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Access to Safe Water - A way to Mitigating Onchocerciasis in Nigeria

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Abstract
Onchocerciasis is a major cause of blindness in many African countries and Nigeria is not an exception. The vector transmitting the disease abounds in fertile riverside areas. Attempts have been made in fighting the disease through control of the vector and use of drugs. Search for preventive alternatives is the main objective of this paper. The paper uses the 2008 Nigeria Demographic and Health Survey data, a cross-sectional national data. The analysis is household based. This paper examines households that are likely to have incidence of Onchocerciasis. Onchocerciasis has in the past greatly reduced the economic productivity and as such exacerbate poverty. Chi-Square tests and T-tests were statistical tools used by the paper. The results show that there exists a regional variation in the incidence of Onchocerciasis across the country (X^2= 925.71, p=0.000). The paper also found that there is a significant difference in incidence of Onchocerciasis by wealth index (X^2= 326.89, p=0.000). Households with river as source of water are significantly more likely to have Onchocerciasis than those that river is not their source. The situation is more precarious in the rural areas (X^2= 250.09, p=0.000). Households with river as source are more likely to have more members with Onchocerciasis (t=11.79, p=0.000). The provision of safe water to households especially in the rural areas is a sure alternative to mitigating onchocerciasis.
Keywords: Water, Onchocerciasis, River Blindness, Nigeria

1. Introduction

Water is very essential to life. There is virtually nothing that human beings do that does not require or involve water. Human beings makes use of water in the preparation of meals, and water is necessary to quench thirst. The issue of water especially improved drinking water is part of Millennium Development Goal (MDG) 7 (ensuring environmental sustainability (National Population Commission and ICF International, 2014). The dangers human are exposed to makes the importance of water pertinent. Onchocerciasis is a communicable parasitic disease (Mboera, 2010). It is one of the Neglected Tropical Diseases (NTD). There have been numerous efforts at controlling onchocerciasis, nevertheless, there are still incidences of the disease. This necessitates the need to devise other means of mitigating against the disease. Indeed there are ooptimism about the global eradication of river blindness.

The socio-economic and psychological consequences of the disease are enormous: blind victims are unable to work or care for their families, and those with skin disease suffer symptoms that make it difficult to lead a normal life. As blackflies lay their eggs in fast moving rivers and streams along fertile riverbanks, these areas are often abandoned for fear of contracting the disease. People move to less productive ground, disrupting agricultural production and threatening food security.

Nigeria carries the highest burden and diversity of neglected tropical diseases (NTDs) in sub-Saharan Africa (Okorie, Bockarie, Molyneux, & Kelly-Hope, 2014). Onchocerciasis is one of the five most prevalent neglected tropical diseases in the world, and each is frequently treated with mass drug administrations (Keenan, Hotez, Amza, Stoller, Gaynor, Porco, & Lietman (2013). Onchocerciasis is a disease affecting millions of people in Africa, South and Central America, and Yemen (Babalola, 2011). It is spread by the blackfly as a vector and caused by the filarial nematode, Onchocerca volvulus. (Convit, Schuler, Borges, Olivero, Domínguez-Vázquez, Frontado, & Grillet, 2013). Onchocerciasis (river blindness) is caused by the parasitic worm Onchocerca volvulus, transmitted to humans by the bite of infected black flies of the genus Simulium, and is characterized by chronic skin disease, severe itching, and eye lesions that can progress to complete blindness (CDC, 2013). Onchocerciasis is endemic in Nigeria (Evans, McFarland, Adamani, Eigege, Miri, Schulz & Richards, 2011).

Approximately 123 million persons are at risk for Onchocerciasis infection in 38 endemic countries with at least 25.7 million infected, and 1 million are blinded or have severe visual impairment (CDC, 2013). Onchocerciasis causes a considerable disease burden in Africa, mainly through skin and eye disease. According to Okanlawon and Osanyintolu (2012), about 33 million Nigerians are at risk of onchocerciasis.

Ivermectin has been used to control onchocerciasis as a public health problem in Africa (Pion, Nana-Djeunga, Kamgno, Tendongfor, Wanji, Njiokou & Boussinesq (2013). Since 1995, the African Programme for Onchocerciasis Control (APOC) has coordinated annual mass treatment with ivermectin (Coffeng, .Stolk, Zoure,

Veerman, Agblewonu, Murdoch & Amazigo, 2013). APOC has been working with ultimate goal of reducing the public health and socio-economic problems associated with onchocerciasis within a period of 12-15 years (Weldegebreal, F., Medhin, G., Weldegebriel, Z., & Legesse, M. (2014).

Mass treatment with ivermectin controls onchocerciasis as a public health problem, but it was not known if it could also interrupt transmission and eliminate the parasite in endemic foci in Africa where vectors are highly efficient (Traore, Sarr, Badji, Bissan, Diawara, Doumbia, Goita, Konate, Mounkoro, Seck, Toe, Toure, & Remme, 2012). It has been proposed that switching from annual to biannual (twice yearly) mass community-directed treatment with ivermectin (CDTI) might improve the chances of onchocerciasis elimination in some African foci (Turner, Osei-Atweneboana, Walker, Tettevi, Churcher, Asiedu, Biritwum, & Basáñez, M.-G., 2013; Turner, Walker, Churcher, Osei-Atweneboana, Biritwum, Hopkins, Prichard, & Basáñez, 2014).

Biannual treatment yields only small additional health gains, its benefit is pronounced in the context of the elimination goals, shortening the time frames for and increasing the feasibility of reaching the proposed operational thresholds for stopping treatment (Turner, *et. al.*, 2014). It may not always be feasible to implement biannual treatment, particularly in hard-to-reach populations (Turner, *et. al.*, 2014). This is not true with the provision of portable water.

The impact of control and elimination programmes by mass drug administration (MDA) targeting onchocerciasis and lymphatic filariasis (LF) in sub-Saharan Africa over the last two decades has resulted in significantly reduced prevalence and intensity of infection, with some areas interrupting transmission (Molyneux, Hopkins, Bradley, & Kelly-Hope, 2014).

According to Higazi, Zarroug, Mohamed, Elmubark, Deran, Aziz, Katabarwa, Hassan, Unnasch, Mackenzie, Richards & Hashim, (2013). Long-term community-directed treatment with ivermectin (CDTI) alone can interrupt transmission of onchocerciasis. Periodic, communitywide mass drug administration (MDA) with ivermectin (Mectizan, Merck) prevents eye and skin disease and might interrupt transmission of the infection, depending on the coverage, duration, and frequency of MDA (CDC, 2013). While there might be some level of success in fighting onchocerciasis, there is the need to worry about the issue of drug resistance. Drug resistance was thought to be a major limitation of mass drug administrations for all five neglected tropical diseases (Keenan, *et. al.,* (2013). Over the years the control of onchocerciasis has relied on the mass drug administration to the at-risk communities (Convit *et. al.,* 2013).

In the words of Molyneux, *et. al.*, (2014), there are some communities in which ivermectin cannot be safely administered due to the risk of serious adverse events and therefore makes pertinent the need for an alternative strategy to combat onchocerciasis. The drugs that were used before ivermectin were found to be toxic and unsuitable for mass distribution, in particular, they precipitate optic nerve disease (Babalola, 2011). The fact that the producers of ivercmetin are willing to distribute the drug for as long as needed is no reason why alternatives cannot be explored. The problem with ivermectin is that it is a monotherapy microfilaricide which has limited effect on the adult worm, and thus will need to be continued for the life span of the adult worm, which may last up to 15 years (Babalola, 2011). There are also early reports of resistance

Although mass drug administration of ivermectin has had a profound effect on control of the disease, additional tools are critically needed (Hess, Zhan, Bonne-Année, Deckman, Bottazzi, Hotez, Klei, Lustigman, and Abraham, 2014). According to Awadzi et al (2014) new tools are needed to achieve elimination of onchocerciasis infection. This is why alternatives should be sought to the use of drugs. The vector of the transmission of onchocerciasis thrives on water, the source of water of communities may help in breaking the chain of transmission. The simulations of Coffeng, *et.al.* (2013) suggest that APOC[1] has had a remarkable impact on population health in Africa between 1995 and 2010 and this health impact is predicted to double through to 2015. This notwithstanding, there is a need for development of novel prevention and treatment modalities, such as next-generation small molecule drugs and vaccines (Barry, Simon, Mistry, & Hotez, 2013). Empowering people with adequate health information is a good means of preventing onchocerciasis where prevalence is high (Okanlawon and Osanyintolu, 2011).

According to (Traore *et. al.*, 2012) onchocerciasis elimination with ivermectin treatment is feasible in at least some endemic foci in Africa. The need to attain the set target of eliminating onchocerciasis by 2025 has led to a shift in onchocerciasis control policy, changing from prevention of morbidity toward elimination of infection (Turner, *et. al.*, 2014). Infection elimination can be obtained if safe water is provided to the at-risk population such that they are no longer exposed to the vectors. The infection rate varied with the occupation of the study subjects, with preponderance among farmers (Dori, Belay, Belete, Panicker, & Hailu, 2012).

There is the need to understand the households that are likely to have incidence of onchocerciasis. Some of the other research questions include are there regional variations in the incidence of onchocerciasis? What effect does having river as source of water has on incidence of onchocerciasis? Does place of residence affect incidence of onchocerciasis.

[1] The African Program for Onchocerciasis Control (APOC) is a highly cost-effective public health program.

2 Method

The data for this paper is derived from the NDHS 2008. This is a nationally representative sample of more than 36,000 households. All women age 15-49 in these households and all men age 15-59. Three questionnaires were used for the 2008 NDHS, namely; the Household questionnaire, the women's questionnaire and the Men's questionnaire. The household questionnaire collected information on characteristics such as the source of water for the household among others. The data analysed in this paper is the household data subset. The sampling details are as indicated in National Population Commission (NPC) [Nigeria] and ICF Macro (2009). The NDHS 2008 is the latest nationally representative sample data that contains issues relating to onchocerciasis for the NDHS 2013 does not have the question relating to the use of drug taken for river blindness.

3 Results

Table 1: Background characteristics of households by River as source and River not Source of drinking or Non-drinking water

		River not source of drinking or Non-drinking water (N=26,946)	River as source of drinking or Non-drinking water (N=7,124)	Total (N=34,070)
Source of drinking water	Piped into Dwelling	4.4	0.0	3.5
	Public tap	8.2	0.0	6.5
	Tube well/Borehole	32.3	0.0	25.6
	Protected well/Spring	18.0	0.0	14.2
	Unprotected well/Spring	27.0	0.0	21.3
	River/Lake/Ponds/Stream	0.0	99.6	20.8
	Rainwater	3.7	0.0	2.9
	Tanker/Cart	2.3	0.0	1.8
	Bottled Water	2.4	0.4	2.0
	Other	1.8	0.0	1.4
	No Response	0.0	0.0	0.0
Source of Non-Drinking water	Piped into Dwelling	4.5	0.0	3.6
	Public tap	8.3	0.0	6.6
	Tube well/Borehole	33.4	0.0	26.4
	Protected well/Spring	18.6	0.0	14.7
	Unprotected well/Spring	27.1	0.0	21.4
	River/Lake/Ponds/Stream	0.0	100.0	20.9
	Rainwater	3.7	0.0	2.9
	Tanker/Cart	2.4	0.0	1.9
	Bottled Water	0.0	0.0	0.0
	Other	1.8	0.0	1.5
	No Response	0.1	0.0	0.1
Wealth Index	Poorest	18.8	30.9	21.3
	Poorer	17.1	29.8	19.8
	Middle	20.0	25.7	21.2
	Richer	22.1	11.9	20.0
	Richest	22.1	1.7	17.8
Geo-Political zone	North Central	16.9	24.0	18.4
	North East	16.0	16.1	16.0
	North West	22.8	8.2	19.8
	South East	12.5	10.6	12.1
	South South	13.3	25.5	15.8
	South West	18.5	15.6	17.9
Place of residence	Urban	37.4	9.0	31.5
	Rural	62.6	91.0	68.5
		100.0	100.0	100.0
		79.1	20.9	100.0

Source: Nigeria Demographic and Health Survey 2008

The results in Table 1 show that 21 percent of the households rely on river as either source for drinking or non-drinking water. The three commonest source of drinking water for households in Nigeria are Borehole, unprotected well/spring and River/Lake/Ponds/Stream (Table 1). The fact that at least one-fifth of the household rely on the river as source of their drinking water increases the chances of members of the household susceptible

to exposure to the vector responsible for onchocerciasis. About 61 percent of the households that rely on river as source of drinking or non-drinking water belong to the lower strata of the wealth quintiles, only about 13 percent of the rich households rely on river as source of drinking or non-drinking water. The proportion of households relying on river as source of water for the use of the household is highest in the South-South geo-political zone, followed by the North-central zone. Reliance on river as source of water for the household is lowest in the North-West geo-political zone. At least 9 out of every 10 households that rely on river as source of water for the household are in the rural areas.

Table 2: Distribution of Households that had a case of Onchocerciasis in the last 12 months before the survey by Geo-political zone, Wealth Index and place of residence.

		Household had case of Onchocerciasis in last 12 months			Chi-Square	p-value
		No	Yes	Total		
Geo-Political zone	North Central	17.4	31.5	18.4		
	North East	14.9	31.2	16.0		
	North West	20.2	13.9	19.8		
	South East	12.5	6.4	12.1		
	South South	16.6	5.2	15.8		
	South West	18.3	11.8	17.9	925.71	0.000
Wealth Index	Poorest	20.9	27.4	21.3		
	Poorer	19.3	26.5	19.8		
	Middle	20.9	25.1	21.2		
	Richer	20.4	14.3	20.0		
	Richest	18.6	6.8	17.8	326.89	0.000
Place of residence	Urban	32.6	16.8	31.5		
	Rural	67.4	83.2	68.5	250.09	0.000
		100.0	100.0	100.0		
		31,749	2,321	34,070		

Source: Nigeria Demographic and Health Survey 2008

An examination of the households that had a case of onchocerciasis in the last 12 months preceding the survey show that the incidence of onchocerciasis is highest in the North-Central geo-political zone (Table 2). The North-Central zone is closely followed by the North-East geo-political zone. The incidence is lowest in the South-South geo-political zone. A chi-square test conducted reveal the fact that exists regional differences in the incidence of onchocerciasis across the country (X^2= 925.71, p=0.000).

The occurrence of onchocerciasis appear to be more prominent among poor households (Table 2). About 54 percent of the incidence of onchocerciasis are in the poorest and poorer households. The paper also found that there is a significant difference in incidence of Onchocerciasis by wealth index (X^2= 326.89, p=0.000). Households with river as source of water are significantly more likely to have Onchocerciasis than those that river is not their source. The situation is more precarious in the rural areas, about 83 percent of households that had a case of onchocerciasis in the last 12 months before the survey reside in the rural areas. There exists a statistically significant difference in incidence of onchocerciasis of households in the urban and rural areas (X^2= 250.09, p=0.000).

Table 3: Incidence of Onchocerciasis in household in the last 12 months preceding the survey by river as source of water and household having improved source of water for drinking

		Household had case of Onchocerciasis in last 12 months			Chi-Square	p-value
		No	Yes	Total		
Household has river as source of drinking or non-drinking water	No	94.0	6.0	100.0		
	Yes	90.1	9.9	100.0	136.15	0.000
Household has drinking water from improved source	No	91.5	8.5	100.0		
	Yes	94.7	5.3	100.0	142.35	0.000
		100.0	100.0	100.0		
		31,749	2,321	34,070		

Source: Nigeria Demographic and Health Survey 2008

About 10 percent of the households that makes use of river as source of drinking or non-drinking water had at least an incidence of onchocerciasis in the last 12 months preceding the survey (Table 3). There is also incidence of onchocerciasis in households that do not have river as source of water for use in their households. The results show that there is statistically significant difference between households that makes use of river as source of water and those that do not have river as source of their water (X^2= 136.15, p=0.000). The effect of

having improved source of drinking water in the household was examined. Only 52.6 percent of households have improved source of drinking water (data not shown). The results indicate that incidence of onchocerciasis is less in households with improved source of drinking water (Table 3). Indeed there is a statistically significant difference among households with improved source of drinking water and those that do not have improved source of drinking water in the incidence of onchocerciasis in the last 12 months preceding the survey (X^2= 142.35, p=0.000).

Table 4: Summary Table of F-test of Number of Household members that took Onchocerciasis drug in last 12 months by Place of residence

River as source of drinking or Non-drinking water	Mean number of household members that took onchocerciasis drug in the last 12 months before the survey			F-test	p-value
	Urban	Rural	Total		
Yes	0.17	0.34	0.32		
No	0.08	0.23	0.17	139.09	0.000

Source: Nigeria Demographic and Health Survey 2008

The number of household members that took onchocerciasis drug in the last months preceding the survey in households with river as source of drinking or non-drinking water is about double the number in the households that does not rely on river for household water use (Table 4). The number of household members who took onchocerciasis drug in the rural areas is twice that in the urban areas. This then gives a rural colouration to the incidence of onchocerciasis (Table 4). The results show that there exists a significant difference among households having river as source of drinking or non-drinking water and those that do not have river as source of water for use of the household in the number of household members that took onchocerciasis drug in the last 12 months preceding the survey (X^2= 139.09, p=0.000).

Table 5: Summary Table of t-test of Number of Household members that took onchocerciasis drug in last 12 months

	N	Mean	SE of Mean	t-test	p-value
River as source of drinking/non-drinking water	7,124	0.32	0.014		
River not source of drinking/non-drinking water	26,946	0.17	0.005	11.79	0.000

Source: Nigeria Demographic and Health Survey 2008

An examination of the effect of source of water on the incidence of onchocerciasis irrespective of place of residence show that, households with river as source are more likely to have more members taking onchocerciasis drug than those in households that the river is not a source of water (Table 5). There is a statistically significant difference in the number of household members that took onchocerciasis drug in households with river as source of water and household that river is not a source of water (t=11.79, p=0.000). The implication is that when households are provided improved source of water, irrespective of the place of residence, the incidence of onchocerciasis is likely to reduce. This is because with improved source of water exposure to the black flies will be greatly reduced.

4 Conclusion

Much of the efforts at mitigating the incidence of onchocerciasis has been more in the use of drugs, which has its latent problem of drug resistance. It appears that the issue of onchocerciasis is linked to the level of development in a community. This is partly due to the fact that the poor appear more susceptible to onchocerciasis than the rich. The poor in terms of sources of water have limited options and are likely to be more dependent on sources of water such as river. The incidence of onchocerciasis is more prominent in the rural areas. The reality is that the more households are provided with safe water the less likely will the spread of onchocerciasis increase. Since prevention is better and more cost effective than cure then the provision of safe water is a sure alternative to mitigating onchocerciasis.

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