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(Research Article)

Assessing the spatial distribution of tuberculosis in Abuja municipal area council, Abuja, Nigeria from 2019 to 2020

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Abstract

Tuberculosis (TB) is an infectious respiratory disease caused by a bacteria known as Mycobacterium tuberculosis. It was first discovered on 24th March, 1882 by Dr. Robert Kosh a German physician and microbiologist. Ever then, it has claimed millions of lives both in developed, developing and underdeveloped countries. This project aims to assess the distribution of Tuberculosis infection cases in Abuja Municipal Area Council (AMAC) with specific objectives to examine the spatial distribution of tuberculosis (TB) infection cases in AMAC from 2019 to 2020, and to identify the TB most vulnerable group in AMAC. The data used was the register of tuberculosis diagnosed patients and tuberculosis positive patients obtained from Garki Hospital, Abuja, being a test and treatment center in AMAC. The shapefile of the study area was used as support data while the software packages used were Microsoft Excel and ArcGIS 10.3. Statistical analysis, dot density, Average Nearest Neighbour Summary, hotspot, and density mapping were used to examine the incidences and prevalence of TB clusters. Results from the analysis showed that most affected persons are residents of Garki, Kabusa, and Gwarimpa. The choropleth analysis showed that out of the eight districts in AMAC, Garki had 41 has the highest number of infected persons while Orozo had 3 patients. It also revealed that patients between the ages of 31 and 40 are the most infected, with the male gender being the most infected. The study recommended that the government should implement TB tests as part of the basic screening test and should be adopted by schools and offices at all levels and as well, create more awareness.

Keywords: Tuberculosis; AMAC; Spatial Distribution; Diagnosed; Patients; Districts

1. Introduction

Tuberculosis (TB), the leading cause of death globally among adults by a single infectious agent, has plagued humans for millennia [1]. Despite being a preventable and curable disease, an estimated 10 million people fell ill with TB in 2019, and over 1.4 million people died because of the infection. The disease burden varies significantly across countries with a range of 5 to 500 cases per 100,000 population and a global average of 150 cases per 100,000. Eight countries (Bangladesh, China, India, Indonesia, Nigeria, Pakistan, Philippines, and South Africa) accounted for over two-thirds of the total cases of the disease in 2018 [2].

Nevertheless, global efforts to combat the disease have yielded slow but progressive dividends, with an estimated 58 million deaths averted through TB diagnosis and treatment over the last two decades. To sustain these achievements and reach the World Health Organization (WHO) goal of ending TB in 2030, current efforts need to be stepped up [2], and one of the crucial steps in TB elimination is case finding (CF) or detection. TB CF or detection, an entry point into

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the TB treatment cascade, refers to the use of a systematic approach in identifying presumptive TB cases through screening and establishing diagnosis using one or more diagnostic tests [3]. The case notification rate (CNR) indicates how effective TB programs are at finding people with active TB and diagnosing them correctly [4].

Tuberculosis (TB) remains an important public health problem in the 21st century. It is the second leading cause of death from a single infectious disease agent. In 2013 alone, an estimated 9 million new TB cases and 1.5 million deaths occurred worldwide, while 360,000 of these deaths are as a result of HIV. The majority of these infections and deaths occurred in the global south, and countries in sub-Saharan Africa are responsible for about a quarter of the world's TB cases [5] The relationship between tuberculosis rates and community socioeconomic risk factors such as low levels of education, income inequality, unemployment, and social deprivation has been well described in high-income countries of Europe and North America [6]; [7].

Similar inverse relationships have been documented between TB rates and socioeconomic indices in middle-income countries [8] [9]. There has been however mixed evidence on the relationship between TB rates and socioeconomic indices in low and middle-income countries with some studies reporting an inverse relationship in Zambia and India respectively [10]. while other studies found no significant relationship between TB and socioeconomic indices in Eastern Cape South Africa, in three West African countries (Guinee, Guinea Bissau, and The Gambia) and India respectively [11]; [12]; [13]. Interestingly, some studies observed a positive relationship between high socioeconomic indices and TB in rural Malawi, Zambia, and Karonga district in Malawi respectively [12]; [10]; [14]. The conflicting conclusions from these studies in low and middle-income countries bring into question whether indicators used in assessing socioeconomic status in the global north are appropriate for the south.

The health care system delivery in Nigeria, as in many other African countries, is indeed highly vulnerable. Due to a high level of deaths, inadequate health care facilities and the emergence of policy options, the assessment of health vulnerability has been the subject of increased research. Despite garnered attention from policy makers, private and international organisations on health issues at local and global scale, spatial information on health-related diseases is not well-documented in Nigeria [15]. Thus, very little is known about the magnitude and the devastating effects of diseases (malaria, cholera, AIDS, tuberculosis, etc.); especially as it involves wider communities. There are increasing casualties and deaths among large number of populations in the country due to poor health care delivery system and lack of adequate research. Specifically, Nigeria is ranked fourth globally and first in Africa among 22 high-burden TB countries in the globe [16]. However, because of the insufficient knowledge on the disease prevalence and its spatial domain, it's proven even more difficult for the government to identify areas of high risk, and where due attention should be focused to provide the needed policies to address the issues. To do this, evidence-based information needs to be established using analytical procedures to support this decision.

Today, Geographical Information Science (GIS) is one of the most notable tools commonly used in health research to inform enabling policy. Presently, the availability of this technology along with the proliferation of disaggregated data has led to several studies that are concerned with disease risk mapping, cluster analysis, spatial pattern, and facility location, among others [17]; [18]. The use of GIS in disease mapping attempts to understand and recognise spatial patterns to grasp its degree of prevalence, and consequently, associate factors responsible for the pattern.

Because undiagnosed TB cases are the major challenge to TB control in Nigeria, any strategy that will identify ongoing TB transmission hot spots in the community is crucial for finding and treating missing TB cases. Electronic recording and reporting of TB are becoming adopted widely by national TB control programs [19]. The electronic data can be imported into a geographic information system (GIS) for mapping and spatial analysis; thus, the data can be used to identify TB transmission hot spots in the community [19]. Such an electronic GIS strategy has been used in early warning systems (EWSs) for infectious disease surveillance [20], such as the China Infectious Disease Automated Alert and Response System (CIDARS) [21] and an early warning outbreak recognition system (EWORS) implemented by the Indonesian Ministry of Health [22].

In recent Reports, from Copenhagen Consensus Center, it was stated that many people in Nigeria carry a latent infection without knowing it with about 5% to develop active TB under 18 months, while the rest are expected to develop TB infection later in life if not treated properly. Tuberculosis is mostly spread among people who stays together every day as they breathe in the same air being circulated them.

Infection of tuberculosis in Nigeria is quite alarming as Nigeria ranks 7th position globally, and 3rd position in Africa, as a country with heavy burden of tuberculosis cases. It is also on record by World Health Organization, that more than 10% deaths in Nigeria are linked to tuberculosis infection as nearly 30 people die died from TB disease every hour [2].

This project aims to assess the distribution of Tuberculosis infection cases in Abuja Municipal Area Council (AMAC) with specific objectives to examine the spatial distribution of tuberculosis (TB) infection cases in AMAC from 2019 to 2020, and to identify the TB most vulnerable group in AMAC.

1.1. Study Area

AMAC is the largest and most developed of the six area councils of Abuja. The bulk of the built-up area of AMAC is made up of the Federal Capital City (FCC). AMAC is located between latitude 7^0 49´ and 8^0 49´ north of the equator and longitude 7^0 07´ and 7^0 33´ east of the Greenwich Meridian (Fig. 1). With a land mass of about 2,500sq km [23], the area records a total annual rainfall of approximately 1,650mm. The temperature is highest, with the greatest diurnal ranges, during the dry season months when the maximum temperature ranges between 30^0C and 35^0C. During the rainy seasons, on the other hand, the maximum temperature ranges between 25^0C and 30^0C [24]. There is a marked difference between the highest and lowest elevations within AMAC. The highest elevation is 213.3m to the North (which is largely urbanized) and 142.2m to the South (which is largely rural) of the FCT. Within AMAC are located the famous Aso Rock, Katempe Hill, and Asokoro rock outcrops. The 2006 National Population and Housing Census puts the population of AMAC at 778,567, the highest within the FCT.

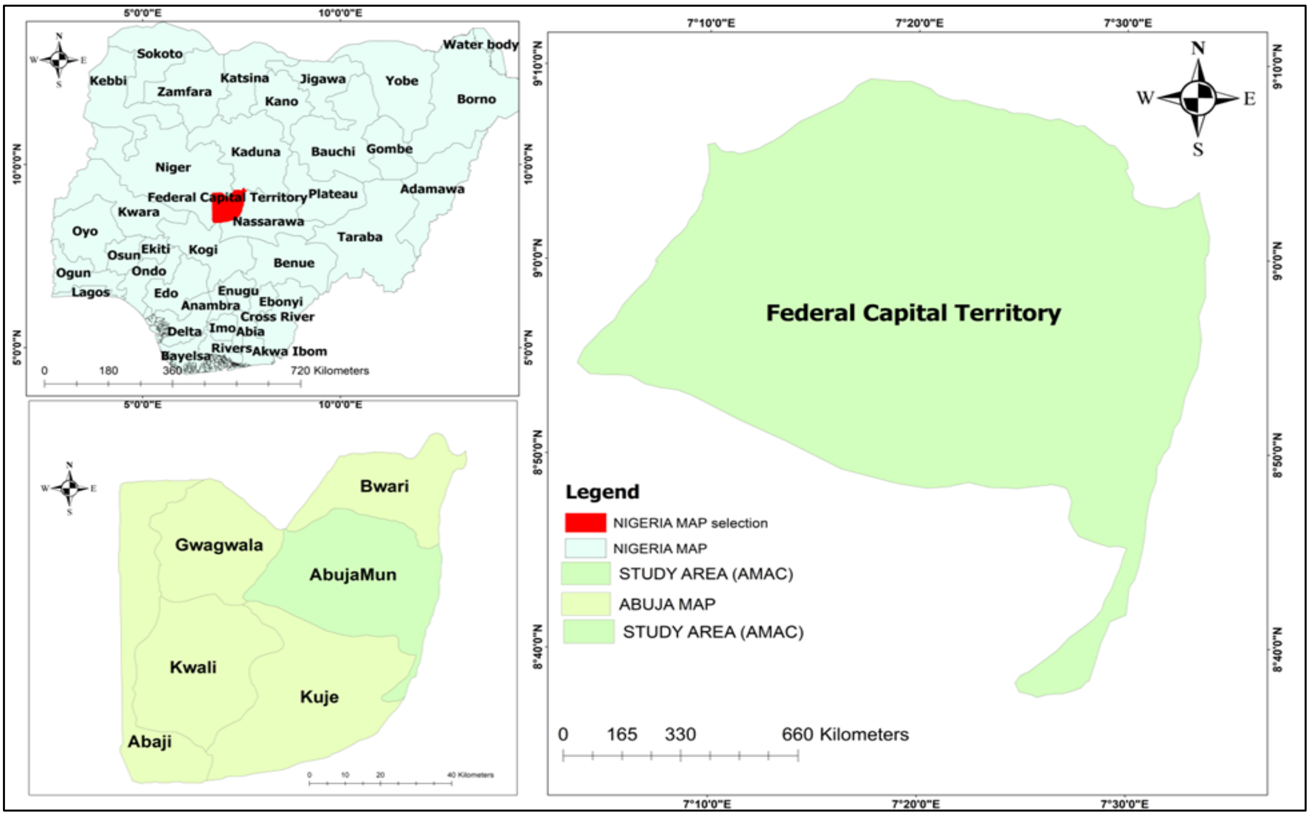

Figure 1 Map of Study Area

2. Materials and method

This research integrates both spatial and non-spatial data, which was digitized on screen, to carry out a spatial distribution analysis of TB prevalence in Abuja Municipal Area Council (AMAC). This section of the research, details the sources and kinds of data being employed, data presentation, and the analytical techniques being employed in other to achieve project goals.

Table 1 Data Type, Sources and Format

Data	Sources	Format
TB cases (Presumptive Register and Treatment Register)	Garki Hospital, Abuja	JPEG (jpg)
Study Area Shapefile	www.diva-gis.org	Esri Shapefile
Districts	https://www.google.com>maps	Esri Shapefile

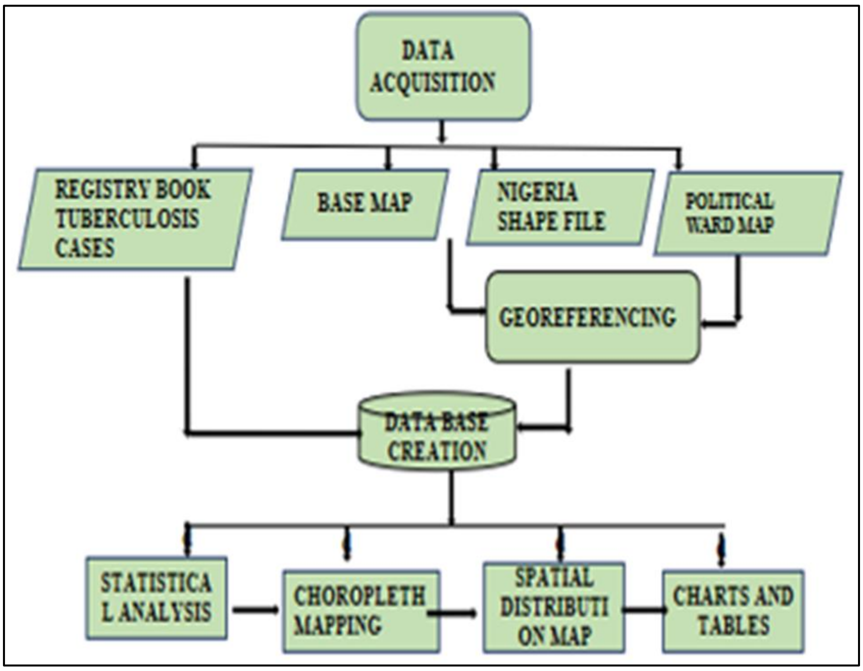

Figure 2 Methodology workflow

2.1. Software Used

The software used for the analysis includes ArcGIS 10.4 which was used in analyzing the spatial image of TB prevalence in the area, Google map which was used in the creation of shape files of the districts within the study and Microsoft Excel for tables and charts

The shape file of the study area was downloaded from a Map Library via www.diva-gis.org along with the Universal Transverse Mercator (UTM), Zone 32 coordinate system. The shapefile of the districts within the study area was created through Google Maps where the area and distance of the districts were obtained using the measuring tool on Google map (https://www.google.com>maps). The obtained statistics were imputed in an Excel spreadsheet which was used to create the charts and was equally converted into a "CSV" file to enable the statistics to be accessible and utilized, using ArcMap.

3. Result and analysis

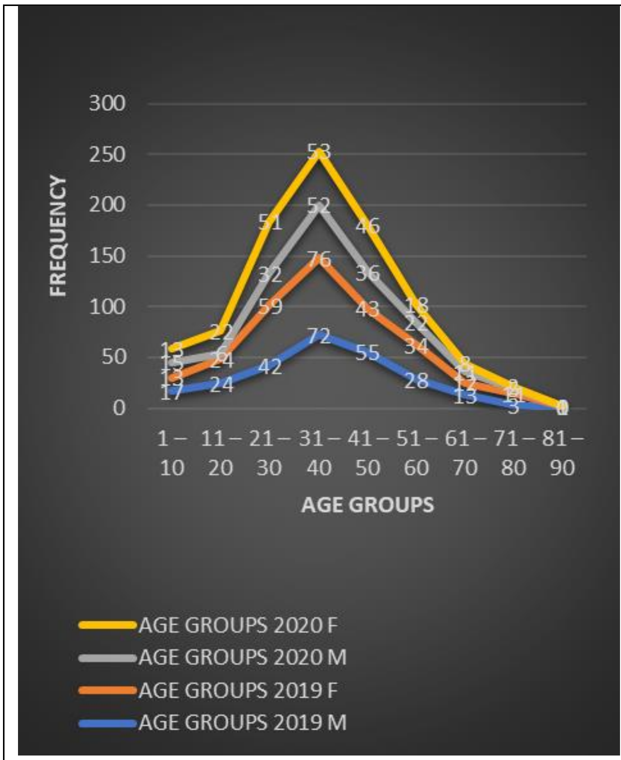

Figure 3a Number of TB diagnosed Patients in (2019 and 2020) according to groups

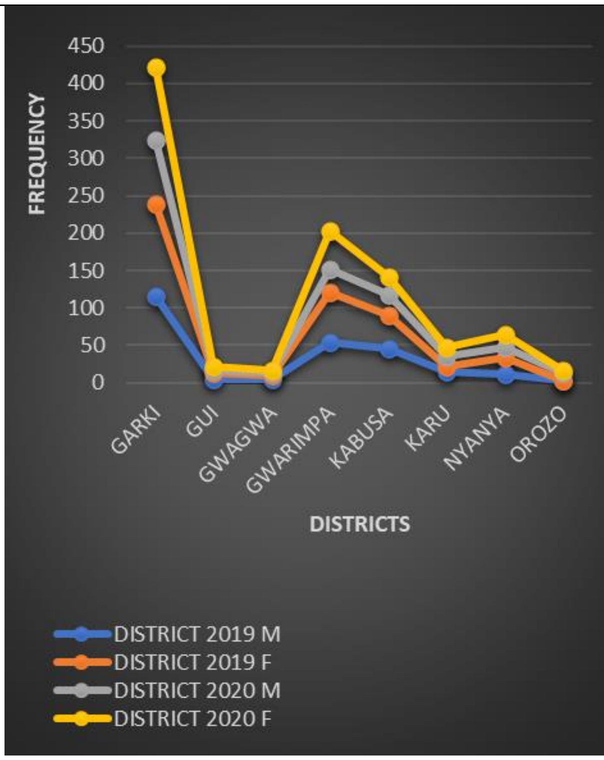

Figure 3b Number of TB diagnosed patients in (2019 and 2020) according to age districts

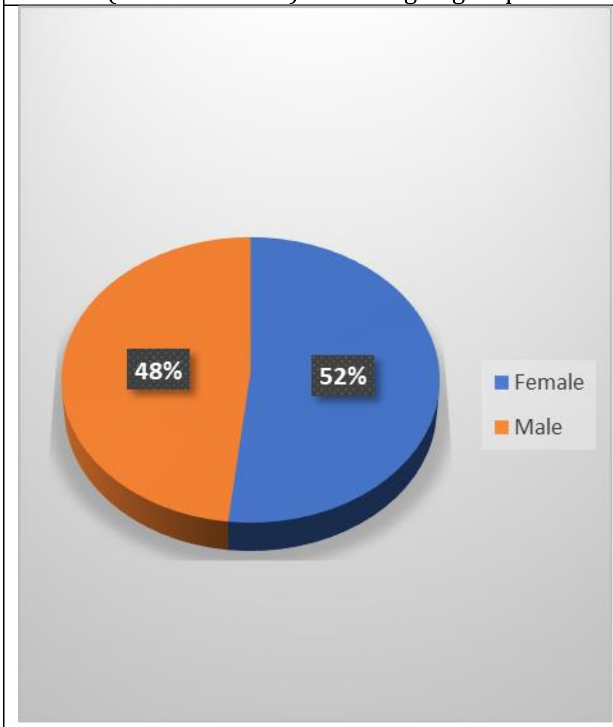

Figure 4a Number of diagnosed according to gender group

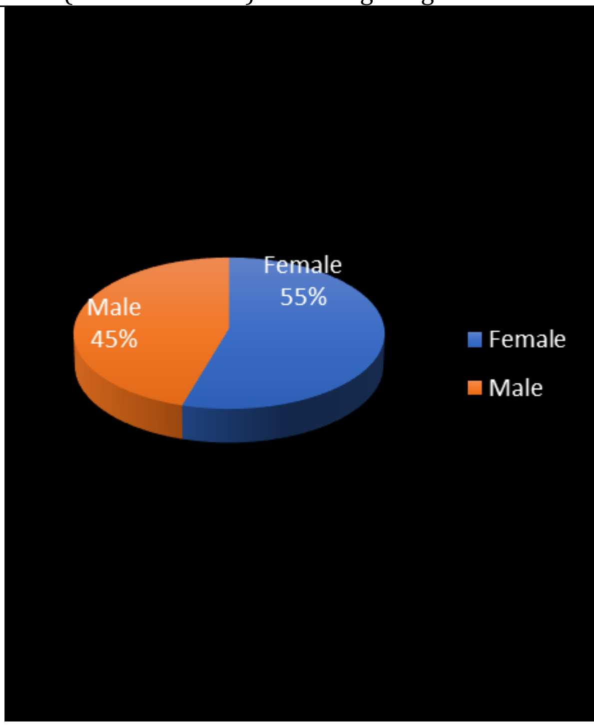

Figure 4b Number of diagnosed patients in 2019 Patients in 2020 according to gender group

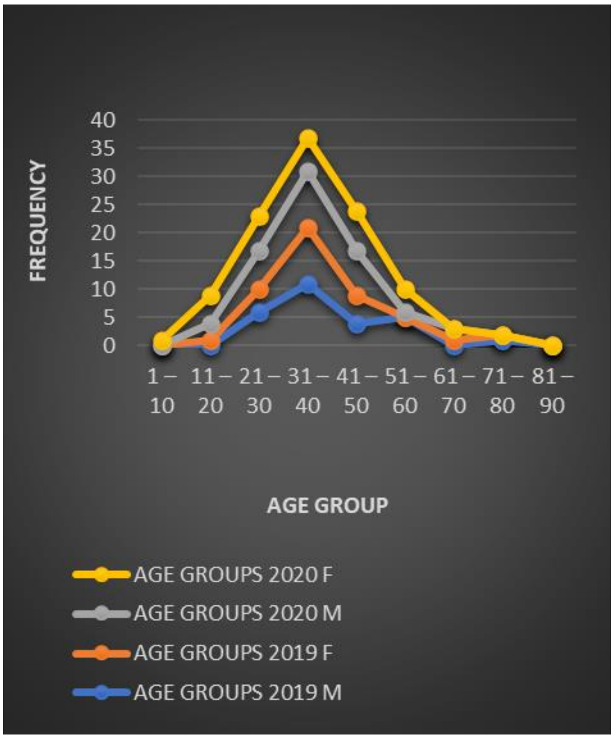

Figure 5a Number of TB positive Patients in (2019 and 2020) according to age group

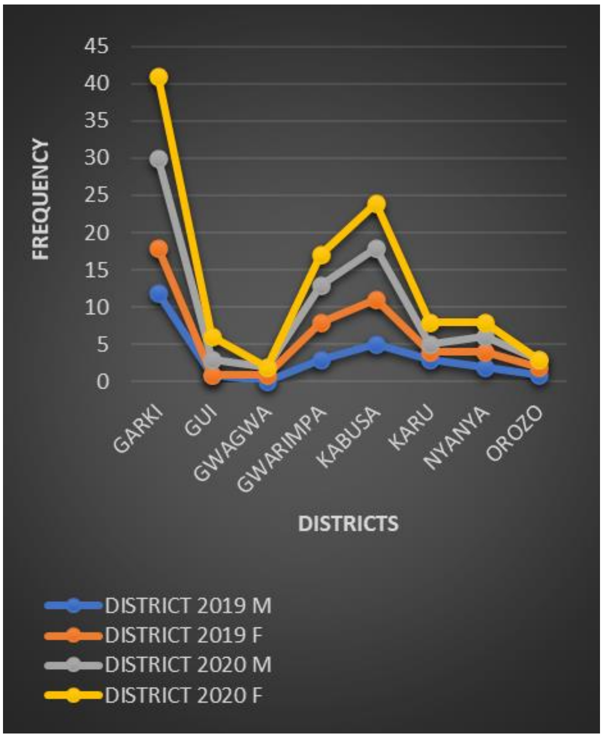

Figure 5b Number of TB-positive patients in (2019 and 2020) according to districts

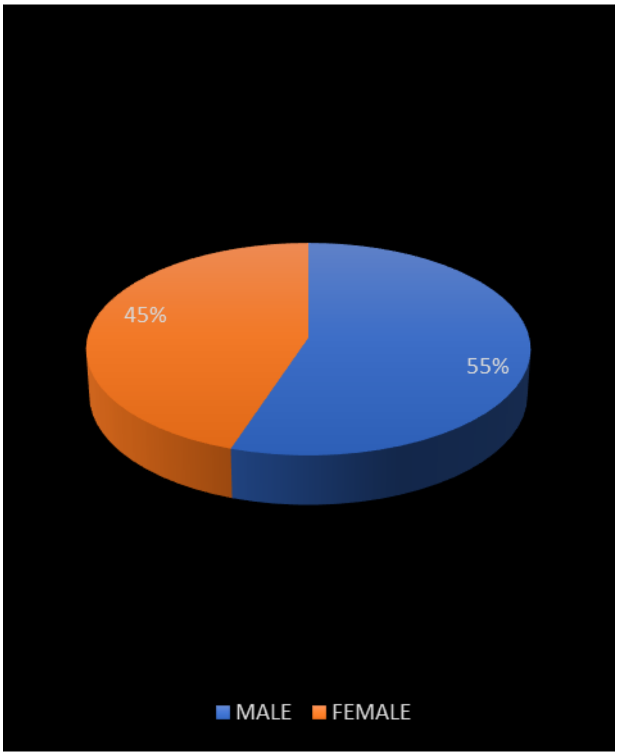

Figure 6a Number of positive patients in (2019) according to gender group

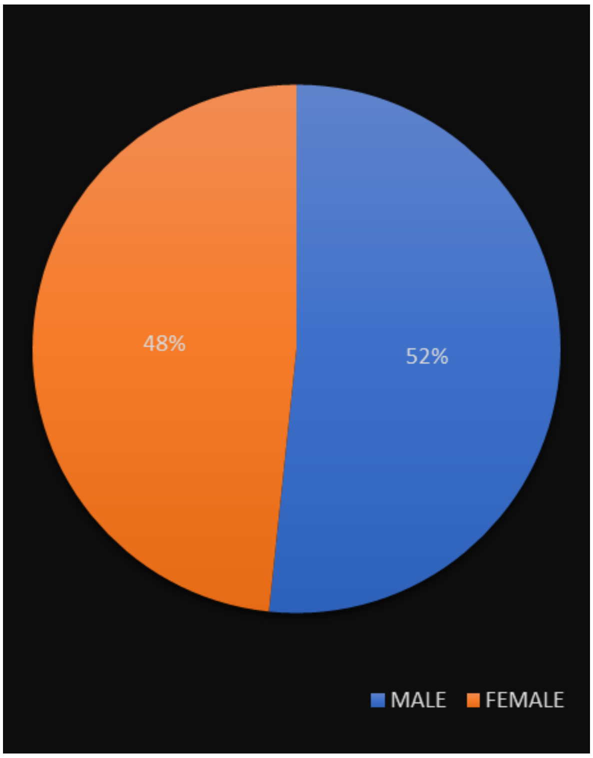

Figure 6b Number of positive patients in (2020) according to gender group

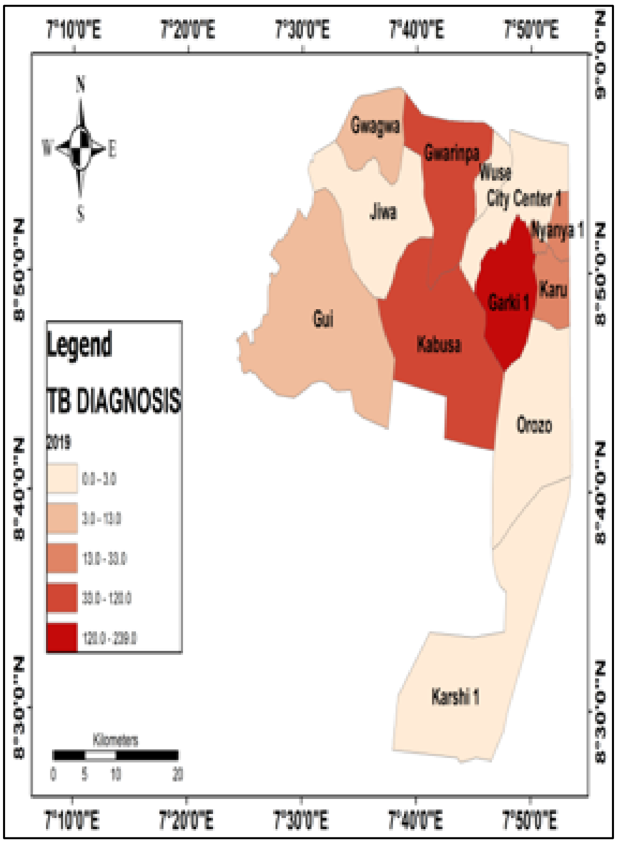

Figure 7a Districts with TB Infection Diagnosis Cases in 2019 under Abuja Municipal Area Council (AMAC)

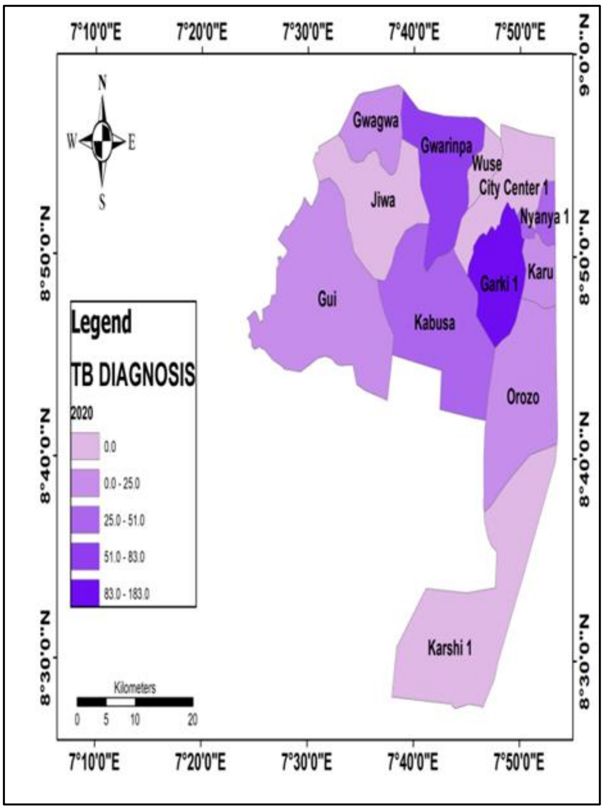

Figure 7b Districts with TB Infection Diagnosis Cases in 2020 under Abuja Municipal Area Council (AMAC)

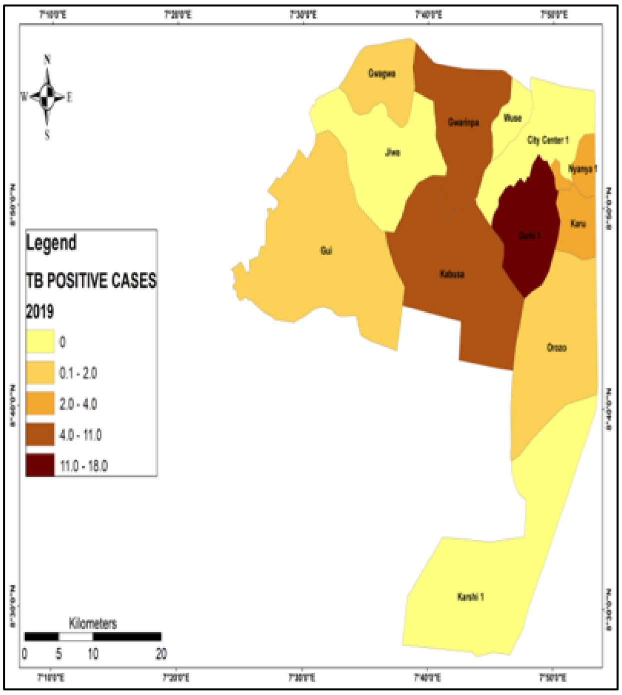

Figure 8a Districts with Positive TB infection Cases in 2019 under Abuja Municipal Area Council (AMAC)

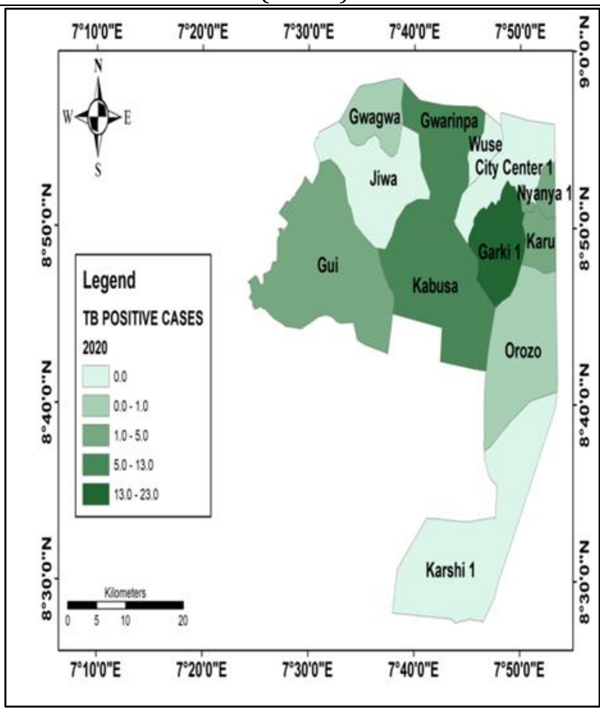

Figure 8b Districts with Positive TB infection Cases in 2019 under Abuja Municipal Area Council (AMAC)

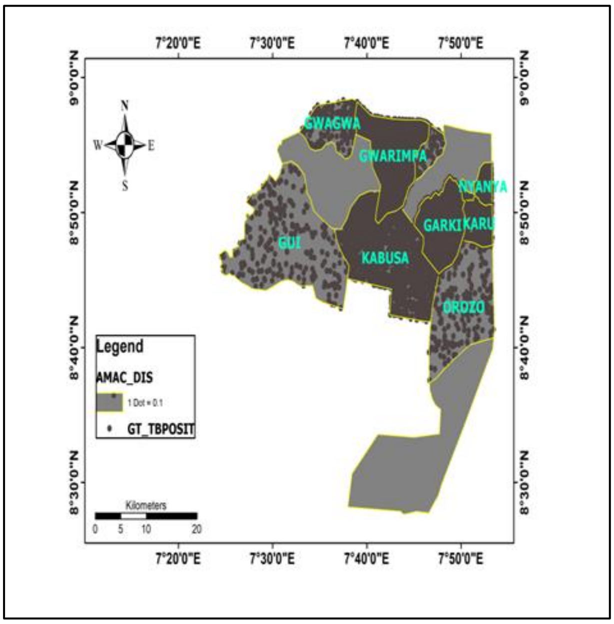

Figure 9a Dot Density of TB Positive Cases in AMAC from 2019 to 2020

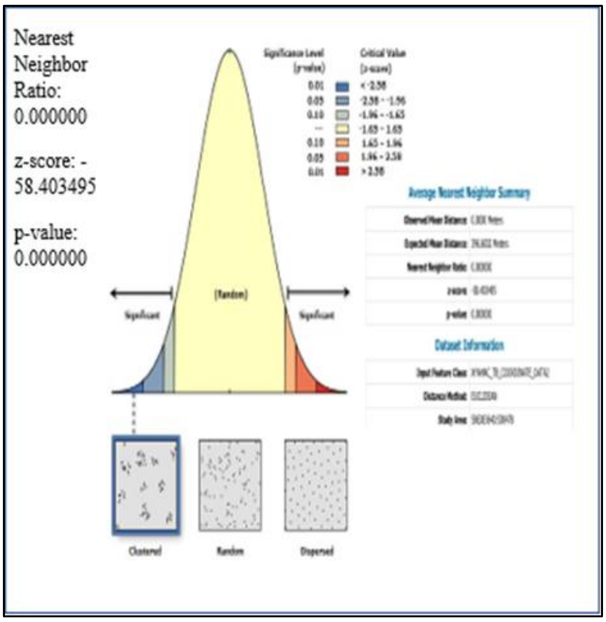

Figure 9b Average Nearest Neighbour Summary

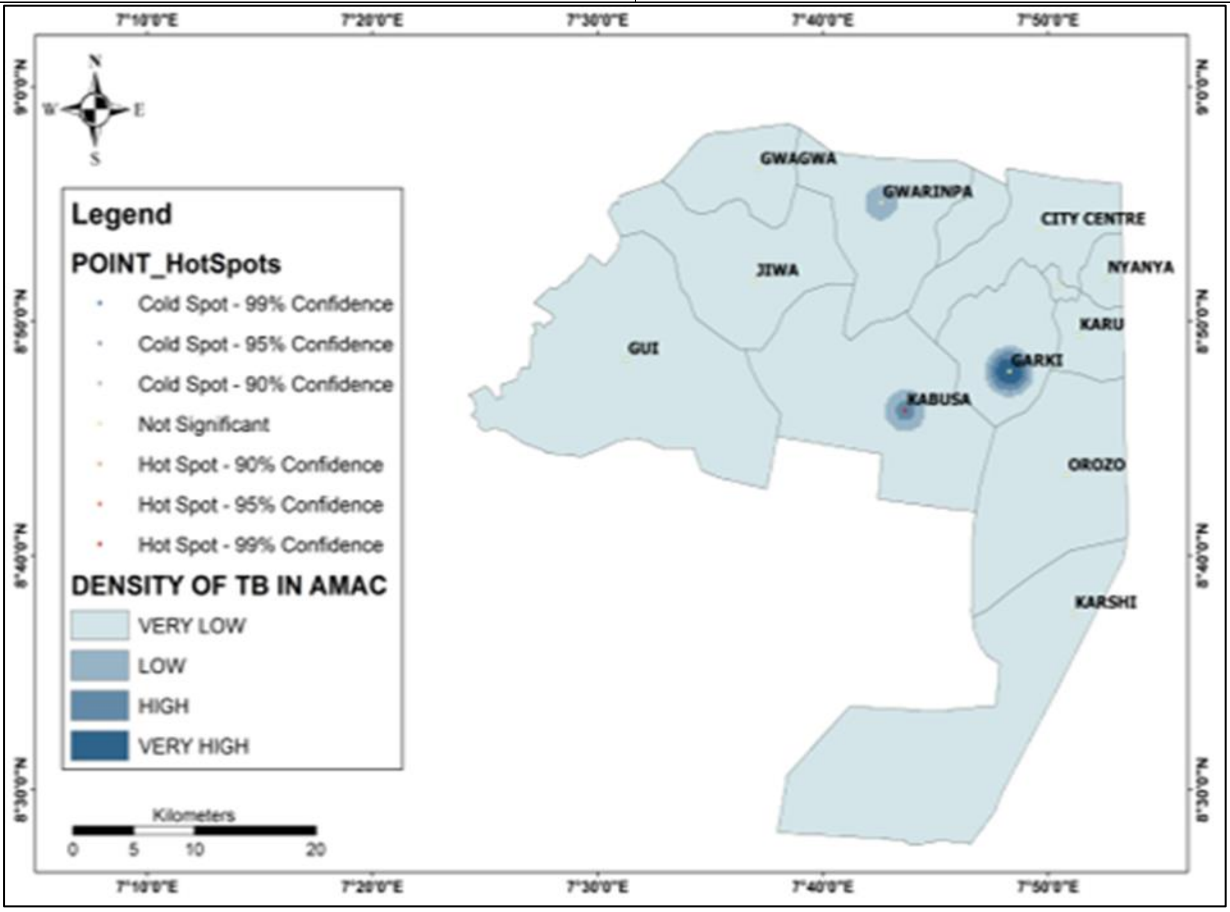

Figure 10 Density and Hotspot of TB Positive Cases in AMAC, FCT

Figure 3a shows the number of patients diagnosed with TB infection in 2019 and 2020. The results reveal that patients between the ages of 21 to 60 are the most diagnosed with TB in 2019 and 2020. Patients between the ages of 31 to 40 have the highest TB-positive infections 148 and 105 in 2019 and 2020 respectively. Figures 4a and 4b show that in 2020, there was 3% decrease in males and 3% increase in females being diagnosed with TB infection from 2019 to 2020.

Figure 5a shows the number of TB-positive patients in AMAC according to age group in 2019 and 2020. The result reveals that patients between the ages of 21 to 50 recorded a high burden of TB infection in 2019 while in 2020, patients between the ages of 11 recorded a high burden of TB infection. There was also a significant increase in TB infection diagnoses among the age group between 11 to 20 in 2020. Figure 5b shows the districts with the number of TB-positive patients residing in them in 2019 and 2020. The result reveals that patients that were tested positive to TB, reside in Garki District, Gwarimpa District, and Kabusa District with Garki having the highest number of TB-positive tested patients in 2019 and 2020 due to its population density.

Figures 6a and 6b show the percentage of gender-based positive TB infections in 2019 and 2020 respectively. The result shows that 45% of TB-positive patients were female and 55% were male in 2019 while in 2020, 48% of positive TB infections were female and 52% were male. The females increased by 3% while the males decreased by 3%.

19Figure 4.1a and Figure 5a reveal that patients between the ages of 21 to 50 years recorded a high number of TB infection diagnoses in 2019 and 2020 with the age groups from 31 to 40 years being the highest. Figure 4.1e revealed that age groups between 31 and 40 years recorded the highest burden of TB-positive infection in 2019 while age groups between 21 to 50 years recorded a high number of TB infection diagnoses in 2020. it also revealed that patients between the ages of 31 to 40 years recorded the highest number of positive TB infections in AMAC in 2019 and 2020. The results from the above tables revealed that more females in AMAC were diagnosed with TB infection in both 2019 and 2020 than males, while males in AMAC recorded the highest positive TB infection than females in 2019 and 2020. Figure 4.1b and figure 4.1f show that the districts with the highest number of TB-diagnosed patients were Garki, Kabusa, and Gwarimpa (accordingly) and are also the districts that recorded high numbers of positive TB infection patients both in 2019 and 2020. figures 4.2a and 4.2b show the spatial distribution of tuberculosis-diagnosed patients in 2019 and 2020 respectively, while figures 4.2c and 4.2d show the spatial distribution of patients that are positive tested for TB in 2019 and 2020 under AMAC. Figures 4.3a, 4.3b, and 4.3c show the dot density, cluster, and hotspots of patients that are positive tested for TB.

4. Conclusion

The capabilities of the use of GIS and spatial analysis have been displayed in this study by analyzing geographically referenced health data in Abuja Municipal Area Council (AMAC). As seen in figures 4.1g and 4.1h there was only 3% reduction of TB incidents by the male gender but the same equivalence was increased by the female gender proving an insignificant change towards the effort of reducing TB incident cases by 20%.

Recommendations

From the spatial statistical analysis and procedures, it is expected that areas with high prevalence and hotspots of TB incident cases within Abuja Municipal Area Council (AMAC) should be given more attention to guide and implement effective prevention strategies. The result of this study should also quicken the government and in the fight against TB in AMAC towards planning different strategies different from the usual. There is also, a need for proper awareness as the majority of people globally, still ignore the dangers that could arise from a cough that has lasted for more than two weeks. Most individuals don't keep tabs on when their cough started only to realize that the cough has lasted for over two to four weeks long. It is also important that while carrying out the awareness campaign by the Government, the health facilities available have to be scrutinized to know if it has what is needed to attend to the infected individuals. There is a need to ensure that there are available trained and experienced clinical personnel in every health facility It is recommended that the government through the Ministry of Health implement TB tests to be among the basic health screening as done in the case of HIV. This should be adopted by schools, and every cooperating organization.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

No conflict of interest is to be disclosed

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