

SPATIAL DISTRIBUTION OF DIABETES MELLITUS INCIDENCE IN A RAPIDLY GROWING URBAN AREA IN NIGERIA

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ABSTRACT: Diabetes Mellitus (DM) disease is one of the oldest diseases known to man. Incidence rate of the disease is on the increase particularly in low and middle income countries. The study investigated the variation in the incidence of DM in Owerri, Imo state Nigeria with a view to understand the risk factors and the disease pattern. Secondary data were collected from three major hospitals in Owerri. A total of 2,197 DM cases were accessed and used for the study on the attainment of ethical approval. The data collected covered the patients that were treated for DM in these hospitals between 2008 and 2017. The study made use of mixed methods comprising descriptive statistics, (tables, charts and percentages), and mapping using ArcGIS 10.4. The results of the study indicated that place of origin or residence were not factors in the distribution of the disease. The results as deduced from maps on the study indicated that there were more cases of DM in 2017 compared to other years such as 2008 which has the least number of cases. The major predisposing factor was shown to be family history (hereditary, 73%), age (56 years and above), gender (female), marital status (married) and occupation (civil servants). The study concludes that DM disease is on the rise in Owerri Imo State, Nigeria and recommends a regional policy response.

Keywords: Spatial Distribution, Incidence, Diabetes Mellitus, Urban Area, Nigeria

INTRODUCTION

Health is an important part of human functionality and diseases have been around with man for a very long time (Centers for Disease Control and Prevention [CDC], 2018). Diabetes mellitus has been described as a condition where there is diminished production of insulin or the ineffectiveness of insulin (American Diabetes Association, 2009; Park, 2015). The disease is said to be predominant in people of African and Asian descent with family history as the major predisposing factor (Photis, 2016). DM is classified as either type I, type II or gestational diabetes (World Health Organization, 2018, 2019). In the tropical region, the incidence of DM has been on the increase. Furthermore, several studies Adeloye et al., (2017) and Adogu et al., (2015) have considered different aspects of the incidence of the disease and gradually more light is being shed on both the incidence and prevalence of the disease. Despite these efforts, there has been a rise in the incidence of DM. The rise has been attributed to the mass consumption of carbohydrates in the tropics, the introduction of food and snacks alien to the people and the redundant lifestyle of some of the people (Osayomi & Orhiere, 2017).

Because of the focus of the previous studies on the health angle of the disease, most of the studies glossed over the spatial and temporal dimension of the incidence of the disease. Previous studies examined DM in resource poor settings (Iloh et al., 2013; Iloh & Uchenna, 2014) and others looked at prevalence and risk prediction Adogu et al., (2015) and Adeloye et al., (2017) while another study concentrated on the socio-economic impact of the disease (Nwosu et al., 2016). Although some studies Osayomi, (2015) and Osayomi and Orhiere, (2017) have attempted in their studies to show disease clusters and in doing so, they emphasised that geography matters in disease aetiology. However, these studies were conducted in Oyo State and its capital territory. Due to the health habits of people in Owerri, DM has been under reported. This observation holds true for numerous regions across Africa as well. Hence, Park, (2015) characterized diabetes disease as an iceberg disease. Also, (Oputa & Chinenye, 2015) identified the disease as a leading cause of death in Nigeria. All these have formed the foundation for the current study which sets out to analyse the spatial and temporal patterns of diabetes mellitus incidence in Owerri, Imo State, Nigeria and identify the primary risk factors contributing to its rise.

MATERIALS AND METHODS

Sources of Data and Instruments of Data collection

The study derived secondary data from three major hospitals in Imo State vis-a-vis Federal Medical Centre (FMC), Umezuruike Hospital and General Hospital Umuguma. These hospitals were selected because they collectively represent key healthcare facilities in the region, providing comprehensive medical services and serving as primary centres for diabetes mellitus diagnosis and treatment. Their inclusion allowed for a comprehensive analysis of DM cases in Owerri, including patients from diverse geographical areas, socioeconomic backgrounds and healthcare accessibility. This is vital for understanding the spatial and temporal patterns of the disease, its risk factors and facilitating the formulation of regional policy responses to address the rising incidence of the disease in the area. Thus, a total of 2,197 diabetes mellitus cases were accessed and used for this study on the attainment of ethical approval from the Ethics Committee, Federal Medical Centre Owerri. The data collected covered the patients that were treated for Diabetes Mellitus in these hospitals between 2008 and 2017.

The instrument of data collection for this study was a structured checklist. The structured checklist was designed to collect information on objectives which were set out to examine the incidence and predisposing factors to DM. Also, the administrative map of Imo State on a Scale of 1:150,000 was acquired. This was to enable the researcher determine the political boundaries of the 27 Local Government Areas' (LGAs) of the state. It also provided information on LGAs headquarters as well as generating minimum mapping unit to map various thematic layers. A Garmin Global Positioning System (GPS) was used to acquire ground truth data to assess accuracy of the political boundary units and distributions of DM locations in the study area. The Geo database attributes and values generated were re-classed.

Study Area

The study area is Owerri, the capital city of Imo State in Nigeria located between Longitudes $6^{\circ}59^{\text{I}}$ and $7^{\circ}10^{\text{I}}$ E and Latitudes $5^{\circ}25^{\text{I}}$ and $5^{\circ}45^{\text{I}}$ N. The area is set at the heart of Igboland and

consists of three local government areas viz Owerri West, Owerri North and Owerri Municipal area. Owerri also serves as the seat of government in Imo state Nigeria since 1977. The area also harbours the three major hospitals in Imo State namely; Federal medical centre (FMC), Umezurike hospital and Imo State Specialist hospital which make up the basis for the required data for this study. (See Fig. 1 for the study area map)

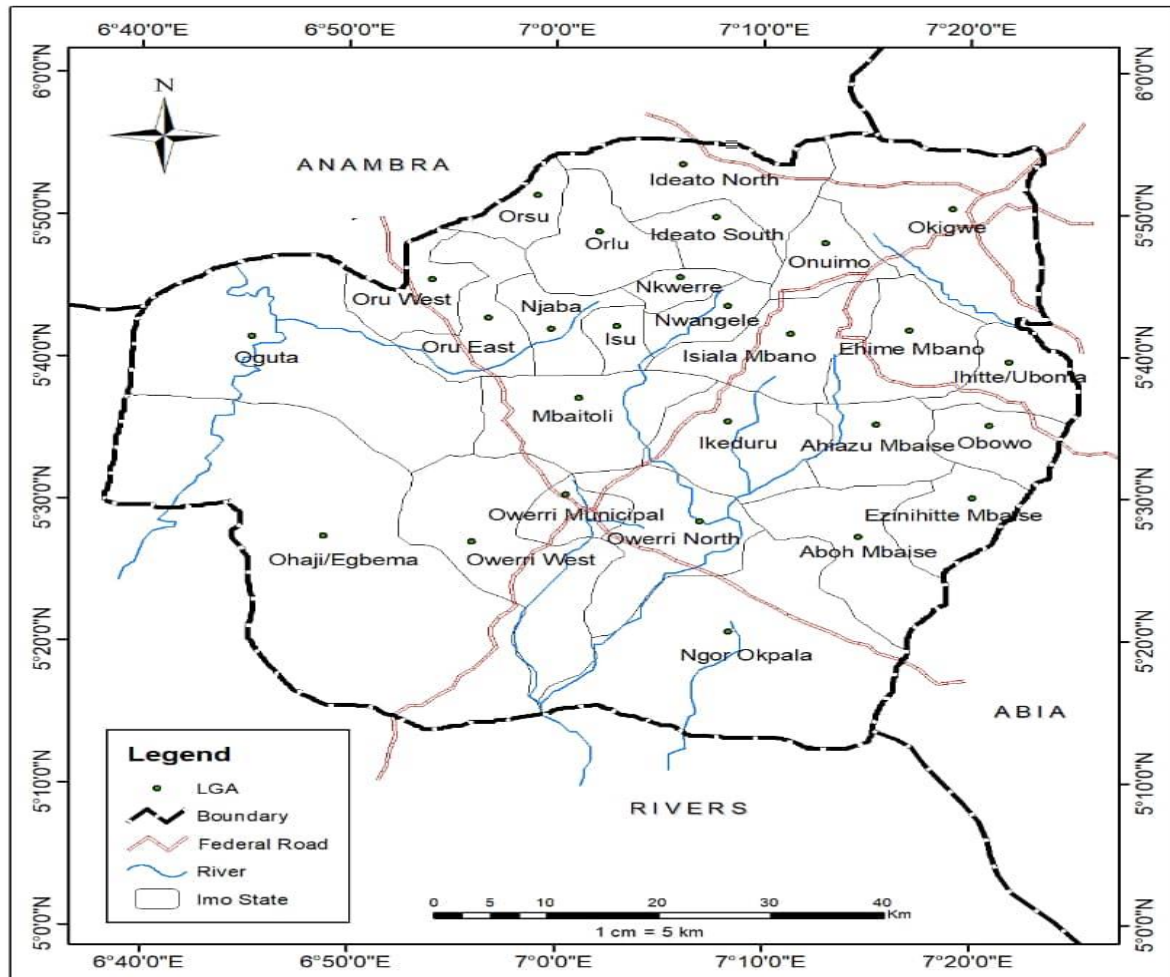


Fig. 1 Study Area

Source: GIS Lab, Imo State University, Owerri

Variable Description and Data analysis

The data required was collected from the hospital records of three hospitals to cover the spatial and temporal distribution of patients with the disease and also the predisposing factors. This enabled the researchers arrive at a valid conclusion regarding the distribution of Diabetes Mellitus in Imo State. Data on the following variables were used to back up this study; DM cases (2008-2017), Locations of patients, temporal distribution of DM, spatial distribution of

DM, spatial distribution by year and prevalence and incidence rate of DM, types of DM, family history, age of patients, gender of patients, educational level, marital status and occupation.

The Geographic Information System (GIS) was used as a tool in analysing the study objective. Choropleth maps were generated using the ArcGIS 10.4. The DM cases for 2008 – 2017 were over-layered on the geo-referenced map of the state according to the location of the patients. The summation of the occurrence of DM cases was imputed across the 27 LGAs according to their values and suitable colour range was used to differentiate the variation across the state. The maps were used to show spatial distribution and variations in the prevalence of DM.

The data that was obtained on predisposing factors and also demographic information were organized into simple frequency tables and percentages to explain the ages of patients, marital status, educational qualification etc.

RESULTS AND DISCUSSION

Spatial Pattern of Diabetes Mellitus

The study relied on secondary data collected from hospital, potentially excluding individuals who did not seek healthcare from the sampled hospitals. This limitation may affect the true prevalence of diabetes in the broader population. Analysis was carried out based on the dataset to ascertain the Local Government Area with the highest contribution to DM cases in Imo State (Figure. 2).

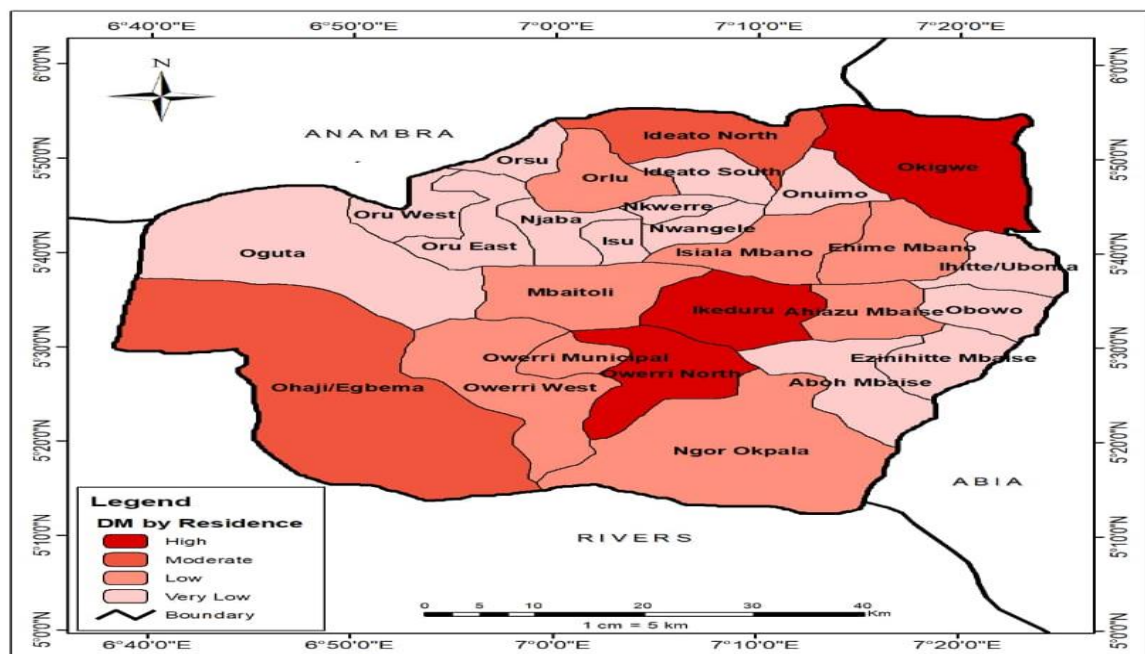


Fig. 2 Spatial Distribution of Diabetes Mellitus by Residence

Source: Data Analysis (2019)

Also, analysis was conducted to ascertain the spatial distribution of Diabetes Mellitus by Local Government. The dataset indicates that the patients used for this study came from all over Imo State but the highest concentration was found around Orlu, Ideato South, Mbaitoli, Ikeduru, Owerri North and Owerri Municipal (Figure 2). The spatial pattern indicates that DM is not limited to any particular LGA but is spread around the study area in different concentrations. It is also clear from the study that urban cluster and proximity to these hospitals may have influenced high concentration of DM in some of the LGAs in Imo State, Nigeria.

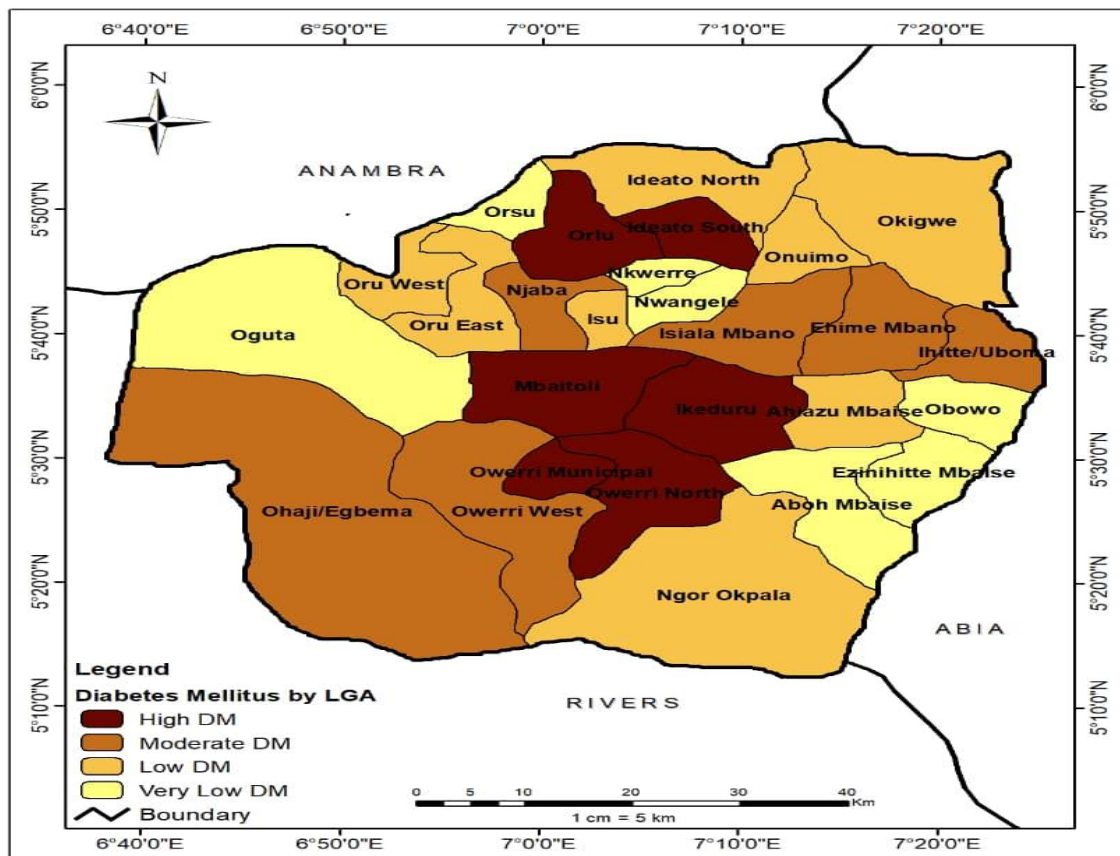


Fig. 3 Spatial Distribution of Diabetes Mellitus by LGA

Source: Data Analysis (2019)

The findings of this study revealed significant insights into the distribution of diabetes mellitus (DM) cases in Owerri, Imo State, Nigeria. Despite the three hospitals being located in the state capital, patients seeking treatment for DM came from various regions across the state, demonstrating the wide reach and importance of these healthcare facilities.

The highest concentration of DM cases was observed in specific areas, particularly in Owerri North, Ikeduru, and Okigwe, indicating localized hotspots of the disease (Figure. 2). This concentration suggests that there may be regional factors contributing to the higher prevalence of DM in these areas, which warrants further investigation.

Furthermore, the analysis highlighted that DM cases were moderately concentrated in Ohaji/Egbema and Ideato North, while other Local Government Areas in Imo State exhibited relatively low DM prevalence (Figure 3). This spatial variation emphasizes the need for targeted interventions and healthcare resource allocation to address the varying disease burdens across different regions within the state. The study affirms that there is a significant spatial association between a patient's geographic location and the occurrence of DM. This finding underscores the importance of considering spatial factors in healthcare planning and policy development. Further finding reveals that proximity to healthcare facilities impacted the distribution of DM cases which highlights the role of accessibility in healthcare-seeking behaviour.

This result aligns with prior research by Osayomi (2015) and Osayomi and Orhiere (2017), which emphasized the influence of distance to health facilities as a crucial factor in healthcare decision-making.

Temporal Distribution of Diabetes Mellitus

Further analysis was carried out to ascertain the year(s) with the highest distribution of diabetes mellitus cases in the study area. See fig. 7

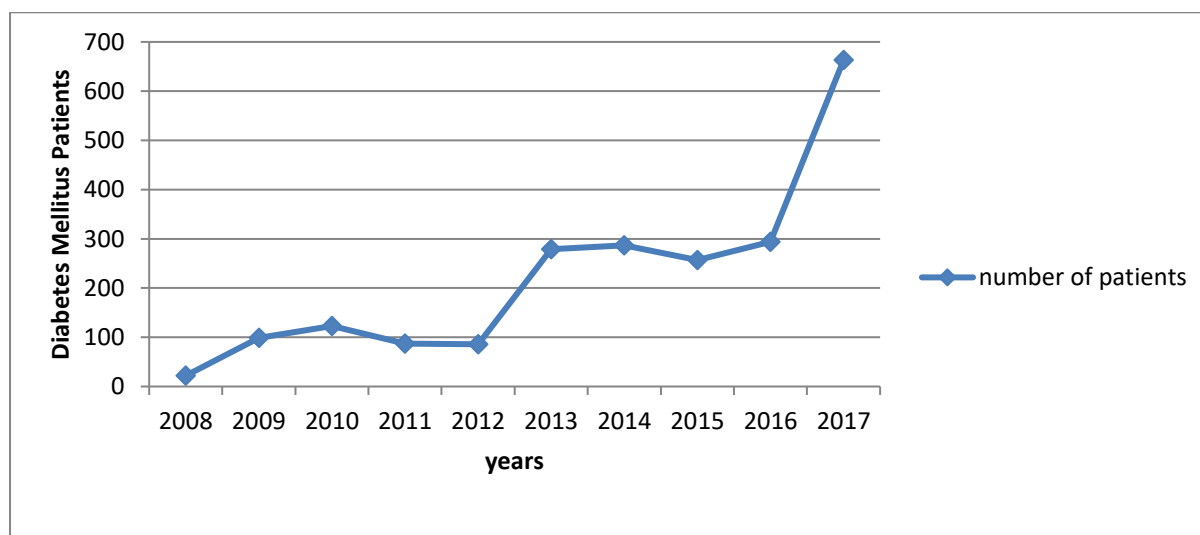


Fig. 4 Temporal Distribution of Diabetes Mellitus

Source: Data Analysis (2019)

The data also indicated that there were more cases of DM in 2017 compared to other years such as 2008 (Figure 5 which has the least number of cases. The discrepancy could be accounted for by the absence of data for Umezurike Hospital for 2008 – 2012. It could also be a pointer to the increasing cases of DM in the study area. The result is in consonance with another study in Nigeria Adogun et al., (2015) in their study of DM Prevalence and Presentation Pattern in Imo State. They opine from their study that the prevalence of DM is on the rise in Nigeria.

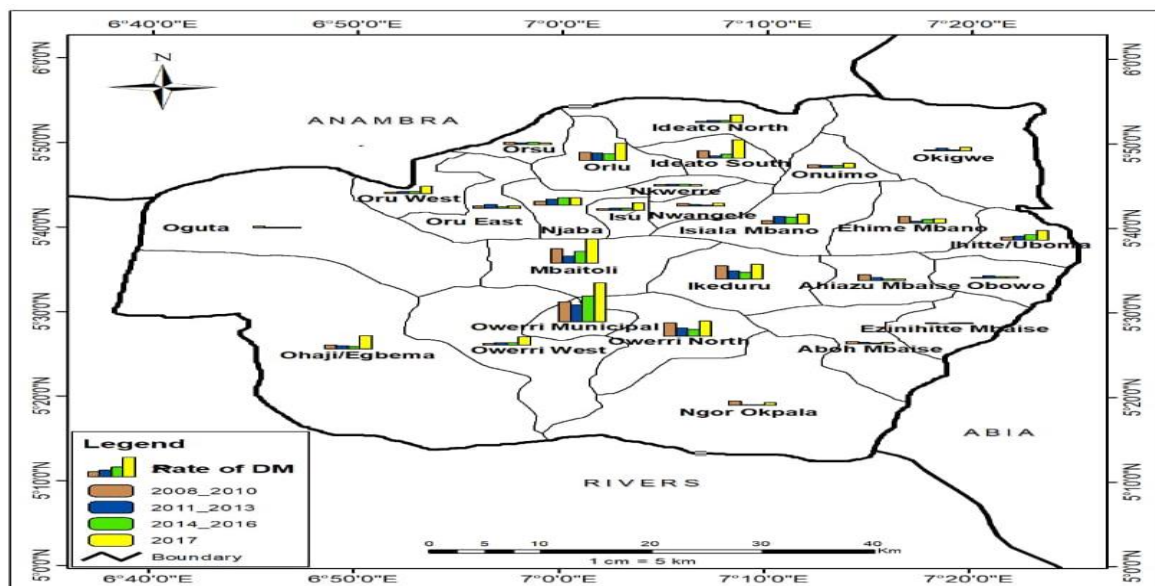


Fig. 5 Rate of Diabetes Mellitus

Source: Data Analysis (2019)

Predisposing Factors of Diabetes Mellitus

Further investigation was carried out to determine the predisposing factors for DM in the study area and the following findings was uncovered based on the dataset;

Table 1 – Predisposing factors of Diabetes Mellitus

Predisposing factor	Range	Percentage %
Age	18-39	12
	31-43	22
	44-56	27
	>56	39
Gender	Female	55
	Male	45
Education	No formal	26
	Primary education	18
	Secondary education	35
	Tertiary education	15
	Vocational education	6
Marital status	Single	4
	Married	68
	Widowed	13
	Divorced	7
	Separated	5

Occupation	Civil servant	51
	Self employed	16
	Business/Trade	18
	Artisans	12
	Unemployed	3
Family history of Diabetes Mellitus	Yes	73
	No	27

Source – Author’s Field survey (2019)

The results of the study indicated that demographic conditions such as age were vital variables in the occurrence of DM in the study area. The findings revealed that 12% of the patients were between the ages of 18 – 30 years, 22% were between the ages of 31- 43 years, 27% were between the ages of 44-56 years, and 39% were 56 years and above. This is an indication that the occurrence of DM is higher among people who are 56 years and above (elderly people) in the study area. This result agrees with the results of another author Adogu et al., (2015) who studied the Prevalence and Presentation Pattern of DM in patients at Imo State University Teaching Hospital (IMSUTH) Orlu, a 10-Year Retrospective study. The results of their study indicated that age was a major factor in the occurrence of DM as it was very common among the elderly people aged fifty years and above. The results of this study also indicated that the most affected age group for DM was 56 years and above. It also showed that in terms of occupation, civil servants were the most affected group. This is in contrast with the work of Nwoke et al., (2017) which was carried out to determine the prevalence of DM, malaria and co-morbidity in three selected hospitals in Imo State, Nigeria. They designed their study to ascertain prevalence using patient’s age, occupation, and gender. Also, management of diabetes and malaria by patients were considered using a descriptive survey research design. The results of their study indicated that age brackets 40-49years had the highest prevalence of diabetes.

Furthermore, the study indicated that the female gender had higher cases of DM than the male gender. In regards to gender, 45% were males and 55% were females. This study agrees with the findings of Nwoke et al., (2017) where the distribution of cases of DM, malaria and co-morbidity based on gender, showed that Females in their study sample has higher prevalence of diabetes, malaria and co-morbidity than males $P < 0.05$. The results of the study disagree with another work of Adogu et al., (2015) where there was a higher prevalence in males 1056 (52.1%) than in females 972 (47.9%).

In addition, the data collected for this study indicated that the highest proportion of the patients, 35 percent, had secondary education, 26 percent had no formal education, 18 percent had primary education while 6 percent had vocational education. A high proportion of the patients were educated. It agrees with the study of Adeloye et al., (2017) and Osayomi, (2015) where it was revealed that the prevalence of DM is also related to the level of education attained. It was higher in respondents with secondary level of education than in those with tertiary education. This could be due to a better understanding of the disease by those with tertiary education who are aware of better adherence to routine clinic check-up, compliance to treatment, exercise and adequate consumption of fruits and vegetables etc.

With regards to marital status of patients, the study indicated that 68% of the patients were married, 13% were widowed, 7% were divorced, 5% were separated and 4% patients were single. Moreover, the results of the study also indicated that 51% were civil servants, 18% were business people in trade, 16% were self-employed, 12% were artisans while 3% were unemployed. The result of the study indicated that civil servants had the highest number of DM cases in the study area.

Finally, the data indicated that 73 percent of the patients had a family history of diabetes while 27 percent did not have a family history. This is an indicator that heredity plays a major role in the occurrence of DM in the study area. The results of this study indicated that family history was the major predisposing factor for DM as those who had a family history of the disease were more than those without the disease. This finding agrees with a study in eastern Nigeria by Iloh et al., (2013) in which they found that family history was the most significant predictor of diabetes mellitus, with patients having a family history of DM being twelve and a half times more likely to develop the disease than those without a family history of DM.

Conclusion/Recommendations

The distribution of DM is not a function of residence or LGA of origin. It is a function of other factors which include lifestyle, age, gender, family history, occupation, marital status etc. This study further concludes that there was a temporal variation in the occurrence of DM disease. The distribution was higher in 2017 and lower in 2008. It was an indicator that people are becoming more aware and reporting more cases. Overall, this study provides valuable insights for healthcare authorities, policymakers, and researchers to formulate targeted strategies and policies to address the rising prevalence of DM in Owerri, Imo State, Nigeria, taking into account both geographic and temporal dimensions.

The occurrence of a diabetes pocket in Mbaitoli, Ikeduru, Owerri North, Owerri Municipal and Ideato South where the prevalence of DM is three times higher than the rest of the state is worrisome and calls for an urgent regional policy response. The policy intervention should not just emphasise primary, secondary and tertiary prevention strategies against DM but also bring into focus its spatial patterns and the predisposing factors within the local context of the disease. It is also recommended that government should improve healthcare accessibility in underserved areas to address geographic disparities in diabetes incidence.

Suggestions for Further Studies

It may be necessary to conduct further studies that employ a comprehensive approach including community-based surveys and data from various healthcare facilities. This will enable the researcher obtain a more accurate data on diabetes prevalence and risk factors.

Ethical Consideration

Ethical clearance was obtained from the health research ethics committee of the Federal Medical Centre, Owerri Imo state, Nigeria. Other clearance was gotten from the Head of Department, Geography and Environmental Management, Imo State University, Owerri, Nigeria.

Author Contribution

Oduaro, Ifeanyi Joachim conceptualized the study design and carried out the investigation, including data acquisition.

Duru Patricia conceived the original idea and supervised the project.

Okorie Fidelis Chinazor carried out data analysis and interpretation of the results.

Oduaro Ifeanyi wrote the manuscript and Duru Patricia reviewed and edited the manuscript.

Conflict of Interest

The authors declare that they have no competing interest.

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