ENDEMICITY OF ONCHOCERCIASIS IN SOME COMMUNITIES IN TARABA STATE, NIGERIA, FOLLOWING LONG-TERM TREATMENT WITH IVERMECTIN

IDOWU, E.T.,[1]* **ADENEYE, A.K.,**[2] **ADELEKE, M.A.,**[3] **SULYMAN, M.A.**[2] and **MAFE, M.A.**[2]

[1]Department of Zoology, University of Lagos, Akoka, Lagos, Nigeria
[2]Public Health Division, Nigerian Institute of Medical Research, P.M.B. 2013 Yaba, Lagos, Nigeria
[3]Department of Biological Sciences, Osun State University, Osogbo, Osun State, Nigeria

*Corresponding author: *eidowu@unilag .edu.ng, etidowu@yahoo.com*

Abstract

This study examined the effect of long term annual ivermectin mass distribution on morbidity status and factors related to the drug distribution programme. Semi-structured questionnaire, focus group discussions and household survey methods were employed to elicit response on key issues of the control programme in four communities of two endemic Local Government Areas (LGAs), Ardo Kola and Gashaka, in which annual mass ivermectin distribution had been on-going for over a decade in Taraba State, Nigeria. Rapid assessment method was also employed in determining morbidity status. The investigations revealed that Barki Dutse and Sibre communities of Ardo Kola LGA were hypoendemic with nodular rate of 2% while Nyambar and Jimtari communities of Gashaka LGA were mesoendemic, with nodular rate of 26% and 22% respectively and 73.3% of those surveyed claimed to have received ivermectin treatment during the last treatment exercise, with a higher percentage in Gashaka LGA ($p<0.05$). Most (85.2%) of the respondents (89.0% in Gashaka LGA and, 81.8% in Ardo Kola LGA) reported disruption in the annual drug distribution in the communities during some years. Nonetheless, majority (79.4%) of the respondents had positive perception of the control programme. It is suggested that sustainability of the annual drug distribution is essential for effective control of the disease in these rural communities.

Keywords: onchocerciasis, long term treatment, community perception.

Introduction

Human onchocerciasis caused by *Onchocerca volvulus* and transmitted by the vector*, Simulium damnosum,* is a severely debilitating disease which constitutes one of the major public health problems in 37 countries, 28 of which are found in Africa (WHO, 1995). The disease is characterized by dermal abnormalities and it is one of the leading causes of blindness in the world (Awadzi *et al* 2004). About 17 to 18 million people are affected by the disease worldwide and over 123 million people are at the risk of the infection (CDC, 2006; Maikaje *et al* 2008). Nigeria has the largest number of affected people, accounting for about a third of the global disease burden (Oyibo and Fagbero-Beyioku, 2004; Opara *et al* 2008).

In the past, the thrust of the disease control was on vector control through Onchocerciasis Control Programme (OCP) (WHO, 1994). Aerial larviciding of potential breeding sites resulted in huge success in reducing the public health significance of the disease (Hodgkin *et a*l 2007). However, the high cost of this approach led to a search for other options such as chemotherapy (Diawara *et al* 2009). The discovery of suitability of ivermectin for human use and its effectiveness against the microfilariae led to its free donation for mass treatment of affected communities and the establishment of the African Programme for Onchocerciasis Control (APOC).

Textflow Limited

Several studies have demonstrated the effectiveness of ivermectin against *O. volvulus* in a number of countries (Remme, 1989; Dadzie *et al* 1991; Collins *et al* 1992; Alley *et al* 1994; Opara *et al* 2007; Njepuome *et al* 2009). The first report on the feasibility of eliminating onchocerciasis through ivermectin distribution has been documented in Mali and Senegal (Diawara *et al* 2009). However socio-cultural factors that may affect distribution, such as acceptance and compliance, limit the extrapolation of this result to other endemic areas (Onwujekwe *et al* 2000).

According to APOC, long term mass administration of ivermectin (a microfilaricide) is required for about 15 years, which corresponds to the approximate life span of the adult worm. Other logistics are however attached to successful distribution of the drug, some of which are distribution costs and prompt accountability for previous drug supply to guarantee future supply. The need for evaluation of the long term annual ivermectin administration on disease burden in the affected communities cannot be overemphasized to determine programme success and enable identification of challenges to be addressed.

Impact assessment of ivermectin use in onchocerciasis control include evaluation of changes in clinical and parasitological profile among adults and children under five and the determination of the infectivity of *Simulium* vector (Alley *et al* 1994; Boussinesq *et al* 1995; Awadzi *et al* 2004; Opara *et al* 2005; Hodgkin 2007 and Diawara *et al* 2009). The use of skin biopsy has been a subject of ethical criticism due to the problem of HIV/AIDS and the pains of skin snipping. Strong correlation has been reported between skin snips and nodular rate for forest zones of southern Cameroon and Nigeria (Kollo *et al* 1995, Adeyeba and Adegoke, 2002), which makes use of nodular rate acceptable for evaluation.

Taraba State has been one of the endemic *foci* of onchocerciasis in Nigeria, with high prevalence of blindness and other complications associated with onchocerciasis (Akogun, 1992). Endemic communities of the state had been on annual ivermectin treatment since 1995. It is envisaged that long term chemotherapeutic intervention should, with time and continuous good coverage (>65%), protect the affected individuals from developing blindness and severe skin manifestations and decreased transmission.

This study was carried out to assess the effect of the long term annual ivermectin mass administration on status of onchocerciasis in communities of Taraba State, Nigeria, and factors related to the distribution programme.

Materials and methods

The study was carried out in four communities of two endemic Local Government Areas (LGAs) of Taraba State, located in north-eastern Nigeria. Taraba State had been classified, through Rapid Epidemiological Mapping of Onchocerciasis (REMO), as one of the endemic States in Nigeria qualified for mass ivermectin distribution.

The two endemic Local Government Areas (LGAs), Ardo Kola and Gashaka were randomly selected based on the existing REMO and Community Directed Treatment with Ivermectin (CDTI) records obtained at the State Ministry of Health. Ardo Kola LGA is located to the north of the state at approximately 40 km away from the state capital while Gashaka LGA, to the south-east is some 300 km away. In each LGA, two communities were selected using simple random sampling. In each of the selected communities, 120 respondents were selected using systematic random sampling technique. The list of households in the onchocerciasis treatment book for each community was used as the sampling frame. Of the expected 480 respondents from the study communities, only 345 consented to be interviewed thus giving a response rate of 71.9%. The following communities were selected; Jimtari and Nyambar in Gashaka LGA and, Sibre and Barki Dutse in Ardo Kola LGA.

Populations of the study communities were predominantly farmers who depended on the surrounding fast flowing rivers and streams, which breed *S. damnosum,s.l.,* vector of onchocerciasis, for various needs such as irrigation, fishing, drinking and other domestic activities.

Advocacy

The four communities were informed and mobilized for the study by the Onchocerciasis Control Program Coordinator of the State Ministry of Health. The inform-consent form was read to each study participant and the details of the study were explained to the participants in their local language through the State Ministry of Health. The consented participants were requested to sign the form, and the head of each community signed on behalf of the community.

Clinical assessment of onchocerciasis morbidity

Rapid Assessment Method (RAM), (Ngoumou and Walsh, 1993) was used to assess onchocerciasis morbidity. Fifty consented male subjects, aged 20 years and above and residents of each selected community for at least 10 years, were examined in a secluded

area, using method described by Murdoch *et al* (1993) for clinical manifestations of onchocerciasis; skin disfigurement, atrophy and other skin complications. Each participant was palpated for nodules and, ability to count fingers at a distance of 3 meters was used to determine blindness (WHO, 1994). The name, age, occupation and other demographic data of each participant were recorded.

Assessment of the community perception of the annual mass ivermectin administration

Semi-structured questionnaires designed to elicit response on key distribution issues and the drug, were used to collect data on the perception of community members on the ivermectin distribution in the community. The questionnaires were administered to a total of 120 participants, aged 15 years and above, randomly selected in each community. The questionnaire probed into the background characteristics of respondent such as age, level of education, and sex. Questions that probed knowledge and perception of existing onchocerciasis control programme in the communities, whether the respondents were treated or not during the last mass treatment exercise, the number of ivermectin tablet received, side effects experienced after treatment, perceived success and problems of the programme implementation and opinion on how the implementation of the programme can be improved upon when asked. Three Focus Group Discussions (FGD), adult men, adult women and youths with each group comprising 5-7 participants were held in each study community. Interviews were also held with State and Local Government Onchocerciasis Control Programme Coordinators as well as with community health workers involved in the distribution of ivermectin, to investigate opinions on the drug distribution in the community and on the perceived effect of the drug at reducing morbidities resulting from onchocerciasis.

Ethical clearance

Ethical approval was obtained for the research protocol from the Nigerian Institute of Medical Research Yaba, Lagos Institutional Review Board (NIMR-IRB) with reference number IRB/09/086b.

Statistical analysis

The results obtained were subjected to statistical analysis using *SPSS Package* and *Epi Info Version 6.0*.

Results

Onchocerciasis endemicity

Based on the WHO guideline, Nyambar and Jimtari communities in Gashaka LGA are still mesoendemic while Barki Dutse and Sibre communities in Ardo Kola LGA were hypoendemic for onchocerciasis (Table 1). The prevalence of skin and lymphatic manifestations were generally very low; 3.5%, 1.0% and 0.5% were recorded for atrophy, *ingunia femora* hernia and acute papular onchodematitis respectively. There was no lymphodema, hanging groin and chronic papular onchodematitis. Blindness rate was 1%.

Table 1. Nodular and leopard skin rates for communities qualified and not qualified for ivermectin treatment.

Local Government Area	Community	Study Data 2009		†Remo Results 1994/ 1997		††*Qualification for ivermectin distribution according to WHO guideline
		Nodular Leopard Rate Skin Rate		Nodular Leopard Rate Skin Rate		
Gashaka	Nyambar	26	1	22	1	Qualified
	Jimtari	22	0	17	1	Qualified
Ardo Kola	Barki Dutse	2	0	7	0	Not Qualified
	Sibre	2	0	20	0	Not Qualified

†Rapid epidemiological mapping data for Gashaka LGA was obtained in 1994 and for Ardo Kola LGA in 1997.
††Criteria for mass treatment: Urgent: leopard skin rate 20%; nodular rate 40%. Highly desirable leopard skin rate 20%; nodular rate 20-30% (WHO, 1992)
*Endemicity status: Hyperendemic; >39% nodular rate, Mesoendemic; 20-39% nodular rate, Hypoendemic; <20% nodular rate.

Community knowledge and perception of the annual mass ivermectin administration, socio-demographic characteristics of respondents

The socio-demographic characteristics of the respondents are presented in Table 2. A larger number (70.4%) of the respondents interviewed were males while 29.6% were females. More respondents (52.5%) were from Ardo Kola LGA and 47.5% were from

Table 2. Socio-demographic characteristics of respondents in communities of Gashaka and Ardo Kola LGAs.

Sex	Gashaka			Ardo Kola			Grand Total
	Jimtari	Nyambar	Total	Sibre	Barki	Total	
Male	71 (66.4)	36 (33.6)	107 (44.0)	72 (52.9)	64 (47.1)	136 (56.0)	243 (70.4)
Female	29 (50.9)	28 (49.1)	57 (55.9)	6 (13.3)	39 (86.7)	45 (44.1)	102 (29.6)
Total	100 (61.0)	64 (39.0)	164 (47.5)	78 (43.1)	103 (56.9)	181 (52.5)	345 (100.0)
Age (in years)							
< 20	12 (100.0)	0 (0)	12 (63.2)	2 (28.6)	5 (71.4)	7 (36.8)	19 (5.5)
20-29	20 (48.8)	21 (51.2)	41 (42.3)	32 (57.1)	24 (42.9)	56 (57.7)	97 (28.1)
30-39	18 (45.0)	22 (55.0)	40 (40.4)	21 (35.6)	38 (64.4)	59 (59.6)	99 (28.7)
40-49	18 (50.0)	18 (50.0)	36 (55.4)	13 (44.8)	16 (55.2)	29 (44.6)	65 (18.8)
50-59	8 (72.7)	3 (27.3)	11 (45.8)	6 (47.2)	7 (53.8)	13 (54.2)	24 (7.0)
60+	24 (100.0)	0 (0)	24 (58.5)	4 (23.5)	13 (76.5)	17 (41.5)	41 (11.9)
Total	100 (61.0)	64 (39.0)	164 (47.5)	78 (43.1)	103 (56.9)	181 (52.5)	345 (100.0)
Education							
No formal education	15 (62.5)	9 (37.5)	24 (40.7)	17 (48.6)	18 (51.4)	35 (59.3)	59 (17.1)
Primary	25 (65.8)	13 (34.2)	38 (45.2)	30 (65.2)	16 (34.8)	46 (54.8)	84 (24.3)
Secondary	8 (100.0)	0 (0)	8 (57.1)	2 (33.3)	1 (66.7)	6 (42.9)	14 (4.1)
Tertiary	38 (48.7)	40 (51.3)	78 (50.3)	24 (31.2)	53 (68.8)	77 (49.7)	155 (44.9)
No response	14 (87.5)	2 (12.5)	16 (48.5)	5 (29.4)	12 (70.6)	17 (51.5)	33 (9.6)
Total	100 (61.0)	64 (39.0)	164 (47.5)	78 (43.1)	103 (56.9)	181 (52.5)	345 (100.0)

Gashaka LGA. Their ages ranged from 13 to 70 years with a mean age of 36.5 years and a median age of 33 years. Two hundred and fifty-three (73.3%) of the respondents had formal education with 49.0% having a minimum of secondary education while 24.3% had primary education. On the other hand, 17.1% of the respondents had no formal education at all and 9.6% did not respond.

Respondents' knowledge of annual mass ivermectin administration

Onchocerciasis control programme was reported by the respondents to have been on-going in the communities between 3 to 19 years with an average and a median of 10 years respectively. Most (85.2%) of the respondents (89.0% Gashaka LGA vs. 81.8% Ardo Kola LGA) reported that there were years that the ivermectin distribution did not take place in their communities while 4.9% disagreed and 9.9% were undecided.

Overall, 73.7% of respondents were treated with ivermectin during the last treatment. Statistical test using ANOVA showed that more people in Gashaka LGA (92.7%) were treated with ivermectin during the last treatment exercise than in Ardo Kola LGA (55.8%) Figure 1. The odds ratio of 10.03 has a 95% confidence interval of 4.98-20.63, and *chi*-square with Yates correction is 57.98 with a p-value < 0.05.

Of the two hundred and fifty-three respondents treated with ivermectin during the last treatment exercise, 94.5% recalled taking the number of tablets that ranged between 1 to 5 with a mean of 3.4 tablets and a median of 4 tablets. Statistical test using ANOVA showed that more people in Gashaka LGA received more tablets with an average of 4 tablets compared to those in Ardo Kola LGA who received an average of 3 tablets ($\chi^2 = 29.40$, $df = 1$, $p < 0.05$).
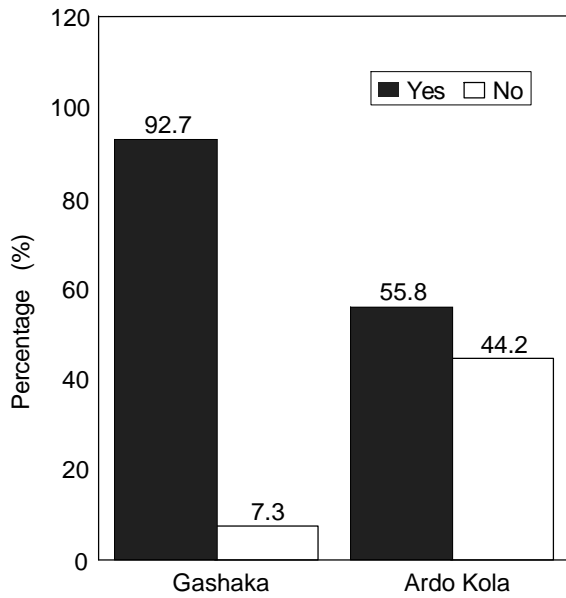
Figure 1. Distribution of respondents treated with ivermectin in Gashaka and Ardo Kola Local Government Areas.

The reasons given by the ninety-two respondents that were not treated with ivermectin during the last treatment exercise are presented in Table 3 showing that most (38.0%) claimed they were not around during the last treatment exercise. Though it would appear that a high coverage rate was achieved, based on respondents' claim, the 25.0% that did not receive the drug in the mass treatment exercise should be a matter of concern for future improvement to ensure higher coverage rate.

Table 3. Reasons for not being treated with ivermectin during the last treatment exercise.

Reasons	Number	Percentage
My father did not allow me to take it	16	17.4
Fear of side effects	5	5.4
The drug is not good	23	25.0
I was not around	35	38.0
Undecided/no reason	13	14.1
Total	92	100.0

On the contrary, there was no significant gender difference attainment ($\chi^2 = 2.00$, *df* =1, *p*>0.05) among those that received ivermectin during the last treatment exercise as illustrated in Figure 2. Similarly, there was no significant difference in level of educational attainment ($\chi^2 = 5.17$, *df* = 3, *p*>0.05) among those that received ivermectin and those that did not. Also,

there was no significant difference in age among those that received ivermectin and those that did not as those treated had an average age of 36.5 years compared to 36.6 years among those not treated ($\chi^2 = 0.79$, *df* =1, *p*>0.05).

Perceived success of the long term treatment with ivermectin.

A larger number (79.4%) of the respondents had positive perception about the success of the onchocerciasis control programme in the locality (Table 4).

Table 4. Perception of onchocerciasis control programme.

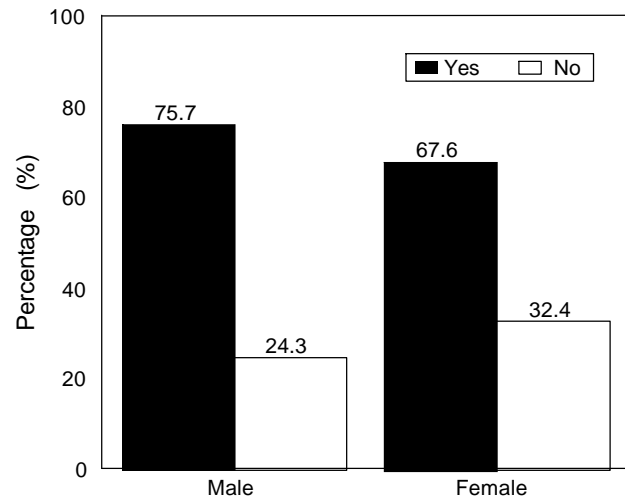| Perception	Number	Percentage
Good: drug is good, programme is successful; has helped reduced blindness	274	79.4
Undecided	71	20.6
Total	345	100.0

Figure 2. Overall sex distribution of respondents in communities of Gashaka and Ardo Kola Local Government Areas according to individuals that receive ivermectin in the last treatment exercise.

When the respondents were asked if there were problems militating against the implementation of the onchocerciasis control programme in their locality, most (87.0%) were affirmative, 11.9% were of contrary opinion and, 1.2% were indifferent. Statistical test showed that LGA of residence significantly influenced

respondents' opinion of whether there are problems militating against the implementation of the onchocerciasis control programme in their locality as illustrated in Figure 3 (χ^2 = 11.07, *df* =2, *p*<0.05). A larger number (90.0%) of the respondents did not disclose the problems perceived to be militating against the implementation of the onchocerciasis control programme in their locality. However (6.0%) did mention irregular annual drug distribution while (4.0%) had experienced side effects from taking the drug.
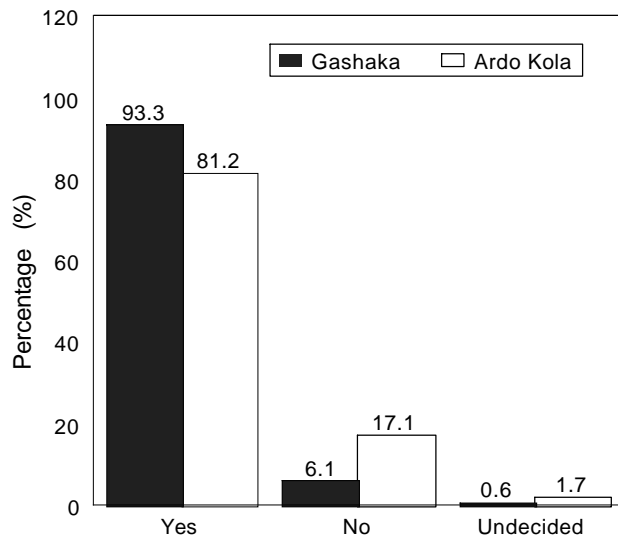

Figure 3. Perception of implementation problems among respondents in Gashaka and Ardo Kola Local Government Areas.

The general opinion of the respondents on how the implementation of the programme can be improved upon in the communities revolves around the perceived need to motivate the community drug distributors (CDDs) through provision of incentives to retain their interest and commitment. Majority (76.8%) of the respondents suggested that government should motivate CDDs by providing them money and means of transport to enhance their distribution activities in the community. While some (9.6%) of the respondents were of the view that more drugs should be supplied to reach the people, others (13.6%) were undecided.

Discussion

The results of this study show that the two communities in Gashaka LGA; Nyambar and Jimtari are still mesoendemic for onchocerciasis while Barkin Dutse and Sibre in Ardo Kola LGA are now hypoendemic based on WHO (1992) suggested criteria for large scale ivermectin treatment, following 10 years of ivermectin distribution in these study communities. The variation

observed in the level of endemicity after repeated treatment may be associated with coverage pattern and drug compliance at Barki Dutse and Sibre in Ardo Kola LGA hence the reduction in disease morbidity was also observed by Boussinesq *et al* (1995) in Northern Cameroon, Opara *et al* (2007) in Lower Cross River Basin and Diawara *et al* (2009) in Mali and Senegal. The maintained mesoendemic status of onchocerciasis at Nyambar and Jimtari communities in Gashaka LGA could be a reflection of discontinuous annual drug distribution, poor drug coverage and compliance. The drug coverage and compliance could have been influenced by many factors amongst which is proximity to the drug collection centre, prompt management of side effects experienced from taking the drug, level of awareness (Opara *et al* 2008). The closeness of Ardo Kola LGA (40 km) to the state capital could account for timely collection of the drug from the state capital and regular administration in the affected communities unlike Gashaka LGA (300 km) in which the coordinator needs to travel several kilometers to obtain the drug. This most often, could only be achieved by a dedicated personnel.

The non availability of information in pre-control period and the refusal of the residents to subject themselves to skin snipping due to scars and pain claimed to have been sustained as a result of past snipping are major limitations observed in this study. Therefore estimation of the individual and community microfilarial loads coupled with the infection rate in children under 5 could not be determined.

The general low skin depigmentation and lymphatic lesions observed in this study is in agreement with previous studies (WHO, 1995; Adewale *et al* 1997; Idowu *et al* 2004). The low blindness rate observed is remarkable since communities along Taraba Valley had earlier been regarded as the worst onchocerciasis focus with high rate of blindness in Nigeria (Akogun, 1992). The low blind rate may have resulted from cumulated effects of ivermectin usage in the study communities (Hodgkin *et al* 2007).

The questionnaire survey revealed that majority of the eligible people in the study communities were treated recently at the time of the survey. The appreciable proportion (26.7%) of those eligible for treatment who claimed to have missed treatment over time, erode the gains of ivermectin distribution (Onwujekwe *et al* 2000; Awadzi *et al* 2004). These people serve as reservoirs of the parasite and active transmission could be experienced in such communities where the potential vectors are available. Public health education and constant monitoring and quick response to the adverse effects mentioned by these respondents

are vital in ensuring continued compliance. The admittance of the success of ivermectin at reducing onchocerciasis morbidity by the respondents is remarkable and this could have influenced the high coverage (over 70%) in the last treatment exercise. Constant motivation of the Community Directed Distributors (CDDs) through incentives and provision of transportation as posited by the respondents will help to retain distribution interest and commitment to distribution in the study communities.

The findings in this study show that there were years that ivermectin distribution did not hold in the study communities as attested to by more of respondents from (Nyambar and Jimtari) Gashaka LGA than those from (Barki Dutse and Sibre) Ardo Kola LGA. It therefore becomes imperative that for effective control of onchocerciasis to be achieved in these endemic study areas, there is the essential need for consistent implementation of annual mass treatment of the affected communities.

It is encouraging that a large number of the respondents had positive perception about the success of the onchocerciasis control programme in their locality. This result provides an optimistic foundation for launching and planning promotional programmes that will de-emphasise side effects of the drug and emphasise on the benefits of the mass treatment exercise in the study area.

In conclusion, the results of this study have revealed the current status of onchocerciasis endemicity in the study communities after long-term repeated treatment with ivermectin. The disease morbidity rate as observed in this study, in the two communities in Ardo Kola LGA which changed from meso- to hypo-endemicity shows that these communities no longer require mass drug distribution but passive treatment for which availability of ivermectin must be assured at the peripheral health facilities. However, onchocerciasis morbidity remains unchanged in the two communities at Gashaka LGA which calls for more organized and uninterrupted mass distribution in the area. Moreover, proper orientation of the residents of the communities on the gains of ivermectin and strengthening of local health officers and CDDs at the affected communities are also required as a matter of urgency to maintain the gains of this long-term drug distribution on the health of the people.

References

Adewale, B., Mafe, M.A. and Oyerinde, J.P.O. 1997. Onchocerciasis in the forest zone of Ondo State, Nigeria. *Nigerian Journal of Medical Research, 1(3 and 4),* 70-73.

Adeyeba, OA. and Adegoke, A.A. 2002. Onchocerciasis in communities in forest zone, south-west Nigeria: Prevalence and diagnostic method for rapid assessment. *African Journal of Clinical and Experimental Microbiology, 3(1):* 29-32.

Akogun, O.B. 1992. Eye lesions, blindness and visual impairement in the Taraba River Valley Nigeria and their relation to onchocercal microfilaria in the skin. *Acta Tropica, 51(2):*143-149.

Alley, E.S., Plaisier, A.P., Boatin, B. A., Dadzie, K.Y., Remme, J., Zerbo, G. and Samba, E.M. 1994. The impact of five years of annual Ivermectin treatment on skin microfilarial loads in the onchocerciasis-focus of Asubende, Ghana. *Transaction of Royal Society of Tropical Medicine and Hygiene,* 88:581-584.

Awadzi, K., Boakye, D. A., Edwards, G., Opoku, N. O., Attah, S. K., Osei-Atweneboana, M.Y., Lazdins-Helds, J.K., Ardrey, A.E., Addy, E.R., Quartey, B.T., Ahmed, K., Boatin., B.A. and Soumbey-Alley, E.W. 2004. An investigation of persistent microfilaridermiasis despite multiple treatments with Ivermectin in two onchocerciasis-endemic *foci* in Ghana, *Annals of Tropical Medicine and Parasitology, 98(3):* 231-249.

Bousinnesq, M., Chippaux, J.P., Ernould, J.C., Quillevere, D and Prod-Hon, J. 1995. Effect of repeated treatments with Ivermectin on the incidence of onchocerciasis in Northern Cameroon. *American Journal Tropical Medicine and Hygiene, 53(1):* 63-67.

CDC. 2006. Onchocerciasis and other parasitic diseases, *Parasitic Diseases Information,* pp. 1-4.

Collins, R.C., Gonzales-Peralta, C., Castro, J., Zea-Flores, G., Cupp, M.S., Richards, F.O. and Cupp, E.W. 1992. Ivermectin: Reduction in prevalence and infection intensity of *Onchocerca volvulus* following biannual treatments in five Guatemalan communities, *American Journal Tropical Medicine and Hygiene 47:* 156-169.

Dadzie, K.Y., Remme, J and De Sole, G. 1991. Changes in ocular onchocerciasis after two rounds of community-based Ivermectin treatment in a holo-endemic onchocerciasis focus. *Transaction of Royal Society of Tropical Medicine and Hygiene, 85*:267-271.

Diawara, L., Traoré, M. O., Badji, L., Bissan, Y., Doumbia, K., Goita, S.F., Konaté, L., Mounkoro, K., Sarr, M.D., Seck, A.F., Toé, L., Tourée., S and Remme., J.H.F. 2009. Feasibility of Onchocerciasis Elimination with Ivermectin Treatment in Endemic *Foci* in Africa: First Evidence from Studies in Mali and Senegal *Plos Neglected Tropical Diseases, 3(7):* 1-4.

Hodgkin, C., Molyneux, D. H., Abiose A., Philippon, B., Reich, M. R., Remme, J. H., Thylefors, B., Traore, M and Grepin, K. 2007. The future of onchocerciasis control in Africa, *Plos Neglected Tropical Diseases, 1(1):* 1-4.

Idowu, E.T. 2004. Epidemiological clinico-parasitological and control studies of onchocerciasis in selected communities of Ondo State. Ph.D Thesis, University of Lagos, Nigeria, p. 282.

Kollo, B., Mather, F.J. and Cline, B.L. 1995. Evaluation of alternate methods of rapid assessment of endemicity of *Onchocerca volvulus* in communities in southern Cameroon. American *Journal Tropical Medicine*

Hygiene, 53(3): 243-247.

Maikaje, D.B., Danguma, P.G., Domo, A., Mbmkar., D.L. Malguri., M.M and Elihu, A. 2008. Investigating suspected human onchocerciasis endemic *foci* in Mubi North and Hong Local Government Areas of Adamawa State, Nigeria. *Nigerian Journal of Parasitology,* 29:72-76.

Murdoch, M. E., Hay, R.J., Mackenzie, L. D., William, J. F., Ghalib, H. W., Coussens, S., Abiose, A. and Jones, B.R. 1993. A clinical classification and grading system of cutaneous charges in onchocerciasis. *British Journal of Dermatology, 129,* 260-269.

Ngoumou, P and Walsh, J.F. 1993. Rapid Epidemiological Mapping of Onchocerciasis. TDR/TDE/ONCHO/93.4: World Health Organization, Geneva..

Njepuome, N.A., Hopkins, D.R., Richards, F.O. Jr., Anagbogu, I.N., Pearce, P.O,, Jibril, M.M. 2009. Nigeria's war on terror: Fighting dracunculiasis, onchocerciasis, lymphatic filariasis, and schistosomiasis at the grassroots. *American Journal Tropical Medicine and Hygiene, 80(5):* 691-8.

Onwujekwe, O.E., Shu, E.N., Ndum, C.C. and Okonkwo, O.P. 2000. Treatment with Ivermectin: What works in one community may not work in another. *Journal of Epidemiology and Community Health, 54,* 79-80.

Opara, K.N., Fagbemi, O.B., Ekme A and Okemu, M.D. (2005). Status of forest onchocerciasis in lower cross River Basin Nigeria: Entomologic profile after five years of Ivermectin intervention. *America Journal of Tropical Hygiene, 73(2)*, 371–376.

Opara, K.N., Fagbemi, B.O., Atting, I.A., Oyene, U.E and Okenu, D.M.N. 2007. Status of forest onchocerciaisis in the Lower Cross River Basin, Nigeria: Change in clinical and parasitological indices after 6 years of Ivermectin intervention. *Public Health, 121,* 202-207.

Opara, K.N., Usip, L.P and Akpabio, E.E. 2008. Transmission dynamics of onchocerciasis in rural communities of Akwa Ibom State, Nigeria. *Journal of Vector Borne Disease, 45,* 225-230.

Oyibo, W.A. and Fagbenro-Beyioku, A.F. 2004. Effect of repeated community based Ivermectin treatment on the intensity of onchocerciasis in Nigeria. *Rur Rem Health J. 3:* 211-216.

Remme, J., Baker, R.H.A., De Sole, G., Dadzie, K.Y., Walsh J.F., Adams, M.A., Alley E.S and Avissey, H.S.K. 1989. A community trial of Ivermectin in the onchocerciasis-focus of Asubende, Ghana: Effect of the microfilarial reservoir and the transmission of *Onchocerca volvulus. Tropical Medicine and. Parasitology, 40,* 367-374.

WHO. 1992. Methods for community diagnosis of onchocerciasis to guide ivermectin–based control in Africa. TDR/TDE/ONCHO/93.2 Geneva: WHO.

WHO. 1994. 25 years of Onchocerciasis Control Programme in West Africa, *WHO Report.* Geneva, 235pp.

WHO. 1995. Onchocerciasis and its control: Report of a WHO Expert Committee on Onchocerciasis control. *WHO Technical Report Series 852,* WHO, Geneva.

WHO. 1987. Expert committee on Onchocerciasis. *Technical Report Series, 752:* 165pp.