Praziquantel treatment coverage among school age children against schistosomiasis associated factors and in Ethiopia: a cross-sectional survey, 2019

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Abstract

Background: World Health Organization estimated that 779 million people are at risk of getting schistosomiasis and 240 million people were infected worldwide. Schistosomiasis due to *S. mansoni* is a wide public health problem in Ethiopia. The aim of the survey was to quantify national and district disaggregated treatment coverage status for schistosomiasis and compare validated coverage with the one reported.

Methods: Community based cross-sectional survey was conducted in April 2019 among households with school age children (5-14 years) in seven purposively selected districts of the country. Segments (villages within the selected kebele) to be surveyed were randomly selected and households to be interviewed from each segment were determined using systematic sampling technique. A total of 3,378 households visited and 5,679 school age children (5-14 years)) were interviewed.

Results: Overall reported treatment coverage of schistosomiasis was 4286 (75.5%). Male SAC were 27% more likely to consume the drug (AOR= 1.27; 95% CI: 1.09, 1.47) than females. SAC with 10-14 years swallowed the drug 45% better than 5-9 years (AOR =1.45; 95%CI: 1.25, 1.69). Statistically significant association was observed between Praziquantel swallowing with school enrollment and heard about mass drug administration. Swallowing status of Praziquantel against schistosomiasis significantly higher for SAC treated in districts applied integrated treatment approach (87.5%) compared with SAC treated in vertical approach (72.5%). Reasons for not taking the drug were asked and the main reported reason for not swallowing Praziquantel in the present study was none attending of the school.

Conclusion and recommendation

Over all treatment coverage of Praziquantel against schistosomiasis in the present study was 75.5%. Although it is in accordance with WHO recommendation for Ethiopia, national programmatic improvements are necessary to achieve higher coverage. To increase treatment coverage of Praziquantel in Ethiopia, school based training should target all schools and mobilization, sensitization and implementation of the community wide treatment need to be improved.

Background

Schistosomiasis (SCH) is a chronic water- related parasitic disease caused by blood flukes of the *genus schistsoma*. It is the most important helminthes infection in tropical developing countries in terms of its public health and socioeconomic importance (1); Ethiopia is not exceptional. People become infected when coming in contact with water containing *schistosom*e infected snails (2.) WHO Report estimated that, globally 779 million people are at risk of getting SCH infection worldwide, 240 million infected cases and more than 200,000 deaths occurring each year (3). About 224 million of infected people were live in Sub-Saharan Africa (SSA) (4).

Next to malaria, SCH is the second most important parasitic infection: killing an estimated 280,000 people per year in African region (5) and in many parts of Ethiopia, SCH due to *S. mansoni and S. haematobium* is a wide public health problem and usually occurs in agricultural communities living along small streams, irrigation schemes and lakes in altitudes below 2000 meter above sea level (6, 7).

National Master Plan for neglected tropical diseases (NTDs) reported that 37.3 million people are living in SCH prone areas, comprising 3.4 million pre-school age children (PSAC), 12.3 million school age children (SAC), and 21.6 million adults (8). The finding of systematic review, and Meta analysis on SCH showed that the national pooled prevalence of *S.Mansoni* among Ethiopian population was 18.7% (95% CI: 14.7-23.5). Other study in Northwest Ethiopia revealed that the prevalence of *S. mansonia* among PSAC was 11.2% (9).

Studies conducted in Amhara region, Ethiopia, indicated that the prevalence of *S. mansoni* among SAC was (89.9%) in Sanja general elementary school (10), 82.8% in Sanja and Ewukat Amba primary school (11), 56.6% in Tach Armachio district (12), 37% in Zarima town of Gonder (13), 20.6% in Gorgora town (14), 14.3% in Ethiopian Orthodox church students around Lake Tana (15) and 2.8% in Bahir Dar Shimbit elementary school (16).

Different factors can be associated with infection with SCH; a study finding from south west Ethiopia revealed that the intensity of *S. mansoni* was significantly higher in Males than females. Infection intensity of *S. mansoni* was also significantly higher among children attending school. However, intensity of *S. mansoni* infection was not significantly associated with age categories (17).

A study done in north western Tanzania revealed that 44.4 % of PSAC were infected with *S. mansoni*, with prevalence in males being 46.2 % and in females 42.6 %. No gender-related difference in prevalence was observed ($\chi 2 = 0.50$, $P < 0.48$). The prevalence of infection increased with increasing age ($\chi 2 = 61.8$, $P < 0.00$). Reported history of lake visits (AOR = 2.31, 95 % CI: 1.06–5.01, $P < 0.03$) and the proximity to the lake shore (<500 m) (AOR = 2.09, 95 % CI: 1.05–4.14, $P < 0.03$) were significantly associated with *S. mansoni* infection (18).

There are many studies in Ethiopia (10-16) indicated for high prevalence and intensity of *S.mansoni* infection among SAC. They also revealed human contaminative activities such as open field defecation and exposure activities such as washing, swimming and bathing in contaminated water bodies favors transmission of SCH. SAC are at risk of getting SCH easily due to their frequent contact to the contaminated water bodies through swimming, fetching, washing clothes and crossing the river while going to the school.

Schistosomiasis is devastating NTDs especially for resource limited settings with poor sewage disposal and in adequate supply of clean water. Therefore, to reduce the burden of SCH, WHO designed strategy for PZQ mass drug administration (MDA) and set goals to control and eliminate SCH by 2020 and 2025 respectively. In order to facilitate the achievement of WHO goals, Ethiopia has started MDA of

Praziquantal preventive chemotherapy (PPC) for all enrolled and non enrolled SAC in November 2015 in collaboration with Imperial College of London.

Therefore, the purpose of conducting the present coverage validation survey was to quantify national and district disaggregated treatment coverage and to compare validated coverage during the survey with the one reported by independent monitors (IM) during the actual drug distribution. It also aimed to identify possible challenges which might hinder effective implementation of MDA to control and eliminate the infection of SCH in Ethiopia.

This coverage validation survey is an ongoing evaluation which is conducted to monitor how the MDA programs of year four phase 2 is going on. The effectiveness of PZQ mass drug treatment on reducing the prevalence of SCH among enrolled and non enrolled SAC in Ethiopia will be assessed by impact evaluation at the end of the program in April 2020 and it will be disseminated to the public.

Methods

Study design, period and setting characteristics

Community based cross-sectional survey was conducted in April 2019 among households with SAC (5-14 years) in seven purposively selected districts of the country. Ethiopia is found in the horn of Sub Saharan Africa (SSA); administratively classified into nine regions and two city administrations. According to the 2018 demographic profile, there are 105, 350,020 populations (19); of which 51% of the population is female, 47.3% were within the age range of 0-14 years. The total area of the country was 1,104, 300 km^2 (20) and more than 80% of the population were live in rural areas (19). Looking to the weather condition of the country, Ethiopia has Dega, Woyna Dega and Qola type of weather conditions.

The health policy of Ethiopia was preventive with a three tier health care delivery system (Primary health care, Zonal hospital and referral or teaching hospital structure). The commonest public health problems to the populations of Ethiopia are communicable disease like Malaria, Tuberculosis, HIV/ AIDS, Helmintheasis, chronic non-communicable disease, road traffic accidents and soon. *S.mansoni* is among the commonest parasitic infections in Ethiopia. This study was conducted in seven purposively selected districts of the country. Districts were selected based on their case report of SCH. Lists of regions with their respective districts: Errer from Harar region, Ittang special from Gambella region, Mecha from Amhara region, Meta from Oromia which is the largest region with the highest number of population in the country, Gura ferda and Wondogenet from Southern Nations, Nationalities and People (SNNP) region and Wombera from the Benshangul Gumuz region. In each of the districts, the total population is more than 100,000 (fig 1).

Survey procedure and sample size determination

One month prior to the MDA campaign, woreda health officers in each district were trained on how to cascade the deworming process and to train health care workers and teachers. Two weeks before

administering PZQ to the SAC, two teachers from each school and one health professional from respective kebele was trained for three days by woreda health officers. Lists of students to be treated were taken from school register and the number of PZQ tablets to be administered was determined by using WHO dose pole. The MDA campaigns have been conducted one month prior to the present coverage validation survey.

The present coverage validation survey was done to assure the number of SAC who were treated in the last MDA campaign one month preceding this survey. After getting the sentinel site list from Federal Ministry of Health (FMOH), seven districts purposively selected from six regions of the country. Five districts undertake vertical treatment approach while two were undertaken an integrated. The number of segments (Villages within the selected kebele) to be included in the survey from each district was determined by coverage survey builder.

Using lottery method, 30 segments were selected from each district. Kebeles (administrative area below the district) to be involved and the number of segments (administrative areas below the kebele) to be surveyed in each district were selected again by lottery method. First the district to be surveyed was selected by purposive sampling method; then the number of kebele in each district was determined. The number of segments to be surveyed from each selected kebele of respective district was identified by dividing the total number of households in the kebele to 50. Segments to be surveyed should contain at least 16 households and the final participant households to be interviewed were selected by systematic random sampling technique after getting selection interval by dividing 50 to 16; which is K=3. . Using the above sampling procedure, from seven districts a total of 3,378 households were visited and 5,679 SAC were interviewed for their swallowing or non-swallowing status of PZQ.

Data was collected using mobile phone data collection application of SurveyCTO. At the end of data collection, it was further transferred to STATA statistical analysis soft ware StataCorp version 14 for cleaning and analysis. Descriptive statistics was done and presented by table, graphs and text narration. Cross tabulation and binary logistic regression analysis was also done. Bivariate and multivariable binary logistic regression analysis was performed to select potential candidate variables and to estimate the independent effect of predictors on swallowing status of PZQ and to control potential confounders. Variables which satisfied the p-value criteria of <=0.25 in bivariate logistic regression analysis were taken as candidate variables for multivariable logistic regression analysis.

Model was built using step wise backward elimination procedure and the effect of using model with reduced or many variables is compared by log likely hood ratio test. The instability of regression coefficient (Multicollinearty) was checked using Variance inflation factor (VIF) and the cutoff point was mean VIF greater than 10 to have significant collinearty. The finding of our analysis revealed that the mean VIF is 2.22. Hence, it indicates absence of multicollienearity among variables in the fitted model. The classifying ability or prediction performance of variables in the final fitted model was checked using Receiver Observed Characteristics (ROC) curve and 77.62% of PZQ swallowing was determined by SAC age, gender of SAC and school enrollment status of SAC. The association between dependant and

independent variables was measured by AOR and statistical significance was assured by P-value < 5% (<0.05).

Result

Socio-demographic characteristics of study participants

Among 5,979 SAC (5-14 years) eligible for interview in seven districts, 5,679 SAC were interviewed, yielding a response rate of 95%. The mean age of SAC was 9.6 years with standard deviation of ±2.8. Almost male and female were equally involved in the survey. Concerning to the school attendance, 4750 (83.6%) of children attended school; of which 4732 (99.6%) children attended at primary school owned by public (Table 1).

Table 1: Socio-demographic characteristics of SAC in study districts, Ethiopia, 2019

S. No	Variables	Categories	Frequency	Percent (%)
1	Age (Years)	5-9	2765	48.7
		10-14	2914	51.3
2	Gender	Female	2853	50.2
		Male	2826	49.8
3	School Attendance	No	929	16.4
		Yes	4750	83.6
4	Educational level	Primary	4732	99.6
		Secondary	18	0.4
5	School type	Public	4612	97.1
		Private	126	2.6
		Religious	12	0.3

Praziquantel treatment coverage against SCH among SAC in study districts, Ethiopia

Out of 5,679 interviewed SAC in districts undertake vertical and integrated mass drug treatment approach, the overall treatment coverage of Praziquantal against SCH was 4286 (75.5%). From 4571 interviewed SAC in districts undertake vertical treatment approach, 3316 (72.5%) of SAC were reported that they were treated with PZQ; and among 1108 SAC interviewed in districts undertake integrated treatment approach, 970 (87.5%) were treated by PZQ against SCH. District disaggregated treatment coverage of Praziquantal showed that students from Itang special in Gambella region reported the highest treatment coverage (90%) and SAC from Errer district in Hareri region had the lowest (59.7%) treatment coverage (Fig:2).

Treatment coverage of PZQ disaggregated by gender, age, school attendance and heard MDA in the sampled districts, Ethiopia, 2019

Gender disaggregated treatment coverage of PZQ showed that male SAC were significantly more likely to consume the drug (77.6%) than females (73.3%) (X^2 =14.77, p-value<0.001); treatment coverage of SCH

was significantly different between age groups of SAC. SAC with 10-14 years swallowed the drug better (83.7%) than 5-9 years (66.8%) (X^2 =222.66, p-value <0.001). Statistically significant difference was observed on swallowing status of PZQ among SAC who attended school and heard about MDA when compared with their counter parts (Table: 2).

Table 2: Treatment coverage of PZQ among SAC disaggregated by gender and other predictors in the sampled districts of Ethiopia, 2019

Variable	Categories	Swallowed PZQ						Chi-square (p-value)
		Yes		No		Unknown		
		No	%	No	%	No	%	
Gender	Female	2092	73.3	679	23.8	82	2.9	14.77 (0.001)
	Male	2194	77.6	556	19.7	76	2.7	
Age (Years)	5-9	1848	66.8	799	28.9	118	4.3	222.66 (0.001)
	10-14	2438	83.7	436	15	40	1.4	
School attendance	Yes	4091	86.1	616	13	43	0.9	1833.40 (0.001)
	No	195	21	619	66.6	115	12.4	
Heard about MDA	Yes	413	91.3	371	8.4	9	0.2	2696.39 (0.001)
	No	271	21.1	864	67.3	149	11.6	

SCH treatment coverage disaggregated by school attendance in districts undertook vertical treatment approach

The school attendance disaggregated analysis in districts conducted vertical treatment approach showed that PZQ treatment coverage among SAC was significantly higher for SAC who attended school (84.1%) compared to their counter parts (14.4%) (X^2 =1595.32,p-value<0.001) (Table: 3).

Table 3: Treatment coverage of PZQ disaggregated by school attendance and other predictors for districts applied vertical treatment approach, Ethiopia, 2019

ariable	Categories	Swallowed PZQ						Chi-square
		Yes		No		Unknown		(p-value)
		No	%	No	%	No	%	
ender	Female	1624	70.2	614	26.6	75	3.2	12.97 (0.002)
	Male	1692	75.0	500	22.1	66	2.9	
ge (Years)	5-9	1405	63.4	709	32	103	4.6	186.19 (0.001)
	10-14	1911	81.2	405	17.2	38	1.6	
chool attendance	Yes	3207	84.1	566	14.9	39	1.0	1595.32(0.001)
	No	109	14.4	548	72.2	102	13.4	

Treatment coverage of PZQ among districts involved vertical and integrated treatment approach

Swallowing status of PZQ against SCH significantly higher among SAC in districts conducted integrated treatment approach compared with vertical (Table: 4).

Table 4 : Treatment coverage of PZQ disaggregated by treatment approach, Ethiopia, 2019

Treatment approach	Swallowed PZQ			X^2	P-value
	Yes (%)	No (%)	Unknown (%)		
Vertical	3316(72.5)	1114(24.4)	141(3.1)	108.5	<0.001
Integrated	970(87.6)	121(10.9%)	17(1.5%)		

Reported reasons for not swallowing PZQ among SAC in study districts, Ethiopia

The main reported reason for not swallowing PZQ against SCH among SAC was not attending school (n=394, 31.9%) (Figure: 3).

PZQ distribution sites reported by interviewee

Most of interviewed SACs in study districts reported that they had received PZQ treatment against SCH from school, 4044 (94.4%) (Fig: 4).

Factors statistically and significantly associated in multivariable logistic regression analysis

Multivariable logistic regression analysis showed that age of SAC, gender and school enrollment status of SAC was statistically and significantly associated with PZQ acceptance and swallowing. Students

with age 10-14 years were 45% more likely to accept and swallow PZQ mass treatment compared with their counter parts (5-9 years); (AOR=1.45, 95% CI: 1.25, 1.69)

After stabilizing age and school attendance in the model constant and compare male SAC with female towards PZQ swallowing status, male SAC were 27% more likely to consume PZQ compared with their counter parts. (AOR= 1.27, 95% CI: 1.09, 1.47). Attendance to the school was statistically and significantly associated with PZQ swallowing against SCH. SAC enrolled to private or public school were almost 21 times more likely to swallow PZQ compared with SAC who didn't; (AOR= 20.90, 95% CI: 17.41, 25.08). (Table: 5)

Model equation for the final fitted multivariable logistic regression analysis

(see Equation in the Supplementary Files)

Table 5: Factors statistically and significantly associated with PZQ swallowing status among SAC in the sampled districts of Ethiopia, 2019

ble	Category	Swallowed PZQ		COR	P-value	AOR	95% CI
		Yes N (%)	No N (%)				
	5-9 year	1,848 (43.1)	917 (65.83)	1	0.000	1	-
	10-14 year	2,438 (56.9)	476 (34.17)	2.54		1.45	**(1.25, 1.69)
er	Female	2,092 (48.81)	761(54.63)	1	0.000	1	-
	Male	2,194 (51.19)	632 (45.37)	1.26		1.27	*(1.09, 1.47)
ol attendance	No	195 (4.55)	734 (52.69)	1	0.000	1	-
	Yes	4,091(95.45)	659 (47.31)	23.37		20.90	**(17.41, 25.08)

Note: COR = Crude Odds ratio, AOR Adjusted Odds Ratio, CI = Confidence interval, *= P value < 0.05, ** < 0.01

Table 6: Final fitted model in multivariable logistic regression, 2019

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. logistic PZQ_Swallowed School_Attendance Gender_new AgeCat

Logistic regression                               Number of obs   =      5,679
                                                  LR chi2(3)      =    1580.84
                                                  Prob > chi2     =     0.0000
Log likelihood = -2373.3584                       Pseudo R2       =     0.2498
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PZQ_Swallowed	Odds Ratio	Std. Err.	z	P>|z|	[95% Conf.	Interval]
School_Attendance	20.9006	1.945671	32.65	0.000	17.41482	25.0841
Gender_new	1.26739	.0948707	3.17	0.002	1.094444	1.467666
AgeCat	1.454347	.1114371	4.89	0.000	1.251544	1.690013
_cons	.2166053	.0197941	-16.74	0.000	.1810855	.2590924

To check the classifying or prediction performance of variables in the final fitted model, ROC curve was done. Based on the Hosmer and Lemeshow criteria, variables in the fitted model were predicting the acceptance or swallowing of PZQ by 77.62%.

This means 77.62% of PZQ swallowing among SAC was determined by age of SAC, gender of SAC and school attendance or enrollment status of SAC (Fig: 5).

Table 7: Test for instability of regression coefficient among variables in the fitted model

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. vif, uncentered
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Variable	VIF	1/VIF
School_Att~e	2.79	0.359065
AgeCat	2.13	0.469032
Gender_new	1.75	0.571624
Mean VIF	2.22	

Discussion

There has been considerable progress towards WHO Roadmap goals for SCH and regional targets, as the control of SCH has become a priority on the agenda of many governments. This drive has encouraged many countries to establish programmes and develop national action plans to control NTDs. By 2016, 36 African countries had developed and launched their national NTDs master plans. Ethiopia is among the countries struggling to control and eliminate the infection of SCH in Africa.

The current survey validation revealed that over all coverage of PZQ acceptance and swallowing rate among SAC against SCH was 75.5%. This finding is almost consistent with the study finding in Mali, coverage rate of 76.7% (21); but it is low compared with the pilot treatment given by WHO (2008–2009) one million school children were treated in the selected schools with 86% PZQ coverage (22) and 86.9 % PZQ treatment coverage in Zanzibar (23). Possible reasons for this inconsistence might be variation on sample size and target population. In our study only SAC were participated whereas in WHO and Zanzibar study both SAC and adults were almost equally involved. It is obvious that adults can accept and swallow drugs more effectively than children's as the drugs were large in size and not convenient for children to swallow.

For Ethiopia, the target coverage level for SCH that was recommended by WHO was 75%; hence the current finding was in line with WHO recommendation of 2011. Achieving target MDA coverage level for SCH is essential to eliminate and control SCH. To ensure program goals are met, coverage level reported by drug distributors may be validated through household coverage surveys that rely on respondent recall.

According to the study finding in Ivory Coast, overall PZQ treatment coverage rate was 47.6% (2730/5733). It also revealed that treatment compliance (acceptance and swallowing) status of PZQ was significantly higher in males than females ($X^2 = 19.96$, $p < 0.001$) (24) (24). This finding is consistent with the present study finding, the odds of acceptance and swallowing of PZQ is 27% more likely for males compared with their counter parts. . A study finding in Uganda revealed that over all PZQ treatment coverage was 48.8%. Factors that improved individuals' odds of taking PZQ were school enrolment and age of children (25).

This finding is consistent with the finding of the present study; the odds of swallowing PZQ for school enrolled SAC almost 21 times more likely compared with SACs not enrolled to school. Similarly, SACs with in age category of 9-14 years were 45% more likely to accept and swallow PZQ than SACs within age category of 5-9 years (Table 5). The most frequent reasons for not taking the 2016 PZQ distribution in Uganda were not being drugs offered and being away during MDA (25). Other study by Knopp and colleagues in Zanzibar revealed that, the main reported reasons for not receiving or taking PZQ were: absence during drug distribution, not drug distributor reached the household, fear of adverse events, being pregnant, and breastfeeding or feeling unhealthy (23). These findings were almost similar with the reasons reported for not to swallow PZQ in the present study (Fig 3).

Policy implications

Schistosomiasis is related with low socio-economic status, poor sanitation, lack of access to healthcare facilities and frequent contact with infected water bodies (25, 26). Offering of MDA twice per year has been successful at reducing magnitude and intensity of infections. Even though Preventive Chemotherapy (PC) is an important component of SCH control, other supportive strategies such as provision of safe water and adequate sanitation, hygiene education and snail control will be essential for

the control and elimination of SCH. However, improvements in MDA can impact disease morbidity and improve short-term outcomes for stakeholders.

Based on the community surveys, PZQ uptake could be improved by leaving supplies of PZQ at health facilities, improving awareness that people can get re-infected post-treatment and emphasizing that PZQ is recommended for adults in these communities. This study supports the concept that bottlenecks for the boundary line PZQ treatment coverage against SCH control by MDA was mainly due to non enrollment status of SAC to the school. Hence, strategies should be established and improved to enroll and reach non-enrolled SAC through enhancing universal primary education and increasing the number of health extension workers and health development armies to reach and distribute drugs for non enrolled students within the community.

Strengthen and limitations of the study

This study has important strengths and limitations. As strength: it directly measured the accuracy of respondent recall in the setting of MDA. It provided an opportunity to investigate respondent recall not only for overall MDA participation, but also for recall of specific medications swallowed by showing the actual drugs. This survey tried to gather data by repeat visit in case the household and SAC was not present at home. Perceived limitations of this study will be: interviewing the SAC for the MDA campaign conducted before a month might have possibility of recall bias. Due to cross-sectional study design, can't measure casual inference and temporality of sequence.

Conclusion

The present study showed that overall treatment coverage rate of PZQ against SCH among SAC in Ethiopia is (75.5%); it is in line with WHO recommendation (75%). The present study also revealed that female SAC, non enrolled SAC, SAC who were not heard for the campaign of MDAs and SAC within age category of 5-9 years were less likely to swallow PZQ against SCH compared with their counter parts. Although self-reported MDA coverage was in accordance with WHO recommendation, national programmatic improvements are necessary to achieve higher coverage. Adequate community mobilization and improved training for MDA distributors, monitors and supervisors should be given to improve PZQ treatment coverage in the future MDAs.

Recommendations

Community mobilization approaches need to be strengthened in order to reach non-attending or non-enrolled school-aged children. To increase coverage and compliance of PZQ in Ethiopia, school based training (SBT) should target all schools and mobilization, sensitization and implementation of the Community Wide Treatment (CWT) need to be improved. To attain elimination strategy of SCH , a very high treatment coverage and compliance of PZQ at national, regional and local level is a key and additional control measures such as biological snail control and behavioral change interventions will need to be considered. The benefit of MDA and drug side effects should also be clearly communicated

for SAC and the drugs should be broken in to two or more parts to easily facilitate swallowing for the SAC especially for those bellow 10 years.

Abbreviations

SAC: School Age Children

SCH: Schistosomiasis

PZQ: Praziquantel

MDA: Mass Drug Administration

SSA: Sub-Saharan Africa

WHO: World Health Organization

PSAC: Pre-school age children

FMOH: Federal Ministry of Health

PC: Preventive Chemotherapy

SBT: School Based Training

CWT: Community Wide Treatment

Declarations

Ethics approval and consent to participate

A letter of support outlining the aims and objectives of the survey was submitted from the Federal Ministry of Health (FMOH) to the Regional Health Bureau and their respective lower level local administrations. Prior to the interview, informed verbal consent to participate was obtained from the parent or legal guardian of the children. The aims of the survey, benefits and risks were explicitly communicated. Local ethics committee ruled that no formal ethics approval was required in this particular case as this coverage validation survey was intended to assess the number of students being treated for SCH one month prior to the current coverage validation survey and compare with the number reported previously. The interviews directly targeted on the SAC, hence parents or household heads did not answer on behalf of the children. At the end of the interviews, , participants within the surveyed households were provided with key health education messages on SCH prevention and control mechanisms.

Availability of data and material

The dataset analyzed for this study is available from the corresponding author (Yilma Chisha Dea) on reasonable request

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Consent for publication

After consent was obtained from study participants, interviews were conducted such that participants remained anonymous during data entry and analysis. No individuals' identity can be revealed upon publication.

Authors' contributions

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All authors have read and approved the final manuscript.

Competing interest:

We authors declare that we don't have any competing interests!!

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Figures

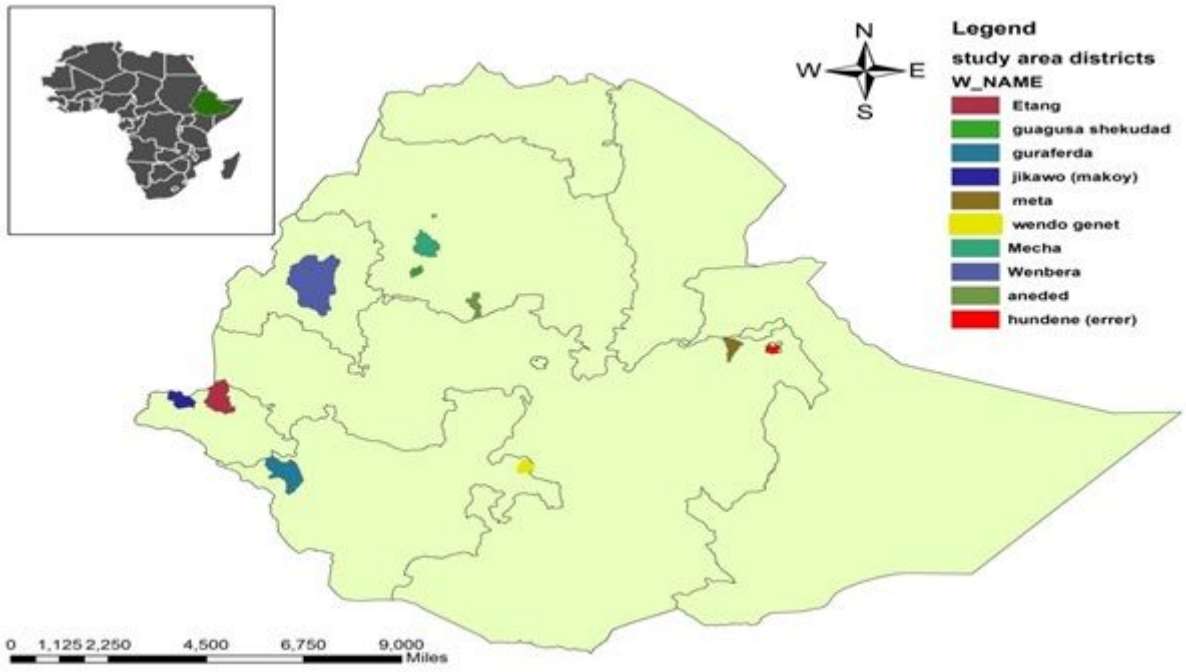

Figure 1

Map of study districts on which coverage validation survey of MDA was conducted, Ethiopia, 2019, prepared by authors

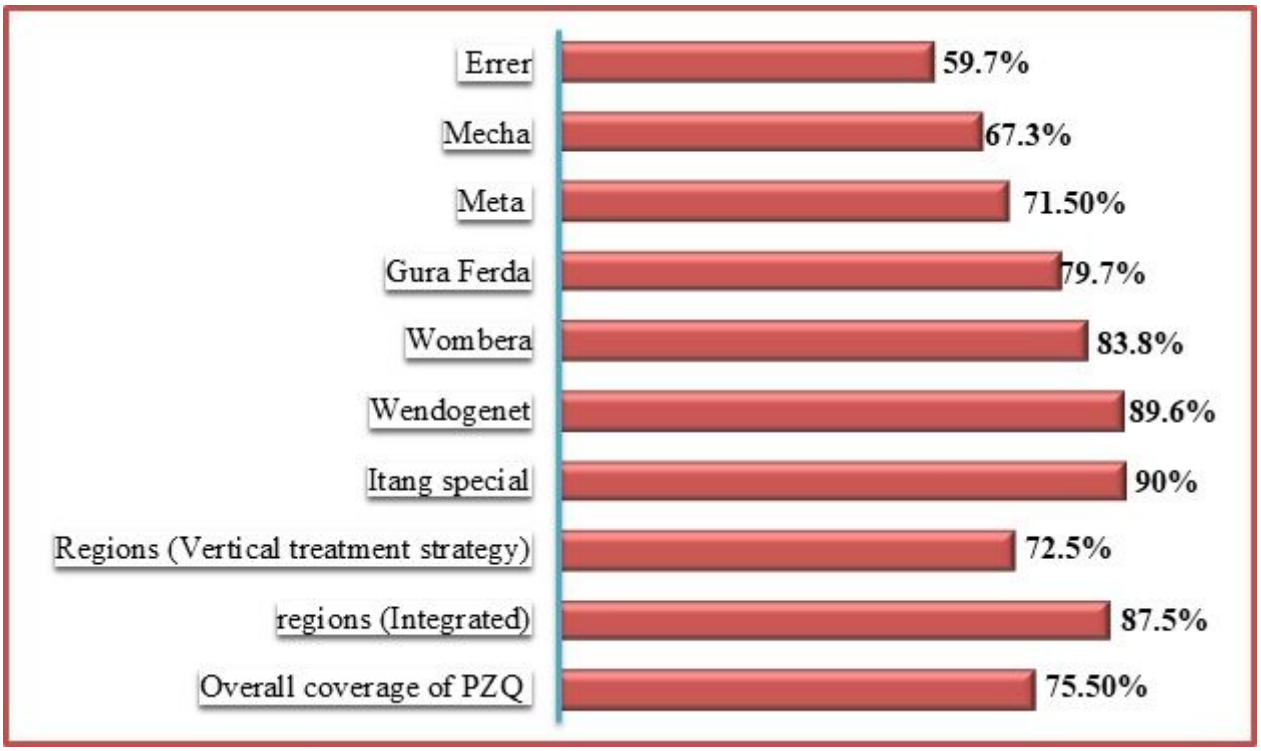

Figure 2

District disaggregated treatment coverage of PZQ among SAC, in the sampled districts Ethiopia, 2019.

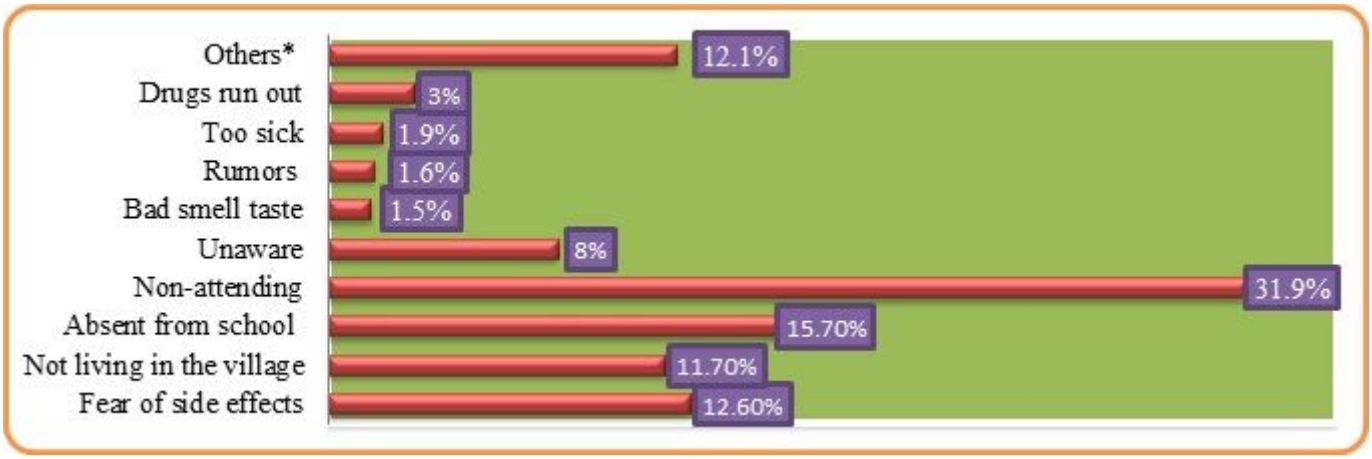

Figure 3

Professed reasons for not swallowing PZQ among SAC in study districts of Ethiopia, 2019. Key: Others*: not definite reasons stated, too far, no MDA, not eaten food, not invited

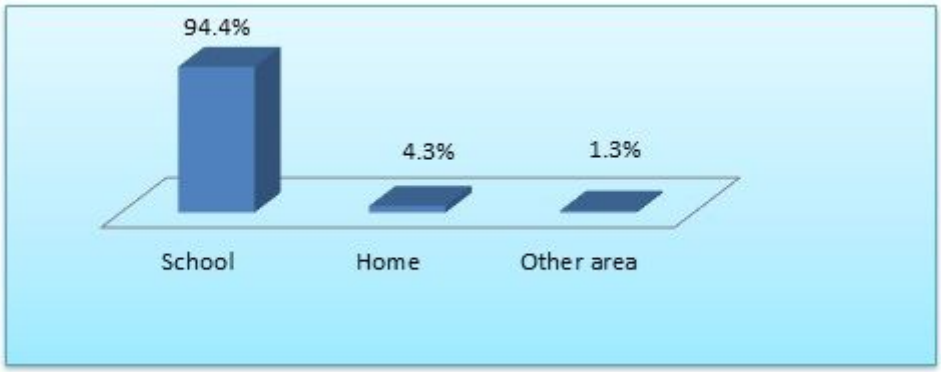

Figure 4

Distribution sites of PZQ against SCH in selected districts of Ethiopia, 2019. Key: Others*: Village head house, Central point, Local health center

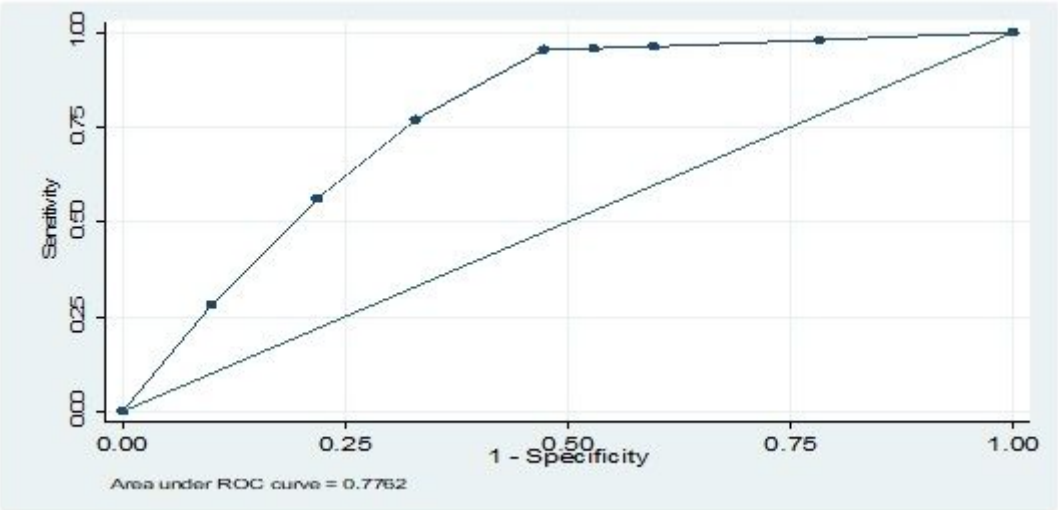

Figure 5

ROC curve showing prediction performance of variables in the final fitted model on swallowing or acceptance of PZQ among SAC, sampled districts, Ethiopia, 2019

Supplementary Files

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- Equation.pdf