ISSN 1996-3351

Asian Journal of Biological Sciences

http://knowledgiascientific.com

Knowledgia SCIENTIFIC
A Place to Publish Outstanding Research

OPEN ACCESS Asian Journal of Biological Sciences

ISSN 1996-3351
DOI: 10.3923/ajbs.2019.851.859

Research Article
Prevalence of Mosquitoes Harbouring Microfilariae in Four Communities in Andoni, Rivers State, Nigeria

C.H. Dimkpa, N. Ebere and A.P. Ugbomeh

Department of Animal and Environmental Biology, Rivers State University, Nkpolu-Orowurokwo, Port Harcourt, Nigeria

Abstract

Background and Objective: Filarial worms spread from person to person by a range of mosquito are the cause of filariasis. Epidemiological and entomological surveys of the prevalence of these filarial worms and their vectors are necessary as they constituent public health problems. The study was therefore; designed to survey mosquitoes harbouring microfilariae in four communities of Andoni in the Niger Delta area of Nigeria. **Materials and Methods:** A total of 320 houses (mud, screened block, zinc roofed and thatch house) were sampled to obtain the indoor resting density of the four communities (Ibotirem, Ataba, Samanga and Dema) for 4 months (May-August). From each house, one bedroom was selected for pyrethrum spray catch (PSC) using standard procedures. Mosquitoes were identified, dissected and examined for microfilariae. Questionnaire were distributed randomly to 200 people with questions relating to Knowledge, Attitude and Perception (KAP) and data presented in percentage. Map of the area was generated by GIS. Indoor resting densities and vector infection rate were calculated following standard methods and tested for significance using ANOVA at $p = 0.05$. **Results:** About 24.1% of the blood fed mosquitoes were infected with *Wuchereria bancrofti*. Three species of mosquitoes *Culexquin quefasciatus*, *A. gambiae* and *Aedes* where found in the area. Vector infection rate for *C. quinquefasciatus* was 51.1%, *A. gambiae* 43.0% and *Aedes* 1.0%. The highest vector infection prevalence was recorded in Dema and the least in Ataba. The *C. quinquefasciatus* and *A. gambiae* contributed a higher vector infection rate when compared to *Aedes*. The KAP survey revealed that majority of respondents were not aware of microfilariae as the cause of lymphatic filariasis infection, 59% were not aware of preventive measures and about 48% had witnessed patients suffering from the disease in the area. **Conclusion:** The findings of this study (the first documented report) will help in achieving a better understanding of the epidemiology of infective microfilariae in the study area.

Key words: *Culex quinquefasciatus*, *Anopheles gambiae*, *Aedes*, mosquitoes, vector infection rate, andoni, rivers state

Citation: C.H. Dimkpa, N. Ebere and A.P. Ugbomeh, 2019. Prevalence of mosquitoes harbouring microfilariae in four communities in andoni, rivers state, Nigeria. Asian J. Biol. Sci., 12: 851-859.

Corresponding Author: A.P. Ugbomeh, Department of Animal and Environmental Biology, Rivers State University, Nkpolu-Orowurokwo, Port Harcourt, Nigeria

Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Wuchereria bancrofti is a microscopic, parasitic nematode which is the significant cause of *Lymphatic filariasis*[1]. The filarial worm is spread from person to person by a range of mosquito vectors, such as *Aedes*, *Culex*, *Anopheles*, *Mansonia*[2]. *Wuchereria bancrofti* is responsible for the disease called lymphatic filariasis and is specified by the WHO as the world's second leading cause of permanent and long-term disability. This mosquito-borne disease is controlled through drug therapy and vector control[3]. *Wuchereria bancrofti* is present where mosquitoes and infected persons are found, in and around temporary pools or standing water. Humans are the only known definitive host of *Wuchereria bancrofti*. Adult worms reside in regional lymphatic vessels while the juveniles circulate in the blood and are ingested by mosquitoes during a blood meal from an infected human. Once inside the mosquito, the juveniles migrate into the thoracic muscles and finally to the mouthparts allowing transmission to the next human host when the mosquito takes a blood meal[4].

Bardaki[5], lymphatic filariasis (LF) has been identified since medieval times and portrayal of the disfiguring disease have been found in medieval art, painting and maps of Greek and Roman medical writers. Ecological and population studies of mosquitoes in Africa have shown the significance of mosquitoes as vectors of lymphatic filariasis. Globally, lymphatic filariasis is one of the most prevalent mosquito-borne parasitic diseases[6]. Lymphatic filariasis is widely circulated in Nigeria and constitutes a public health problem as well as a major cause of acute and chronic morbidity[7]. In Africa 34 countries are endemic and Nigeria is believed to bear the highest burden of lymphatic filariasis, with estimated 80-120 million people at risk. Nigeria is ranked third most endemic country for the disease after India and Indonesia[8]. Infection with lymphatic filariasis has led to lost days of work, absence from school, expenses for preventive measures, cost of burial in case of death, reduced economic growth due to the disease, disfigurement of the skin, loss or reduction in agricultural labour input resulting in food shortage and scarcity[9-10].

Control of the disease caused by *Wuchereria bancrofti* can be achieved through eradication of mosquito by insecticides, indoor spray, reducing infection amongst mosquitoes, treatment of carriers by using heterozon and cyanine, movement from areas of infection, protection from mosquitoes using mosquito nets or mosquito repellants while sleeping at night, control of breeding sites of mosquitoes and proper sanitation of the environment[11]. The epidemiology of the disease in Nigeria varies because of the diversity of the environmental conditions of the different regions. Globally, Nigeria is ranked third highest with lymphatic filariasis[12]. Previous studies have shown that some parts of Nigeria (Niger Delta and Rivers state) are endemic for a number of tropical diseases, including prevalence of lymphatic filariasis[13-19]. The status of lymphatic filariasis in Rivers state however is not extensively comprehendible. This work which is part of a larger study, describes the prevalence of the disease using mosquitoes to ascertain the presence of the parasitic nematode (*Wuchereria bancrofti*). This study on *Wuchereria bancrofti* can be justified as results of such investigations go a long way to determine their prevalence and incidence rates within the surveyed localities. Epidemiological and entomological investigations may have been carried out in some parts of the Niger delta[16,20-21], but none in the study area. This study therefore aims to fill this gap and determine the prevalence of mosquito carrying microfilariae in four selected communities of Andoni, Nigeria

MATERIALS AND METHODS

Study area: Andoni is a local Government Area in Rivers state, Nigeria. Andoni occupies an estimated area of about 360 km^2 with a projected population of about 260,000 people. It lies about 4°3'N latitude and 7°35'E longitude falling within the South-Eastern flank of the Niger delta, a region rich in oil and gas. Its land mass transverses the chains of Islands between the Qua Ibo river in the east and Andoni river in the west. It is bounded by Bonny to the west, Okrika and Ogoni to the north, Ibibio to the north-east and the Atlantic waters to the South. Andoni is a coastal area, where majority of the people survive through farming and fishing practices, therefore they may have little or no knowledge about the parasitic nematode.

Location of sampling stations: The study was from May 2017 to August 2017 in four rural communities (Ibotirem, Ataba, Dema and Samanga (Fig. 1), all in Andoni Local Government Area, Rivers state Nigeria. The study sites had tropical mangrove vegetation, the housing structures were made up of sand screed block, mud, zinc and thatched houses. Some houses bore resemblances of traditional architectural pattern with mud walls and thatched roofs. The source of water for the communities were well water, rainfall and streams and the study sites were all surrounded by chains of Islands. They were located within the coastal region of Andoni and they could be reached by local and speed boats. Most parts of the area was water logged, settlement pattern was random and

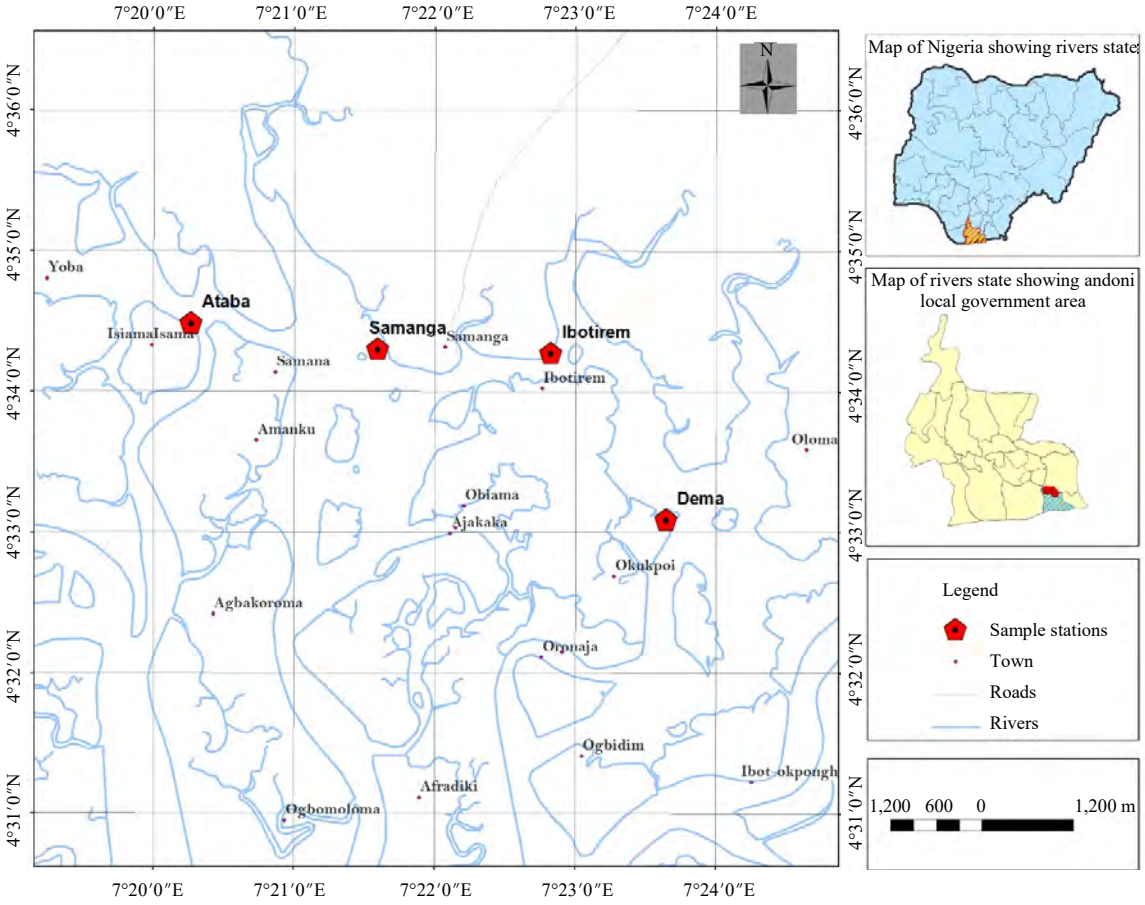

Fig. 1: Sampled stations in andoni local government area of rivers state (GIS generated using GPS coordinates)

human inhabitants were confined to families and compounds. Farming and fishing were the two main occupations engaged by the human inhabitants which ran along gender lines. Farming was done by the females while fishing was pre-dominantly a male occupation done more intensively at night. The GPS coordinates was recorded at the sampling stations.

Ethical consideration: Verbal informed consent was obtained from the head of each of the randomly selected households before their houses were accessed for mosquito collection in all the study localities. Verbal consent was also granted from human inhabitants for physical examination of infected individuals from the study stations.

Collection of mosquitoes: All mosquito samples were collected using standard procedures provided by WHO[22]. About 80 sampling units (houses) were randomly selected from the four localities (Dema, Ibotirem, Samanga and Ataba). Adult mosquito indoor collection was carried out during the morning hours between 6 am-10 am using a pyrethrum spray known a pyrethrum spray catch technique (PSC). All layered pieces of furniture and floor was covered with white sheets. The insecticide (Raid) was applied as one entered the room until every surface was sprayed. All doors and windows were closed after spraying to allow for mosquito knockdown. All dead and immobile mosquito were collected with forceps into a petri dish lined with a Whatman paperfor identification and dissection.

Identification and dissection of mosquitoes for presence of microfilariae: A dissecting microscope was used for observation and identification of mosquitoes based on their morphological features according to Gilles and De Meillon[23] with particular reference to the head, thorax, wings, length of maxillary palps and hind legs. The mosquitoes were dissected using the procedure by Abeyasingha *et al.*[24]. The anterior part of mosquito to be dissected was placed on a slide with the head pointing to the right hand side and a drop of physiological saline added to keep the specimen fresh. The

head, thorax and abdomen were dissected separately on a glass slide and examined under a compound microscopic for larvae. All the microfilariae isolated from the mosquitoes in this study were sheathed had nuclei that did not extend to their tails and their tails tapered evenly[25].

Questionnaire administration: About 50 questionnaires were administered in each of the 4 sampled stations giving a total of 200 questionnaires. The questions comprised of 2 parts, 6 household information and 12 on knowledge (KAP) of the human respondents about lymphatic filariasis. The questionnaire was arranged and structured with some modifications based on the work of Eberhard *et al.*[26].

Statistical analysis of data: Determining the indoor resting densities of mosquitoes using PSC across the sampling stations was computed using[27]:

$$\text{IRD} = \frac{\text{No. of mosquitoes collected}}{\text{No. of houses or rooms sampled}}.$$

Inferential statistics was used for analysis of variance (ANOVA) which was to assess the significant difference in the counts of the three species of the mosquitoes at $p<0.05$.

Vector infection rate was calculated using the formula described by Amaechi *et al.*[28]:

$$\text{Vector infection rate} = \frac{\text{No. of mosquitoes carrying L1+L2+L3}}{\text{No. of mosquitoes dissected}} \times 100$$

Where:

L_1 = Larval stage 1
L_2 = Larval stage 2
L_3 = Larval stage 3

RESULTS

A total of 1139 mosquitoes were caught from all the stations during the study period in the 320 rooms from the four stations (Table 1). The IRD ranged from 3.4-4.1. Dema had the highest IRD which was different at $p<0.05$ from the other communities.

Three species of mosquitoes were identified namely *Culex quinquefasciatus*, *Anopheles gambiae* and *Aedes* spp. The vector infection rate of microfilariae was highest in Demand in *C. quinquefasciatus* across stations. The infection rate of *Aedes* mosquitoes in the sampling stations was very low in Dema and zero at the other stations (Table 2).

Table 1: Indoor resting densities of mosquitoes from 80 rooms

Sample stations	No. of mosquitoes sampled (% per study area)	Indoor resting densities (IRD)
Ibotirem	275	3.5[b]
Ataba	267	3.4[b]
Dema	328	4.1[a]
Samanga	269	3.4[b]
Total	1139	14.4

Table 2: Microfilariae infection rate of the three species of mosquitoes in the communities from Andoni

Stations	*Culex quinquefasciatus*	*Anopheles gambiae*	*Aedes*	Total
Dema	24.0[a]*	23.0[a]	1.0[a]	48.0[a]
Ibotirem	17.5[a]	14.0[a]	0.0[a]	31.5[b]
Samanga	5.5[b]	3.5[b]	0.0[a]	9.0[c]
Ataba	4.5[b]	2.5[b]	0.0[a]	7.0[c]

*Same superscript along column are not different at $p<0.05$

The respondents were within the ages of 15-50 years with the males making up 56.5% while 44.5% were female (Fig. 2). Also, 45.5% of respondents were married, 41.5% were single and 13% were divorced. Occupation of the respondents included fishing (28.5%), farming (20%), civil service (12.5%), student (19.5%) and business (19.5%). Their educational qualification revealed 37% with formal education, while 43.5% were informal and 19.5% were without any form of education (Fig. 2). Andoni indigenes made up 80.5% of the respondents.

The KAP (Fig. 3) revealed that many of the respondents had not heard about lymphatic filariasis as a disease before (59.5%) while 21.5% had some knowledge and 19% were uncertain. About 30% of respondents had witnessed patients suffering from the disease in Andoni. Many of the respondents lacked knowledge of cause of lymphatic filariasis with 64%. Some respondents (45.5%) believed filariasis was punishment from God. Respondents knowledge about elephantiasis revealed that many (64%) did not relate it to same vector as malaria. Knowledge of death from elephantiasis was 46.5%, while 35.5% had no knowledge. About 25% of respondents had knowledge of preventive measures for filariasis while 59% had none and 16% were uncertain. About 76% of respondents were unaware of methods of transmission of the disease. The knowledge about *W. bancrofti* was also limited as more than 79% were unaware of the filarial parasite.

DISCUSSION

The indoor resting densities (IRD) of mosquitoes was 14.4% (1139) in the study area. This was lower than the reports of Mbah *et al.*[29], who reported an indoor resting density of 1296 in an entomological survey of mosquitoes responsible for the transmission of lymphatic filariasis in Cross river state.

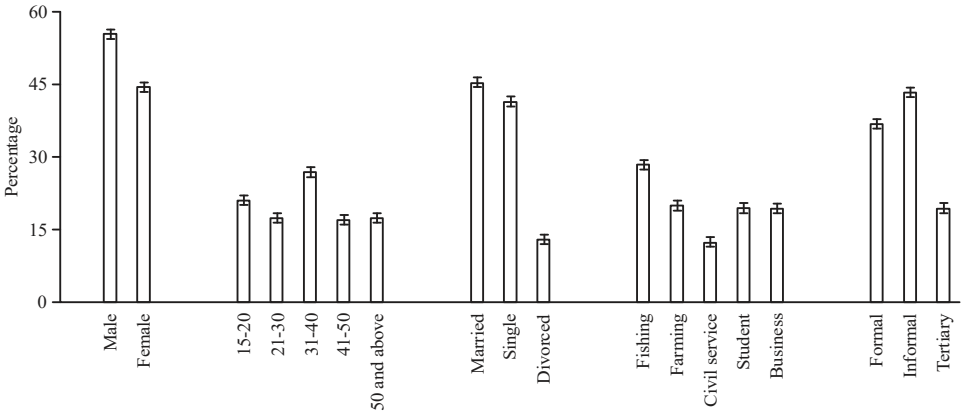

Fig. 2: Demographic characteristics of respondents (n = 200)

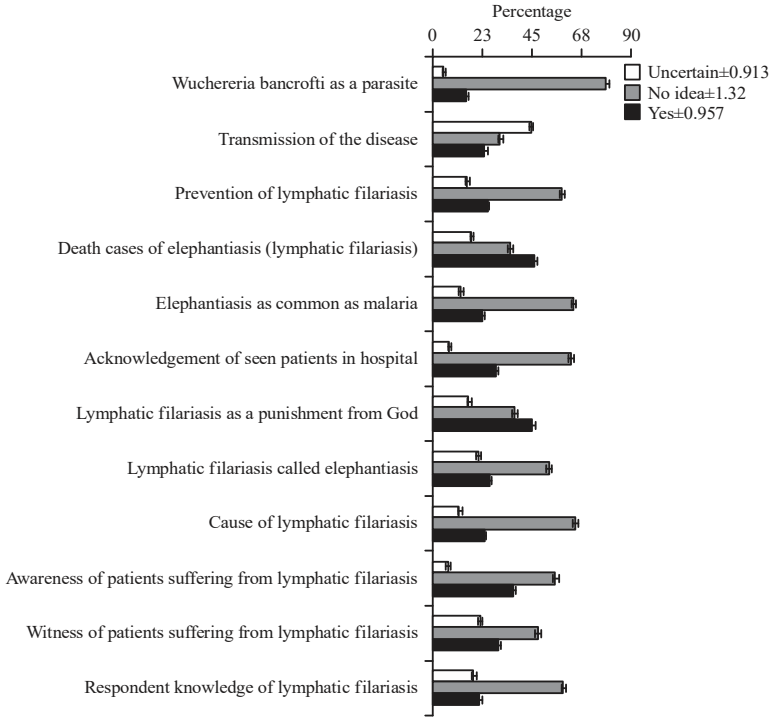

Fig. 3: Respondents knowledge of lymphatic filariasis (n = 200)

The IRD was also lower than reports of Okorie *et al.*[30], who reported a total of 1600 mosquitoes in Ibadan. The difference in the indoor resting densities could be linked to the number of months sampled and the sampling methods used. Mbah *et al.*[30], who sampled for 12 months and made use of two sampling procedures (Human bait catch technique and Pyrethrum spray catch technique), while this present study was conducted for only four months (May-August) and used only the pyrethrum spray catch technique. This might explained the differences between Mbah[29] with a higher IRD and this present study. Okorie *et al.*[30] sampled for 8 months (Rain and dry seasons) using pyrethrum spray catch and the difference in the month sampled may probably be the reason they had a higher adult indoor resting densities of mosquitoes. The most abundant mosquito species in the study area was *C. quinquefasciatus* which agrees with the findings of Nwoke *et al.*[31]. The high abundance of *C. quinquefasciatus* in the study area could be because they breed in unsanitary conditions with smelling water collections and in areas with pit latrines, stagnant water bodies which were common in the study areas. This result is in agreement with the reports of Manyi and Imandeh[32], Oduola and Awe[33] and Tandina *et al.*[34]

that *C. quinquefasiatus* and *A. gambiae* were pre-dominant domestic mosquito species which are the most common vectors in Africa.

The infection rates of *C. quinquefasciatus* ranged from 4.5-24% in Andoni and 2.5-23% for *Anopheles gambiae*. This result is comparable to the result of Ahmed *et al*.[35], who obtained infection rates of 37.48% for *C. quinquefsciatus* and 7.99% for *A. gambiae*, respectively. *C. quinquefasciatus*, is probably the most adaptable vector due to its widespread distribution and existence in a range of temperate regions[35]. Amaechi *et al*.[28] stated that *C. quinquefasciatus* is the major vector in the transmission of lymphatic filariasis in Nigeria. The predominance of *C. quinquefasciatus* in this study is in line with observations by Kelly-Hope *et al*.[36] and Taylor[37] on the possible involvement of *C. quinquefasciatus* in the transmission of lymphatic filariasis in northern Nigeria and West Africa. *Aedes* mosquito had the least vector infection rate of <1%, probably due to the fact, that *Aedes* mosquitoes were the least prevalent in all the study sites. This is in line with the report of Kuhlow[38] and Gouge *et al*.[39]. The low occurrence of *Aedes* can also be attributed to the fact that *Aedes* prefers man-made habitats such as cracked cesspits, clogged drainages and culvets which were not common in the communities[39]. Adeleke *et al*.[40] Aedes are viral disease causing vectors and have also been incriminated in harbouring *W. bancroti*.

The mean rate of vector infection in the study area showed Dema to have the highest infection rate (48%) of microfilaria in mosquitoes. The highest infection rate recorded in Dema, is linked to the fact that Dema had the highest number of patients suffering from lymphatic filariasis which in turn creates favourable environment for uninfected vectors to take a blood meal from infected humans and infect other inhabitants in the community. This makes Dema a vulnerable station compared to other stations.It may also be linked to the fact that in Dema, mosquito breeding sites were frequently observed such as domestic runoffs and discarded household materials such as water cans and plastic containers[41-43]. The vector infection rate in the four stations (7, 9, 31.5 and 48%) were in contrast to the report of Ahmed *et al*.[35], who reported vector infection rates of 16.83, 14.1, 9.47 and 10.53% across four study stations in Makurdi, Benue state. The variation in the vector infection rate may be attributed to differences in sampling size, sampling duration and frequency of vector to human contact.

Knowledge, attitude and perception (KAP) of lymphatic filariasis data with a higher number of male respondents of 55.5% than female respondent can be attributed to the fact that males were more active and showed great zeal in participation towards the questionnaire exercise. The highest rate of participants in relation to age was observed between 31-40 years of age, which constitute an overall 27%, that are mostly young active individual who are physically strong and engage in sports activities during the day and other social cultural activities in the area. Results of the KAP could be attributed to the most encountered respondents seen during the day who were willing to be questioned. Data obtained showed majority (45%) of the respondents were married, in line with the belief of the rural people of Andoni that attach great value to marriage and therefore were mostly married. Amaechi *et al*.[44] also observed high respondent of married individuals.

Andoni is a coastal area surrounded by chain of rivers, enriched with aquatic environment making fishing a pre-dominant practice in the area. Respondent's knowledge in relation to lymphatic filariasis, revealed that many inhabitants in the sampled stations had none or poor knowledge of the disease as was observed by Amaechi *et al*.[44] and Omudu and Okafor[45]. The poor knowledge of respondents regarding the cause of lymphatic filariasis could be illiteracy and lack of awareness about the disease. Despite the endemic status of lymphatic filariasis in the sampled stations majority of respondents lacked good knowledge on preventive measures and cause of the disease as they attributed the disease to punishment from God. Most of the respondents linked the cause of the disease to witch craft and mystical beliefs as was also reported by Ahorlu *et al*.[46]. Good health centres are required to educate the people on endemic disease, preventive measures, causative organisms and vectors. This will reduce the ignorance on cause and prevalence of infection. Low literacy levels, superstitious beliefs and ancient traditions are major hinderances to disease control[47]. Majority of the respondents did not know that mosquito was the vector of lymphatic filariasis which is in agreement with the findings of Rath *et al*.[48].

This present investigation revealed a very low knowledge from respondents in Andoni about lymphatic filariasis and *W. bancrofti.* They lacked information on the dangers and complicated health problems associated with the disease and mosquito bite. About 4 males and one female were observed in the communities to be suffering from Lymphatic filariasis during the study. Higher infection in males could be because of the greater exposure of males to the mosquito infectious bite from their occupation and lifestyle. Roper *et al*.[49] most males cluster within open places in the community with bare bodies to drink local alcohol, which corresponds with the peak hours of the host seeking behaviours of the mosquitoes. On the contrary, females remain around the kitchen where

smokes may repel the mosquito vectors to a minimal level before bed time and are therefore less bitten by blood sucking mosquito vectors. More study is required to reveal the disposition of more males to females in filarial infections. Higher prevalence of infection in males, observed in the four sample stations during the study period also conforms with the report of Udonsi and Odey[50], that males are more exposed to mosquito bites through fishing which was more of a nocturnal activity. This means that infections were mostly from the outside as exposure within the home should be the same for males and females. In contrast to this, a higher prevalence of infections was observed in females by Simonsen *et al.*[51], in coastal Ghana. In coastal Ghana, females were more involved in coastal fishing and were therefore more infected with filariasis.

CONCLUSION

Three species of mosquito were identified from the study area and the infection rate was up to 48% in Dema (one of the communities). Microfilariae infection rate in mosquitoes was significantly higher in *C. quinquefasciatus* and *A. gambiae* than in *Aedes* mosquito implying that *C. quinquifasciatus* and *A. gambiae* were the major vectors of *W. bancrofti* in the communities. The *W. bancrofti* was the only filarial parasite encountered during the study. The KAP revealed that most of the respondents were unaware of the vector, causative organism, methods of prevention and the disease known as filariasis or elephantiasis. The findings of this study will help in achieving a better understanding of the epidemiology of filarial parasitic disease in Andoni Local Government Area, Rivers state, which is a pre-requisite for sustainable disease control. This is the first documented report of mosquitoes harbouring *W. bancrofti* in Andoni. It will add to the epidemiological baseline data of the disease in Nigeria. More research is recommended on the higher disposition of males to filarial infection as was observed during this study.

SIGNIFICANCE STATEMENT

This study discovered the presence of enabling environment for *Culex quinquefasciatus* and *A. gambiae* in the four communities in Andoni, the presence of the disease as well as the microfilarial carrying mosquitoes that can be beneficial in the planning of public health management of the area. This study has helped to uncover the critical areas such as the need to create public awareness, educate the people, build functional health centres and teach the people preventive measures in the study area.

REFERENCES

1. Anosike, J.C., B.E. Nwoke, E.G. Ajayi, C.O. Onwuliri and O.U. Okoro *et al.*, 2005. Lymphatic filariasis among the Ezza people of Ebonyi State, Eastern Nigeria. Ann. Agric. Environ. Med., 12: 181-186.
2. Burri, H., L. Loutan, V. Kumaraswami and V. Vijayasekaran, 1996. Skin changes in chronic lymphatic filariasis. Trans. R. Soc. Trop. Med. Hygiene, 90: 671-674.
3. WHO., 2010. Progress report and strategic plan of the global programme to eliminate lymphatic filariasis: Halfway towards eliminating lymphatic filariasis, WHO/HTM/NTD/PCT/2010.6. World Health Organization, Geneva.
4. Baron, S. and J. Cross, 1996. Medical Microbiology: Parasitology. The University of Texas Medical Branch of Galveston, Galveston, Texas.
5. Bardaki, J.A., 2010. Parasitological and social aspects of lymphatic filariasis in Taraba state. Ph.D. Thesis, Department of Zoology, University of Jos, Nigeria.
6. Manguin, S., M.J. Bangs, J. Pothikasikorn and T. Chareonviriyaphap, 2010. Review on global co-transmission of human Plasmodium species and *Wuchereria bancrofti* by Anopheles mosquitoes. Infect. Genet. Evol., 10: 159-177.
7. Okon, O.E., C.I.I boh and K.N. Opara, 2010. Bancroftian filariasis among the Mbembe people of cross river state, Nigeria. J. Vector Borne Dis., 47: 91-96.
8. Michael, E. and D.A. Bundy, 1997. Global mapping of lymphatic filariasis. Parasitol. Today, 13: 472-476.
9. Pani, S.P., J. Yuvaraj, P. Vanamail, V. Dhanda, E. Michael, B.T. Grenfell and D.A.P. Bundy, 1995. Episodic adenolymphangitis and lymphoedema in patients with bancroftian filariasis. Trans. R. Soc. Trop. Med. Hygiene, 89: 72-74.
10. Srividya, A., R. Lall, K.D. Ramaiah, K. Ramu, S.L. Hoti, S.P. Pani and P.K. Das, 2000. Development of rapid assessment procedures for the delimitation of lymphatic filariasis-endemic areas. Trop. Med. Int. Health, 5: 64-71.
11. Taylor, M.J., W.H. Makunde, H.F. McGarry, J.D. Turner, S. Mand and A. Hoerauf, 2005. Macrofilaricidal activity after doxycycline treatment of Wuchereria bancrofti: A double-blind, randomised placebo-controlled trial. Lancet, 365: 2116-2121.
12. WHO., 2011. Global programme to eliminate lymphatic filariasis: Progress report. Weekly Epidemiol Rec., 87: 345-356.
13. Ajero, C.M.U., B.E.B. Nwoke, N.J.C. Okolie, H.U. Nwanjo and G. Oze *et al.*, 2007. Bancroftian filariasis in the Niger Delta area of Eastern Nigeria. Res. J. Med. Sci., 1: 113-117.
14. Ufomadu, G.O., B.E.B. Nwoke, J.I. Akoh, Y. Sato and Y. Ekejindu *et al.*, 1990. The occurrence of loiasis, mansonellosis and wuchereriasis in the Jarawa river valley, Central Nigeria. Acta Trop., 48: 137-147.

15. Eigege, A., F.O. Richards, Jr., D.D. Blaney, E.S. Miri and I. Gontor *et al*., 2003. Rapid assessment for lymphatic filariasis in central Nigeria: A comparison of the immunochromatographic card test and hydrocele rates in an area of high endemicity. Am. J. Trop. Med. Hygiene, 68: 643-646.
16. Agi, P.I. and A. Ebenezer, 2009. Observations on filarial infection in Amassoma community in the Niger Delta, Nigeria. J. Applied Sci. Environ. Manage., 13: 15-19.
17. Braise, E., B. Ikpeme, E. Edet, I. Atting, U.F. Ekpo, B. Esu and O.O. Kale, 2003. Preliminary observations on the occurrence of lymphatic filariasis in Cross River State, Nigeria. Niger. J. Parasitol., 24: 9-16.
18. Anosike, J.C., C.O.E. Onwuliri and V.A. Onwuliri, 2003. Human filariasis in Dass local government area of Bauchi state, Nigeria. Trop. Ecol., 44: 217-227.
19. Udoidung, N.I., E.I. Braide, K.N. Okpara, I.A. Atting and H.A. Adie, 2008. Current status of bancroftian filariasis in rural communities of the lower cross river basin, Nigeria: Parasitological and clinical. J. Public Health, Vol. 16. 10.1007/s10389-008-0189-6.
20. Udonsi, J.K., 1986. The status of human filariasis in relation to clinical signs in endemic areas of the Niger Delta. Ann. Trop. Med. Parasitol., 80: 425-432.
21. Amadi, E.C., 2000. Epidemiological and entomological studies of filariasis in Ogoniland, rivers state. Ph.D. Thesis, Animal and Environmental Biology Department, University of Port Harcourt, Nigeria.
22. WHO., 1975. Manual on practical entomology in Malaria. Part I and II methods and Technique, World Health Organization offset Publication No. 13. World Health Organization, Geneva, Switzerland, pp: 160.
23. Gilles, M.T. and B. De Meillon, 1968. The anopheline of Africa South of Sahara (Ethiopian 200 graphical region). S. Afr. Inst. Med. Res. Johannesburg, 54: 343-343.
24. Abeyasingha, R.R., A.M. Yapabanadara, P.H.D. Kusumawathie, D. Perera, B.S.L. Peiris, H.M.P. Hewavitharane and R.D.J. Harishchandra, 2009. Guidelines for entomological surveillance of malaria vectors in Sri Lanka. Anti-Malaria Campaign, pp: 62-67.
25. Chandler, A.C. and C.P. Read, 1969. Introduction to Parasitology. 10th Edn., Library of Congress, USA., pp: 473-494.
26. Eberhard, M.L., E.M. Walker, D.G. Addiss and P.J. Lammie, 1996. A survey of knowledge, attitudes and perceptions (KAPs) of lymphatic filariasis, elephantiasis and hydrocele among residents in an endemic area in Haiti. Am. J. Trop. Med. Hygiene, 54: 299-303.
27. WHO., 2013. WHO malaria entomology and vector control 2013 learners guide trial. WH/cds/CPE/SMT/2002, Vol. 18, World Health Organisation, Geneva, pp: 55-56.
28. Amaechi, A.A., B.E.B. Nwoke and C.N. Ukaga, 20111. A comparative study of human lymphatic filariasis vectors and filarial transmission Indices Control Trial Using Insecticide Treated Bed Net (ITBN) in Ebony state, Nigeria. Global Res. J. Sci., 1: 18-23.
29. Mbah, M., S.S. Akpan, I.B. OtuBassey and H.B. Daniel, 2015. Entomological survey of mosquitoes responsible for the transmission of lymphatic filariasis in Biase Cross river state, Nigeria. Swift J. Med. Med. Sci., 1: 1-5.
30. Okorie, P.N., K.O.K. Popoola, O.M. Awobifa, K.T.Ibrahim and G.O. Ademowo, 2014. Species composition and temporal distribution of mosquito populations in Ibadan, Southwestern Nigeria. J. Entomol. Zool. Stud., 2: 164-169.
31. Nwoke, B.E.B., E.A. Nwoke, C.N. Ukaga and M.I. Nwachukwu, 2010. Epidemiological characteristics of *Bancroftian filariasis* and the Nigerian environment. J. Public Health Epidemiol., 2: 113-117.
32. Manyi, M.M. and G.N. Imandeh, 2008. Infection rates of mosquitoes with malaria and lymphatic filarial parasites in Makurdi, Benue State-Nigeria. J. Pest Dis. Vector Manage., 8: 464-470.
33. Oduola, A.O. and O.O. Awe, 2006. Behavioural biting preference of *Culex quinquefasciatus* in human host in Lagos metropolis Nigeria. J. Vector Borne Dis., 43: 16-20.
34. Tandina, F., O. Doumbo, S.F. Traore, P. Parola and V. Robert, 2018. Mosquitoes (Diptera: Culicidae) and mosquito-borne diseases in Mali, West Africa. Parasites Vectors, Vol. 11. 10.1186/s13071-018-3045-8.
35. Ahmed, U.C., B.M. Matur and Y.D. Malann, 2016. Comparative assessment of the vector competence and transmission of malaria and filariasis in Makurdi, Benue State, Nigeria. Int. J. Mosquito Res., 3: 55-61.
36. Kelly-Hope, L.A., D.H. Molyneux and M.J. Bockarie, 2013. Can malaria vector control accelerate the interruption of lymphatic filariasis transmission in Africa; capturing a window of opportunity? Parasit. Vectors, Vol. 6. 10.1186/1756-3305-6-39.
37. Taylor, A.W., 1930. The domestic Mosquitos of Gadau, Northern Nigeria and their relation to malaria and filariasis. Ann. Trop. Med. Parasitol., 24: 425-435.
38. Kuhlow, F., 1987. Observations and experiments on *Culex-antennatus* (Becker) as a potential vector of Bancroftian-filariasis in West-Africa. Trop. Med. Parasitol., 38: 349-350.
39. Gouge, D.A., K.A. Smith, C. Olson and P. Baker, 2001. Mosquitoes. The University of Arizona, College of Agriculture and Life Sciences, Tuscon, Arizona.
40. Adeleke, M.A., C.F. Mafiana, A.B. Idowu, S.O. Sam-Wobo and O.A. Idowu, 2010. Population dynamics of indoor sampled mosquitoes and their implication in disease transmission in Abeokuta, South-Western Nigeria. J. Vector Borne Dis., 47: 33-38.

41. Anyanwu, I.W., R.I.S. Agbede, O.J. Ajanusi and J.U. Umoh, 1999. A survey of culicids (mosquitoes) in a Northern Guinea savannah town of Zaria, Kaduna state. Niger. J. Parasitol., 20: 137-148.
42. Okogun, G.R.A., J.C. Anosike, A.N. Okere and B.E.B. Nwoke, 2005. Ecology of mosquitoes of Midwestern Nigeria. J. Vector Borne Dis., 42: 1-8.
43. Adeleke, M.A., C.F. Mafiana, A.B. Idowu, M.F. Adekunle and S.O. Sam-Wobo, 2008. Mosquito larval habitats and public health implications in Abeokuta, Ogun State, Nigeria. Tanzania J. Health Res., 10: 103-107.
44. Amaechi, E.C., C.C. Ohaeri, O.M. Ukpai, P.C. Nwachukwu and U. Ukoha, 2016. Lymphatic filariasis: Knowledge, attitude and practices among inhabitants of an irrigation project community, North Central Nigeria. Asian Pac. J. Trop. Dis., 6: 709-713.
45. Omudu, E.A. and F.C. Okafor, 2011. Study of chronic lymphatic filariasis related knowledge, attitudes and perception among three ethnic groups in Benue state, Nigeria. Niger. J. Parasitol., 32: 135-142.
46. Ahorlu, C.K., S.K. Dunyo, K.A. Koram, F.K. Nkrumah, J. Aagaard-Hansen and P.E. Simonsen, 1999. Lymphatic filariasis related perceptions and practices on the coast of Ghana: Implications for prevention and control. Acta Trop., 73: 251-261.
47. Nzeako, S.O., O.H. Okunnuga and F.O. Nduka, 2016. Lymphatic filariasis and malaria awareness amongst residents of port harcourt metropolis. Int. J. Applied Sci. Res. Rev., Vol. 3. 10.21767/2349-7238.100051.
48. Rath, K., N. Nath, M. Shaloumy, B.K. Swain, M. Suchismita and B.V. Babu, 2006. Knowledge and perceptions about lymphatic filariasis: A study during the programme to eliminate lymphatic filariasis in an urban community of Orissa, India. Trop. Biomed., 23: 156-162.
49. Roper, M.H., R.S. Torres, C.G. Goicochea, E.M. Andersen and J.S. Guarda *et al*., 2000. The epidemiology of malaria in an epidemic area of the Peruvian Amazon. Am. J. Trop. Med. Hygiene, 62: 247-256.
50. Udonsi, J.K. and E.O. Odey, 1985. Filariasis in yala areas of cross rivers basin, Nigeria. Niger. J. Parasitol., 6: 4-10.
51. Simonsen, P.E., D.W. Meyrowitsch, W.H. Makunde and P. Magnussen, 1995. *Bancroftian filariasis*: The pattern of microfilaraemia and clinical manifestations in three endemic communities of Northeastern Tanzania. Acta Trop., 60: 179-187.