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Mapping of Lymphatic Filariasis by Observation of Elephantiasis in Enugu State, Southeastern Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. Authors LNN, IOO and MOI designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors LNN and KCI managed the analyses of the study. Authors LNN and KCI managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Background: Lymphatic filariasis (LF) caused by filarial parasites can lead to complication like swollen legs with rough thickened skin, known as elephantiasis. A study of mapping of LF by observation of elephantiasis in five Local Government Areas (LGAs) in Enugu State.
Aim: The study was to determine the prevalence of elephantiasis according to gender, age and occupation and to develop map of LF prevalence in Enugu State, Southeastern Nigeria.
Study Design: The study was a cross-sectional survey of the studied population for elephantiasis. A total of 349 persons aged 15 years and above, participated in the study. The study was conducted between January and May, 2018 and the participants were selected through systemic sampling technique.
Materials and Methods: Physical examination of individuals was employed to determine elephantiasis. Geographic Information System (GIS) was used for mapping.
Results: A total of 4.9% (17) prevalence of elephantiasis was recorded. Females had highest prevalence, 8.3% (13) against 2.1% (4) in males. There was significant association between elephantiasis and gender (X^2 = 7.158, df = 1, p = 0.007, (p < 0.05)). Age group 45 – 54 years had the highest prevalence of 12.3% (7) while no case was observed in age groups 15 – 24 years, 25 –

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34 years and 35 – 44 years. There was significant association between elephantiasis and age (X^2 = 13.934, df = 5, p = 0.016, (p < 0.05)). Artisans with a prevalence of 11.4% (4) had the highest prevalence, while no case was reported in students, civil servants and carpentry occupation groups. There was no significant association between elephantiasis and occupation (X^2 = 4.917, df = 5, p = 0.426, p > 0.05)). Nkanu East (Onichagu) had the highest prevalence with 5 cases (9.1%) while Awgu (Ibite) had the least with 3 cases (3.0%).

Conclusion: People living with LF morbidity are in the study area. The State Ministry of Health and Partners should develop morbidity management activities that will alleviate the burden of elephantiasis.

Keywords: Prevalence; lymphatic filariasis; elephantiasis; mapping; Enugu.

1. INTRODUCTION

Lymphatic filariasis (LF) is a disease condition that occurs when filarial parasites transmitted to humans through bites from infected mosquitoes lodge in the lymphatic system and grow into adult worms over several years [1]. The disease is caused by *Wuchereria bancrofti*, *Brugia malayi*, and *B. timori*, with *W. bancrofti* causing over 90% of the infections [2]. The disease leads to complication like swollen legs with rough thickened skin, also known as elephantiasis and can occur in other parts of the body including the scrotum in men [1]. Currently, about 859 million people in 50 countries worldwide remain threatened by LF and require preventive chemotherapy to stop the spread of this parasitic infection [3]. Nigeria has the heaviest burden of LF in sub-Saharan Africa [2]. As of 2017, Nigeria accounted for 14.3% of the global population of people that required LF treatment as an estimated total of 128, 342,058 people in 583 out of 774 Local Government Areas (LGAs) required preventive chemotherapy for LF [1].

Lymphatic filariasis infection involves acute and chronic conditions. The majority of infections are asymptomatic, showing no external signs of infection while contributing to transmission of the parasite [3]. These asymptomatic infections cause damage to the lymphatic system and the kidneys and alter the body's immune system. When lymphatic filariasis develops into chronic conditions it leads to lymphoedema or elephantiasis of limbs [2-4]. Such body deformities often lead to social stigma and sub-optimal mental health, loss of income-earning opportunities and increased medical expenses for the affected persons [2].

Knowledge of the geographical distribution of LF is required to aid elimination programs. This will aid control efforts on highly endemic areas [4]. Therefore, it is necessary to determine the prevalence and mapping of LF to allow for virtualization and prioritization of problem areas for greater application of intervention in Enugu State. The objectives of the study was to determine the prevalence of LF by observation of elephantiasis in gender, age and occupation groups and to develop Geographic Information System (GIS) maps of LF in the study areas.

2. MATERIALS AND METHODS

2.1 Study Area

Enugu State is geographically located between latitude 6.4231°N and longitude 7.4878°E with a land area of 8,727.1 square kilometers and has a population of about 4,881,500 inhabitants [5]. The inhabitants of the area are mainly Igbos engaging in farming and trading. Others are artisans and civil servants. The state experience rainy season (May to November) and dry season (December to April). The area experience an annual rainfall between 152 and 203 cm. Average daily temperature ranges from 22.2 to 30.6°C. The study was carried out in five villages across five LGAs in three senatorial districts of the State. The villages are Onunkwo (Ogonogeji Ndiagu Akpugo) in Nkanu West LGA, Ibite (Agbudu) in Awgu LGA, Ogwu (Obollo eke) in Udenu LGA, Onichagu (Amagunze) in Nkanu East LGA and Amaegbu (Ihenyi - Eha-Amufu) in Isi-Uzo LGA. There has been Mass Drug Administration (MDA) with Albendazole since 2014 in order to control or eliminate LF in the villages. Every village has treatment register which contained the list of household members. Albendazole tablets were administered annually to eligible registered persons, thereby maintaining at least 65% therapeutic coverage annually.

2.2 Study Design

The study was a cross-sectional survey of the study population for elephantiasis, conducted between January and May, 2018.

2.3 Study Population

The study populations were selected from the villages registered as have being under treatment. The systemic sampling technique was employed, which involved the selection of units of the sample at a fixed interval on the sampling frame with the first member selected at random [6,7].

2.3.1 Sample size

The total sample size used in this study was 349 persons which varied across the LGAs. The distribution were: Amaegbu in Isiuzo LGA (88 persons as study population and 51 as sample size), Ibite in Awgu LGA (115 as study population and 101 as sample size), Ogwu in Udenu LGA (95 as study population and 92 as sample size), Onichagu in Nkanu East LGA (133 as study population and 55 as sample size) while Onunkwo in Nkanu West LGA (105 as study population and sample size of 50 persons).

2.4 Socio-Demographic Data Collection

The socio-demographic data of the participants such as name, age, occupation and gender were obtained using a structured questionnaire.

2.5 Determination of Elephantiasis

The elephantiasis among participants were determined using a method earlier described [8]. The method involved physical examination of individuals for elephantiasis**.** Participants were simply asked to lift their clothing to expose their legs. Other studies followed the same approach in the examination of their study participants for elephantiasis [9,10].

2.6 Geographic Information System Mapping of Lymphatic Filariasis by Circulating Filarial Antigens Prevalence in the Study Area

2.6.1 Use of global positioning system

The global positioning system (GPS) receiver provided unique coordinates or spatial reference data (point) and elevation. Geographic coordinates were obtained by inserting A4 batteries into the GPS receiver, held it in the left hand and stood at a desired position in a village. The GPS receiver was then turned on and allowed time to acquire good signals from GPS satellites until it had received at least three satellites required to enable it to determine the coordinates of the villages. When it was ready to navigate, page button was pressed, switched to menu, then MARK was selected and ENTER was pressed. The coordinates and elevation that appeared was copied into an excel sheet.

2.6.2 Use of ARCGIS for map production

ArcGIS Software was used for map development using the coordinates and LF prevalence data from the study locations. This was done by creating database in the excel software using the data collected, digitizing the map of Enugu State (Base map) using the ArcGIS 10.2 [11], importing the data in the excel into ESRI ArcGIS software 10.2 and converted to comma delimitated file for the purpose of mapping, geospatial referencing, and the spatial distribution of the village and LGA names, sampled cases and prevalence. The ArcGIS map was developed using graduated circle spatial method. The values were also classified by their sizes for analysis of prevalence value.

2.7 Data Analysis

Data obtained were analyzed using Statistical Package for Social Sciences (SPSS) for Windows, Version 23. Chi square was used to determine the association between categorical variables. Statistical significance was determined at 95% significance level.

3. RESULTS

Elephantiasis was observed on 17(4.9%) out of 349 individual in the study (Table 1). Females had the highest prevalence of 13(8.3%) while males had 4(2.1%). Elephantiasis was observed on leg or upper limb and arm or upper limb of positive participants (Plate 1). A total of 2(12.5%) out of 16 elephantiasis of legs occurred on both feet in females. All LGAs reported higher elephantiasis prevalence in females more than males except Udenu that had higher elephantiasis in males (4.3%) than females (2.2%). Nkanu West and Isiuzo LGAs had no males with elephantiasis. The LGA which had the highest female elephantiasis prevalence was

Isiuzo (25.0%), followed by Nkanu West and Nkanu East that had prevalence of 16.7% each. There was significant association between elephantiasis and gender (X^2 = 7.158, df = 1, p = 0.007, (p < 0.05)).

The elephantiasis prevalence in age groups ranges from 0.0% to 12.3% (Table 2). The age group with the highest prevalence of 7(12.3%) was 45 – 54 years, followed by 55 – 64 years 7(7.7%) and 65+ years 3(2.5%). There was no case of elephantiasis in 15 – 24, 25 – 34and 35 – 44 years in all the LGAs. Also, in Udenu, Nkanu West and Isiuzo LGAs, there was no case of elephantiasis in age group 65+ years. Age group 45 – 54 years recorded prevalence of elephantiasis ranging from 7.7% to 16.7%. Both Nkanu East and Isiuzo had the highest prevalence in 45 – 54 years with 16.7% each. All the LGAs recorded cases in 55 – 64 years except Awgu where there was no case and with Isiuzo LGA which had the highest prevalence. Only Nkanu East (12.5%) and Awgu (2.6%) LGAs had cases in 65+ years. There was significant association between elephantiasis and age (X^2 = 13.934, df = 5, p = 0.016, (p < 0.05)).

Table 1. Prevalence of lymphatic filariasis by elephantiasis in gender across five LGAs in Enugu State

LGAs	Gender		Total (%)
	Male (%)	Female (%)	
Udenu	2 (4.3)	1 (2.2)	3 (3.3)
Awgu	1 (2.4)	2 (3.4)	3(3.0)
Nkanu West	0 (0.0)	2 (16.7)	2 (4.0)
Nkanu East	1 (3.2)	4 (16.7)	5 (9.1)
Isiuzo	0 (0.0)	4 (25.0)	4 (7.8)
zTotal	4 (2.1)	13 (8.3)	17 (4.9)

Plate 1. Some cases of elephantiasis observed during the study in the five LGAs in Enugu State

The prevalence of elephantiasis in all occupation ranges from 0.0% to 11.4% (Table 3). Artisan 4(11.4%) had the highest prevalence, followed by farming, 12(4.7%) while trading group had 1(3.8%). No cases were reported in student, civil servant and carpentry groups in all LGAs. The only LGA that had trading with elephantiasis was Awgu. Farming was the only occupation that reported elephantiasis in all LGAs. There was no significant association between elephantiasis and occupation (X^2 = 4.917, df = 5, p = 0.426, p>0.05)).

Elephantiasis was observed in all the villages in the LGAs, ranging from 3.0% to 9.1% (Fig. 1). Nkanu East (Onichagu) had the highest prevalence of 5(9.1%). Others were Isiuzo (Amaegbu) 4(7.8%), Nkanu West (Onunkwo) 2(4.0%), Udenu (Ogwu) 3(3.3%) while Awgu (Ibite) had 3(3.0%). There was no significant association between elephantiasis and LGA (X^2 = 4.470, df = 4, p = 0.426, p>0.05)).

4. DISCUSSION

The overall prevalence of elephantiasis was 4.9% in this study. This compares favorably with another study where prevalence of 4.2% was reported [12]. Both lymphoedema and elephantiasis were regarded as elephantiasis in this study. This agrees with other studies where no distinction was made between the two manifestations [13,14]. Lower elephantiasis

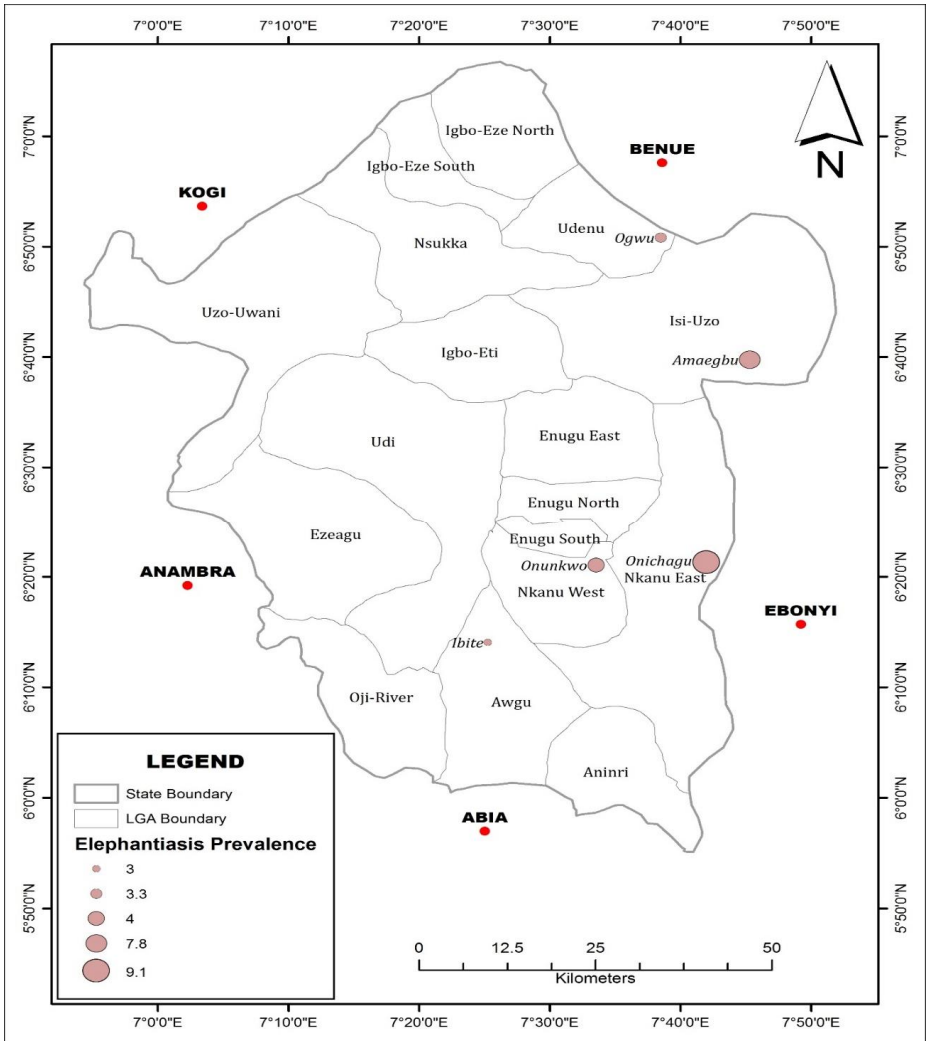

Fig. 1. GIS map of Enugu State showing prevalence of elephantiasis in the study areas
(Source: produced by the researchers using GIS)

Table 2. Prevalence of lymphatic filariasis by elephantiasis in age groups across five LGAs in Enugu State

LGAs	Age (years)						Total (%)
	15 – 24 (%)	25 – 34(%)	35 -44 (%)	45 -54 (%)	55 -64 (%)	65+ (%)	
Udenu	0 (0.0)	0 (0.0)	0 (0.0)	1 (7.7)	2 (11.8)	0 (0.0)	3 (3.3)
Awgu	0 (0.0)	0 (0.0)	0 (0.0)	2 (11.8)	0 (0.0)	1 (2.6)	3 (3.0)
Nkanu West	0 (0.0)	0 (0.0)	0 (0.0)	1 (11.1)	1 (4.8)	0 (0.0)	2 (4.0)
Nkanu East	0 (0.0)	0 (0.0)	0 (0.0)	2 (16.7)	1 (5.0)	2 (12.5)	5 (9.1)
Isiuzo	0 (0.0)	0 (0.0)	0 (0.0)	1 (16.7)	3 (25.0)	0 (0.0)	4 (7.8)
Total	0 (0.0)	0 (0.0)	0 (0.0)	7 (12.3)	7 (7.7)	3 (2.5)	17 (4.9)

Table 3. Prevalence of lymphatic filariasis by elephantiasis in occupation across five LGAs in Enugu State

LGAs	Occupation						Total (%)
	Farming (%)	Civil Servant (%)	Carpentry (%)	Trading (%)	Student (%)	Artisan (%)	
Udenu	2 (3.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (8.3)	3 (3.3)
Awgu	1 (1.6)	0 (0.0)	0 (0.0)	1 (9.1)	0 (0.0)	1 (7.7)	3(3.0)
Nkanu West	2 (5.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (4.0)
Nkanu East	3 (6.8)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (28.6)	5 (9.1)
Isiuzo	4 (9.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	4 (7.8)
Total	12 (4.7)	0 (0.0)	0 (0.0)	1 (3.8)	0 (0.0)	4 (11.4%)	17 (4.9)

Prevalence than the present study has been reported in different places. They include 0.3% [15], 1.4% [16], 2.3% [17], 2.4% [18], 2.9% [19] and 3.7% [20]. On the other hand, higher elephantiasis prevalence has been reported in other studies. They include 15.9% in Igwun River Basin of Abia state [21], 8.88% in Afikpo North LGA of Ebonyi state [22], 8.6% [23] and 9.0% [24] reported in Ghana and Uganda respectively. Also, a higher elephantiasis prevalence of 6.4% was reported in Ado LGA of Benue state [9] while 6% was reported in another study [25]. The high prevalence in this study suggests that LF infection in the study area has been in the population for a while. Manifestation of elephantiasis takes years after the transmission of infective (mf stage L3) *W. bancrofti* by female *Anopheles* mosquitoes and blockage of lymphatic vessel by the adult worm.

In this study, females (8.3%) were more affected by lymphoedema than males (2.1%). The observation is in tandem with some other studies that made similar observation in their study areas [9,23,25,26]. The high elephantiasis prevalence in females suggests that these manifestations caused by the presence of the filarial parasites are more prominent in females.

This study has revealed age dependent variation in elephantiasis from one LGA to another in age group greater than 45 years. However, there was no occurrence of elephantiasis in young adults (< 45 years). The study has shown that elephantiasis is commonest in age group 45 – 54 years, but the low prevalence in older adults (65+ years) may probably be because many in this age group may have died as a result of many years of the disease burden arising from incapacitation and debilitation.

This study found that farming, artisan and trading are basically the occupation of those with elephantiasis, but there was no significant association in the proportion in prevalence across all occupation. A report attributed elephantiasis and generally lymphatic filariasis cases to long exposure during outdoor activities such as farming and fishing as well as swamps and stagnant water surrounded by the high canopy of the rain forest vegetation. The environment where these activities are carried out favour breeding of mosquito species that transmit *W. bancrofti* [21].

5. CONCLUSION

As observed in the study, people living with lymphatic filariasis morbidity are in the study area. The State Ministry of Health and Partners should develop morbidity management activities that will alleviate the burden of the elephantiasis cases in the state. Improvement in health education among the study populations to understand the cause and spread of the disease is recommended.

CONSENT AND ETHICAL APPROVAL

Ethical approval to conduct the study was obtained from Enugu State Ministry of Health Ethical Committee. Consent of all study participants was obtained before the study.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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