

THE RWANDA NTD CONTROL PROGRAM



COST EFFECTIVENESS EVALUATION OF MASS DRUG ADMINISTRATION FOR SOIL-TRANSMITTED HELMINTHS & SCHISTOSOMIASIS

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TABLE OF CONTENTS

INVESTIGATORS	2
TABLE OF CONTENT.....	3
LIST OF ABBREVIATIONS.....	4
ACKNOWLEDGMENTS.....	5
1. INTRODUCTION AND BACKGROUND	6
1.1 Overview of the MDA intervention.....	7
1.2 Justification the study..	8
1. Potential use of the study findings.....	9
2. DATA COLLECTION AND METHODS	9
2.1 Overview	9
2.2 Perspective.....	10
2.3 Effectiveness.....	10
2.4 Cost analysis	10
2.5 Datta collection.....	11
2.6 MDA intervention cost	12
2.7 Cost effectiveness analysis	12
2.8 Sensitivity analysis.....	12
2.9 Ethical clearance.....	13
3. FINDINGS AND RESULTS.....	14
3.1 Total program cost.....	15
3.2 Cost per child treated.....	15
3.3 Effectiveness and cost effectiveness	15
3.4 Sensitivity analysis	16

3.5 Finding from qualitative datta collected	17
4. DISCUSSIONS.....	19
5. LIMITATION OF THE EVALUATION STUDY	23
6. CONCLUSIONS AND RECOMMENDATIONS.....	26
7. REFERENCES.....	28
ANNEXES.....	30

LIST OF ABBREVIATIONS

MDA – Mass Drug Administration

MOH - Ministry of Health

NTD - Neglected Tropical Diseases

STH - Soil-Transmitted Helminthes

UNFPA- United Nations Fund for the Population

UNICEF- United Nations Children’s Fund

USAID- United States Agency for International Development

WHO- World Health organization

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1. INTRODUCTION AND BACKGROUND

Neglected Tropical Diseases (NTDs) are disabling, disfiguring and sometimes deadly diseases that impact 1.4 billion people living on less than \$1.25 a day [1]. These 13 parasitic and bacterial infections are the most common afflictions of the world's poorest people. Spread by mechanisms as simple as a bite of an infected fly or contact with contaminated water, they blind, disable, disfigure and stigmatize their victims, trapping them in a cycle of poverty and disease. In many endemic countries, at least half of the population tends to be infected with one of these parasites. Most of the burden tends to fall on school children who tend to have relatively high prevalence and intensity of infection with round and whip worm and highest intensity with intestinal schistosomiasis.

Fortunately, there are highly cost-effective, proven interventions for the seven most common NTDs that account for 90% of the total NTD disease burden [1]. Evidence shows that reducing the burden of NTDs contributes substantially to development through ensuring children stay in school, improve child and maternal mortality, and increasing productivity of the workforce.

The Rwandan Ministry of Health (MOH), in collaboration with its health sector development partners including Access Project over a period of 2 years have built a program to effectively reduce the suffering caused by NTD's. Targeting the most common NTD, Soil-transmitted Helminths (STHs), which affected 65.8% of school-going children and schistosomiasis *mansoni*, which affected 2.7% of the same group [2]. To address this health risk, the main health intervention used in the MOH program is Mass Drug Administration (MDA) with albendazole and praziquantel.

The key objective of NTD Control Program is to decrease the morbidity and mortality due to 5 NTDs (STHs, schistosomiasis, trachoma, lymphatic filariasis and onchocerciasis) to levels where the diseases are not of public health significance.

The strategies of the program include;

- Establish the magnitude of NTDs in Rwanda
- Develop national capacities for NTD control
- Ensure proper management of cases
- Strengthen preventive measures and Behavior Change Communication
- Strengthen epidemiological surveillance

Results from the past two years of implementation reveal that more than four million people nationwide were treated for STHs and schistosomiasis. The NTD Control Program under MOH has registered a tremendous decrease in prevalence and intensity of STHs and schistosomiasis in school age children, hence the need to conduct cost-effectiveness study evaluating the MDA intervention. Cost-effectiveness analysis has previously been used in assessing feasibility and affordability of MDA of anthelmintic programs.

The objective of this study was therefore to determine the potential cost effectiveness of the MDA for STHs & schistosomiasis in Rwanda. This will help to compare the magnitude and value of inputs and outputs in order to evaluate the economic efficiency of this intervention.

1.1 Overview of the MDA Intervention

In 2007, the Rwandan Ministry of Health, in collaboration with its health sector development partners mainly Access project launched a national NTD control program to effectively reduce the suffering caused by NTD's. Implemented through the MOH, the programme provides anthelmintic treatment to schools and communities at risk of morbidity due to helminthes. In brief the program was implemented through district hospitals, health centers supported by district hospitals and schools supported by health centers. The program comprises the following activities: health education and mobilization, training of teachers and facility heads, field supervision and school-based delivery of two drugs. Mass drug administration with praziquantel to treat schistosomiasis and albendazole/mebendazole to treat STHs was given to schools in all intervention

districts. However, much as the schistosomiasis existed in the districts evaluated, not all school children received praziquantel as the disease distribution is only localized near the lake regions. Drugs were picked from the national MOH offices by district hospitals and distributed to supported health centers. Treatment in schools was carried out by teachers who were trained at the district hospitals.

The MDA is integrated within the Mother and Child Health (MCH) week, whereby a number of activities are undertaken. An intervention package offered comprise of vaccination (catch-up of dropout children of less than a year of age and pregnant women whose vaccination status lags behind), Mebendazole/Albendazole de-worming for the children between 12 months to 16 years and breastfeeding mothers, Praziquantel de-worming for the children of 5 to 16 years in the bilharzias risk zones, Vitamin A supplementation to the children between 6 to 59 months and breastfeeding mothers, Iron and folic acid supplementation to pregnant women thus offering contraceptives to women who need it.

The implementation of these activities is supervised by a committee comprised of officials from MOH and partners such as; UNICEF, WHO, the Global Fund, Access Project, UNFPA and USAID. These partners make various contributions to the different activities during the MCH week. With regard to the MDA, Access Project is the main partner that makes contributions in form of drugs for school age children and adults at high risk of STHs and schistosomiasis, supervision costs of some districts and supply of IEC materials.

1.2 Justification of the study

The treatment of STHs and schistosomiasis contributes heavily to the children's nutrition and growth, which in turn lead to increased mental and cognitive development, improved school enrolment and performance and subsequently to better productive capacity in adulthood. Deworming with praziquantel and albendazole/ mebendazole is, therefore, regarded as an investment in human capital as part of a poverty reduction campaign as well as a health improvement

strategy and is becoming a priority of national governments. The proposed study seeks to evaluate the MDA intervention with the hope that the evaluation outcome will contribute to a better understanding of whether the MDA intervention was cost effective.

1.3 Potential Use of the Study Findings

The main use of the findings from the evaluation is to inform the partners concerned of how effective this intervention has been compared to other similar interventions in the region. The findings will reveal the estimated cost per child treated and the effect of the treatment. It also provides some guidance on data capture and recording to facilitate future cost effectiveness evaluations. This evaluation is the first of its kind to be undertaken, and thus provides a basis of undertaking such assessments. The evaluation reveals strengths and weaknesses of an integrated approach, identified at both national and district level.

2. DATA COLLECTION AND METHODS

2.1 Overview:

The costing analysis was carried out following the ingredients approach. This approach involved identifying all constituent resource items involved in the MDA intervention, assigning them their economic cost and aggregating them to obtain the costs of implementing the program. The basic format used was to compare all the inputs into the MDA of STHs and schistosomiasis against the outputs and outcomes from the project for the year 2009. Costs involved in the start up phase of the program including furniture, vehicles and computers were also included apportioned accordingly based on a 3% discount rate. Expenditure and salary data was collected retrospectively through interviewing key national officials involved in the MDA intervention including staff from the Access project, TRAC *Plus*, MOH, UNICEF and key district and schools personnel. Data collection was carried out nationally and in three of the intervention districts during the months of April and May 2010. The districts, health centres and schools visited were purposively selected in order to obtain detailed and relevant data on the costs and effectiveness of the MDA intervention.

2.2 Perspective:

The perspective adopted was that of the provider, in this case the government, rather than society, since the costs of accessing STHs and schistosomiasis were considered negligible as the targeted children were mainly treated in their own schools.

2.3 Effectiveness

Evidence of the program effectiveness was measured in terms of anemia cases averted, which help to determine how many anemia cases have been averted as a result of the MDA intervention. This measure was also chosen to enable the comparison of effectiveness in the Rwanda MDA intervention with other published estimates and studies since anemia cases averted is the most commonly used effectiveness measure.

To estimate the annual cases of anemia averted, we used epidemiological data collected through longitudinal surveys of selected schools within the first two years of MDA intervention implementation. For purpose of this study, anaemia was defined as haemoglobin concentration (Hb) <11g/L. The number of cases of anaemia averted was determined by multiplying the absolute difference in proportion of anaemia cases averted between the first two years of the intervention by the total number of children treated. The cases averted were calculated on a district-by-district basis, as well as, overall assuming the mean difference in proportion of anaemia cases averted among districts.

2.4 Cost Analysis

Both financial and Economic costs of the intervention were estimated in the study. Financial costs represent the cash expenditures paid out in implementing the MDA intervention activities at the National and local levels. However, we also considered a number of other important costs that were not reflected in the standard financial accounts. The economic costs included the opportunity costs of using existing MOH staff and school teachers as well as the annuitized capital costs, hence representing the true costs of the MDA intervention.

The opportunity costs of staff were based estimated using salary costs, based on Rwandan civil service pay scales for 2009. Building costs were estimated using rental costs. The cost of all drugs used during the intervention included cost, freight and insurance. All cost data recorded in Rwandan Francs was exchanged to US dollars (\$) using official average exchange rates of the 2009: 571.233 Rwandan Francs = US\$ 1 <http://www.oanda.com/convert/classic>. Costs occurring after 12 months were discounted at 3% to reflect the notion that the economic value of resources diminishes with delays in their availability and use. Research Costs were excluded from the study but care was taken to include all costs related to supervision and monitoring of the implementation.

2.5 Data collection

All expenditure data, cost data, effectiveness data and general program implementation data was obtained from the various stakeholders involved in implementing the MDA for STHs and schistosomiasis using semi- structured tools. For all funding sources data collection included a review of program financial records and program documentation, and interviewing of key personnel for additional information. Existing cost and effectiveness data collection tools in NTD Control Program were adjusted for the purpose of recording costs and effectiveness data obtained from this study.

Program related expenditure was checked by the Access project staff, MOH personnel, district hospital accountants, and health center heads and crosschecked by the consultants for accuracy. During the analysis phase all costs incurred at national level were averaged out to the intervention districts and added to the MDA program costs at the district level. Supervision costs from the national level to the districts where aggregated at the district level.

There was also use of Focus Group Discussions (FGDs) and Key informant interviews to collect qualitative information with regard to the distribution of drugs in school children. The people interviewed were mainly teachers,

community health workers, supervisors at district level, heads of district hospitals and some key personnel working with various partner institutions.

These interviews were conducted in each of the districts visited. The main interest was to know how drugs were administered, how long it took to administer the drugs at schools, and what kind of changes have been observed before and after the program was introduced

2.6 MDA Intervention costs

The MDA cost data collected and presented in this paper were organised into different categories, including national supervision and monitoring costs considered as program running costs, local supervision and management costs at district and school level termed as program and running costs, training, IEC and Community mobilization, drug procurement and administration. Other recurrent costs involved in the program set-up included trainings at national and district levels, office equipment and community sensitization.

2.7 Cost-effectiveness analysis

Effectiveness of the study was assessed in terms of:

- Cost per child treated per year
- Cost per anaemia case prevented
- Cost per heavy infection averted

The counterfactual for the purpose of this cost-effectiveness analysis of MDA with Albendazole and Praziquantel was defined as 'do nothing' since prior to the current control program, no efforts were made to control STH and schistosomiasis in the country. Outcome measures were cost per child treated per year, cost per case of anaemia averted, and the cost-effectiveness ratios presented were based on annual economic costs and anaemia cases averted.

2.8 Sensitivity Analysis

Sensitivity analysis was carried out to allow for uncertainty within the cost-effectiveness study on both the costs and effectiveness. A one-way sensitivity analysis was undertaken to assess the impact of key variables on estimates of the

cost per anaemia case averted. Sensitivity analysis was undertaken to investigate the effect on the results of varying the effectiveness of treatment in reducing the proportion of anemia cases (reduced to reflect differences in the impact of treatment on anemia in different transmission settings, and effect of anemia cases in high altitude places), the discount rate, and prices of the intervention drugs (reduced by 20% and increased by 20% to reflect the use of cheaper drugs in the future and slightly more expensive drugs).

2.9 Ethical clearance

Ethical clearance for the cost analysis, as well as the data from the year one follow up survey in sentinel sites, has been sought from the Rwanda National Ethics committee.

3. FINDINGS AND RESULTS

3.1 Total Program costs

The economic cost of the intervention was calculated by valuing cost of teacher's time and other program officials to provide an equivalent annual cost at the district level. Table 1 presents the economic costs of the MDA intervention in each district by major cost components.

The total economic cost was estimated at: US\$ 27,810 in Musanze district, US\$ 26,749 in Burera district and, US\$ 30,628 in Nyagatare.

In most of the districts, the large cost component consisted of the drugs ranging from 21.02%, 36.31% and 32.59% of total costs in Burera, Musanze and Nyagatare, respectively. This was followed by the cost of teachers' time, ranging from 31.52% of total costs in Burera district, 27.50% in Musanze district and 28.17% in Nyagatare district.

Table 1 Comparative Economic Costs (2009 Prices) of anthelmintic treatment by major cost categories and percentage of overall costs by district in Rwanda, 2009

		Cost (US\$)	%
Burera	Start-Up costs	83	0.31%
	Training	1,257	4.70%
	Communication and IEC	1,133	4.23%
	Cost of Drugs	5,623	21.02%
	Program running Costs	1,976	7.39%
	Drug distribution expenses	8,246	30.83%
	Opportunity costs for teachers time	8,431	31.52%
	Total costs	26,749	
Musanze	Start-Up costs	83	0.30%
	Training	894	3.21%
	Communication and IEC	1,133	4.07%
	Cost of Drugs	10,097	36.31%
	Program running Costs	1,976	7.11%
	Drug distribution expenses	5,980	21.50%
	Opportunity costs for teachers time	7,647	27.50%
	Total costs	27,810	
Nyagatare	Start-Up costs	83	0.27%
	Training	849	2.77%
	Communication and IEC	1,133	3.70%
	Cost of Drugs	9,982	32.59%
	Program running Costs	1,976	6.45%
	Drug distribution expenses	7,978	26.05%
	Opportunity costs for teachers time	8,627	28.17%
	Total costs	30,628	
Total costs	85,187		

3.2 Cost per child treated

The overall average cost per child treated in the three districts of Burera, Musanze and Nyagatare was estimated at US\$ 0.24. The economic cost per child was estimated at: US\$ 0.24 in Musanze district, US\$ 0.27 in Burera district and US\$ 0.22 in Nyagatare district. There was no considerable variation in the economic costs per child treated between the districts reviewed.

Table 2: Estimated Economic Cost per child treated of NTD control by district in Rwanda in 2008-2009, including the valuation of staff time using salary costs

District	USD (\$) 2009 Prices
Burera	0.27
Musanze	0.24
Nyagatare	0.22
Overall	0.24

3.3 Effectiveness and cost-effectiveness

In the statistical analysis of data from the year one follow-up study in the sentinel sites for longitudinal monitoring of STHs and schistosomiasis in Rwanda, the MDA was associated with a significant reduction in the proportion of children that are anemic overall. The study traced and followed up a total of 2,166 school children after two rounds of albendazole treatment and one round of praziquante treatment. Anemia defined as Hb<11g/dl, overall as a result of the MDA fell from 16.1% to 13.7% in 2009, following 1 round of treatment with praziquantel and 2 rounds of treatment with albendazole.

In the districts included in the evaluation, the MDA intervention was associated with a significant reduction in proportion of children that are anemic in Nyagatare and Musanze districts. Similarly the program was associated with a reduction in proportion of heavy infections in the districts of Musanze and Nyagatare. Table 3 reports details of proportion of anemia cases averted and cases of heavy infection averted within the study population.

Overall, 350,342 children were treated in the three districts at an estimated average economic cost of US\$ 6.61 per case of anemia averted (this is an average for two districts shown in table 3). In other words, US\$ 6.61 was spent by the program for every case of anemia averted. Similarly, the average cost per case of heavy infection averted was US\$ 8.09 based on two districts that had reliable effectiveness data. In other words, US\$ 8.09 was spent for every case of heavy infection averted. Cost-effectiveness based on cases of anemia averted ranged from US\$ 4.66 in Nyagatare to US\$ 12.30 in Musanze. The corresponding cost-effectiveness based on cost per case of heavy infection averted ranged from US\$ 4.45 in Musanze to US\$ 31.61 in Nyagatare.

Table 3: Proportion of cases averted and cost per anaemia case averted as a result of the NTD control program in two districts in Rwanda

District	Total Number Treated	Prevalence (%) of anaemia at baseline	Prevalence (%) of anaemia follow-up	Cost (US\$) per anaemia case prevented
Nyagatare	138,416	13.80	9.05	4.66
Musanze	113,323	2.20	0.20	12.30
Average				6.61

Table 4: Proportion of cases averted and cost per case of heavy infection averted as a result of the NTD control program of districts in Rwanda

District	Total Number Treated	Prevalence (%) of high infection at baseline	Prevalence (%) high infection at follow-up	Cost (US\$) per heavy infection case prevented
Nyagatare	138,416	0.70	0.00	31.61
Musanze	113,323	6.32	0.80	4.45
Average				8.09

3.4 Sensitivity analysis

The variables used in the sensitivity analysis and the effects on the overall costs and cost-effectiveness are shown in Table 5. If the price of drugs used is reduced by 20% to reflect future reductions in price of anthelmintics drugs the cost per

anemia case averted reduces from US\$ 6.61 to US\$ 6.23. If increased by 20% to reflect possible future increments in price of drugs, the cost per anemia case averted increases slightly from US\$ 6.61 to US\$ 7.06. Overall, changes in drug prices have negligible effect on overall economic cost per anaemia case prevented in the districts reviewed.

Lower levels in the effectiveness of the MDA were associated with higher cost-effectiveness ratios and similarly cost-effectiveness depended most on the background prevalence of anemia: By raising prevalence of anemia to 20% to reflect higher baseline levels of anemia, the cost per anemia case averted falls favorably to US\$ 1.55 per anaemia case averted, and by altering the baseline to 30%, the cost per case of anemia case averted falls significantly to US\$ 0.93. Lower levels of effectiveness of the intervention in terms of low cases of anemia were associated with the worst cost-effectiveness ratios. Cost-effectiveness depended significantly on the background prevalence of anemia and on the background prevalence of heavy infection in children before treatment.

Table 5: Sensitivity analysis variables and Outcomes

Variable	Revised values in Analysis	Average Cost per Case of Anaemia averted(US\$)	Adjusted Cost per Case of Anaemia averted(US\$)
Drug price	Baseline Reduced by 20%, Increased by 20%	6.61	6.23 (Reduced by 20%), 7.06 (Increased by 20%)
Baseline anaemia prevalence (%)	Baseline Increased to 20% and 30% to reflect variations in settings and environments	6.61	1.55 (Prevalence raised to 20%), 0.93 (Prevalence raised to 30%)

3.5 Findings from qualitative data collected

Some helpful information was gathered through Focus Group Discussions (FGDs) and key informant interviews conducted at the district level which involved supervisors, heads of district hospital and teachers, and conducted at both the national involving various partners. The outcome of the focus group discussion

depended on the location of the school, vulnerability of the children, and the size of staff for each school visited.

FGDs with teachers:

Overall, the teachers reported significant decrease in absenteeism, parents report to teachers of increased appetite, and decrease in abdominal pain and abdominal swelling. There were a few reported cases of abdominal pains and nausea associated with drug prescription.

FGDs involved the community health workers and supervisors:

The health community workers involved in supervision of drugs distribution reported that the current approach of training and sensitizing all community health workers in a given sector, yet a few are usually hired during the MCH week has some negative consequences. It leads to low concentration and commitment by the participants during the training because none is sure if they will be hired. The realistic approach is to train only those who are to be used.

It was also observed that there in some places there is poor planning by supervisors at the district hospital with regard to the required drugs, this leads to underestimation or overestimation of the required amount of drugs. In the case of overestimation, there is wastage and underestimation of required drugs leads to some people missing drugs. Hence there is need to undertake detailed assessments of the target beneficiaries.

Key informants:

Some key informants like heads of district hospitals, suggested that some drugs should be supplied to district hospitals so that they are in position to administer the medication on day to day patients who are in need of the medication.

4. DISCUSSIONS

The costs and effects of school-based control of helminth infection have been estimated previously in some studies [3-6]. This study adds to the body of knowledge of existing studies that have investigated the cost-effectiveness of MDA of STH and schistosomiasis under a school based control program using praziquantel and albendazole and suggests that the MDA intervention is a potentially cost-effective strategy. The overall economic cost per child treated was US\$ 0.24(range 0.22-0.27), and the cost-effectiveness was US\$ 6.61(range 4.66-12.30) per case of anemia averted and US\$ 8.09 per case of heavy infection averted.

Few studies, however, have looked at the cost-effectiveness of school-based control of STH and schistosomiasis under nationwide programmatic conditions [6, 7]. The first study to explicitly document costs and effectiveness of a nationwide school-based control helminth control program was carried out in Uganda [6]. This study estimated the cost per child treated ranging from US\$ 0.41 to US\$ 0.91 at varying outputs. The corresponding cost –effectiveness values in the intervention districts ranged from US\$ 1.70 in one district to US\$ 9.51. Similarly, in Burkina Faso, a crude micro-costing of total costs of a combined school-based and community based national control program earlier estimated the financial cost per child of providing praziquantel and Albendazole to school going children at a unit cost of US\$ 0.32 [7].

Differences in method of implementation, target population, locations, and methodology applied, outcome measures and assumptions make it very difficult to compare these results with other school-based national delivery programs. Generally, the cost-per child treated estimates from this evaluation (US\$ 0.24 per child treated per year; 0.22-0.27) much lower than previous NTD control programs which suggests that the MDA delivery strategy applied was efficient. The financial cost per child treated was estimated between US\$ 0.24 and US\$ 1.22 in Ghana and US\$ 0.23 and US\$ 0.79 in Tanzania using praziquantel and Albendazole respectively [3, 4], US\$ 0.39 in schools and communities within

Uganda [6], and US\$ 0.32 in Burkina Faso [7]. The corresponding economic cost per child treated was estimated between US\$ 0.27 and US\$ 2.94 in Ghana, US\$ 0.26 and US\$ 1.32 in Tanzania using praziquantel and albendazole respectively [3, 4], US\$ 0.54 in schools and communities within Uganda [6]. However, the studies in Ghana and Tanzania had additional costs as a result of prior screening of urinary schistosomiasis in schools and generally used proprietary drugs and not generic drugs that could have led to higher costs. The study in Uganda was carried out comprehensively and included start-up costs and central costs in their analysis which were not included in the studies carried out in Ghana and Tanzania.

Table 6: Documented NTD Costing Studies conducted in Africa

Study	Program Description	Economic Cost (US\$) per child treated (2009)
Brooker et al., 2008, Uganda	Nationwide –MDA school based, vertically implemented through vector control division in MOH.	0.54 (0.41-0.91)
PCD Ghana, 1998	School based targeted treatment, include prior screening at school level	0.27 – 2.94
PCD Tanzania, 1999	School based targeted treatment, include prior screening at school level	0.26 – 1.32
Gabriel et al., 2006, Burkina Faso	Nationwide -School based and Community based, vertically implemented through MOH	<u>0.32*</u>
Access Project Rwanda MDA Evaluation	Nationwide- Integrated MDA School-based	<u>0.24 (0.22-0.27)</u>

In terms of cost-effectiveness, previous estimates for helminth control use a variety of outcome measures, including cost per anemia case averted and cost per death averted or cost per disability adjusted life year (DALY) averted. The impact of MDA on outcomes specific to estimating the DALYs in STH and Schistosomiasis control was not assessed during this program and therefore more intermediate health outcome measure anaemia was selected since it was more epidemiologically relevant outcome in children and some data had been collected during a survey in the first year of the MDA intervention. The choice of

anaemia also enables data from this study to be compared to data from other MDA school-based interventions.

Regarding cost-effectiveness, a study in Uganda, found that the cost effectiveness of school-based anthelmintic treatment (using albendazole and praziquantel) ranged between US\$ 1.70 and US\$ 9.51 per anaemia case averted in six districts [6]. Similarly a study as part of the Tanzania NTD control program reported the cost per case of anaemia averted to be US\$ 7.43 using a school-based existing system [8].

Table 7: Documented cost-effectiveness studies for NTD control intervention in programs in different countries

Study	Program Description	Economic Cost (US\$) per anemia case averted (2009)
Brooker et al.,2008 (Uganda)	Nationwide -MDA school -based, vertically implemented through vector control division in MOH.	1.7 – 9.51
Guyatt et al.,2001(Tanzania)	Nationwide-school-based	7.43
Access Project Rwanda MDA Evaluation	Nationwide- Integrated MDA School- based	<u>6.61 (4.66-12.30)</u>

Results from this evaluation show that the cost per anaemia case averted will tend to vary where the need is greatest primarily in settings with high prevalence of anaemia. From the sensitivity analysis conducted on particular variables, cost per anaemia case averted is US\$ 1.55 in settings where background anaemia is assumed at 20% and US\$ 0.93 where background prevalence is assumed at 30% suggesting that areas with higher background anaemia prevalence prior to an intervention are associated with favorable cost-effectiveness ratios. Similarly the cost per heavy infection averted as a cost-effectiveness measure was not favorable for Nyagatare district which had very low background prevalence levels of heavy infection.

This evaluation has showed that the cost-effectiveness tends to vary with the reduction in the prevalence of anaemia and heavy infection among school going children. Generally, the cost per anaemia case averted depended on the effectiveness of the intervention. Districts credited with higher background prevalence of anaemia and heavy infection are more likely to have more favourable cost-effectiveness ratios in terms of cost per anaemia cases averted and lead to a cost-effective control program.

5. LIMITATIONS OF THE EVALUATION STUDY

Although this evaluation inferred that the reduction in the prevalence of anaemia was due to the intervention, there could be other potential factors responsible for the observed changes. Factors such as higher altitude could lead to detection of higher Hb levels and Hct levels than those at lower altitude. However, the values baseline values of anaemia detection were varied during sensitivity analysis to reflect the possible variations at lower levels. Further analysis would be required on the survey data from the sentinel sites in longitudinal monitoring of STHs and schistosomiasis in Rwanda in order to inform future estimates of cost-effectiveness on the study.

In addition, the cost per delivery per child are relatively low compared to similar studies carried out elsewhere since the disease distribution of schistosomiasis is only localized near the lake regions and as a result not all school children received praziquantel during the campaign.

Another limitation is that the number of anaemia cases averted is an intermediate health outcome, which does not reflect a universally comparable health outcome measure such as disability-adjusted life years (DALYs) or deaths. Estimation of alternative outcome measures such as quality-adjusted life years (QALYs) remains a challenge in a sub-Saharan African setting, where individuals suffer multiple health insults and are typically unable to distinguish between conditions [9, 10]. The use of DALYs on the other hand remains controversial especially in assessing the basis of converting observed changes in patterns of helminth infection into DALYs. As a result various assumptions have to be made that can be questionable. As indicated by Brooker et al., 2007 in their study in Uganda, another alternative outcome measure could be the proportion of individuals harboring a heavy infection [11] since morbidity is associated with prevalence of heavy infection. However, these units are specific to individual helminth species, making the definition of a single, multiple-species threshold impossible. Therefore the comparison of the cost-effectiveness of the MDA of STHs and schistosomiasis in relation to other school-based helminth control

programs and public health interventions requires a more universal unit. The advantage of measuring cost-effectiveness in terms of anaemia is that it is an outcome measure that can easily be assessed and has previously been used to evaluate school-based helminth control programs and other tropical disease interventions.

Other limitations encountered in this evaluation included the following:

1) The national level data collection from the organizations that supported the intervention:

MDA intervention was implemented by MOH in partnership with various organizations mainly Access Project, UNICEF, UNFPA, USAID and WHO. Each organization contributed resources to implement the intervention but Access Project was the main responsible of it. Different data collected from these organizations had to be adjusted to reflect the level of support resources from each organization.

2) Field data collection at the decentralized levels: districts and conducting the Focus Group Discussion in schools:

Cost and personnel's time allocation to the intervention was collected from both the central and decentralized levels. At the decentralized level, field data collectors visited district hospitals and schools that benefited from the intervention. Cost of personnel's input at district, health centers, and schools were estimated based on the percentage of time input to implement the intervention. The main limitation was to have fair estimate of the time since personnel were involved in various interventions. To have a fair estimate, we took the number of days taken off during implementation and follow up versus total dedicated time to implement other interventions.

Additionally, focus group discussions were conducted in each of the districts visited. Our main interest was to know: the process of drug administration, how long it took teachers to distribute the drugs at schools, and what kind of changes have been observed before and after the intervention was introduced. The main

limitation was that some focus group discussion had varying outcomes because of different school staffing levels (e.g. if a school has more staff, the cost to implement the program will decrease), and therefore we had to adjust and make averages to fairly estimate how much of the teachers' time was invested to administer the drugs and report the program outcome data to the health centers.

3) Estimating the cost of transportation of drugs between the district hospitals and health centers and between health and schools posed some limitations:

Drugs were transported from the central level to district hospitals using district vehicles while from district hospitals to the health centers and from health center to schools, drugs were transported using motorcycles. The major transport limitation was estimating the cost of transport between district hospitals and health centers and between health centers and schools because of varying distances. To get a fair estimate of transport cost, we took the furthest and closest points between district hospital and health centers and between health centers and schools and divide by two to have average cost.

6. CONCLUSIONS AND RECOMMENDATIONS

The overall cost per anaemia case prevented of US\$ 6.61 (range US\$ 4.66-12.30) suggests that the Rwandan MDA strategy is a cost-effective strategy. The corresponding overall value of cost-effectiveness based on cases of heavy infection averted was less favorable at US\$ 8.09 per case of heavy infection averted primarily because of the very low background baseline values of heavy infection prevalence in Nyagatare district.

However, the results of this analysis show that the Rwanda MDA nationwide program in school based children falls within the range of the per capita costs of other NTD control treatment strategies [3, 4, 6] that suggest school based delivery of simple treatments is low cost approach. Furthermore, the simultaneous delivery of the NTD control program through MDA in schools alongside other health interventions yields cost savings.

The prevalence of anemia was generally low in Rwanda compared to other studies carried out in other countries based on the year one follow-up survey in sentinel sites for longitudinal monitoring of STHs and schistosomiasis which led to less favorable cost per anaemia case averted that would be achieved in a setting with relatively higher levels of anaemia. Similarly, the alternative outcome measure used of cases of heavy infections averted was relatively low particularly in Nyagatare district.

Generally, the results show that the cost-effectiveness of the Nationwide MDA strategy is sensitive to particular variables including, the number of children treated, baseline prevalence in anemia and heavy infection among school children. This is indicative that MDA strategy is likely to be most cost-effective where the anemia is widespread and heavy infection among school children is wide spread and need is greatest.

Recommendations:

This evaluation provides a primary analysis of the cost-effectiveness of the Rwandan MDA strategy, albeit in only 3 districts out of the 30 intervention districts. We recommend a follow up cost-effectiveness study that will cover a more representative number of districts in order to reflect a more detailed cost-effectiveness analysis of the program in the different regions of the country.

In addition it would be helpful to capture comprehensively the contributions of other key partners both at the national and district levels who have contributed to the successful implementation of this project in order to assess the impact on the affordability of the MDA intervention.

Access Project could work with MOH to ensure costs by the different partners in relation to MDA are shared with MOH in order to have a centralized source of cost data to guide future work in cost-effectiveness analysis.

7. REFERENCES

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Annex 1: Persons met during the data collection

Nyagatare District

Director, Nyagatare Hospital
Supervisor of health services, Nyagatare Hospital
School Teachers at “Groupe Scolaire Cyabayaga”
School Teachers at Nyaruziba Primary School

Musanze District

Director, Musanze Hospital
Supervisor of health services, Musanze Hospital
Director of Administration & Finance, Musanze Hospital
Accountant, Musanze Hospital
Community Health workers in the district

Burera District

Supervisor of health services, Burera Hospital
Director of Administration and Finance
Head teacher
School Teachers at Musasa Primary School
Community health workers in the district

Annex 2: Data collection tools

Intervention Drugs - Recurrent

To be completed by economist in consultation with Program Manager(s).

Please note that the timeframe of this questionnaire = 1 year.

**Financial
(Cost) Year:**

DD/MM, YYYY - DD/MM, YYYY

**Date
completed:**

Organization and level:

(e.g. MOH at regional level, NGO at national level)

Item	Unit (e.g. tablet, vial, etc.)	Currency	Value of Object <i>Fill only one per item</i>		# of units	No of children treated in District	Funding or Donation Source	Additional cost: shipping/customs <i>(if not already included in cost/value per unit)</i>	Additional cost: repackaging/ in-country transport
			If purchased, cost per unit:	If donated, value per unit:					
Albendazole									
Azithromycin									
Mebendazole									
Mectizan									
Praziquantel									
Tetracycline ointment									
Other:									

Supplies - Recurrent

To be completed by economist in consultation with each funding source.

Financial (Cost)

Year: _____

DD/MM, YYYY - DD/MM, YYYY

Date completed: _____

INPUT	# of units	Annual Cost per unit	Allocation of Use (%)			
			A. Single intervention		B. Integrated interventions	
			% of time	Intervention Codes	% of time of MDA	Intervention Codes
Radio spots						
Community radio shows						
Height poles						
IEC Posters						
IEC Leaflets						
IEC booklets						
Materials Development/training manuals						
Banners						
Telephone expenses						
Haemoglobinometers						
Hemacue cuvettes						
Hemastix						
ICT card tests						
Ink for printers						
Lancets						
Materials Development/training manuals						
Office supplies (paper, pens, etc)						
Printing						
Reagents						
Stadiometers						
Stool/urine pots						
Telephone Calls						
Weighing scales						

Other Recurrent Costs

Item(If costs not available include in 10% of rental costs)	Value of Object <i>Fill only one per item</i>		Allocation of Use (%) A+B must equal 100%			
	If purchased, cost:	If donated, value:	A. Single intervention		B. Integrated interventions	
			% of time	Intervention Codes	% of time of MDA	Intervention Codes
BUILDINGS						
Cleaning						
Electricity						
Heating						
Insurance						
Operations & maintenance						
Rent						
Repairs						
Water						
Other						
VEHICLES/LOGISTICS/TRANSPORT						
Vehicle fuel & oil						
Motorcycle fuel & oil						
Insurance						
Maintenance (e.g. tires, oil change)						
Rentals						
Taxes						
Vehicle registration						
Other						
OTHERS						
National workshops						
National trainings						
District workshops						
District trainings						

Personnel - General Data				Financial (Cost) Year:			
<i>To be completed by economist in consultation with program manager and/or MOH personnel office.</i>						DD/MM, YYYY -	
						DD/MM, YYYY	
				Date completed:			
				Currency:			
				Organization and level: <i>(e.g. MOH at regional level, NGO at national level, etc.)</i>			

A. How much time was spent on MDA related Activities?(To be guided by retrospective questionnaire: Personel)

Salaried employees	Official Position Title	Interventions Involved in	Monthly gross base salary	Monthly benefits and emoluments*	# of Months worked per year	% Time on MDA	Total Cost to MDA
1							0
2							0
3							0
4							0
5							0
6							0
7							0
8							0
9							0
10							0
11							0
12							0
13							0
14							0
15							0

*Excluding per diem