Mass drug administration targeting *Onchocerca volvulus* in Owabi catchment area in Ashanti Region, Ghana: Determinants of drug coverage and drug uptake.

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A R T I C L E   I N F O

A B S T R A C T

Introduction: Achieving high Mass Drug Administration (MDA) coverage and drug uptake are pivotal in the efforts to eradicate onchocerciasis. The present study investigated the extent and predictors of ivermectin MDA coverage and uptake from the individual and healthcare providers' perspectives. The extent of ivermectin distribution and uptake, and the predictors of distribution and uptake were investigated in endemic communities in the Ashanti Region of Ghana.

Methods: A cross-sectional survey was conducted from August to October 2019 in communities within the Atwima Nwabiagya North District. A total of 2008 respondents were interviewed. Data was collected with REDCap mobile App which had an electronic version of the structured questionnaire. Descriptive data was presented in frequency tables, and bivariate and multivariate logistics regression analysis were performed to measure the associations between exposure variables and outcome variables which were received and uptake of MDA drugs.

Results: A total of 1284 (63.9%) respondents did not receive ivermectin during the 2019 MDA programme and more than half of them were not aware of the drug distribution (53.3%). The most common reasons for not ingesting the drug were fear of side effects (47.7%) and not trusting the drug distributors (20.0%). Respondents in the age group 48–57 years (AOR = 1.37; 95%CI: 1.01–2.67), Persons in the high wealth index (AOR = 1.40; 95%CI: 1.11–1.77), Being aware of the MDA programme (AOR = 6.67: 95%CI: 4.76–9.35), MDA being beneficial (AOR = 2.12; 95%CI: 1.54–2.92) participating in previous MDA (AOR = 5.44; 95%CI: 4.25–6.98) and having stayed in the communities for 10 years and above significantly increased the odds of receiving MDA drugs. Previous uptake of MDA drugs (AOR = 10.58; 95%CI: 5.78–19.38) and perception of the MDA drug as beneficial (AOR = 5.25; 95%CI: 2.55–10.82) increased the likelihood of ingesting drugs when received.

Conclusion: The main health system challenge was limited awareness creation regarding MDA. This seems to affect the optimal utilization of the ivermectin MDA intervention. MDA programmes against onchocerciasis eradication should be designed taking into account specific contextual factors to improve implementation outcomes.

1. Introduction

Mass Drug Administration (MDA) using ivermectin for the eradication of onchocerciasis has for over 20 years proven to be a safe and potent microfilaricide against *Onchocerca volvulus* (Duke et al., 1991) and therefore has been the preventive chemotherapy approach against the disease (WHO, 2010).

MDA of ivermectin was introduced in Ghana in 1995 as a Community Directed Treatment strategy and was intended to eliminate onchocerciasis in Ghana and other endemic African countries (Brattig, 2004). Higazi et al. (2014), referred to an MDA approach with ivermectin for the treatment and control of onchocerciasis as the drug that has changed the face of tropical medicine and the provision of health care services to persons living at under-served places in the world (Higazi et al., 2014). Achieving the World Health Organisation recommendation of 80% geographical coverage and 65% drug uptake rate (compliance or therapeutic coverage), onchocerciasis is expected to be eradicated in Ghana by 2020 (WHO, 2011). Geographical coverage refers to the proportion of eligible people who received the MDA drug during a round of MDA. Drug uptake refers to the number of eligible people who ingested the drug they received. The efficacy of ivermectin against onchocerciasis has been reported in numerous studies (Batsa Debrah et al., 2019; Walker et al., 2017; Cupp et al., 2011; Koroma et al., 2018a). Among the successes is a study by Koroma et al., (2018) which was conducted in Sierra Leone to assess the impact of multiple rounds of MDA on microfilaridermia (MF) prevalence. The study recorded a microfilaria prevalence decrease of 60.26% after five rounds of MDA (Koroma et al., 2018a).

In Ghana, MDA campaigns are conducted annually for areas that are considered to be hypoendemic (microfilarial prevalence <30–35%) and mesoendemic microfilarial prevalence between 30 and 35% and 60%) for onchocerciasis and biannual for hyperendemic microfilarial prevalence ≥60%) settings which are in line with international practice (Koroma et al., 2018b). Ghana has in the past adopted the house-to-house approach and the administration of drugs in special population groups as strategies for the MDA campaign (Campbell et al., 2018). Prior to the MDA campaigns, Community Drug Distributors (CDDs) are selected from the communities involved. They are then trained on the process with Information, Education, and Communication materials using posters. The local health authorities then inform the community about the campaign through social gatherings and mass media. There have been substantial gains from the introduction of MDA of ivermectin (Walker et al., 2017; Cupp et al., 2011; Koroma et al., 2018c). Despite these successes, the parasite remains endemic in some communities. This suggests therefore that there is a low drug uptake over the years in some communities (Babu and Mishra, 2008), which calls for a review of the MDA campaign process.

Previous studies reviewed reported MDA drug uptake ranging from 46% to 75.6% (Babu and Mishra, 2008; William et al., 2016; Dicko et al., 2019). In the study conducted in Ghana by Dicko et al., (2019) a geographical coverage of 73.5% (the eligible population that received the drug) was achieved with only 66.6% compliance (people that actually consumed the drug) resulting in a noncompliance rate of 33.3% (Dicko et al., 2019). Two studies conducted in Cameroon on compliance of ivermectin by Kamga et al. (2018) and Senyonjo et al. (2016) found that 10% of community members living in onchocerciasis endemic settings had never taken ivermectin during the distribution (Senyonjo et al., 2016; Kamga et al., 2018).

Several factors have been associated with low coverage and non-compliance to ivermectin MDA. These include absence from home/community at the time of the MDA programme, perception of adverse effects of the drug, ethnicity, age and years lived in the community and the thought of not being susceptible to the disease or a low-risk perception (Dicko et al., 2019; Senyonjo et al., 2016; Kamga et al., 2018). Also, awareness about MDA, knowledge on the benefit of the drug, knowing someone in the household who previously has taken the drugs also influence drug uptake (compliance) (Babu and Mishra, 2008; Krentel et al., 2016). In a study by Babu and Mishra (2008), it was stated that "when people are aware that the MDA drug protects them from the disease, they will comply with medications" (Babu and Mishra, 2008). Also in the Ghana study, fear of drug adverse events was the main reason for noncompliance (Dicko et al., 2019). It is clear from the above that compliance estimates are varied in different settings. It is also evident that factors that promote or hinder ivermectin MDA coverage and uptake vary between countries.

Achieving high MDA coverage and drug uptake rate is pivotal in the efforts to eradicate onchocerciasis. MDA drug coverage and uptake are attributable to different factors from the individual and healthcare providers' perspective (William et al., 2016). The present study, therefore, examined the extent to which ivermectin was received by at-risk groups and the level/extent of uptake. It also measured the associations between demographics, socio-economic status, MDA programme related factors such as awareness and aspects related to drug distribution knowledge on onchocerciasis, and uptake of drugs in endemic communities in peri-urban areas in the Ashanti Region of Ghana.

2. Materials and methods

2.1. Study design

A cross-sectional questionnaire-based survey was conducted from August 2019 to October 2019 in two peri-urban communities and two rural communities in the Ashanti Region, Ghana.

The main objectives of the survey were to measure the associations between selected demographic, socio-economic predictors, knowledge-related predictors and: 1) Whether community members received drugs or not during the last round of MDA; and 2) Whether community members, who received drugs during the last round of MDA, ingested the drugs.

2.2. Study areas

The Atwima Nwabiagya North District was purposely selected for the study due to reports indicating that the district had a geographical coverage of MDA targeting onchocerciasis of less than 80% during the MDA in 2016 and 2017 (74.2% and 74.6%, respectively) (Ghana Health Service M of health, 2018).

In Atwima Nwabiagya North District, two rural communities (Owabi and Daabaa) and two peri-urban communities (Koforidua and Ntensere) were selected for the study. All four communities are located along the Owabi dam, commonly referred to as part of the Owabi catchment area. They were purposely selected for the study due to personal communication with the District Health administrations and community leaders who indicated a high intensity of transmission of *O. volvulus* in these communities.

The Owabi dam is located 10 km north-west of Kumasi, the capital town of the Ashanti Region. The Owabi catchment area covers an area of 69 km2 (Akoto and Abankwa, 2014) and has a population of 63,154 individuals (Nwabiagya and Assembly, 2017; Ghana Statistical Service, 2010). The Owabi River flows through agricultural land close to the surrounding villages and it serves as the main source of water for farming purposes. About 67% of the working population in the district are engaged in agriculture. The main tree crops cultivated are cocoa, citrus, and oil palm whilst maize, cassava, plantain, cocoyam, and rice are the major food crops produced in the district. The other major economic activities are manufacturing, services, and commerce (MoFA, 2020). A report from the district assembly suggests a high level of poverty, especially among women due to lower literacy rates, and income disparities between rural and peri-urban settings (Nwabiagya and Assembly, 2017).

2.3. Study population

The study population included all persons aged 18 years and above who have lived in the study communities for more than three months prior to the data collection. Children less than 18 years were excluded.

2.4. Sample size estimation

Assuming a drug uptake rate of 43% (Brieger et al., 2011), and a minimum ratio for receiving drugs or not of 1:1, using a power of 80%, a 95% confidence interval with the ability to detect a statistically significant difference of less than 5%, the results of a sample size calculation indicated an appropriate minimum sample size of 1937 individuals.

2.5. Tools for data collection

The questionnaire was developed and pilot tested in one endemic community in the study district by members of the research team.

2.5.1. Data collection

The households in rural communities (Owabi and Daabaa) were randomized using simple random sampling techniques. In the peri-urban communities (Koforidua and Ntensere), each community was demarcated into six clusters. Two clusters from each community were selected using a simple random technique. Subsequently, a systematic sampling technique was used to select households for the survey. In each household, one person (either the household head or a household member aged 18 or above) was selected as a respondent for an interview. Besides information regarding socio-economic and MDA related factors, the respondent was asked if drugs were received and ingested or not during the last round of MDA. A total of 2008 respondents (each representing one household) were included in the study. The data was collected using a pre-coded structured interviewer-administered questionnaire with a total of 24 questions. A electronic database was designed using the Research Electronic Data Capture (REDCap®) system hosted at the Kwame Nkrumah University of Science and Technology (Harris et al., 2009). A total of 10 field staff were trained to administer the questionnaires and to conduct the interviews. The field staff were trained in a two-day workshop which included a review of the questionnaires and interview guides, field-based training, education, and a pilot run of the questionnaires and interview guide in an adjacent community.

2.6. Exposure and outcome variables

Outcome variables included coverage of MDA of ivermectin and drug uptake. Coverage of MDA of ivermectin was defined as a self-reported indication of whether the community member received the ivermectin from the Community Drug Distributors during the round of MDA in 2019 or not. Drug uptake was defined as a self-reported indication of whether the person, who received ivermectin during the round of MDA in 2019, ingested the drug or not.

Exposure variables were selected *a priori* based on previous studies and on the assumptions that these are determinants of MDA drug coverage and drug uptake in a low resource setting like Ghana. The ages of the respondents were grouped and categorized into 18–29 years, 30–39 years, 40–49 years, 50–59 years, and 60 years and above. Marital status was categorized into single or separated and living with a spouse. Employment status was classified into unemployed, skilled and unskilled and education into no formal education,

basic (from primary school to Junior High School), Secondary (respondents who had completed Senior High School), and Tertiary (Participants who had attained a post-secondary education). The duration stayed in the community was categorized into <10 years and ≥ 10 years. A wealth index was constructed for the socio-economic status index of the study respondents from household asset data using principal components analysis and categorized as low and high. (Ghana Statistical Service, 2014) The socio-economic variables used for the construct were: access to electricity in household, a bank account, radio, television, covered with health insurance, mobile phone, own any livestock, other farm animals or poultry, refrigerator, own any agricultural land, own car/truck, sewing machine, computer, motorcycle, cement/ceramic/marble/porcelain tiles/terrazzo as flooring materials, electricity/LPG/natural gas/biogas as fuel for cooking, pipe/borehole/protected well/bottle/sachet water, flush/pour flush toilet facility, type of roofing (metal/wood/ceramic/brick tiles/slate/asbestos/sheets. These were coded as one if an individual has the household asset or otherwise zero. Each asset was assigned a weight (factor score) generated through principal components analysis, and the resulting asset scores were standardized in relation to a normal distribution with a mean of zero and standard deviation of one. Each household was then assigned a score for each asset, and the scores were summed for each household; individuals were ranked according to the total score of the household in which they resided. The sample was then divided into two quintiles (low and high). Other variables included whether the respondent had ever heard of onchocerciasis and aspects related to MDA (time drug was ingested, reasons for ingestion, ingesting ivermectin in the previous MDA, perception of MDA programme, and discomfort after ingesting the drug).

The data was analysed using Stata 16.0 statistical software (StataCorp. 4905 Lakeway Drive Station, Texas 77,845, USA).

Descriptive data was presented in frequency tables. Bivariate and multivariate analyses were used to measure the associations between exposure variables and the two previously mentioned outcome variables. Results were reported as odds ratios (ORs) and 95% confidence intervals (95%CI). Multivariate logistics regression models were fitted using a backward stepwise approach to adjust for the effect of demographic and socio-economic factors.

Table 1
Demographic and socio-economic characteristics of all respondents ($N = 2, 008$).

Variables	Number of respondents	Percentage
Name of community		
Daabaa	415	20.7
Koforidua	1010	50.3
Ntensere	454	22.6
Owabi	129	6.4
Duration stayed in the community		
< 10 years	829	41.3
≥ 10 years	1179	58.7
Age (in years)		
18–27	862	42.9
28–37	459	22.9
38–47	309	15.4
48–57	168	8.4
58 years and above	210	10.5
Sex		
Female	1370	68.2
Male	638	31.8
Occupation		
Unemployed	422	21.0
Fisherman/Farming	201	10.0
Trading	570	28.4
Artisan	318	15.8
Civil servant	90	4.5
Student/Apprentice	311	15.5
Other	96	4.8
Marital status		
Single	839	41.8
Cohabiting	131	6.5
Married	832	41.4
Divorced	98	4.9
Widowed	108	5.4
Educational status		
No formal education	270	13.5
Basic (Primary and JHS)	1196	59.6
Secondary	448	22.3
Tertiary	94	4.7
Household Wealth Index		
Low quintile	1005	50.1
High quintile	1003	49.9

3. Results

3.1. Demographic and socio-economic characteristics of all respondents

A description of the respondents is given in Table 1. A total of 2008 respondents were recruited from the four communities. Half of the respondents 1010 (50.3%) were recruited from Koforidua, a town in the Atwima Nwabiagya North district and 1370 (68.2%) were females. The 18–27 years group (42.9%) formed the majority of the respondents. The largest proportion of respondents were engaged in trading (28.4%), 21.0% were unemployed and 15.8% were artisans. Almost equal proportions of the respondents were married (41.4%) and single (41.8%), respectively. The majority of respondents had completed basic education (59.6%), whereas 13.5% reported that they had no formal education. More than half of the respondents (58.7%) had stayed in the community for at least ten years. Approximately half of the respondents were classified as being in the low and high quintiles of household wealth index, (50.1% and 49.9%, respectively).

Table 2 provides descriptive results regarding the proportion of respondents who received drugs during the last round of MDA, reasons for not receiving drugs, and perceptions and acceptance of MDA. A total of 1284 (63.9%) respondents did not receive drugs during the 2019 MDA programme. The most common reasons cited for not receiving drugs were not being aware of the drug distribution (53.3%) and being absent from home during drug distribution (32.2%). The majority of the respondents considered the drugs beneficial (76.7%), and 87.2% mentioned that they would accept to take the drug if offered at the time of the interview. In addition, 88.3% were willing to encourage others to take the drugs.

Table 3 provides descriptive results regarding ingestion of the drugs, among the respondents who received the drugs. Among the respondents who received drugs, 91.0% decided to ingest the drugs, and among these respondents, 78.5% reported that they ingested the drugs in the presence of the Community Drug Distributor (CDD). The most common reason for ingesting the drug was to prevent onchocerciasis (72.8%). The most common reason for not ingesting the drug was fear of side effects (47.7%), and not trusting the drug distributors (20.0%). One out of ten respondents (10.8%) reported having felt some form of discomfort after taking the drugs. The most common type of discomfort related to ingestion of drugs was nausea (36.6%).

The results of bivariate and multivariate analyses regarding predictors for whether the respondents were offered MDA drugs or not are presented in Table 4. The odds ratios indicate the odds of receiving the MDA drugs. The 40–49 age group had higher odds of not being offered the drug than all the other age groups.

Respondents in the age group 48–57 years (AOR = 1.37; 95%CI: 1.01–2.67) had increased odds of receiving MDA drugs compared to those in the 18–27 years. Persons in the high wealth index quintile had significantly increased odds of receiving the drugs as compared to respondents in the low wealth quintile (AOR = 1.40; 95%CI: 1.11–1.77). Being aware of the MDA programme significantly increases the odds of being offered drugs (AOR = 6.67: 95%CI: 4.76–9.35). Respondents who considered the MDA drug as beneficial were more likely to receive the drugs (AOR = 2.12; 95%CI: 1.54–2.92). It was further observed that participating in previous

Table 2

Drug coverage, perception, and acceptance of drugs related to the last round of MDA in 2019.

Variables, N = 2, 008	Frequencies	Percentage
Did respondents receive MDA drugs?		
No	1284	63.9
Yes	724	36.1
Reasons for not receiving the drug (*n* = 1284)		
Absent from home	414	32.2
CDD did not come to the house	276	21.5
CDD did not come to the community	75	5.8
Shortage of drugs	10	0.8
Taking chronic medication	9	0.7
Not aware of drug distribution	684	53.3
Was pregnant	42	3.3
Do not know	48	3.7
Other	57	4.4
Do you perceive the MDA to be beneficial?		
No	278	13.8
Yes	1541	76.7
Don't know	189	9.41
MDA drug to be accepted if given at the time of data collection		
No	212	10.6
Yes	1751	87.2
Undecided	45	2.2
Respondents to encourage others to take MDA		
Yes	1772	88.3
No	198	9.9
Undecided	38	1.9
Ever participated in the previous MDA?		
No	1078	53.7
Yes	930	46.3

Table 3

Descriptive assessment of MDA drug uptake among respondents who received drugs during the last round of drug distribution in 2019.

Variables, N = 2, 008	Frequency	Percentage
Did respondents swallow the MDA drug? (*n* = 724)		
No	65	9.0
Yes	659	91.0
Time drug was swallowed (*n* = 659)		
In presence of CDD	517	78.5
Swallowed later the same day	103	15.6
Swallowed it the following day	39	5.9
The most important reasons for ingesting the drugs among those who ingested the drugs (*n* = 659)		
To prevent onchocerciasis	480	72.8
To improve my health	118	17.9
I complied with the instructions	102	15.5
Do not know	20	3.0
The most important reasons for not ingesting the drugs (n = 65)		
Respondents not at risk	5	7.7
Drug not effective	2	3.1
Fear of side effect	31	47.7
Pregnancy	7	10.8
Had taken alcohol	1	1.5
Do not trust the CDD	13	20.0
Faith/religious beliefs	0	0.0
Other	17	26.2
Knowledge of household members that took the drug		
Everyone in the household	480	23.9
Few people in the household	336	16.7
Nobody in the household	357	17.8
Do not know	835	41.6
Any discomfort after taking the drug among respondents that ingested the drug (n = 659)		
No	588	89.2
Yes	71	10.8
Type of discomfort after taking the drug among respondents who reported discomfort (*n* = 71)		
Nausea	26	36.6
Swelling	9	12.7
Headache	9	12.7
Rashes	13	18.3
Other	23	32.4
MDA drug is more beneficial than discomfort		
Agree	913	45.5
Disagree	15	0.8
Do not know	1080	53.8

MDA programmes significantly increased the likelihood of receiving the drugs (AOR = 5.44; 95%CI: 4.25–6.98). Furthermore, respondents who had stayed in the communities for more than 10 years were more likely to receive the drugs as compared to respondents who have stayed less than 10 years (AOR = 1.29; 95%CI: 1.02–1.64).

The results of bivariate and multivariate analysis regarding predictors for whether the respondents ingested the drugs or not among respondents who received the drugs are presented in Table 5. The odds ratios indicate the odds of ingesting the drugs. A previous uptake of MDA drugs (AOR = 10.58; 95%CI: 5.78–19.38) and a perception of the MDA drug as being beneficial (AOR = 5.25; 95% CI:2.55–10.82) significantly increased the likelihood of ingesting drugs.

4. Discussion

In the present study, we observed a relatively low level of MDA coverage (36.1%). The WHO recommends that MDA campaigns must achieve a drug coverage of 80% and above in order to meet the elimination target of 2025 (WHO, 2020; Gebrezgabiher et al., 2019). In urban areas of sub-Saharan Africa, drug coverage in urban areas has been reported to be lower compared to rural areas in some studies conducted in Africa (Kisoka et al., 2014; Babu and Kar, 2004). There is an observed decrease of about 50% drug coverage compared to the previous estimates of over 70% from the district programme report. This difference could be explained by the calculation used. The programme report uses the people who received the drugs as the numerator and the eligible and registered community members as the denominator whereas in this study, the sampled population was used as the denominator with the number who reported receiving the drug as the numerator. Notably, the results of the present study have shown higher drug coverage among high socio-economic strata as compared to lower socio-economic strata. (Nandha et al., 2007; Njomo et al., 2014) Although the reason for the disparity in this study was not assessed, some review articles suggest high coverage of public health programmes among people with high socio-economic status (Pampel et al., 2010). Further, observed drug coverage compared with other relevant studies conducted outside Africa showed some consistency in relation to low coverage (Nujum, 2011; Banerjee et al., 2019). In a study by Nujum and Sitikantha which was conducted in 2011 and 2019 respectively in India, average coverage of MDA targeting lymphatic filariasis of

Table 4

The associations between demographic, socio-economic, and MDA knowledge related predictors and whether the respondents received MDA drugs or not ($N = 2008$).

Variable	Number of respondents who received drugs (% of the total in each group)	UAOR (95%CI)	p-value	AOR (95%CI)*	p-value
†Age					
18–27 years	293 (40.5)	Ref		Ref	
28–37 years	148 (20.4)	0.92 (0.73–1.18)	0.522	1.05 (0.75–1.49)	0.763
38–47 years	115 (15.9)	1.15 (0.88–1.51)	0.307	1.15 (0.76–1.73)	0.512
48–57 years	70 (9.7)	1.39 (0.99–1.94)	0.057	1.64 (1.01–2.67)	0.045
58 years and above	98 (13.5)	1.70 1.25–2.31)	0.001	1.37 (0.88–2.13)	0.163
†Sex					
Male	207 (28.6)	Ref		Ref	
Female	517 (71.4)	1.26 (1.03–1.54)	0.022*	0.95 (0.74–1.24)	0.717
†Marital status					
Single/Separated	385 (53.2)	Ref		Ref	
Living with Spouse	339 (46.8)	1.08 (0.90–1.29)	0.425	1.14 (0.87–1.50)	0.332
†Occupation					
Unemployed	269 (37.2)	1.86 (1.41–2.44)	<0.001	1.07 (0.75–1.54)	0.698
Skilled Labour	97 (13.4)	Ref		Ref	
Unskilled Labour	358 (49.6)	2.26 (1.73–2.94)	<0.001	1.37 (0.98–1.93)	0.068
†Educational status					
No Formal Education	127 (17.5)	2.08 (1.54–2.82)	<0.001	1.19 (0.78–1.80)	0.428
Basic	435 (60.1)	1.34 (1.08–1.67)	<0.001*	1.04 (0.78–1.37)	0.796
Secondary and above	162 (22.4)	Ref		Ref	
†Household Wealth Index					
Low quintile	321 (44.3)	Ref		Ref	
High quintile	403 (55.7)	1.42 (1.18–1.71)	<0.001*	1.40 (1.11–1.77)	0.005
Duration of stay in the community					
Up to ten years	468 (64.6)	Ref		Ref	
More than 10 years	256 (35.4)	1.47(1.22–1.78)	<0.001*	1.29 (1.02–1.64)	0.035
Ever heard of onchocerciasis					
No	565 (78.0)	Ref		Ref	
Yes	159 (22.0)	2.36 (1.92–2.91)	<0.001*	1.12 (0.86–1.47)	0.388
Aware of the MDA Program					
No	50 (6.9)	Ref		Ref	
Yes	674 (93.1)	15.66 (11.51–21.30)	<0.001*	6.67 (4.76–9.35)	<0.001
MDA drug beneficial					
No	73 (10.1)	Ref		Ref	
Yes	651 (89.9)	3.95 (3.02–5.17)	<0.001*	2.12 (1.54–2.92)	<0.001
Participation in previous MDA					
Yes	581 (80.3)	Ref		Ref	
No	143 (19.8)	10.88 (8.73–13.57)	<0.001*	5.44 (4.25–6.98)	<0.001

†These variables were adjusted in the final model.

about 50% was observed with a significantly lower coverage among its urban population compared to rural population (Nujum, 2011; Banerjee et al., 2019). The observed coverage of 40% though of a different target, among their urban population (Nujum, 2011) was similar to this study assuming a negligible difference in the disease target.

The observation of a significant association between not receiving the drug and unawareness of the MDA programme suggests significant increase in the likelihood of receiving the drugs hinged on being aware of the MDA programme. The awareness campaigns are usually conducted just a week before the MDA, providing information on the days set aside for the drug distribution. This one-week prior notice seems too short for the campaign. The short days will not allow for more awareness creation (which gives information on the benefit of the MDA drugs and the consequence of not receiving the drugs) which will compel the community members to stay at

Table 5

The associations between demographic, socio-economic, and MDA knowledge related predictors and whether the respondents, who received drugs, ingested the drugs or not. (N = 2008).

Variable	Number of respondents who ingested the drugs received (% of the total in each group)	UAOR (95%CI)	p-value	AOR (95%CI)	p-value
¡Age					
18-27 years	263 (39.9)	Ref		Ref	
28–37 years	130 (19.7)	0.82 (0.44–1.53)	0.541	0.74 (0.31–1.78)	0.502
38–47 years	105 (15.9)	1.20 (0.57–2.54)	0.638	1.00 (0.34–2.91)	0.998
48–57 years	65 (9.9)	1.48 (0.55–3.97)	0.433	2.02 (0.60–6.84)	0.257
58 years and above	96 (14.6)	5.48 (1.28–23.35)	0.022	4.23 (0.84–21.19)	0.080
¡Sex					
Female	468 (71.0)	Ref		Ref	
Male	191 (29.0)	1.25 (0.69–2.25)	0.458	1.20 (0.60–2.41)	0.599
¡Marital status					
Single/Separated	311 (47.2)	Ref		Ref	
Living with a spouse	348 (52.8)	1.18 (0.71–1.97)	0.526	0.57 (0.28–1.16)	0.120
¡Occupation					
Unemployed	251 (38.1)	1.66 (0.92–2.97)	0.091	2.45 (1.11–5.41)	0.027
Skilled Labour	88 (13.4)	1.16 (0.54–2.49)	0.702	2.82 (1.09–7.32)	0.033
Unskilled Labour	320 (48.6)	Ref		Ref	
¡Educational status					
No Formal Education	119 (18.1)	2.34 (1.00–5.44)	0.049	1.45 (0.50–4.19)	0.494
Basic	400 (60.7)	1.80 (1.02–3.17)	0.043	1.50 (0.75–2.98)	0.248
Secondary and above	140 (21.2)	Ref		Ref	
¡Household Wealth Index					
Low quintile	292 (44.3)	Ref		Ref	
High quintile	367 (55.7)	1.01 (0.61–1.69)	0.962	1.33 (0.73–2.42)	0.356
Duration of stay in the community					
Up to ten years	224 (34.0)	Ref		Ref	
More than 10 years	435 (66.0)	1.88 (1.13–3.14)	0.015*	1.66 (0.89–3.07)	0.108
Ever heard of onchocerciasis					
No	141 (21.4)	Ref		Ref	
Yes	518 (78.6)	1.41 (0.79–2.50)	0.244	1.19 (0.60–2.35)	0.615
Aware of MDA Program					
No	43 (6.5)	Ref		Ref	
Yes	616 (93.5)	1.73 (0.74–4.02)	0.203	0.71 (0.26–1.92)	0.501
MDA drug beneficial					
No	53 (8.0)	Ref		Ref	
Yes	606 (92.0)	5.08 (2.80–9.23)	<0.001*	5.25 (2.55–10.82)	<0.001
Previous uptake of MDA drug					
No	101 (15.3)	Ref		Ref	
Yes	558 (84.7)	10.09 (5.82–17.50)	<0.001*	10.58(5.78-19.38)	<0.001

* Statistically significant.
¹ These variables were adjusted in the final model.

home to receive the drug. This phenomenon could be the reason for the observed association between being aware of the MDA programme and receiving the drug. This reason also implies that pre-MDA campaigns should be intensified to enhance awareness and uptake.

The observation that about three out of ten persons who did not receive the drugs because they were absent from home is remarkable. This challenge has been observed in other studies conducted in sub-Saharan communities particularly among the urban and peri-urban populations (Kisoka et al., 2014; Njomo et al., 2012; Offei and Anto, 2014). A study conducted in India by Banerjee

et al., (2019) found that Community Drug Distributors do not repeat house visits whenever members were not present. A recent study conducted in Ghana by Agyemang, et al., (2018) bemoaned the fact that CDDs are required to complete distribution of the drugs in the entire village, covering all households within just 7 days irrespective of the size of the catchment area (Babu and Kar, 2004). This phenomenon has the potential of hindering the success of the MDA Programme. This study did not examine the reasons why some people were not at home at the time of the drug distribution.

Generally, the CDDs distribute the drugs during working hours when a proportion of the community may be absent due to work activities, which take place outside the house during the same period. Given that majority of the community members are farmers (MoFA, 2020), the probability that the community members were engaged in seasonal agricultural work at the time of the visit by the CDD, is a possible explanation for this finding. We recommend that the MDA programme coordinators work with the community health workers and the CDDs (who are residents of the communities) to understand the times of the day when people are more likely to be home and incorporate them into the training of the CDDs.

The low level of MDA coverage observed in the present study suggests a low involvement of community members in the MDA campaignwhich to some extent demonstrates loss of interest in the MDA programme. This observation is of concern given the original intent and the rationale behind the involvement of community participation in rolling out public health interventions like the MDA. The situation is even more worrying with the observation that about two in every ten respondents who did not get the drug was because the CDDs did not visit their homes. This raises a question of the extent of commitment and motivation by the CDDs. A study conducted a decade ago by the community-directed treatment with ivermectin (CDTI) group evaluated the effectiveness of implementing community-driven public health interventions such as the MDA. It was found that communities and community implementers were deeply committed to the Community Directed Intervention process and were more motivated by intangible incentives than by external financial incentives (Nandha et al., 2007). However, a recent study conducted in Ghana by Agyemang et al., (2018) reported that altruism among CCDs have declined (Agyemang et al., 2018). According to Agyemang and colleagues, lack of financial motivation to CDDs is a major hindrance towards improved MDA coverage (Agyemang et al., 2018). This calls for a review of the implementation in Ghana and the need to source for funds to motivate the CDDs.

A recorded drug uptake rate of 91.0% among those who received drugs in the present study is higher than some studies conducted in Africa (Senyonjo et al., 2016; Brieger et al., 2011; Kisoka et al., 2014). Report on uptake as low as 66.6% among those who received the drugs was observed in a study conducted in the Western region of Ghana by Dicko and colleagues in 2019 (Dicko et al., 2019). Another study conducted in Tanzania by Parker and Allen (2013) revealed that despite the high disease burden of lymphatic filariasis, drug uptake in the MDA programme had consistently declined (Parker and Allen, 2013). Community members did not prioritize these diseases as compared to malaria and HIV/AIDS. Also, they distrusted the MDA programme due to inadequate information on the drug, potency, and expectations. Health staff and CDDs could not explain key questions posed by community members, and this led to wild rumours of potential birth control agenda by the government. Further, individuals with hydrocele and elephantiasis who took the medication indicated they did not experience a reduction in either the size of their swelling. These coupled with many unanswered questions, led to the questioning of merit of the MDA programme thus leading to low MDA uptake in these communities. (Parker and Allen, 2013) Learning from this study, it is important that the programme implementers take a critical view at the training manuals for CDDs. The training ensures that the CDDs have adequate understanding of the Neglected Tropical Disease (Vectors that spread the disease, causative agents, risk factors, at risk groups and signs and symptoms') and the benefit of the MDA programme in interrupting the transmission pathway.

In the present study, perceived benefits of the distributed drugs were a significant predictor for drug uptake. In a study by Babu and Mishra (2008) it was observed that when people are aware that the MDA drug protects them from the disease, they would comply with the medication. This observation is also consistent with a review study which showed a significant adherence to the MDA drugs as a result of the community members being aware of the benefits of the drug (Krentel et al., 2013). A systematic review of the factors that shape the implementation of the MDA programme found that awareness creation through innovative community health education programmes accounted for implementation success (Silumbwe et al., 2017).

We observed that about half of the respondents who received the drug and refused to ingest it were afraid of side effects. This observation is consistent with other studies conducted in Africa (Dicko et al., 2019; Senyonjo et al., 2016; Agyemang et al., 2018). In the study by Agyemang et al., (2018) several instances of side effects after ingesting ivermectin were documented. These included oedema (swollen limbs, face eyes, penis), rashes, joint pains, reduction in body weight, dizziness, collapsing, and the emergence of other diseases that led to the death of some people. The authors described the sequence of records as mimicking that of "a rich store of occasional instances of individual cases given by CDDs" (Agyemang et al., 2018). Unlike the Expanded Programme on Immunization (WHO, 2017), there is inadequate surveillance systems for MDA campaign like a system for adverse events following immunization (AEFI) reporting. Future MDA programmes must consider education on possible adverse drug reactions as well as a surveillance system on any adverse events. This will potentially address non-compliance which is attributed to side effects.

From this study, the association between awareness and drug uptake suggests the adoption of a multifaceted approach through enhanced social mobilization strategies in order to increase MDA uptake. The MDA awareness can be created at different stages of the distribution exercise; pre-MDA campaign, during drug distribution, and continuous education. At each stage, different strategies may be adopted. In a mixed-methods study conducted in Kenya, some of the CDDs in the qualitative interview suggested that "…community members require more frequent information to be educated and know well about the disease being prevented." According to them, "continuous announcements and sensitization of members for about a week will increase awareness of the programme" (Njomo et al., 2014). With regard to the mode of education, the results showed the need to engage family and community heads in the educational campaign (Njomo et al., 2014).

The present study does not represent the national population but only the specific areas where coverage of the MDA programme

was lower than expected. Further, recall bias was a possibility since respondents were required to recall information about the MDA campaign that had been completed two months ago. In order to minimize the recall bias, the data was collected about a month after the MDA campaign. Further, being a cross-sectional study, it has a limited ability to establish causality. This study also offers useful information on the need to adopt strategies that are community-centered with the potential of improving coverage and compliance to ivermectin.

5. Conclusion

It is clear from the discussion of the present study and that of other studies that treatment coverage of ivermectin MDA depends largely on the success of the MDA programme. The health system challenge of limited awareness creation affects the optimal utilization of the ivermectin MDA intervention. Community engagement using various means including the active involvement of local authorities could be the gamechanger. Also, the selection, training, and motivation of drug distributors should be considered crucial in MDA programmes since they directly interact with target populations. Their actions can affect individuals' and families' MDA compliance decisions. Increasing the number of CDDs and the number of days can improve interactions and improve treatment coverage and drug uptake rate. Finally, MDA for onchocerciasis eradication programmes should be designed with implementation strategies based on specific contextual factors to improve implementation outcomes.

Authors' contributions

FAO, EO-D, SN PF, DWM conceptualized and designed the study. EOY, SFO, NMK, IN, EA, SB, OA and EXA were responsible for the data collection, data cleaning and analysis. FAO drafted the initial manuscript. EO-D and SN supervised the project and DWM, revised the draft manuscript. All authors read and agreed to the final manuscript and will be accountable for it.

Ethics approval and consent to participate

The study was explained to the participants and caregivers in clear and unambiguous language. Written informed consent was obtained before inclusion in the study. Ethical approval was obtained from the KNUST Committee on Human Research Publications and Ethics (CHRPE/AP/001/19) and permission was sought from the District Health Directorate.

Consent for publication

Not applicable.

Availability of supporting data

The study data collected, analysed and presented are available at the first authors' institution and is available upon formal request.

Author's information

Not applicable.

Declaration of Competing Interest

The authors declare that they have no conflicts of interest.

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