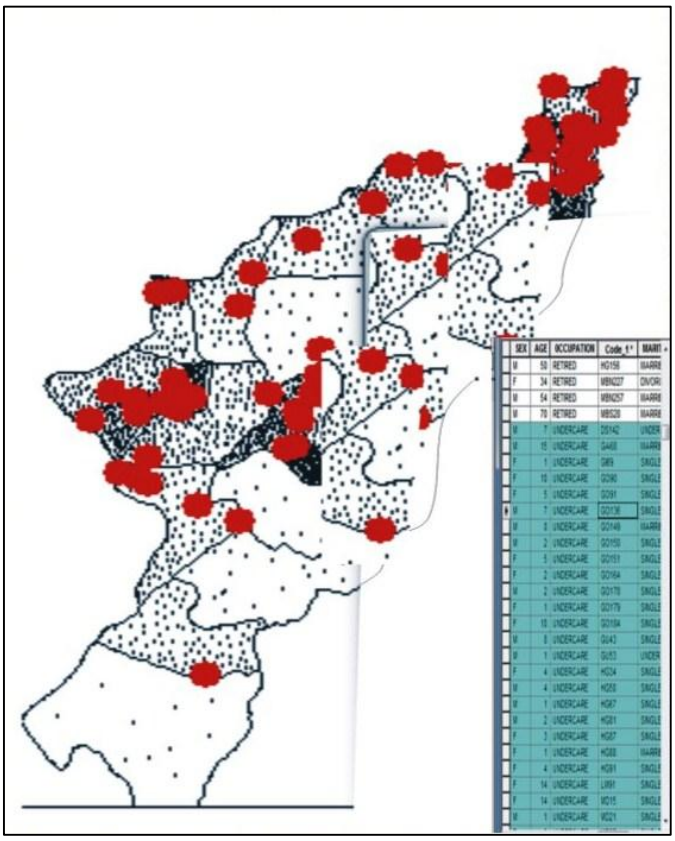


Figure 9: Query of Under Care Patients Diagnosed in Adamawa State from October, 2018 –October, 2019.

Figure 9 highlights all the sixty-four (64) under care patients (0-15 years) in the database in green colour showing all their geo-spatial attributes and also selecting them on the map in red colour through query. The age frequency distribution on the map reveals that the minimum age of the under care patients is zero (0), while the maximum age is fifteen (15) and the mean age is six (6) with age one and two, having the highest number of under care patients.

Conclusion

The study demonstrates the wide applications of GIS to understanding the spatial patterns of HIV spread and how HIV related data can be stored, manipulated, and displayed. it expected that GIS use and spatial analysis methodologies will continue to gain acceptance as more researchers and implementers, and policymakers develop knowledge and capacity in this growing field and increasingly recognize its usefulness. The purpose of the study is to map the spatial pattern of HIV and to analyze the demographic characteristics of patients in Adamawa state, Nigeria. Findings from the study suggest that Michika Local Government Area (LGA) has the highest (310) population, while Toungo Local Government Area has the least (11) population of HIV/AIDS Patients in Adamawa State. HIV/AIDS Patients in Adamawa State are 55%. There is a high concentration of HIV/AIDS Patients in urban Centres than in the rural areas of Adamawa State. The greater percentage of females (85%) and males (15%) infected with HIV/AIDS in Adamawa State are in the age group of 15-19 and 0-4, respectively. There are more females (68%) than males (32%) infected with HIV/AIDS in Adamawa State. The majority (82%) of the people infected with HIV/AIDS in Adamawa State are unemployed,

while very few (15%) of those employed are infected. Most (71%) of the HIV/AIDS Patients in Adamawa State are married, while only 29% of unmarried were infected with the virus.

The GIS database developed can be easily manipulated through either query, use of identifier tool, statistical analysis, and safe storage of data as can be seen in Figures 2-7. Specifically, Figure 4 shows how the identifier tool reveals attributes of a selected patient on the map which include: age, sex, location, marital status, occupation, file number, treatment center, and all other information entered into the database. Another key analysis in the study was the critical role of GIS in performing *queries (See figure* 9) where all under care patients across the study area were highlighted by using the query application in the GIS package. GIS spatial analysis may allow for a more efficient allocation of resources and appropriate response targeting in healthcare. Of note, while this study was focused on more technologically and methodologically applications, the study demonstrated the utility of simply visually displaying mapped data points, such as for plotting the locations of HIV patients for further analysis not displayed in the present research

Finally, the information provided in the study is relevant for close monitoring, tracking, and evaluation of PLWHIV in Adamawa State, Nigeria. The map presents a platform on which HIV data can be built and managed for policy and decision making.

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