Assessment of the Prevalence of Clinical Manifestations of Onchocerciasis and Evaluation of Transmission Interruption in Sentinel Communities in Imo State, Nigeria After 20 Years of Mass Drug Administration

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DOI: https://doi.org/10.51244/IJRSI.2025.12150005P

Received: 29 December 2024; Accepted: 10 January 2025; Published: 10 February 2025

ABSTRACT

Onchocerciasis remains a public health concern in Nigeria, though community-directed ivermectin interventions have significantly improved outcomes. This study evaluated onchocerciasis prevalence and transmission status in nine endemic communities in Imo State after 20 years of ivermectin distribution. Conducted from April 2022 to March 2023, the research focused on three LGAs: Ehime (Nzerem Ikpem and Umueze 1), Okigwe (Amano, Amuro, Ibii,Ihube and Umulolo) and Ezinihitte (Itu and Udo), communities along the Imo River. A total of 652 respondents were assessed for clinical manifestations, and the Ov16 IgG4 rapid diagnostic test was performed on 225 participants. Black fly abundance and microfilaria infection rates were also evaluated. Findings revealed a 94.03% reduction in nodules from a pre-control rate of 25.67% to 2.15%, with Okigwe LGA showing the highest reduction (95.28%). Clinical manifestations, including nodules (1.54%), leopard skin (0.15%), and onchodermatitis (0.46%), were more frequent among older residents and males (2.31%) compared to females (1.81%). No manifestations were observed in individuals aged 5–30 years or among civil servants, traders, and students. The Ov16 IgG4 test detected no *Onchocerca volvulus* antibodies. Of the 1,022 black flies captured, none carried infective larvae (L3), indicating a 0% infectivity rate.This study highlights the success of ivermectin in reducing onchocerciasis prevalence and interrupting transmission. However, ongoing surveillance and public health education are crucial to prevent reinfection and maintain progress in these communities.

Keywords:Onchocerciasis, Mass Drug Administration, Disruption, Sentinel communities, Imo State

INTRODUCTION

Commonly known as river blindness, onchocerciasis is a debilitating disease caused by the filarial nematode *Onchocerca volvulus*. This parasitic infection is transmitted via the bites of infected blackflies, belonging to the Simulium genus, which thrives in areas near fast-flowing rivers. The female worms produce microfilariae (mf) that can reside in nodules and migrate to the eyes, resulting in inflammatory lesions. During their blood meals, blackflies ingest these microfilariae, which then progress through the L1, L2, and L3 larval stages. The infective L3 larvae are transmitted to humans through subsequent bites, thus completing the parasite's lifecycle (Katabarwa *et al*., 2013).

The clinical symptoms associated with onchocerciasis are profound, encompassing skin disorders, visual impairment, and social stigma. These manifestations contribute to considerable economic difficulties within the impacted communities (WHO, 2023). Although the disease can lead to permanent vision loss, it predominantly manifests as skin disease, affecting 70% of individuals. In 2017, skin disease accounted for more than 90% of the years lived with disability attributed to onchocerciasis (James *et al*., 2018).

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI | Volume XII Issue XV January 2025 | Special Issue on Public Health

The primary strategy for controlling onchocerciasis has been the mass drug administration (MDA) of ivermectin, a safe and effective microfilaricidal drug. Ivermectin, donated by Merck & Co. (Mectizan) since 1987, kills the microfilariae, reducing the risk of developing eye and skin diseases. It also decreases the fecundity and lifespan of adult worms (Cupp and Cupp, 2005). The World Health Organization (WHO) has adopted a community-directed treatment with ivermectin (CDTI) strategy, which has shifted from morbidity control to elimination of transmission. The goal is to interrupt the transmission of *Onchocerca volvulus* in 12 (31%) endemic countries by 2030 (WHO, 2020).

The consistent use of ivermectin plays a crucial role in preventing the advancement of the disease and limiting its transmission by targeting and destroying microfilariae in the skin, reducing the risk of transmission to the blackfly vector (Gardon *et al.,* 2002). The World Health Organization recommends implementing annual mass drug administration (MDA) with a coverage rate of 80% for a period of 15 to 17 years to effectively lower transmission rates and decrease the occurrence of skin infections, particularly in pediatric populations (Gardon *et al.*, 2002; Murdoch, 2018; WHO, 2020). While community-directed treatment initiatives have led to successful elimination in some African regions, challenges continue to exist in areas with elevated transmission levels, especially in forested regions that provide year-round breeding habitats for vectors (Duamor *et al.*, 2017).

Recent findings suggest that the transmission of *Onchocerca volvulu*s has been eradicated or is close to eradication in 110 out of 282 locations, representing 39% of the sites assessed. This is a significant indicator of progress towards the World Health Organization's target for 2030. In Africa, the Onchocerciasis Control Programs, initially managed by the African Programme for Onchocerciasis Control (APOC) and subsequently by the Expanded Special Project for the Elimination of Neglected Tropical Diseases (ESPEN), have been dedicated to eliminating the disease as a public health issue (Tekle *et al*., 2022). These initiatives have concentrated on administering annual doses of ivermectin, which has led to a reduction in the prevalence of onchocerciasis, thereby alleviating it as a public health and socioeconomic challenge. Nevertheless, despite years of intervention efforts, approximately 249.5 million individuals across 28 countries still require treatment to fully eradicate onchocerciasis, not accounting for those in regions with undetermined transmission status.

In 2023, a total of 172.2 million individuals received treatment for onchocerciasis, achieving a global coverage rate of 69% (WHO, 2023). In Nigeria, more than 30 million people in over 36,000 communities benefit from annual treatment via mass drug administration (MAM) utilizing Mectizan, with several states sustaining effective coverage for more than ten years (WHO, 2023). In light of new evidence suggesting that onchocerciasis could be eradicated with ivermectin, Nigeria formulated a national strategy aimed at halting transmission by 2020 and eradicating the disease by 2025.

Over the last ten years, observations from West, Central, and East Africa have indicated that transmission has been interrupted in specific regions following a minimum of 15 years of mass drug administration (MDA). The World Health Organization's roadmap for neglected tropical diseases, covering the period from 2021 to 2030, aims to confirm the interruption of transmission in 12 out of 38 endemic countries by 2030 (WHO, 2023). As this objective draws nearer, it is essential to gain a deeper understanding of the elimination status within endemic communities and the factors that have contributed to the successful interruption of transmission throughout sub-Saharan Africa. In areas with prolonged MDA, there has been a notable reduction in the clinical manifestations of onchocerciasis, indicating that the extensive use of ivermectin has effectively diminished the parasite population and disrupted transmission cycles (Boussinesq *et al*., 2021). Nevertheless, the observed low prevalence of clinical symptoms prompts critical inquiries: does this signify genuine elimination, or are there lingering infections that could potentially reactivate transmission if interventions are halted?

The World Health Organization published guidelines in 2016 regarding the cessation of mass drug administration (MDA) and the verification of transmission interruption, which are based on serological monitoring of children and molecular xenomonitoring of vectors. This research aims to assess the prevalence of key clinical manifestations of onchocerciasis in sentinel communities, while also evaluating the interruption of transmission in alignment with WHO recommendations.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI | Volume XII Issue XV January 2025 | Special Issue on Public Health

MATERIALS AND METHOD

The research was conducted in nine endemic communities within the designated Local Government Areas, which are traversed by sections of the Imo River. This river serves as the primary water source in Imo State and constitutes a significant breeding ground for the vector *Simulium damnosum* (black fly) (Ukaga, 1997). The region is situated between latitudes 5°30'1"N and 5°58'1"N, and longitudes 70°10'1"E and 70°25'1"E. Breeding sites are formed by rocks and various geological formations along the riverbed and its banks. The climate is characterized by two distinct seasons: a dry season from November to March and a wet season from April to October, with annual rainfall ranging from 1,500 mm to 2,200 mm. The temperature fluctuates between a maximum of 31.9°C and a minimum of 22.5°C. The predominant vegetation in the area is rainforest. The local population primarily engages in agriculture, fishing, hunting, palm wine tapping, sand dredging, and small-scale trading, with the majority identifying as Christians. The intervention for onchocerciasis treatment using ivermectin began in these communities over twenty years ago, around 1994, following a rapid assessment survey to determine areas suitable for mass drug administration and distribution

Ethical clearance and informed consent

The study was approved by the Ethical Committee of Imo State University, Owerri. Approval was also obtained from the Ministry of Health and the Local Government Areas. Informed consent was secured from both the village heads and the participants. Additionally, trained flycatchers from the sentinel communities were employed for the study. A six-man concept-trained personnel was recruited for the study including two (2) Nurses, two (2) Medical laboratory scientists, and two (2) Public health personnel (DSNO) of each LGA.

Preliminary visit and selection of study

The researcher and their team visited the Local Government Chairman, the Head of the Health Department, and the Head of Onchocerciasis Control to discuss the research and seek approval. Meetings were also held with the village heads and participants to explain the rationale and design of the study.

S**tudy population**

A target population was drawn from consented individuals in the 9 sentinel villages from the three selected endemic L.G.A"s of Ehime (Nzerem Ikpem and Umueze 1), Okigwe (Amano, Amuro, Ibii, Ihube andUmulolo) and Ezinihitte(Itu and Udo); they were grouped into two categories. The first 6 villages, were purposely selected based on available baseline data in Imo State. These 6 villages were selected based on being monitored as foci areas (villages). Also, 3 villages were randomly selected that are richly traversed by the fast-flowing Imo River.

Sample Size

The villages selected for the study were chosen based on their location along the Imo River Basin. The sample size of individuals interviewed was calculated using the Joseph Meyers sample size formula for an unknown population:

$$n = Z^2 \cdot p \cdot (1-p)/e^2$$

Where:

- n = required sample size
- Z = Z-score (standard normal deviate corresponding to the desired confidence level, e.g., 1.96 for 95% confidence)
- p = estimated proportion of the population with the characteristic of interest (if unknown, p=0.5p = 0.5p=0.5 is used as a conservative estimate)

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- *e* = margin of error (desired level of precision, expressed as a decimal, e.g., 0.05 for ±5%)

Based on this calculation, a total of 72 or 73 respondents were examined and interviewed in each of the 9 sentinel areas, resulting in a total minimum population of 652 consented respondents.

Selection/Training of personnel

For the study, a six-member team was recruited, consisting of two nurses, two medical laboratory scientists, and two public health personnel (DSNO) from each Local Government Area (LGA). These professionals had previously received training and were provided with an additional two weeks of instruction regarding the research objectives, methodologies, questionnaire administration, and data collection processes. The nurses participated in patient examinations and interviews, as well as the administration of preventive ivermectin doses to black flycatchers. The medical laboratory scientists were tasked with identifying the manifestations of onchocerciasis, such as palpable nodules, leopard skin, and Ochodermatis. The public health officers were responsible for ensuring that the captured black flies were transported appropriately for dissection.

The inclusion criteria focus on vulnerable groups, individuals who are unaware of ivermectin but are symptomatic, and adults involved in the concept group. The exclusion criteria include non-consenting adults and non-consenting groups.

Study Design

The research involved a cross-sectional survey conducted within nine selected endemic communities. A baseline assessment was performed before the initiation of mass drug administration (MDA) of ivermectin, alongside a parasitological survey carried out in collaboration with the Carter Centre and the support of the Imo State government. The OV 16 test was employed to determine the presence of infection among the participants. Following the acquisition of consent from randomly chosen individuals, interviews were conducted, and participants were examined for clinical signs of nodules, onchodermatitis, and leopard skin. Additionally, a longitudinal study design was implemented to assess the presence of infected and infective black flies, utilizing trained human attractants for monthly fly captures over 12 months. The captured flies were subsequently dissected to identify the larval stages (L1, L2, or L3) of *Onchocerca volvulus*.

Data Analysis: Descriptive statistics were utilized to illustrate the basic frequencies of onchocerciasis clinical manifestations in the demographic characteristics analyzed. The Chi-squared test was applied to assess the relative monthly abundance of captured blackflies.

RESULT

Table 1: Community-related Clinical manifestations

S/N	Name of Community	No Examined			Prevalence of clinical manifestation			Pre-control nodule rate%
			Male	female	Nodule rate (%)	LS%	Onchodermatitis%	
Ehime LGA								
1	Nzerem Ikpem	67	48	19	1 (1.50)	0	1 (1.50)	23
2	Umueze 1	63	40	23	1 (1.59)	0	0 (0.0)	20
Okigwe LGA								
3	Amano	61	44	17	1 (1.64)	0	0 (0.0)	40

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4	Amuuro	68	44	24	1 (1.48)	0	1 (1.48)	30
5	Ibii	107	69	38	2 (1.87)	1 (0.94)	1 (0.94)	24
6	Umulolo	92	63	29	1(1.09)	0	0 (0.0)	40
7	Ihube	70	45	25	1 (1.43)	0	0 (0.0)	24
Ezinihitte LGA								
8	Itu	61	35	26	1 (1.64)	0	0 (0.0)	15
9	Udo	63	44	19	1 (1.59)	0	0 (0.0)	15
	Total	**652**	**432**	**220**	**10(1.53)**	**1(0.15)**	**3(0.46)**	

Table 1 shows the clinical manifestations of nodule rate, leopard skin, and Onchodermatitis about the pre-control rate (%) in the communities. The result shows that 14 (2.15%) specific clinical manifestations of an individual(s) were identified from the 652 respondents examined. Okigwe had 9 (2.26%) manifestations accounting for 64.28% of the identified clinical manifestations in the study area, while Ehime with 3(2.3%) made up 21.43%. Two (1.61%) clinical manifestations were identified in Ezinihitte LGA representing 14,29% of observed manifestations in the study area. Leopard skin was not observed in Ehime Mbano.

The study area recorded a hydrocele mean percentage of 1.53% which is a 94.03% reduction from the pre-control nodule rate of 25.67%. Local Government wise, Ehime observed a 92.88% reduction in hydrocele rate, Okogie 95.28% reduction, while Ezinihitte decreased from a pre-control nodule rate of 15% to 1.61 representing 89.27% reduction. Leopard skin recorded a prevalence of 0.15% (1), but was not diagnosed in Ehime, whileOnchodermatitis had a prevalence of 0.46%(3) and was not observed in Ezinihitte, figure 22.

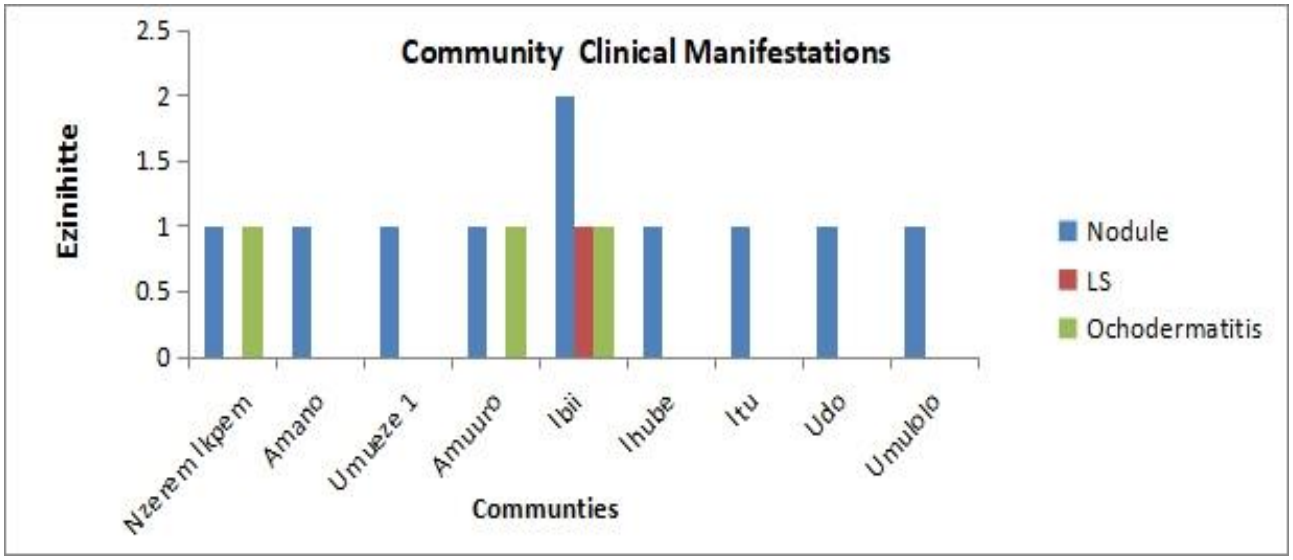

Fig 1 The clinical manifestation of nodule rate, leopard skin, and onchodermatitis in the communities

Table 2: sex-related clinical manifestations

S/N	Sex	Number examined	Nodule (%)	Onchodermatitis %	LS%	Total
1	Male	432	8 (1.85)	2 (0.46)	0 (0.00)	10(2.31)
2	Female	220	2(0.91)	1 (0.45)	1 (0.45)	4(1.81)
	Total	652	10(1.53)	4(0.46)	1(0.15)	14

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Sex-related clinical manifestations are illustrated in Table 2. The sex-related clinical manifestation showed that males presented more manifestation 10(2.31%) than females (1.81%), however, leopard skin was not noticed among males

Table 3: Age group-related clinical manifestations of onchocerciasis

S/N	Age (years)	Number examined	Nodule%	Onchodermatitis %	Leopard skin (%)	Total
1	5-10	84	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
2	11-20	90	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
3	21-30	138	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
4	31-40	96	1 (1.04)	0 (0.0)	1 (1.04)	2 (2.17)
5	41-50	64	3 (4.69)	0 (0.0)	0 (0.0)	3 (4.69)
6	51-60	51	2 (3.92)	1 (1.96)	0 (0.0)	3(5.88)
7	61 and above	129	4 (3.10)	2 (1.55)	0 (0.0)	5(4.76)
	Total	**652**	**10 (1.53)**	**3 (0.46)**	**1 (0.15)**	

Table 3 shows age group-related clinical manifestations. There was a clinical manifestation of onchocerciasis in respondents between 5-30 years. The age-related clinical manifestation recorded the highest occurrence rate (5.88%) in subjects within 51-60 years consisting of 2(3.92%) and 1 person(s) with nodule and Onchodermatitis respectively, followed by 4.76% among those 61 years and above, made up of 4(3.1%) having nodules and 2(1.55%) presenting onchodermatitis. The age group 41-50 years presented 3(4.69%) incidences of the nodules, while the least prevalence (2.17%) of clinical manifestation was observed in respondents that 31-40 years, consisting of one incidence of nodule and onchodermatitis.

The occupation-related clinical manifestations are shown in Table 4. The civil servants, traders, and students o did not present clinical manifestations of onchocerciasis. The clinical manifestations are higher among Farmers (4.45%), made up of 6 (2.97%) incidences of nodules, 2 (0.99%) onchodermatitis, and one person presenting leopard skin manifestation. One artisan had nodules, while other occupations cauterized as 'others' presented 4 (10%) incidences of clinical manifestation comprising 3 nodule cases and one onchodermatitis.

Table 4: Occupation-related clinical manifestations

S/N	OCCUPATION	Number examined	Nodule(%)	Onchodermatitis(%)	LS(%)	Total
1	Civil servants	23	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
2	Traders	172	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
3	Artisan	80	1(1.25)	0 (0.0)	0 (0.0)	1(1.25)
4	Students and pupils	135	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
5	Farmers	202	6(2.97)	2(0.99)	1(0.5)	9(4.45)
6	Others	40	3(7.50)	1(2.50)	0 (0.0)	4 (10)
	Total	**652**	**10(1.53)**	**3(0.46)**	**1(0.15)**	

Other sand diggers, quarry workers, beggars

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI | Volume XII Issue XV January 2025 | Special Issue on Public Health

Table 5 shows the number of years lived in the Community about clinical manifestations. The result shows that 50% of the clinical manifestations occurred in respondents 20 years and above, though it represents a 2.67%(7) prevalence. Individuals who have lived 11-20 years in the community produced 35% of the manifestations, though it is a 2.53% prevalence. Subjects that have up to 10 years in the community witnessed 14,28% of the manifestation. Furthermore, nodules were observed in all the groups, while leopard skin was observed in individuals that have lived more than 20 years in the communities.

Table 5: Number of years lived in the Community about clinical manifestations of onchocerciasis

	Number examined		**Number with manifestation**			**Total**	**Cumulative (%) N=14**
Years Lived	**Male (%)**	**Female (%)**	**Nodule (%)**	**Leopardskin (%)**	**Onchdermatitis (%)**		
<5	43 (9.95)	24 (10.91)	1(1.49)	(0.00)	0 (0.00)	1(1.49)	(7.14)
5-10	86 (19.91)	40 (18.18)	1(0.79)	0(0.00)	0.00	1(0.79)	(7.14)
11-20	130. (309)	67 (30.45)	4(2.03)	0(0.00)	1 (0.51)	5(2.53)	(35.71)
21 & above	173 (40.05)	89 (40.40)	4 (1.53)	1(0.38)	2 (0.76)	7(2.67)	(50)
TOTAL	432 (66.26)	220 (33.74)	10 (1.53)	1 (0.15)	3 (0.46)		

Table 6 shows the result of the Ov 16 IgG4 rapid diagnostic test among children less than 10yrs in the endemic area. The test did not identify *Onchocerciasis volvulus* antibodies in the respondents.

Table 6: Prevalence of Microfilaria using Ov 16

L.G.A	Communities	Number examined	Negative	**%**
Ehime	Nzerem Ikpem	25	0	0
	Umueze 1	25	0	0
Okigwe	Amano	25	0	0
	Amuro	25	0	0
	Ibii	25	0	0
	Ihube	25	0	0
	Umulolo	25	0	0
Ezinihitte	Itu	25	0	0
	Udo	25	0	0
		225	0	0

Table 7 provides a detailed overview of the entomological indices of *S. damnosum* across different months, segregated into rainy and dry seasons. One thousand and twenty-two flies werecaptured and dissected made up of 199 (19.47%) parous (flies that have laid eggs): and 823 (80.53%) nulliparous (flies that have not laid eggs) black flies. No infective larvae (L3) were found in any of the flies, indicating an overall infectivity rate of 0%.

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Table 7: Annual/seasonal Entomological Indices of *S. damnosum*

Months	**No of flies captured and dissected (%)**	**Percentage abundance (%)**	**Number parous (%)**	**Number Nulliparous(%)**	**Number of infective larvae (L3)**	**Infectivity %**
April	100	9.80	19(19)	81(81)	0	0.00
May	86	8.40	16(18.61)	70(81.39)	0	0.00
June	100	9.80	20(20.0)	80(80)	0	0.00
July	91	8.90	18(19.78)	73(80.2)	0	0.00
August	56	5.48	12(21.43)	44(78.54)	0	0.00
September	130	12.72	25(19.23)	108(80.77)	0	0.00
October	114	11.15	22(19.30)	92(80.7)	0	0.00
Rainy season months	**677**	**66.24**	**132(19.78)**	**545(80.22)_**	**0**	**0.00**
November	93	9.09	18(19.35)	75(80.65)	0	0.00
December	56	5.48	11(19.64)	48(80.36)	0	0.00
January	58	5.68	12(20.69)	46(79.31)	0	0.00
February	36	3.52	7(19.44)	29(80.56)	0	0.00
March	102	9.98	19(18.63)	83(81.37)	0	0.00
Dry season months	**345**	**33.76**	**67(19.42)**	**278(80.58)**	**0**	**0.00**
Total	**1022**	**100**	**199(19.47%)**	**823 (80.53%)**	**0**	0.00

There was significant seasonal variation in the relative abundance of the blackflies captured $p<0.05$. A total of 1-22 flies were captured with more in the rainy season (April to October) 677 (66.24%) than in the dry season (November to March) 345 (33.76%), fig 17. The rainy season presented similar parity rates (19.78% parous, 80.22% nulliparous) compared to the dry season. (19.42% parous, 80.58% nulliparous).

The highest abundance was recorded in the rainy month of September (130 flies, 12.72%), while the lowest abundance was observed in February (36 flies, 3.52%). The parity rates were consistent across months, with parous flies ranging from 18.61% to 21.43%, and nulliparous flies from 78.54% to 81.39%.

DISCUSSION

The study, was a follow-up of the rate of infectivity and transmission status of Onchocerciasis after MDA has carried out mass drug administration of Ivermectin in the study areas. The demographic data (Table 1) reveals a comprehensive demographic profile and pre-control nodule rates of the sampled population across various communities in Imo State, Nigeria. Key findings include a higher male participation in the study, with significant variations in pre-control nodule rates across different LGAs and communities. The distribution of age groups, occupations, and duration of residence also highlights important socio-economic factors that could influence the dynamics of Onchocerciasis transmission and control.

Out of 652 respondents, a low prevalence (2.15%) of clinical manifestations were identified (table 1). The clinical manifestations observed include nodule rate (1.54%), leopard skin (0.15%), and onchodermatitis (0.46%). The significantly low prevalence in this study could affirm that ivermectin, known to be embrostatic

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI | Volume XII Issue XV January 2025 | Special Issue on Public Health

is effective in reducing microfilaria load and clinical manifestation in the individual and communities. Pre-control nodule rates are an important measure of the baseline burden of onchocerciasis in the community (WHO,2023). Monitoring changes in these rates post-treatment would be crucial to evaluate the impact of the intervention. The distribution of clinical manifestations and pre-control nodule rates varies across the three LGAs with Okigwe recording the most manifestation (64.28%) of total manifestations) and the highest nodule rate (31.6%). The 20 years of ivermectin administration have led to a significant reduction in the clinical manifestations of Onchocerciasis across all the studied LGAs. The study area recorded a mean percentage of 1.53% for hydrocele, showing a 94.03% reduction from the pre-control nodule of 25.67% (92.88% reduction in Ehime, 95.28% in Okigwe and Ezinihitte with 89.27% reduction). Okigwe LGA, despite having the highest pre-control nodule rate, also showed the most considerable reduction in clinical manifestations, suggesting a positive impact of the treatment, therefore, affirming the embryostatic effect of ivermectin, The result is consistent with the observation of Afework *et al.* (2012) and Tekle (2012). However, the presence of even a few cases of leopard skin and onchodermatitis indicates the need for ongoing surveillance and control measures to prevent reinfection and achieve complete elimination of Onchocerciasis in the region. The absence of *Onchocerca* antibodies in the assessment of children less than 10 years in the endemic area reveals no current harboring of microfilaria and elimination of parasitic stock that can ensure transmission.

The result revealed a higher prevalence of clinical manifestations in males (2.31%) compared to females (1.81%) (table 2). This trend aligns with findings from other studies where males often show higher prevalence rates due to greater exposure to vector bite during outdoor activities such as farming and fishing (Nkeiru *et al.*,2016, Njamnshia *et al.*, 2024). Males have a higher nodule rate (1.85%) compared to females (0.91%). This disparity could be due to higher occupational exposure among males, who are more likely to work in environments conducive to the breeding of the blackfly vector (*Simulium* spp.) (Urem *et al.*, 2022). The prevalence of onchodermatitis is similar between males (0.46%) and females (0.45%). This indicates that factors other than sex, such as genetic predisposition or immune response, may play a role in the manifestation of onchodermatitis (Murdoch *et al*., 2002). Leopard skin was only observed in one female respondent (0.45%) and none in males. This rare presentation might be due to individual variations or specific local environmental factors (Federal Ministry of Health (2017).These findings underscore the importance of tailored intervention strategies considering gender-specific exposure and risks in the management of Onchocerciasis. Nwoke *et al*., 2001 earlier observed that Onchocerciasis is a significant public health concern, and understanding its clinical manifestations helps guide prevention and management strategies.

No clinical manifestations (nodules, onchodermatitis, or leopard skin) were recorded in respondents aged 5-30 years, which progressed significantly with age (higher in 51-60 years and 61 years and above age groups) (table 3). The analysis reveals a clear age-related trend in the clinical manifestations of onchocerciasis, with older age groups exhibiting higher prevalence rates of nodules and onchodermatitis. The absence of clinical manifestations in younger age groups (5-30 years) underscores the chronic and cumulative nature of the disease, which becomes more apparent with age due to prolonged exposure to the infective bites of the blackfly vector (WHO, 2010). However, Noma, 2012 in asserting the efficacy of ivermectin opined that the nodules in older individuals are likely undissolved nodules. These findings highlight the importance of early intervention and sustained vector control measures to mitigate the long-term impact of onchocerciasis, particularly in endemic regions.

Traders, students, and civil servants showed no clinical manifestations, which may be attributed to their lower exposure to the blackfly vector due to indoor or less risky activities compared to outdoor occupations like farming (Emuka *et al*., 2008, Federal Ministry of Health, 2017 and Njamnshia *et al*., 2024) (table 4). Nkeiru *et al*., 2016 presented a similar in their public health analysis of the manifestation of onchocerciasis in rural communities in Nigeria. The prevalence of nodules and onchodermatitis was higher among males, especially those engaged in farming. This aligns with existing research indicating that men in rural areas are more likely to engage in outdoor activities that increase exposure to blackflies (WHO, 2010). Overall, the occupation-related analysis reveals that individuals engaged in outdoor and high-risk occupations, such as farming and certain vector-exposing miscellaneous jobs (‘others’), have a higher prevalence of clinical manifestations of onchocerciasis. This pattern is consistent with the known epidemiology of the disease, where prolonged and repeated exposure to blackfly bites increases the risk of developing onchocerciasis (Boatin and Richard, 2006).

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI | Volume XII Issue XV January 2025 | Special Issue on Public Health

Conversely, occupations with predominantly indoor activities, such as civil servants, traders, and students, showed no clinical manifestations, indicating significantly lower exposure risk.

Table 5 presents data on the clinical manifestations of onchocerciasis about the number of years individuals have lived in the community. The results indicate a clear correlation between the duration of residence in the community and the prevalence of onchocerciasis manifestations. Individuals who have lived in the community for longer periods (21 years and above) show the highest prevalence of clinical manifestations (50%), though the overall prevalence within this group is 2.67%. This trend suggests that prolonged exposure to the blackfly vector increases the risk of developing onchocerciasis (WHO, 2010). The study revealed that the manifestation among indigenes, who had lived in the area only for less than 5 years (1.49) was discovered to be a visitor, who had no history of ivermectin swallow. This affirms that a long-time swallow of ivermectin is effective in reducing and suppressing microfilaria transmission and manifestation (Bamidele *et al*., 2019).

Males generally presented with a higher incidence of clinical manifestations across all categories of duration lived in the community, particularly those residing for 21 years and above. This could be linked to gender-specific occupational activities, with males possibly engaging more in outdoor work that exposes them to blackfly bites (Emuka *et al*., 2008).

The result of the Ov 16 IgG4 rapid diagnostic test among children less than 10yrs in the endemic area did not identify *Onchocerciasis volvulus* antibodies in the respondents indicating the elimination of the reservoir for microfilaria transmission. This may suggest that long-time administration of ivermectin in the communities is effective in reducing and suppressing microfilaria transmission (Bamidele *et al*., 2019).

The result showed significant seasonal variation in fly abundance, with 66.24% captured during the rainy season (April to October) and 33.76% during the dry season (November to March). (table 15). The peak abundance was in September (130 flies, 12.72%), while the lowest was in February (36 flies, 3.52%). The higher abundance of flies during the rainy season aligns with the breeding habits of *S. damnosum*, which prefers the increased water flow in rivers and streams typical of this season for larval development. It is observed that the number of flies does not translate to equivalent infectivity, rather is a surest means of transmission, but infection is transmitted, if in contact with infected blood meal or black fly, previously infected. The reduced population Density in July and August could be attributed to continuous flooding of the river during the peak rainy season, which may have resulted in the dislodging and washing away, of immature stages/breeding sites of *Simulium* flies, to long distances away (Okon *et al*., 2002)).

A total of 199(19.47%) of 1022 flies were parous and parosity varied according to months of collection. With the highest parity of 25(19.23%) in Sept. The study is in agreement with Opara *et al*. (2005) and Amaechi *et al.* (2017). But in contrast to the work by Bamidele *et al.* (2019). the low proportion of parous flies may be an indication of the aging of the local black flies population or the presence of migratory female species. The majority of the flies caught and dissected were Nulliparous108 (80.77%), in the month Sept. This is in agreement with the study by Adeleke *et al*. (2010), Katabarwa *et al.* (2011) but in contrast to the work by Opara *et al*.,(2008) , who recorded the majority of parous flies. Therefore, the bite only constitutes nuisance. The low parity of black fly could be attributed, to the effect of ivermectin blood meal uptake by the biting vector, which could have interrupted the gonotrophic life cycle of the microfilaria, in the black fly as well as the studied population. However, the consistent parity rates suggest stable reproductive activity across seasons. These observations are consistent with the report of Nwoke and Uwazie, 1991 in Imo State, Nigeria.

The absence of infective larvae indicates no current transmission of onchocerciasis by the sampled flies during the study period. This could be due to effective control measures such as ivermectin distribution and vector control programs. Continued monitoring is essential to confirm the interruption of transmission and to ensure that the disease remains under control.

Studies have shown that integrated vector management (IVM) combining insecticide spraying, environmental management, and community-based interventions can significantly reduce vector populations and interrupt disease transmission (WHO, 2010 and WHO, 2023. Furthermore, WHO, 2023 opined that Climate change and environmental modifications can alter the habitat and life cycle of *S. damnosum*, potentially impacting their

population dynamics and the risk of onchocerciasis transmission . The ongoing surveillance is critical to detect any resurgence in fly infectivity, especially in areas where onchocerciasis was previously endemic. The World Health Organization, (2023) emphasizes the importance of robust entomological monitoring in post-treatment surveillance to ensure sustained interruption of transmission.

CONCLUSION

This study has established that the 20 years of ivermectin administration in the study area has resulted in a small prevalence of clinical manifestations of Onchocerciasis., which is better exemplified by the over 90 reductions in the nodule rate from 25 pre-control rates. There was no current transmission as the black fly dissected did not reveal microfilaria neither did the individuals harbour *onchocerciasis volvulus* antibodies. This observation affirm the success of mass drug administration of ivermectin in the the elimination of the disease as a public health burden.

ACKNOWLEDGEMENT

This research was funded by Tertiary Trust Fund (TEDFUND) Institutional research project intervention grant, TETF/DR&D/CE/UNI/IMO/IBR/2020/VOL. 1.

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