

Original Research Article

Studies on Human Onchocerciasis in Delta State, Nigeria

Abstract

The epidemiology of human onchocerciasis was conducted to investigate the distribution, transmission and impact of the disease in endemic communities of Aniocha North, Aniocha South and Oshimili North Local Government Areas of Delta State, Nigeria. A total of 1,201 subjects were examined by skin snips biopsy, in 41 communities, out of which 138 (11.5%) were positive for the onchocercal parasite. The highest infection rate of 12.5% was recorded in Aniocha North, followed by Oshimili South (11.5%) and Aniocha South (10.7%). The differences was however, not significant ($P>0.05$). The prevalence was insignificantly higher in males (12.2%) than in female (9.9%). Age-wise, the general pattern showed that the prevalence increased significantly with age. The prevalence of onchocerciasis generally differed widely among the various occupational groups sampled. The prevalence was almost two-fold among farmers (19.3%) compared to drivers and bike riders group (10.2%). The study has provided a pre-control evidence-based data for the control of onchocerciasis in the Delta north endemic foci and adjacent areas.

Keywords: *Onchocerciasis, Onchocerca volvulus, Prevalence and pattern, Distribution Delta State, Nigeria*

1. Introduction

Onchocerciasis is well recognized as one of the major tropical diseases of public health importance in endemic parts of the world, especially in Sub-Saharan, Africa. It is a terminally blinding disease caused by *Onchocerca volvulus* and it is transmitted by members of *Simulium damnosum* laro in West Africa [1,2]. Studies have shown that over

30 37 million people are infected globally with about 90 million at risk of the
31 disease in Africa [3].

32 In Nigeria, the most populous nation in Africa, it was estimated that
33 the 7-10 million Nigerians are infected with *Onchocerca volvulus*, about 40
34 million are at risk of the disease, and 120,000 cases of onchocerciasis-related
35 blindness (4). Except for Lagos State, all the States of the federation are
36 endemic to the disease [5]. The prevalence of onchocerciasis has also been
37 reported in Delta State [6, 7].

38 In Delta State, free doses of ivermectin are distributed annually to
39 communities through the Community Directed Treatment with Ivermectin
40 (CDTI) [8]. Despite this intervention approach, pockets of endemic foci still
41 exists partly due to the spatial variation in the distribution of the infection as
42 well as the presence of the vector. Adeleke *et al* [9] reported the increased
43 biting rate of the black flies in areas where ivermectin distribution had been
44 successful.

45 Given the spatial distribution across geographical area, current
46 information on the prevalence and distribution pattern are essential in
47 developing effective control programmes for onchocerciasis. Therefore, this
48 study was carried out to determine the prevalence and the pattern of
49 distribution of onchocerciasis in the study area. It is expected that the result
50 of this study will be valuable for the evaluation and monitoring of the CDTI
51 in the study area.

52

53

54 **2. MATERIALS AND METHODS**

55 **2.1 Study Area and Subjects**

56 The study was carried out in 41 communities within Aniocha North,
57 Aniocha South and Oshimili North Local Government Areas in north
58 senatorial zone of Delta State, Southern Nigeria. It lies roughly between
59 longitude $6^{\circ} 10'$ and $6^{\circ} 45'$ East and Latitude $6^{\circ} 5'$ and $6^{\circ} 30'$ North. The area
60 has tropical climate marked by two distinct seasons: the dry and rainy
61 seasons. The dry season occurs between November and March, while the
62 rainy season begins in April and lasts till October. There exists a brief dry
63 spell in August commonly referred to as “August break”. The average
64 annual rainfall is about 190.5cm. Rainfall is heaviest in July. The area has a
65 high temperature, ranging between 29°C and 38°C with an average of about
66 30°C . The average annual relative humidity was between 68% and 77%.

67 The 41 communities with a combined population of about 450,000
68 people at the time of this study are socio-culturally similar. The subjects are
69 predominantly farmers; however, those who are engaged in other
70 occupations supplement their earnings with proceeds from subsistent
71 farming.

72

73 **2.2 Preparation for the study / ethical clearance**

74 Prior to the study, two field workers were recruited to function as
75 facilitators and field assistants in each local government area. Furthermore,
76 community leaders were first briefed on the relevance of the study, and their
77 cooperation was sought in the mobilization of their people. Informed consent
78 was also sought from those who willing agreed to participate in the study.
79 Ethical approval for the study was obtained from the department of Animal
80 and Environmental Biology, Delta state University, Abraka, and Delta State
81 Ministry of Health, Asaba.

82 **2.3 Skin Snip Biopsy**

83 Skin snips were aseptically taken from each subject from right iliac
84 crest and the two gluteal folds (buttocks), were taken for parasitological
85 examination from each individual during daytime using a
86 Walsercorneoscleral punch manufactured by surgitrac co. Ltd, 1902, Global
87 trade center, 15, Wingkin Road, Kwai Chung, Hong Kong. The punch was
88 treated with glutaradehyde and sodium hypochloride solution and rinsed
89 with distilled water and alcohol [2, 10]. The skin snips were separately
90 placed in polystyrene microtitration plates with U-shaped wells (96 wells

each) containing 0.3 ml of 0.95% physiological saline solution. When filled, the wells were covered with cellotape to prevent evaporation and spilling of the contents in transit [2, 11].

2.4 Microscopic Examination

Skin snips collected in the field were incubated at room temperature before microscopic examination within 24 hours [12]. However, microfilarial suspensions which could not be examined within twenty four hours after collections were preserved by the addition of a drop of 10% formalin into each micro titration, pending microscopy [13]. The microfilarial suspensions together with the skin snips were sucked up with a Pasteur pipette into a clean slide and the wells were washed up so as to release microfilariae which may adhere to the wells. The specimen removed were teased out in physiological saline and examined under low power (x40 objective) for microfilariae of *O. volvulus*. Subjects were considered to be infected if more than one microfilaria are found in the two skin snips. The microfilariae were counted in each specimen and the average of the two specimens was recorded as the microfilarial score [14].

109 **2.5 Data Analysis**

110 Data from the parasitological survey was entered into Microsoft
 111 excel version 2010 and graphpad version 2010 was used for data analysis. In
 112 addition to measures of dispersion, that is, standard deviation, mean and
 113 standard error, chi square analysis was employed to test for significance
 114 differences between the rates of Onchocercal infection among the subjects in
 115 the three local government areas. For age-related onchocercal infection,
 116 analysis of variance (ANOVA) was used to examine significant difference
 117 and thereafter a Post hoc test (Tukey honest or Multiple Comparisons test)
 118 was used to detect where the differences lied.

119 120 **3. RESULTS**

121 122 **3.1 Prevalence of Human Onchocerciasis in the study area**

123
124 The study included a total of 1,201 subjects from 41 communities in
 125 three different but contiguous local government areas, Delta north senatorial
 126 zone. The general prevalence of the disease in the three local government
 127 areas of Delta State, Nigeria, is presented in Table 1. Out of the 1,201
 128 examined persons, 138 were positive for Onchocerca volvulus - the
 129 onchocercal parasite. Thus, the overall prevalence of human onchocerciasis

in the study area was therefore 11.5%. The highest prevalence was recorded in Aniocha North (12.5%), followed by Oshimili South (11.5%) and Aniocha South (10.7%). There was no significance difference in the prevalence of the disease ($P>0.05$) in the three local government areas. However, there was significant difference in the prevalence of onchocerciasis among the communities in all three local government areas (data not shown).

137

Table 1. General Pattern of Distribution of Human Onchocerciasis in the Study area

140

L.G.A	Number of Communities Sampled	Number of Individuals Examined in each L.G.A	No. infected (%)
ANIOCHA NORTH	11	344	43(12.5)
ANIOCHA SOUTH	15	432	46(10.7)
OSHIMILI NORTH	15	425	49(11.5)
Total	41	1,201	138(11.5)

3.2 Gender-related Prevalence of Human Onchocerciasis in the Study area.

Table 2 shows the general gender-related prevalence of human

144 onchocerciasis in the study area. Overall, the prevalence of onchocerciasis
 145 was slightly higher among male (12.2%) than female (9.9%). There was no
 146 significant gender difference ($P>0.05$) in the prevalence of the disease in the
 147 study area. The gender- prevalence by L. G. A. also reveals an insignificant
 148 higher prevalence among male subjects (Table 2).

149 Table 2.General Gender-related Prevalence of Human Onchocerciasis in the
 150 study area

151

L.G.A	Number of Communities Examined	Number of Individuals Examined in each L.G.A	No. infected (%)
ANIOCHA NORTH	M	201	29(14.4)
	F	143	14(9.8)
ANIOCHA SOUTH	M	296	35(11.8)
	F	136	11(8.1)
OSHIMILI NORTH	M	329	37(11.3)
	F	96	12(12.5)
TOTAL	M	826	101(12.2)
	F	375	37(9.9)

152 **3.3 Onchocercal Infection in relation to Gender and Age in the**
 153 **study area**

154 The age related onchocercal infection in the three local
 155 governments the study area of Delta State is presented in Table 3.

156 In general, the prevalence of onchocerciasis increased
 157 progressively with age until age group 50-59 years thereafter there
 158 was a sharp decrease in the prevalence. Similarly, the
 159 age-prevalence with respect to L.G.A followed similar trend. There
 160 was significant difference in the prevalence of onchocerciasis in
 161 relation to age. Furthermore, stratification of the prevalence by
 162 gender and age (Table 4) shows that for both sexes and across
 163 L.G.A, the prevalence increases with age with a peak at 50-59
 164 years.

165 Table 3: Onchocercal Infection in relation to Age in the study Area

L.G.A	Number Examined	Number of infected	No (%) infected in Age groups						
			Age group (Yrs)						
			10-19	20-29	30-39	40-49	50-59	60-69s	≥70
Aniocha North	344	43	3(7.0)	4(9.3)	6(14.0)	11(25.6)	12(27.9)	6(14)	1(2.3)

Aniocha South	432	46	4(8.7)	3(6.5)	8(17.4)	13(28.3)	15(32.6)	3(6.5)	0(0.0)
Oshimili North	425	49	2(4.1)	6(12.3)	7(14.3)	8(16.3)	15(30.6)	7(14.3)	4(8.2)
Total	1,201	138	9(6.5)	3(9.4)	21(15.2)	32(23.2)	42(30.4)	16(11.6)	5(3.6)

166

167 Table 4: Onchocercal Infection in relation to Gender and Age in the study

168 area

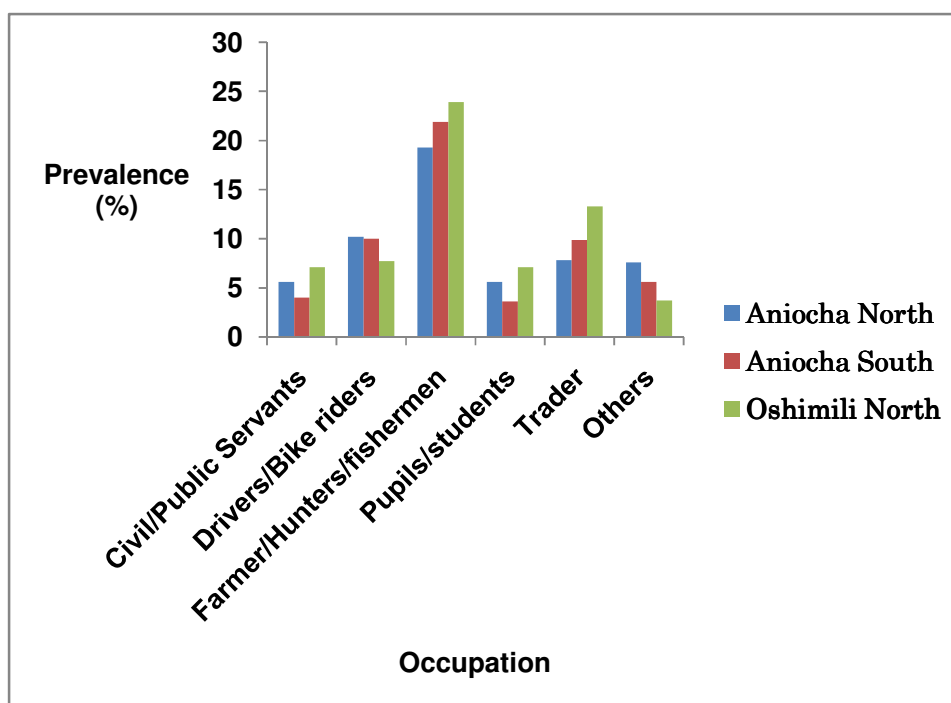
L.G.A	Number Examined	Sex	No (%) infected in Age groups						
			Age group (Yrs)						
			10-19	20-29	30-39	40-49	50-59	60-69s	≥70
Aniocha North	344	M	2(1)	2(1)	4(2)	8(4)	9(4.5)	4(2)	0(0)
		F	1(0.7)	2(1.4)	2(1.4)	3(2.1)	3(2.1)	2(1.4)	1(0.7)
Aniocha South	432	M	3(1)	2(0.7)	6(2)	10(2.4)	12(4.1)	2(0.7)	0(0)
		F	1(0.7)	1(0.7)	2(1.5)	3(2.2)	3(2.2)	1	0(0)

Oshimili North	425	M	2(0.6)	4(1.2)	6(1.8)	7(2)	11(3.3)	5(1.5)	2(0.6)
		F	0(0)	2(2.1)	1(1)	1(1)	4(4.2)	2(1.2)	2(2.1)
Total	1,201	M	7(0.9)	8(1)	16(1.8)	25(3)	32(3.9)	11(1.3)	2(0.2)
		F	2(0.5)	5(1.3)	1(1)	7(1.9)	10(2.7)	5(1.3)	3(0.8)

169

170 **3.4 Human Onchocerciasis in relation to Occupation in the study area**

171 A cross L.G.A, the prevalence of onchocerciasis varied with the occupation
 172 of the subjects (Figure 1). The highest prevalence was observed among
 173 farmers, followed by traders and drivers. Analysis of variance showed no
 174 significant difference in the prevalence of onchocerciasis with occupation
 175 ($F= 0.07$, $P = 0.93$).



176

177 Figure 1. Prevalence of Onchocerciasis in relation to Occupation in the study area

178

179 4. DISCUSSION

180 Results from various studies have implicated Nigeria as an endemic area for
 181 onchocerciasis and estimates of prevalence of infection ranging from low to
 182 high rates were reported [1, 2, 5-7]. The prevalence of the infection as
 183 reported shows some spatial variation with highest endemicity of 83.0% in
 184 Edo State [1].

185 This study found that the prevalence of onchocerciasis in Delta North
 186 senatorial zone was 11.5% and the pattern of distribution was not

187 significantly different ($p>0.05$) in the three local government areas.
 188 Adopting the endemic rates classification of World Health Organization,
 189 these communities can be regarded as hypoendemic for onchocerciasis. The
 190 prevalence observed in our study area was lower than the reports from some
 191 parts of the country including our study area. For instance, 6 reported a
 192 prevalence of 41.1% in a rural farm settlement in Aniocha North Local
 193 Government Area in Delta State. Similarly, Emina and Okaka [7] observed a
 194 prevalence 91.9% in rural community of Okuetolo in Delta State. The
 195 reduction in the prevalence rate observed in this study is likely due to the
 196 onchocerciasis intervention by the Africa Programme on Onchocerciasis
 197 Control (APOC) with the distribution of ivermectin through the Community
 198 directed treatment with ivermectin (CDTI).

199 Furthermore, the disparity in the prevalence of onchocerciasis further
 200 explain that the focal nature of the disease depends on the presence of a
 201 specific ecology, including but not limited to fast-flowing waters and the
 202 characteristics of the vectors involved in the transmission.

203 Given the enormous effort by the APOC in the yearly distribution of
 204 Ivermectin, it is not surprising to observe that the study area is still

205 considered an hypoendemic area for onchocerciasis as this is partly explain
 206 by 1.) the presence of the vector; black fly 2.) communities are located close
 207 to relatively fast flowing rivers (0.51 – 0.95m/s) such as Rivers Ohe,
 208 Namormai and Otor, as well as other tributaries which favour the breeding of
 209 *Simulium* vectors and 3.) the presence of bushes made up of trees, and shrubs
 210 near many homes, whose twigs and canopies provide desirable resting
 211 shades for the vector flies.

212 In this study, there was a numerical gender bias in the participation in
 213 the survey. The number male who volunteered to participate in this study
 214 was over twice the number of female counterparts. Factors responsible for
 215 this could be associated with cultural (where in females are a traditionally
 216 expected to be more conservative or reserved compared to males), and also
 217 inadequate health education. This finding is in line with that of Abdulahi and
 218 Oyeyi [15] in Tudun Wada and Doguwa Local Government Areas of Kaduna
 219 State, where more males than females were examined in a similar survey.
 220 Although, religious factors such as pudah often also contributes to the
 221 reluctance of females in northern Nigeria to participate in surveys of this
 222 nature.

223 In spite of the obvious numerical bias in favour of examined males
224 over females in this survey, the general picture of human onchocerciasis in
225 the study area of Delta state showed that there was no significant difference
226 between the proportion of infected males and females ($P > 0.05$). This
227 finding agrees with that of Okonkwo *et al*[2] where infection rate between
228 males (38.9%) and females (26.7%) were not significantly different ($P>0.05$)
229 among farmers in Ebonyi state. Also, the finding of this study is in
230 agreement with that of other researchers in other parts of Nigeria as
231 referenced above in onchocercal gender-related infection, but at variance
232 with the report of Akinbo and Okaka[16], who found significant gender
233 difference in the prevalence of onchocerciasis in Ovia North East Local
234 Government Area of Edo State, Nigeria.

235 The age-related prevalence increased progressively with age with a
236 slight decline from 60 years to 70 years and above. This observation is in line
237 with existing reports on human onchocerciasis. For instance, Dadzie *et al*[17]
238 and Little *et al* [18] separately explained that this was due to a steady buildup
239 of infection as a result of early human-vector contact which is sustained
240 throughout the period of existence. Worthy of note here, is the fact that the

241 most infected ages of 20 to 59 years are the most functional working age
 242 bracket, thus impacting negatively on the rural economy. Generally more
 243 subjects were infected with human onchocerciasis as individuals advanced
 244 in age, the worst being 50 – 59 years when the infection stabilized and
 245 decreased beyond this age. Similarly, Okonkwo *et al* [2] in Ebonyi State,
 246 Nigeria observed highest infection rate of 55.3% in subjects aged 50 years
 247 and above, while the least infection of (15.5%) was within the age range of
 248 20–29 years. Each of the three local government areas had results similar to
 249 that of the overall with respect to age-related prevalence of onchocerciasis in
 250 the study area. It is not surprising that the highest infection rates was within
 251 the working age; since this group were the ones who go out to farms or other
 252 places of work very early in the morning and stayed till very late in the
 253 evening. This exposed them to more frequent bites of blackflies thus
 254 predisposing them to infection. Result of prevalence of onchocerciasis in
 255 relation to gender and age in the current study indicates that males and
 256 females of the different age groups had similar propensity to the disease.

257 The only visible difference in the result is that infection rate was
 258 higher in males at most age groups than females of the same age groups. For

instance, the highest prevalence of 3.9% was generally recorded in males of age group 50 – 59 years. In the communities of Aniocha North Local Government Area, the highest prevalence of 12.5% was respectively recorded in the males and females of age group 50 – 59 and 30 - 39 years in Philip’s camp. Similarly, the females within 50 – 59 years in Ewulu recorded the highest prevalence with 22.2% in Aniocha South Local Government Area, followed by the males (50 – 59 years) of Umute (19%). In surveys of this nature, males often record higher prevalence compared to female counterpart in the communities because men usually stay outside the house more and so have greater exposure to bites by vector blackflies[15]. The results of the communities of Oshimili North Local Government Area showed that females in Asoko (20 – 29 years), Ilah (50 – 59 years) and Ugwu-Ozalla (60 – 69 years) recorded the highest prevalence of 20%. This of course was a deviation from the overall prevalence.

The prevalence of human onchocerciasis among the various occupational groups sampled in the study area of Delta State shows that the disease is related to occupational. That is, the occupational groups that carry out most of their activities outdoors, especially with most parts of their

277 bodies exposed are more predisposed. Rasheed [19] alluded to this, when he
 278 reported that the prevalence of the disease was associated with activities like
 279 farming and washing near rivers. Inhabitants' vocations therefore, have
 280 some effect on the pattern of distribution and prevalence of onchocerciasis
 281 infection.

282 In Aniocha North Local Government Area, results of the
 283 occupational – related prevalence shows that infection rates and occupation
 284 were associated. The infection was more prevalent among farmers, hunters
 285 and fishermen, followed by the drivers and bike riders. Statistical analysis of
 286 the results did not however reveal any significant difference ($P > 0.05$)
 287 between the occupational groups. However, in Aniocha South and Oshimili
 288 North Local Government Area respectively, there was significant difference
 289 ($P < 0.05$) in the prevalence with respect to occupational. The reason for
 290 this variation is unclear. However, it is reasonable to attribute this difference
 291 to variation in vectorial capacity or degree in human-vector contact. The
 292 observed association between prevalence and occupation is in accordance
 293 with report on human onchocerciasis elsewhere [2]. This no doubts may be as
 294 a result of higher frequency of contact of these occupational groups with

295 infected vectors. Also, local transporters (drivers and bike riders) ranked
 296 second the in the prevalence of onchocerciasis. This is not an expected
 297 finding as they are constantly moving from one rural area to another,
 298 secondly, they often for passengers at junctions and under shades while in
 299 the evening, they gathered at the corner of streams or pools of water to wash
 300 their bikes or caps at the close of the day. Theses pattern of activities
 301 predispose them to vectorial inoculation. Thus this may explain the
 302 relatively high prevalence of the infection among this occupational group.

303 Other vulnerable groups were the school age children, 10 years and
 304 above. These groups are often sent to fetch water from nearby streams and
 305 many of whom delight in washing, bathing or doing their laundries in the
 306 streams. Also, poor living conditions among some rural dwellers often
 307 deprive most school aged children from going to school. Rather, they follow
 308 their parents to farms and bush markets. Therefore, it is pertinent to point out
 309 that people whose daily activities and engagements frequently bring them in
 310 close proximity to infected black fly are the most venerable groups in
 311 endemic areas.

312 The moderately high infection rate of civil/public servants and

313 traders (particularly in Oshimili North Local Government Area) may not be
 314 unconnected with the fact that some of them may have in the time past or are
 315 currently engaged in other outdoor activities such as farming, hunting or
 316 fishing. Another explanation that appears plausible for the relatively high
 317 infection rate in traders is that a good number of them travel from one bush
 318 market to another. Some of them actually go to buy and/or sell in markets
 319 that are close to fast flowing streams or rivers which may be breeding sites
 320 for *Simulium* vector.

321 In summary, the study has revealed that there are
 322 relationships in the rate of infection of onchocerciasis with gender, age,
 323 occupation and location in the study area. Thus, it is recommended that
 324 comprehensive epidemiological surveys of onchocerciasis in remote areas
 325 should be carried out and all the affected population treated with ivermectin.
 326 The CDTI programme of APOC should be extended with ten more years
 327 beyond 2015. It should even be consolidated upon, in order to ensure a
 328 consistent ivermectin delivery to inhabitants of the area and to monitor
 329 compliance with drug usage.

330

331 **CONSENT AND ETHICAL APPROVAL**

332 Informed consent was also sought from those who willing agreed to
 333 participate in the study. Ethical approval for the study was obtained from the

334 department of Animal and Environmental Biology, Delta state University,
335 Abraka, and Delta State Ministry of Health, Asaba.

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337 REFERENCES

- 338 1. Akinbo FO, Okaka CE. Prevalence and socio-economic effects of onchocerciasis
339 in Ovia North East Local Government Area of Edo State, Nigeria. *Rivista Di*
340 *Parasitologie*. 2005; 22(3): 215-221.
- 341 2. Okonkwo CI, Iroha IR, Ayogu TE, Oji AE and Onwa NC. Epidemiology of human
342 onchocerciasis among farmers in Ebonyi State, Nigeria. *International Journal of*
343 *Medicine and Medical Sciences*. 2010; 2(8), 246-250.
- 344 3. Dori GU¹, Belay T, Belete H, Panicker KN, Hailu A. Parasitological and
345 clinico-epidemiological features of onchocerciasis in West Wellega,
346 Ethiopia. *Journal of Parasitic Disease*. 2012; 36(1):10-18.
- 347 4. Uttah EC. Onchocerciasis in the Upper Imo River Basin, Nigeria: prevalence and
348 comparative study of waist and shoulder snips from mesoendemic communities.
349 *Iranian Journal of Parasitology*. 2010; 5(2), 33-41.
- 350 5. Sam-Wobo SO, Adeleke MA, Jayeola OA, Adeyi AO, Oluwale AS, Ikengu
351 M, Lawniye A, Gazama J, Kagni A, Kosoko TO, Agbeyangi O, Bankole S, Toe
352 L, Mafiana CF. and Yameogo L. Epidemiological evaluation of onchocerciasis
353 along Ogun River System, South-West Nigeria. *Journal of Vector Borne*
354 *Disease*. 2012; 49: 100-104.
- 355 6. Nmorsi OPG, Oladokun IAA, Ekwunoye OA and Oscha E. Eye Lesions and
356 onchocerciasis in a Rural farm Settlement in Delta state, Nigeria. *Southeast Asian*
357 *Journal of Tropical Medicine and Public Health*. 2002; 33(1):28-32.
- 358 7. Emina, MO and Okaka CE. Onchocerciasis in Okuetolo, a rural community in
359 Delta State, Nigeria. *South African Option*. 2004; 63(3): 96-102.
- 360 8. African Programme for Onchocerciasis Control [APOC]. Final communique of the

- 361 11th session of the Joint Action Forum (JAF) of APOC, Paris, France, 6–9
362 December 2005. APOC, Ouagadougou(Burkina Faso).
- 363 9. Adeleke MA, Sam-Wobo SO, Mafiana CF and Olatunde GO. Perception on
364 bioecology of onchocerciasis vectors around Osun River, South-West
365 Nigeria. *Journal of Public Health and Epidemiology*. 2011;3(4):162-166.
- 366 10. Botto C, Gillespie AJ, Vivas Martinez S, Martinez N, Plamchart S, Bassanez Mand
367 Bradley JE. Onchocerciasis hyperendemic in the Unturan Mountains: The value of
368 the recombinant antigens in describing a new transmission area in southern
369 Venezuela. *Transactions of the Royal Society of Tropical Medicine and Hygiene*,
370 1999;93, 25 -30.
- 371 11. Ufomadu GO, Braide EI, Ekejindu GOC, Tada T, Takahasi H and Akoh JI.
372 Evaluation of skin snip biopsies from different body regions of onchocerciasis
373 patients in central Nigeria. *Acta Tropica*. 1988; 45:257-261.
- 374 12. Rahmah N, Lim BH, Anuar AK, Shenoy RK, Kumaraswami V, Kakinm SL,
375 Chotechuang P, Kanjanopas K and Ramachandran CP. A Recombinant
376 antigen-based Ig G4 ELISA for the specific and sensitive detection of
377 *Brugia malayi* infection. *Transaction of the Royal Society Tropical Medicine and*
378 *Hygiene*. 2001;95, 280-284.
- 379 13. Onwuliri CO, Nwoke BE, Lawal IA, Iwuala MO. Onchocerciasis in Plateau State
380 of Nigeria II: The prevalence among residents around the Assob River area. *Annal*
381 *of Tropical Medicine and Parasitology*. 1987;81(1):49–52.
- 382 14. Anosike JC, Onwuliri, COE and Onwuliri VA. Human filariasis in Dass local
383 government area of Bauchi state, Nigeria. *Tropical Ecology*. 2003; 44(2):
384 215-226.
- 385 15. Abdullahi Y and Oyeyi TY. Current status of Onchocerciasis in Tudun Wada and
386 Doguwa Local Government Areas of Kano State. *The Nigeria Journal of*
387 *Parasitology*. 2003; 24:77-88
- 388 16. Akinbo FO and Okaka CE. Hyperendemicity of Onchocerciasis in Ovia
389 Northeast Local Government Area, Edo State, Nigeria. *Malaysian Journal of*
390 *Medical Science* 2010;17(4) 20- 24.

- 391 17. Dadzie Y, Neira M and Hopkins D. Final report of the conference on the
392 eradication of onchocerciasis. *Filaria Journal*,2003; 2(1):2.
- 393 18. Little MP, Breitling LP, Basanez MG, Alley ES and Boatin BA. Association
394 between microfilarial load and excess mortality in onchocerciasis: an
395 epidemiological study. *Lancet*; 2004; 363(9420): 1514-1521.
- 396 19. Rasheed MU. Onchocerciasis in different regions of Ethiopia.*The Internet*
397 *Journal of Parasitic Diseases*, 2008; 3(2).