Report

Angola: Mapping of Schistosomiasis and Soil-Transmitted Helminths. Pilot - Zaire Province

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A collaboration between:

Angolan Ministry of Health through the Neglected Tropical Disease Control Programme, and MENTOR Initiative

Cover photograph taken by José C. Sousa-Figueiredo at a Primary School in Soyo, Zaire Province

Photos in this report were a collaborative work between José C. Sousa-Figueiredo and Paul Monaghan

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Acronyms

ALB	Albendazole
CCA	Circulating cathodic antigen
EPG	Eggs per gram
LATH	Liverpool Associates in Tropical Health
LSTM	Liverpool School of Tropical Medicine
MDA	Mass Drug Administration
MoHSS	Ministry of Health and Social Services
NTD	Neglected Tropical Diseases
PZQ	Praziquantel
STH	Soil-Transmitted Helminths
WASH	Waster, sanitation and hygiene
WHO	World Health Organisation

1. Executive Summary

Schistosomiasis and Soil-Transmitted Helminth (STH) infections, four of the most common Neglected Tropical Diseases (NTDs) in sub-Saharan Africa, are thought to be endemic in Angola. With the availability of deworming drugs, the Government of Angola is now ready to start Mass Drug Administration (MDA) to treat school-age children with these infections. To better target this MDA intervention, an updated disease map is crucial for ensuring future cost-effectiveness. The pilot survey for the mapping was conducted in March 2014 using rapid and microscopy-based protocols. This included 1,680 students from 56 schools, representing a school sampling coverage of 1:4 schools in total. All sampled children were treated on site with praziquantel and albendazole and no significant numbers of adverse reactions were encountered. The distribution of urogenital and intestinal schistosomiasis in Zaire was found to be moderate and focalized, with all STH infections also largely present. The high quality disease map, with increased sampling density, will allow the government to better plan chemotherapy strategies at the provincial or municipality level, maximizing efficiency and minimizing drug wastage.

2. Introduction

Neglected Tropical Diseases (NTDs)—are a group of debilitating infectious diseases that contribute to extreme poverty. [1]According to the World Health Organization, more than one billion people—one-sixth of the world's population—suffer from one or more NTDs, which can cause disfigurement, disability, and even death. NTDs are called 'neglected diseases' because they have been largely wiped out in the developed world but persist only in the poorest, most marginalized communities and conflict zones. They thrive in places with unsafe water, poor sanitation and limited access to basic health care.

Schistosomiasis (snail fever) is a parasitic worm disease transmitted by freshwater snails.[2] It causes the highest mortality among the NTDs, but can be treated by drug therapy, which reduces the severity of lesions that result in chronic and life threatening diseases. Soil-transmitted helminth infections: Hookworm, ascariasis (roundworm) and trichuriasis (whipworm) are parasites that are ingested in contaminated food or water, or in the case of hookworm, exposure of the skin (often the feet) to larvae in contaminated soil. Infection can cause anaemia and malnutrition, as well as other more serious and/or fatal problems.[3]

Control of these infections has gained much international interest and political commitment since 2000, when the United Nations member states and 23 international organizations agreed on the eight Millennium Development Goals (MDGs). The World Health Organization (WHO) subsequently advocated that control of schistosomiasis contributes to the achievement of the MDGs, and in 2001 the World Health Assembly endorsed resolution 54·19 which recommends regular de-worming of school-aged children at risk of infection (http://www.who.int/inf-pr-2001/en/pr2001WHA-6.html).[4,5]

In the fight against these diseases of poverty, preventive chemotherapy campaigns are now the front-line intervention, administering safe, efficacious and low-cost anthelminthics, i.e. praziquantel (PZQ) for schistosomiasis and albendazole (ALB) for soil-transmitted helminthiasis (STHs).[6] In the past decade, several campaigns have been implemented throughout sub-Saharan Africa targeting school-children (six to 15 years old) and/or adults (over 15 years old) in high-risk occupational groups (e.g. fishermen).[7] To do so, precise mapping of the diseases at a country-level is crucial and usually the first step to take. Angola is now starting this process.

3. Background on the Angolan situation

Schistosomiasis and soil-transmitted helminth (STH) infections are believed to be endemic in Angola. The World Health Organization (WHO) estimates that all Angola children are at risk for STH and schistosomiasis (i.e. 5.2 million children).[8] However, these estimates are based on previous mapping initiative (2005) which covered only a few of the municipalities. While this may be sufficient for STH infections, it certainly is not for schistosomiasis, a far more focal disease. Due to this lack of up-to-date information, a mapping initiative was initiated in 2013. Due to the country's large size, sparsely located population and since this is a new type of activity by the Government, the protocol for the mapping of schistosomiasis and STHs in Angola calls for a phased approach. Figure 1 below shows these phases geographically, with Phase 1 covering the Zaire, Uige and Huambo Provinces.

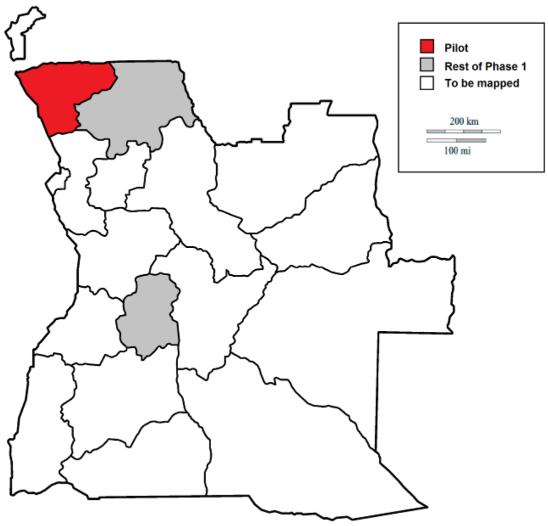


Figure 1: Map of Angola's governmental provinces with Zaire in red, Uige (North) and Huambo in grey

3.1. Objectives

The mapping protocol has the following primary objectives:

1. To understand levels of schistosomiasis and STH in Angolan school-aged children;
2. To identify the type(s) of schistosomiasis (intestinal or urogenital) endemic in Angola;
3. To establish a strategic plan for mass drug administration of albendazole and praziquantel at the school-level.

4. Methodology

Prior to setting out to the field, meetings were held in Luanda with representatives from the NTD programme of the Ministry of Health (Dr. Pedro Van-Dúnem and Dr. Alice Sicato). Importantly, key meetings were also held at the provincial level with the Public Health Department of Zaire Province. Prior to the field work, José Figueiredo held a training workshop from Mbanza Congo (Zaire Province) on schistosomiasis and STH, the morbidity caused by these diseases, their diagnosis, treatment and control. Participants included 16 Ministry of Health staff from provincial and municipality level, and three MENTOR provincial staff (Appendix 1). All Provincial and Municipal-level individuals were chosen with care, taking into account their current responsibilities and the field work to be undertaken. Capacity building at the point-of-contact is one of the priorities of MENOTR.

Fieldwork took place between the 23th of March and 2nd of April 2014. All municipalities were visited during the field work (Appendix 2 for pictorial representation of the province). At each school a questionnaire was conducted in the school principal's office relating to general knowledge, water, sanitation, hygiene and history of previous treatment (for full data entry form, see Appendix 3). All sampled children included in the survey were provided with praziquantel and albendazole by members of the mapping team. For more details on the methodology, please refer to the protocol document.

4.1. GPS mapping of schools

Mapping usually starts with random selection of a number of schools to be surveyed. However, in Angola we did not have a georeferenced Ministry of Education database. Therefore, before field activities for the mapping commenced, provincial MENTOR teams were deployed to collect the GPS coordinates for all schools. In association with the Provincial Direction of Health, GPD coordinates for all schools in the province were gathered, along with selected information for each school (number of students, contact details for school director). This enabled the structured random sampling of the schools, making sure geographical representation was achieved. This is of particular importance when mapping schistosomiasis, as the disease is highly focalized and dependent on water bodies. See below Figure 2 for the resulting structured random sampling.

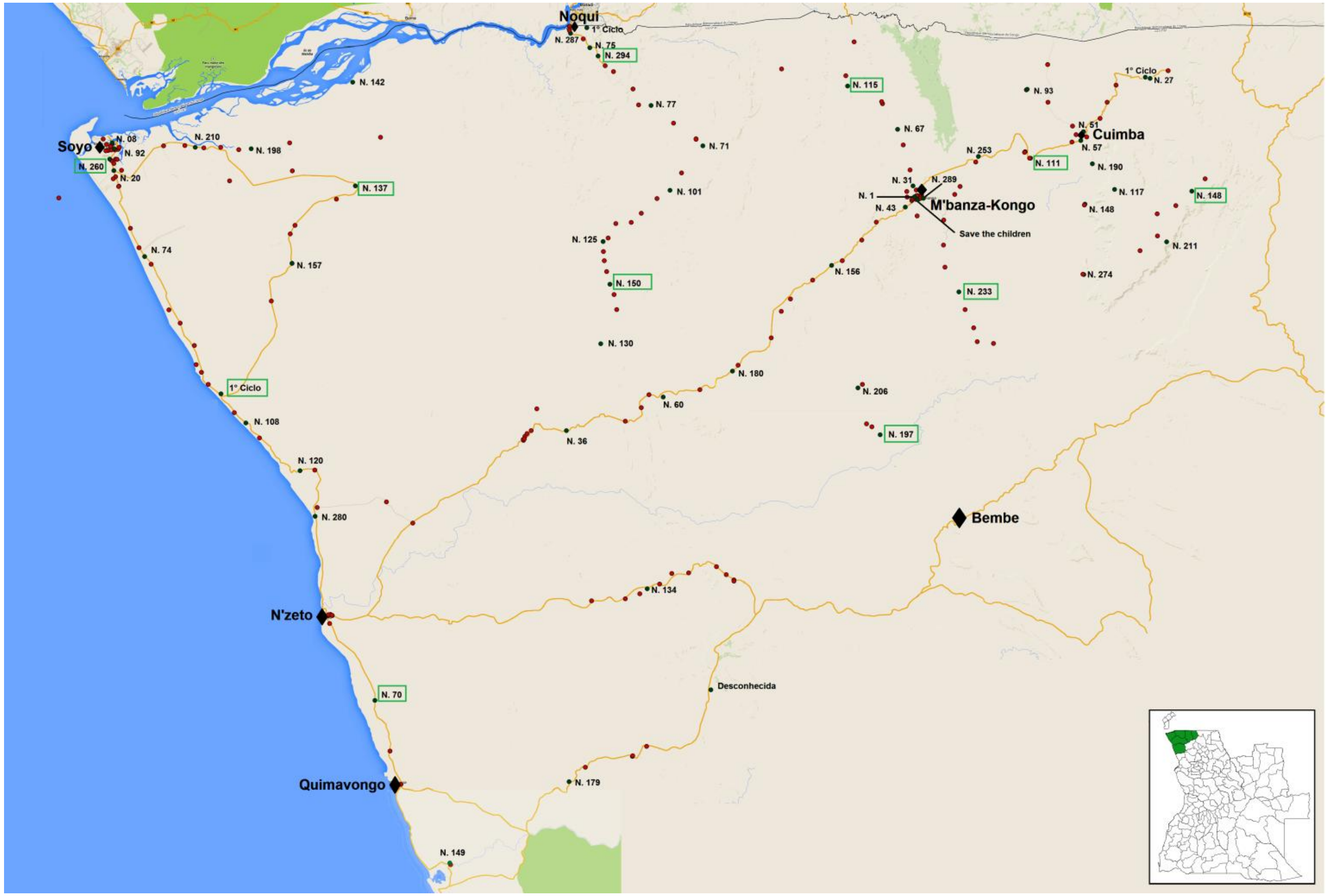


Figure 2. School selection for Zaire province. Schools covered the geographical length of the province, from Cuimba to Nzeto. All circles represent schools. Those in red were not selected; those in green were selected to be mapped using rapid diagnostic tests, and those in green with a green rectangle around them were selected to be mapped using microscopy.

4.2. Set up in the field

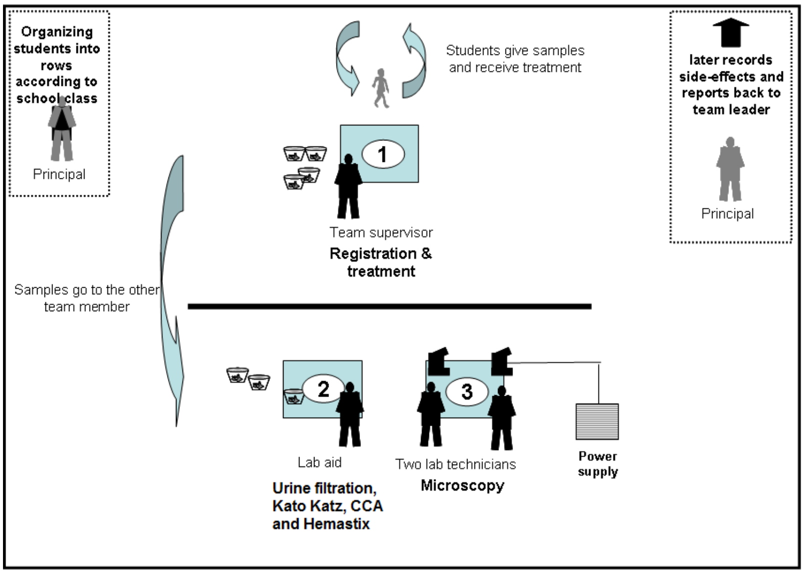


Figure 3: Schools surveyed with rapid diagnostic tests and microscopy. Team is composed of a team leader, one laboratory aid and two lab technicians. The team was mobile using a single 4x4 vehicle and spent a full day at each school for processing samples. The Questionnaire applied by the team supervisor can be seen in Appendix 3. This 'classical' surveillance method is to provide traditional epidemiological evidence to bolster directly findings from rapid diagnostic teams as shown in Figure 3.

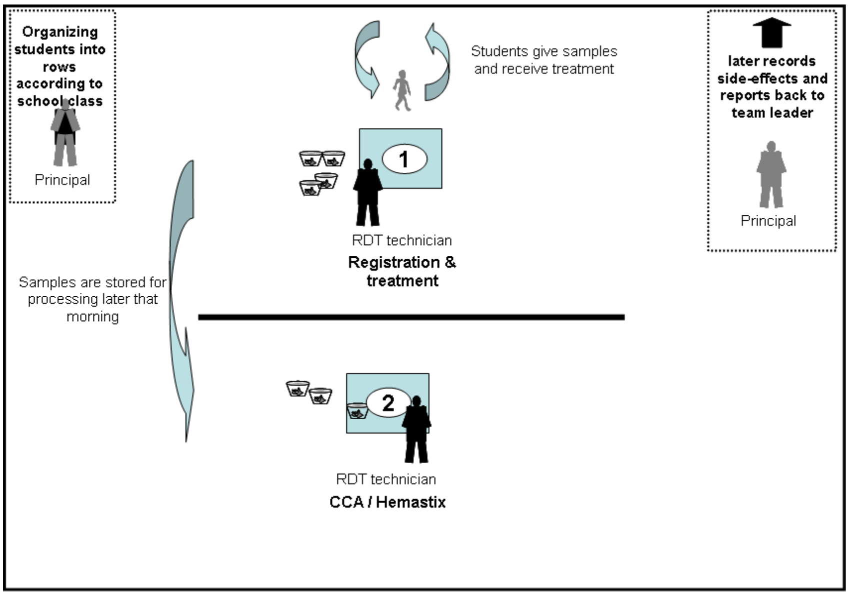


Figure 4: Schools surveyed by a rapid diagnostician. Team composed of a single person whom is dropped off at the school by a vehicle (meaning a single vehicle can carry four technicians and work at four schools each day). A working day is finished by lunch-time. The questionnaire applied can be seen Appendix 3. This rapid surveillance method follows from recent advances in state-of-art research in diagnostics.

5. Results

Of the 220 schools registered in Zaire Province (2013 MoE census), a total of 56 schools were visited by the mapping teams (i.e., sampling one in every four), 12 in Cuimba (31 available), 13 in Mbanza Congo (58 available), 9 in Noqui (29 available), 5 in Nzeto (18 available), 11 in Soyo (61 available) and 6 in Tomboco (23 available) (see Table 1). For a full list of the schools visited, please see Appendix 4.

Municipality	Total number of schools available	Total Mapped	Mapped by microscopy
Cuimba	31	12	2
Mbanza Congo	58	13	2
Noqui	29	9	2
Nzeto	18	5	1
Soyo	61	11	3
Tomboco	23	6	1
TOTAL	**220**	**56**	**11**

Table 1. Schools visited, according to municipality.

5.1. Questionnaire results

At each school, a questionnaire was implemented and data gathered informs us that overall 71% of schools had latrines; however only 21% had latrines in working condition, and only 14% of schools had a safe water source. In the schools with safe water source, 25% had access to tap water and 75% had access to borehole water.

Data gathered during the questionnaire informs us that coverage of this campaign was extremely high, with 86% of schools having received treatment in 2013 and 91% of schools having received treatment in the recent past.

Of the 56 head teachers questioned, 70% reported to know what schistosomiasis is, when in fact only 52% could correctly explain symptom, infection process and prevention. A few teachers reported blood in urine to be prevalent among their student population (27%) and almost all (89%)

acknowledged blood in urine to be a sign of disease. See Figure 5 and Table 2 for questionnaire results detailed by municipality and overall.

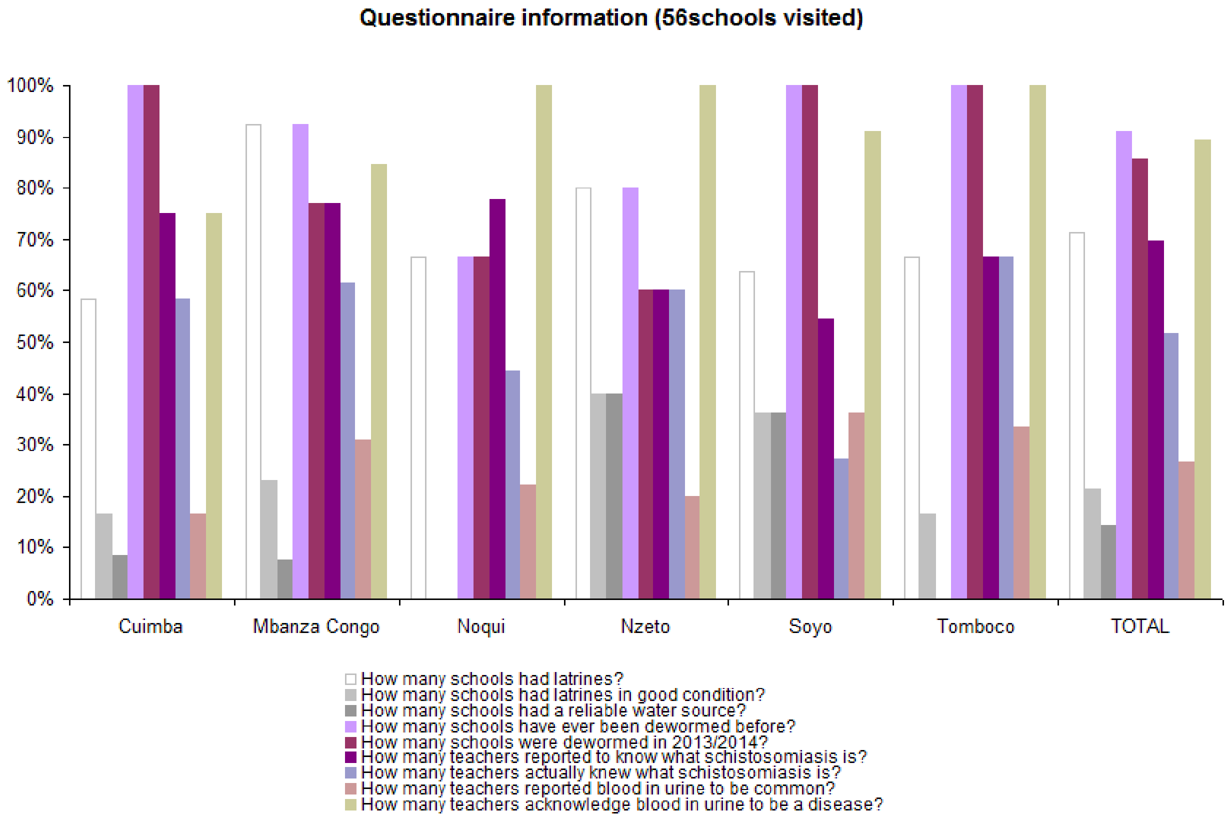


Figure 5: Percentage of positive responders to each questions (each bar colour) by municipality and overall.

		Cuimba	Mbanza Congo	Noqui	Nzeto	Soyo	Tomboco	TOTAL
Number of schools surveyed		12	13	9	5	11	6	56
Number of students surveyed		360	390	270	150	330	180	1680
How many schools had latrines?		58%	92%	67%	80%	64%	67%	71%
How many schools had latrines in good condition?		17%	23%	0%	40%	36%	17%	21%
How many schools had a reliable water source?		8%	8%	0%	40%	36%	0%	14%
Type of water source?	**Tap**	0%	0%	-	50%	25%	-	25%
	Borehole	100%	100%	-	50%	75%	-	75%
How many schools have ever been dewormed before?		100%	92%	67%	80%	100%	100%	91%
How many schools were dewormed in 2013/2014?		100%	77%	67%	60%	100%	100%	86%
How many teachers reported to know what schistosomiasis is?		75%	77%	78%	60%	55%	67%	70%
How many teachers actually knew what schistosomiasis is?		58%	62%	44%	60%	27%	67%	52%
How many teachers reported blood in urine to be common?		17%	31%	22%	20%	36%	33%	27%
How many teachers acknowledge blood in urine to be a disease?		75%	85%	100%	100%	91%	100%	89%

Table 2 - Results from the questionnaire

5.2. Population studied

In the 56 primary schools visited, 1,680 children were screened using rapid diagnostic tests for schistosomiasis. The mean age of students surveyed was 12 years and ranged between 5 and 22 years. There was an equal proportion of boys and girls in the survey (838 girls/842 boys). All children were recruited from primary school. Of these 56 schools, 11 schools were additionally surveyed using microscopy techniques with the main objective of detecting levels of soil-transmitted helminths. Intestinal and urogenital schistosomiasis were also diagnosed during microscopy surveys to confirm that rapid diagnostic tests were working correctly. A total of 330 students were included in this subset. All children surveyed were treated with albendazole (1680 tablets distributed) and praziquantel (4109 tablets distributed).

5.3. Schistosomiasis

Our data shows that schistosomiasis is prevalent in Zaire province, particularly so in Mbanza Congo municipality (see Figure 6). Prevalence of schistosomiasis (both intestinal and urogenital) was found to be 20% in Cuimba, 28% in Mbanza Congo, 16% in Noqui, 26% in Nzeto, 9% in Soyo and 2% in Tomboco (overall prevalence of 18%). See Table 3 below for further details.

Municipalities	No. schools	No. students	*S. haematobium* prevalence	*S. mansoni* prevalence	Prevalence of any *Schistosoma*
Cuimba	12	360	8.1%	13.6%	20.0%
Mbanza Congo	13	390	11.8%	21.0%	28.2%
Noqui	9	270	15.2%	1.5%	16.3%
Nzeto	5	150	22.0%	6.0%	26.0%
Soyo	11	330	8.5%	0.0%	8.5%
Tomboco	6	180	0.0%	1.7%	1.7%
TOTAL Zaire Province	56	1680	10.5%	8.8%	17.6%

Table 3: Number of students and schools involved in the rapid mapping per municipality. Prevalence values for urogenital and intestinal schistosomiasis.

It is important to note, however, that due to the nature of this infection distribution is often focalized or heterogeneous, and Angola is no exception. This will in turn affect the way we interpret the results. In this case for example, even though overall and municipality levels are moderate to low (<50%), we were able to identify higher foci of infection such as School no. 115 in Mbanza Congo (63% prevalence of *S. haematobium*) and School no. 253 in Mbanza Congo (70% of *S. mansoni*). See Appendix 6 for details on school-level prevalence.

As a proxy measure of urogenital morbidity, we assessed the number of children were urinating bloody urine (macro-haematuria), and final results reached 1% in Cuimba, 3% in Mbanza Congo, 0.4% in Noqui, 1% in Nzeto, 0% in Soyo and 1% in Tomboco (overall prevalence of 1%)

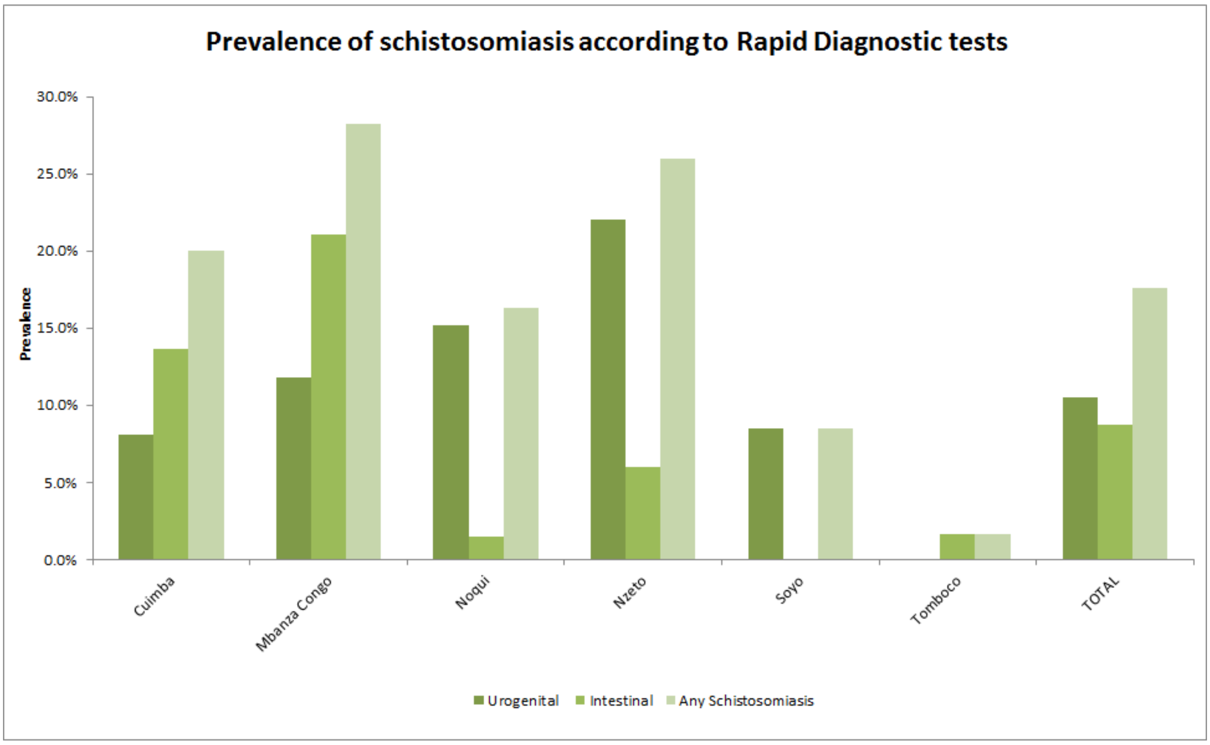


Figure 6: Prevalence of schistosomiasis (both types and any) according to rapid diagnostic tests in each of the municipalities and total. For actual data and confidence intervals, see tables in Appendix 4.

5.4. Soil Transmitted Helminth (STH) infections

All STH infections were identified in Zaire Province using microscopy. Prevalence of STH infections (any of the three) was found to be 20% in Cuimba, 12% in Mbanza Congo, 25% in Noqui, 7% in

Nzeto, 40% in Soyo and 20% in Tomboco (overall prevalence of 23.3%, with co-infection prevalence of 2.7%).

Hookworm, was fairly absent among school-children, with only Noqui municipality having significant levels of infection – 17% (overall prevalence of 4.1%). Likewise, *Trichuris trichiura* was largely absent, with recorded levels varying between 0% in Cuimba and 8% in Soyo (overall prevalence of 3%). *Ascaris lumbricoides*, on the other hand, was far more prevalent, with levels reaching 33% in Soyo (overall prevalence of 15%). See Figure 7 for graphical representation of prevalence levels recorded for STHs and Table 4 for further details.

Municipalities	No. schools	No. students	Hookworm prevalence	*Ascaris lumbricoides* prevalence	*Trichuris trichiura* prevalence
Cuimba	2	60	0.0%	20.0%	0.0%
Mbanza Congo	4	120	0.0%	8.3%	3.3%
Noqui	2	60	16.7%	11.7%	1.7%
Nzeto	1	30	0.0%	0.0%	6.7%
Soyo	3	90	4.4%	33.3%	7.8%
Tomboco	1	30	6.7%	13.3%	0.0%
TOTAL	**11**	**330**	**4.8%**	**17.6%**	**3.3%**

Table 4: Number of students and schools per municipality involved in the microscopy mapping. Prevalence values (and confidence intervals) for STH infections.

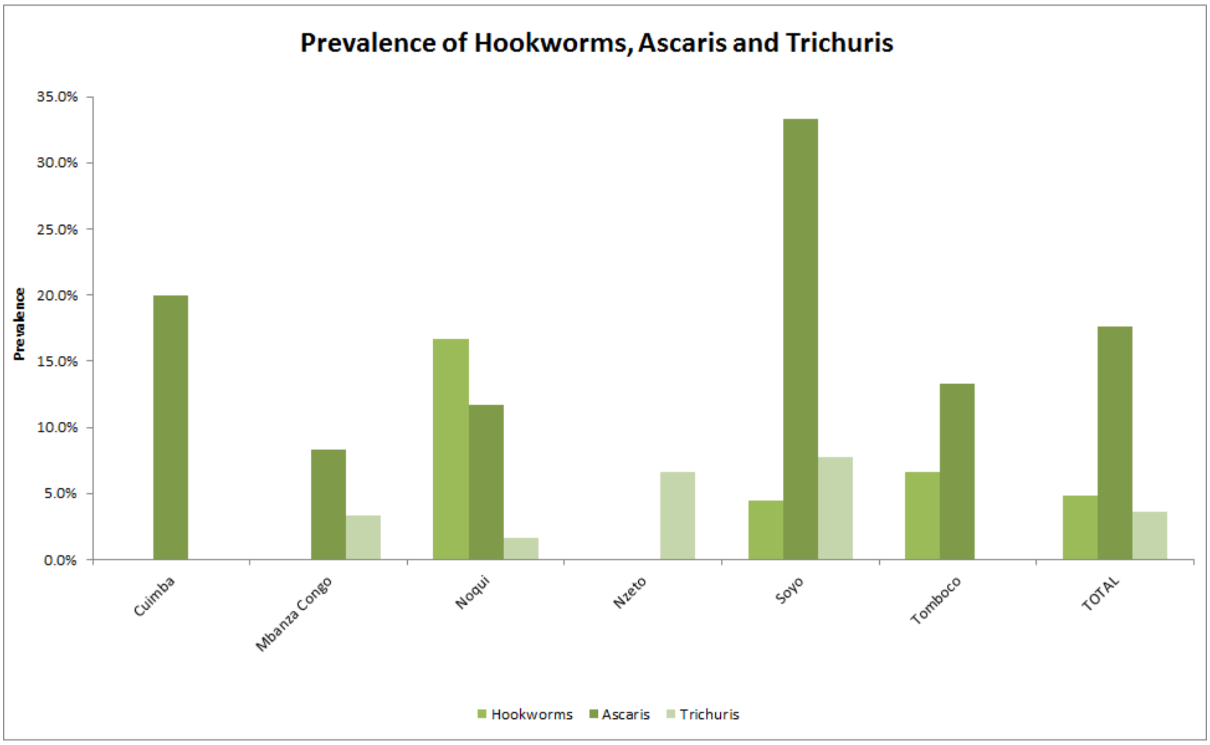


Figure 7: Prevalence of STH infections according to microscopy in each of the municipalities, and total. For actual data and confidence intervals, see tables in Appendix 4.

6. Discussion

6.1. WASH and Previous deworming initiatives

Zaire Province is very rural (for the most part) and far away from the capital city Luanda, therefore one would expect lower standards of hygiene and sanitation but these numbers are surprisingly low, especially for safe water source. With this in mind, there is still work to be done, especially in provision of good quality latrines, as well as maintenance (by teachers and village volunteers). Furthermore, very few teachers knew exactly what schistosomiasis or STH infections were, indicating that these diseases are still neglected in Zaire province.

MENTOR had implemented an albendazole distribution campaign in December 2013 targeting school-aged children. The information gathered by the questionnaire indicates that the school coverage achieved by said MDA was 86%. In their report, MENTOR states that a 77% student coverage was achieved during the MDA[9], which means that their student coverage could have been higher if only their school coverage was closer to 100%. As there are only 220 registered primary schools in Zaire, one would expect higher school coverage from a coordinated initiative. Future activities should focus on achieving 100% school coverage to be able to maximize student treatment coverage.

6.2. Use of rapid diagnostic tests and mapping resolution

The use of modern, easy-to-use rapid diagnostic tests has brought about new possibilities in science. Until the early 90s, schistosomiasis mapping was conducted based on microscopy protocols; urine filtration for urogenital schistosomiasis and the Kato-Katz technique for intestinal schistosomiasis[10,11]. In the late nineties, microhaematuria, or presence of non-visual blood in urine, was found to be a good proxy for diagnosis of urogenital schistosomiasis and from then on, even WHO guidelines recommend the use of microhaematuria rapid tests for mapping of urogenital schistosomiasis [12]. Since then, the scientific community has been actively pursuing a viable rapid diagnostic test for intestinal schistosomiasis. While there are still many variants in development, only one is available commercially - the circulating cathodic antigen (CCA) test. This test measures the amount of worm proteins (antigens) being passed out through the child's urine. This mapping initiative is at the forefront of research, and it constitutes the second time the CCA test is being used on a larger scale.

Our data suggests that both the microhaematuria test and the CCA test performed well - microhaematuria sensitivity 92% and specificity 91%; CCA sensitivity 100% and specificity 93%. These performances were estimated based on the few schools where both microscopy and the rapid diagnostic tests were employed (11 schools) and it clearly indicates that the infections identified by these two tests in the schools where microscopy was not employed (remaining 56 schools) were correctly diagnosed. These results are similar to those found elsewhere.[13,14]

6.3. Cost-effectiveness analysis

These tests are very easy to use and yield very quick and reliable results, meaning a team composed of a single person can survey a school (30 children) in less than two hours, while a microscopy team would require at least eight hours and would be composed of at least four people and a vehicle. This has immense impact on costs. The budget for this pilot mapping indicated that each child surveyed using rapid diagnostic tests cost $XXX, while the same child to be surveyed using standard microscopy methods would cost $XXX. Here, the biggest weights are clearly staff per diems (more staff for more days) and transportation (dedicated vehicle). A single vehicle can carry four to five rapid diagnosticians and carry out the mapping of eight to ten schools in a single day while a microscopy team can only map a single school in the same time span.

6.4. A mapping initiative with properties of Monitoring and Evaluation

Normally, after a mapping initiative a monitoring and evaluation (M&E) project is developed and implemented to run concurrently with the mass drug administration (MDA).[12] M&E costs approximately one third of the mapping initiative but it is conducted every year (or biennially), whereby researchers follow a cohort of children from grade 1 to grade 5 and ascertain if these children (a cohort) are improving in the presence of treatment. A project such as this would involve more children per school but significantly less schools than those sampled by the mapping initiative. An M&E project is very important because standard mapping protocols do not gather information that can be used to track MDA programme's performance. This protocol, on the other hand, includes some aspects of the M&E which could potentially allow the Angolan Government to decide not to conduct a standard M&E and therefore save time and money.

In the microscopy schools, we quantified infection intensity by counting eggs in school (standard protocol during M&E). As for the rapid diagnostic schools, there is also information which could be used as proxy of infection severity. Each of these two tests gives out a semi-quantitative reading. The CCA test tells us how much protein it identified in the urine according to the shade of the test band (light red to dark red), while the Hemastix test tells us how much blood was in the urine by the change in colour (from light green to dark green/blue). This means that these tests can give us more information than just a simple positive/negative like a pregnancy test. And this information could also be used if this mapping initiative were to be repeated in 5 or 6 year's time. For example, a province may have similar prevalence to what it had at baseline, but the amount of triple positives diminished. This is very similar as to how we use infection intensity according to egg counts in standard M&E protocols.

So, in conclusion, this mapping protocol has not only allowed us to ascertain where the infections are and provide enough evidence for an accurate treatment recommendation, but it has also served as a great basis to ascertain performance of future treatment programmes. This, without the added expenditure of a complete M&E cohort study.

7. Treatment regimen recommendations

7.1. Schistosomiasis and praziquantel administration

Data from the rapid diagnostic tests showed that schistosomiasis was present in every municipality surveyed; with very few (1.7%) co-infections identified. Apart from two municipalities (Soyo - 8.5%, and Tomboco - 1.7%), prevalence of schistosomiasis exceeded 10% (moderate risk according to WHO). In fact, overall prevalence of both types of schistosomiasis was 17.6%, meaning mass treatment should take place every two years covering all school aged children (enrolled and not enrolled) (See Figure 8). If finances or drug availability are an issue, the treatment regimen for Tomboco and Soyo municipalities could be lowered to treatment once every five years. Deworming guidelines by WHO are in Appendix 7.

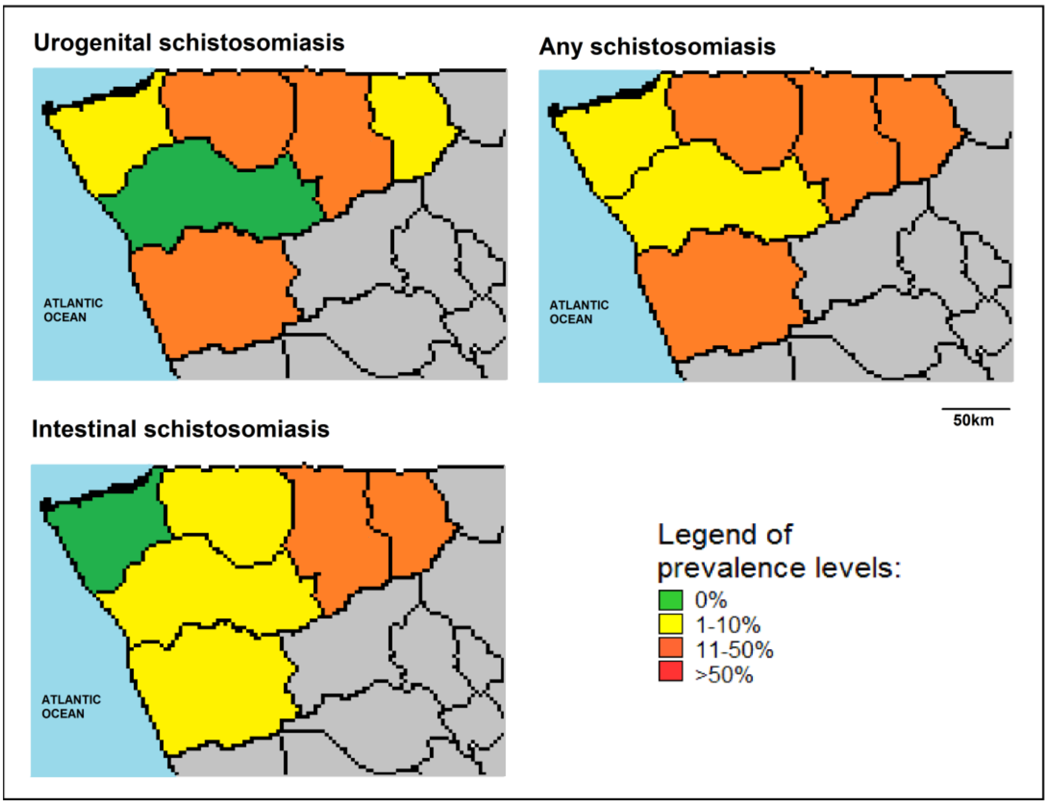


Figure 8: Prevalence of schistosomiasis (urogenital, intestinal and any type) by municipality. For municipality names, please see Appendix 5.

7.2. STH infections and albendazole distribution

Of the three common STH infections, *Ascaris lumbricoides* was the most common in Zaire province. Apart from Mbanza Congo and Nzeto, STH infection prevalence reached above 20% (see Figure 9). Importantly, we found this moderate transmission even though a highly efficient Albendazole distribution campaign had taken place less than four months prior. This clearly shows that these infections are not only prevalent, but also well established, which allowed for this rapid re-infection process. These results suggest that albendazole distribution at a school-level is necessary in Zaire province and should take place once a year. If finances or drug availability are an issue, the treatment regimen for Mbanza Congo and Nzeto municipalities could be lowered to treatment once every five years. Deworming guidelines by WHO are in Appendix 7.

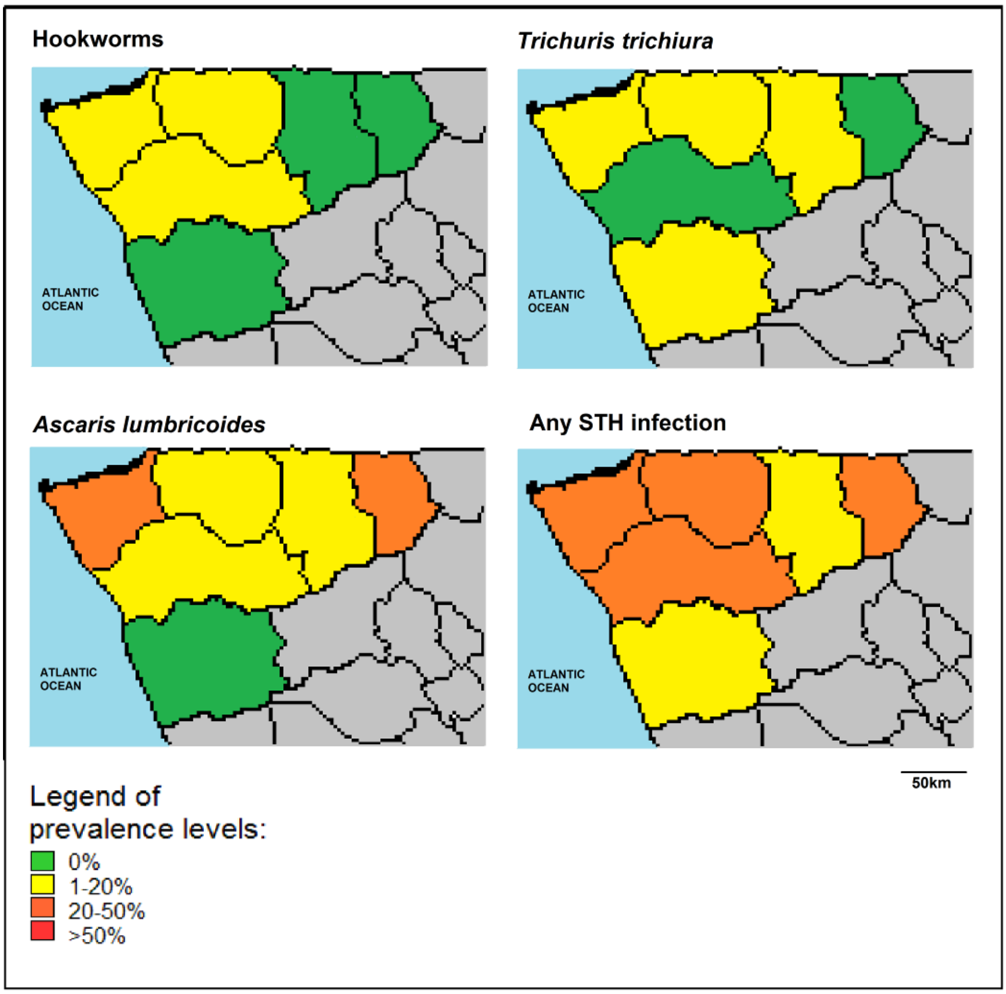


Figure 9: Prevalence of STH infections (Hookworms, *Ascaris lumbricoides and Trichuris trichiura)* by municipality. For municipality names, please see Appendix 2.

8. Recommendations for future field-work activities

8.1. Logistics

1. Procurement by the logistics team (national and international) must be closely monitored by the NTD programme coordinator (Paul) to ensure exact quality is achieved. Paul now has the knowledge necessary to supervise this.
2. Procurement must be COMPLETE and checked by MENTOR NTD programme coordinator before it is sent to the province to be mapped, when in advance of the training/mapping
3. There is a need for further equipment for future mapping: correct forceps, correct syringes, empty lab bottles, Pasteur pipettes, lab coats, masking tape, metal boxes for lab team, and plastic carrier boxes for RDT teams.
4. All printing should be done in Huambo well in advance, with extras to spare
5. T-shirts or polo shirts should be made for everyone taking part of field activities (around 60 per province to be mapped, 40 L and 20 XL)
6. Toyota Pick-ups and Land Cruisers should have their tyres changed to BF Goodrich AT or Goodyear Wrangler AT/SA. This would ensure far better reliability off-road and ensure that any car can reach any location.
7. Training should take place in a conference room as well as in a lab
8. Money for the per diems and fuel should be available in the local bank at least one week before activities commence

8.2. Technical

9. There needs to be higher political involvement (from central level MINSA) to support any activities. For example, cars should be made available by DPS or central level
10. IEC materials should be developed and printed for distribution to the schools and health facilities during the mapping and MDA (Schistosomiasis, STH, LF, Oncho, WASH)
11. This mapping initiative could be repeated at the end of a 5 to 6 year drug cycle and impact could be readily assessed as this protocol measured prevalence of morbidity associated with these diseases (macro- and microscopic blood in urine), measured intensity of infection (quantified infections) and its geographical reach is in excess of any M&E protocol.

9. Conclusions

The data gathered suggests that Zaire province is a moderate transmission environment for both schistosomiasis and STH infections, meaning there a need for praziquantel distribution every other year, and albendazole distribution on a yearly basis in all Zaire schools. For a summary of the recommendations see Table 5. The protocol developed and deployed led to the successful mapping of 1,680 children, representing just over 80,000 students in the province. The whole mapping initiative cost $XXXX. See Appendix 8 for cost breakdown.

	Recorded Prevalence	Praziquantel	Albendazole	WASH improvements
Cuimba	Schistosomiasis - 20% STH infections - 20%	Treatment every two years	Annual treatment	Needed
Mbanza Congo	Schistosomiasis - 28% STH infections – 12%	Treatment every two years	No mass treatment needed *	Needed
Noqui	Schistosomiasis - 16% STH infections - 25%	Treatment every two years	Annual treatment	Needed
Nzeto	Schistosomiasis - 26% STH infections - 7%	Treatment every two years	No mass treatment needed *	Needed
Soyo	Schistosomiasis - 9% STH infections - 39%	Treatment at least once during primary school years (e.g. every five years)	Annual treatment	Needed
Tomboco	Schistosomiasis - 2% STH infections - 20%	Treatment at least once during primary school years (e.g. every five years)	Annual treatment	Needed
Zaire Province	**Schistosomiasis - 18%** **STH infections - 23%**	**Treatment every two years**	**Annual treatment**	**Needed**

Table 5: Recommendations by municipality of at the provincial level. Deworming guidelines by WHO are in Appendix 7. * may also be given out once every five years along with PZQ MDA to reduced the number of new infections. WASH stands for water, sanitation and hygiene.

10. Acknowledgements

Overall, this pilot survey was a success and brought together a new dialogue between teachers, researchers and all local health stakeholders. Local technicians showed to be extremely cooperative and flexible, even when conditions were adverse (field activities took place in the rainy season in one of the wettest areas of Angola).

Capacity at the provincial and municipal levels was definitely strengthened by this initiative, and all 16 participating technicians are now versed in Schistosomiasis and STH epidemiology, control, advocacy and diagnosis.

We would like to acknowledge the Zaire DPS (Provincial Health Department), in particular Dr. Pedro Manuel, whom was very kind to supply us with items which were missing from our procurement, such as Lab standard Iodine, lab coats, lab bottles and Pasteur pipettes. More importantly, we were given permission to use the excellently-equipped provincial school of public health labs, which allowed us to improve our training session.

We would like to acknowledge the support from MENTOR provincial staff for undertaking the georeferencing of the schools and for taking part in the mapping.

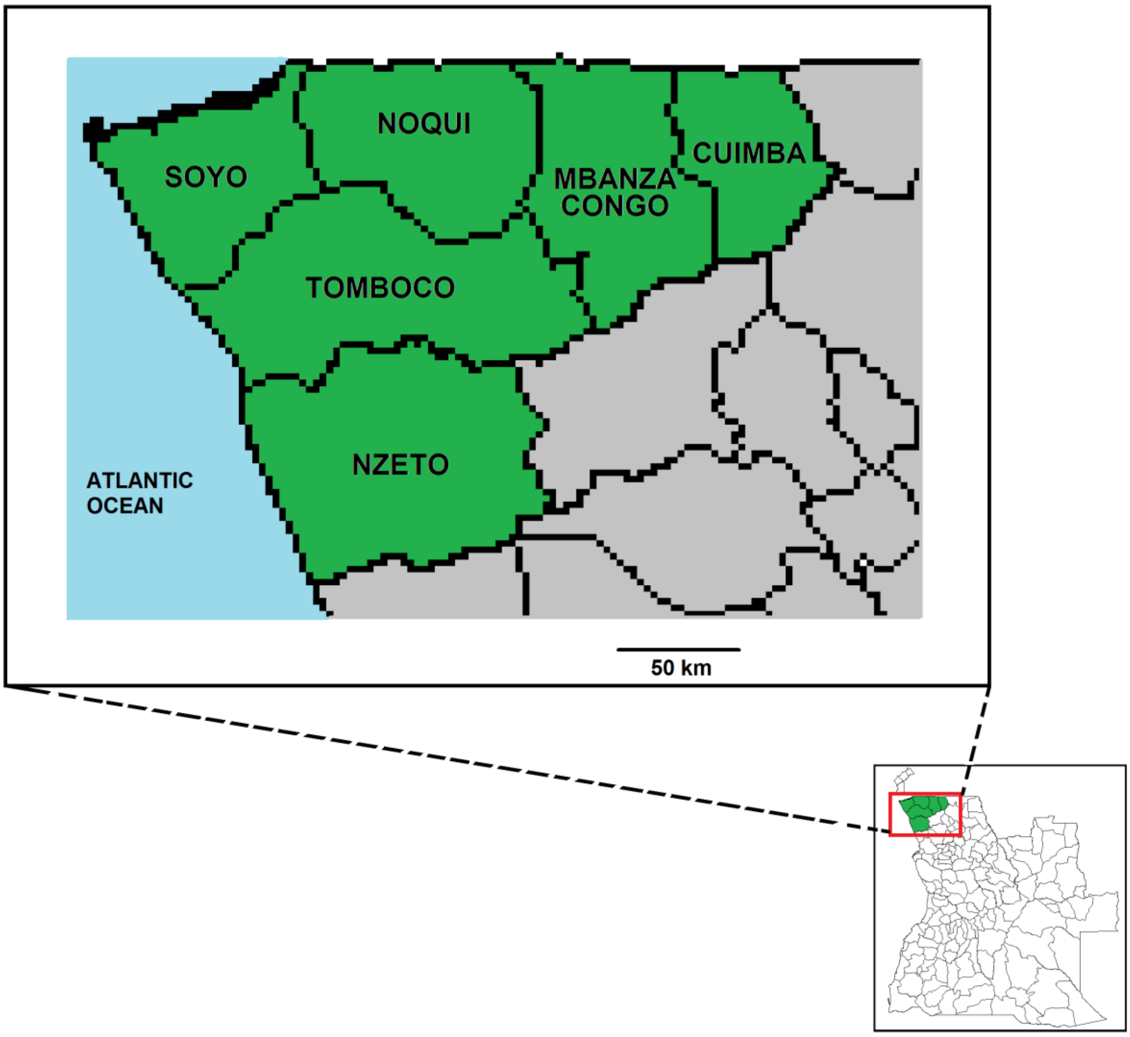
We would like to acknowledge the support and effort by the Provincial NTD programme coordinator for the MoH, Mr. Afonso Diabanza, and also the regional health departments for making available their vehicles while we worked in their areas.

Last but not least, we would lie to give our many thanks to Dr. Pedro Van-Dúnem and Dr. Alice Sicato from the NTD control programme at central level for their support and input during the planning phases, and also Dr. Adelaide de Carvalho for officially authorizing the work.

Appendix 1: List of Participants in training and field

Nome	Work place	Job	Telephone
Afonso Diabanza	DPS- Zaire	Coordenador PNDTNs	934-625-310
Miguel Diabanza	DMS- MBK	Sup - Mob Soc	931-106-732
Samuel Ntiama	HMN	Enfermeiro	936-483-281
Mavambu Tandu	Noqui	Sup - VE	922-056-813
Henriques Tungayani	Kuimba	Tec - VE	925-920-933
Casimiro Nzinga Fernandes	HMT	Sup - IEC	923-241-327
José Nsalambi	HMK	Enfermeiro	948-319-718
Alvaro Luvisa M Junior	DMS- MBK	Sup - VE	923-291-527
Pedro Manuel	DPS	Sup Prov Lab	923-643-380
Antonio Alberto Nunes	ICCT - MBK	Enfermeiro	928-133-237
Diayikua Kimkela	Teciytco Pav	Enfermeiro	947-380-393
Garcia Fernandes	HMT	Sup- VE	929-019-565
Mario Daniel	ICCT – Nzeto	Enfermeiro	926-011-407
Simsu Ngombe	Cons – Mun Soyo	Chefe de CS	925-882-772
José André Emiliana	LAC - Kuimba	Tec Lab	929-978-631
Pedro Gabriel	Nzeto	Tec - VE	927-990-540
Tekudiomova Luis João	MBK	MENTOR – Sup DTNs	926-746-027
Afonso Mendes Andre	MBK	MENTOR – Sup DTNs	936-951-760
Bibiana Regina	MBK	MENTOR – Sup DTNs	933-076-869
José Figueiredo	Londres	Acessor	932-730-348
Paul Monaghan	Huambo	MENTOR - Coord de DTNs	941-541-839

Appendix 2: Municipalities



Appendix 3: Mapping School Questionnaire (in Portuguese)

<table>
<tr><td colspan="3"></td></tr>
<tr><td>Data da visita</td><td>(DD-MMM-AAAA)</td><td>|___|___|-|___|___|___|-|___|___|___|___|</td></tr>
<tr><td>Inicais do Líder de Equipa</td><td></td><td>|___|___|___|</td></tr>
<tr><td>Província</td><td colspan="2"></td></tr>
<tr><td>Município</td><td colspan="2"></td></tr>
<tr><td>Código de Município</td><td>(MMM)</td><td>|___|___|___|</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td>Gráus decimais Este</td><td colspan="2">|___|___|___|.|___|___|___|___|___|___|___|___|___|___|___|</td></tr>
<tr><td>Gráus decimais Sul</td><td colspan="2">|___|___|___|.|___|___|___|___|___|___|___|___|___|___|___|</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td>Nome da escola</td><td colspan="2"></td></tr>
<tr><td>Codigo da Escola</td><td>(EEE)</td><td>|___|___|___|</td></tr>
<tr><td>Nome do director da escola e contacto</td><td colspan="2">Telemóvel:</td></tr>
<tr><td>Número de salas</td><td colspan="2">|_____|</td></tr>
<tr><td>Número de professores</td><td colspan="2">|_____|</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td></td><td>Rapazes inscritos</td><td>Raparigas inscritas</td></tr>
<tr><td>Total</td><td>|___|___|___|___|</td><td>|___|___|___|___|</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td>1.Há latrinas na escola? (0=Não; 1=Sim)</td><td colspan="2">|___|</td></tr>
<tr><td>1.Se SIM, especifique as condições (e.g. a trabalhar, estragadas etc)</td><td colspan="2">|__________________|</td></tr>
<tr><td>1.Há alguma fonte de água potável na escola? (0=Não; 1=Sim)</td><td colspan="2">|___|</td></tr>
<tr><td>1.Se SIM, qual? (especificar, e.g. bomba de água, fonte, torneira)</td><td colspan="2">|__________________|</td></tr>
<tr><td>1.Esta escola já recebeu campanhas de desparazitação? (0=Não; 1=Sim)</td><td colspan="2">|___|</td></tr>
<tr><td>1.Se SIM, quando foi? (escrever Ano)</td><td colspan="2">|__________________|</td></tr>
<tr><td>1.Sabe o que é a schistossomiase ou bilharziose? (0=Não; 1=Sim)</td><td colspan="2">|___|</td></tr>
<tr><td>1.Se sim, como se transmite e previne? (escrever se correcto ou não)</td><td colspan="2">|__________________|</td></tr>
<tr><td>1.Costuma mandar estudantes ao centro/posto por urinar sangue? (0=Não; 1=Sim)</td><td colspan="2">|___|</td></tr>
<tr><td>1.Acha que fazer xixi com sangue é doença? (0=Não; 1=Sim)</td><td colspan="2">|___|</td></tr>
</table>

Appendix 4: List of schools visited

	Province	Municipality	Name of school (alphabetical order)	GPS coordinate		Total no. of students available
				South	East	
1	Zaire	Cuimba	Escola nº290	-6.21835	14.90182	340
2	Zaire	Cuimba	Escola nº99	-6.13432	14.45511	749
3	Zaire	Cuimba	Escola nº57,	-6.1316	14.61304	788
4	Zaire	Cuimba	Escola nº51,	-6.11091	14.61304	2170
5	Zaire	Cuimba	Escola do 1º Ciclo	-5.98799	14.76945	NA
6	Zaire	Cuimba	Escola nº27	-5.98799	14.76945	742
7	Zaire	Cuimba	Escola nº93	-6.06357	14.438	NA
8	Zaire	Cuimba	Escola nº274	-6.08888	14.63954	610
9	Zaire	Cuimba	Escola nº190	-6.1845	14.6384	117
10	Zaire	Cuimba	Escola nº211	-6.3665	14.80979	NA
11	Zaire	Cuimba	Escola nº128	-6.38635	14.74767	240
12	Zaire	Cuimba	Escola nº117	-6.24733	14.69699	200
13	Zaire	M'Banza Congo	Escola nº31	-6.238	14.2279	1297
14	Zaire	M'Banza Congo	Escola nº253	-6.17312	14.38196	226
15	Zaire	M'Banza Congo	Escola nº203	-6.26091	14.24356	167
16	Zaire	M'Banza Congo	Escola nº67	-6.10742	14.19218	255
17	Zaire	M'Banza Congo	Escola nº289	-6.25481	14.25946	1116
18	Zaire	M'Banza Congo	Escola nº1	-6.26349	14.23074	3525
19	Zaire	M'Banza Congo	Escola nº43	-6.28621	14.21121	NA
20	Zaire	M'Banza Congo	Escola nº115	-6.00694	14.07602	106
21	Zaire	M'Banza Congo	Escola nº224	-6.17142	12.36231	NA
22	Zaire	M'Banza Congo	Escola nº233	-6.17142	12.36231	180
23	Zaire	M'Banza Congo	Escola nº156	-6.4214	14.4027	561
24	Zaire	M'Banza Congo	Escola nº180	-6.66599	13.80982	327
25	Zaire	M'Banza Congo	Escola nº194	-6.78558	14.11612	234
26	Zaire	Noqui	Escola nº5	-5.86728	13.4311	878
27	Zaire	Noqui	Escola nº75	-5.91664	13.48836	270
28	Zaire	Noqui	Escola nº287	-5.88298	13.43385	175
29	Zaire	Noqui	Escola 1ºCiclo	-5.87008	13.43159	570
30	Zaire	Noqui	Escola nº77	-6.05049	13.61997	139
31	Zaire	Noqui	Escola nº71	-6.14458	13.7412	386
32	Zaire	Noqui	Escola nº101	-6.24479	13.6646	454
33	Zaire	Noqui	Escola nº125	-6.36419	13.5092	355
34	Zaire	Noqui	Escola nº150	-6.45067	12.7293	280
35	Zaire	Nzeto	Escola nº149	7.80035	13.15229	311
36	Zaire	Nzeto	Escola nº169	7.60277	13.42889	NA
37	Zaire	Nzeto	Escola nº70	-7.42315	12.97609	50
38	Zaire	Nzeto	Escola nº124	-7.13409	13.79177	NA
39	Zaire	Nzeto	Escola nº134	-7.16418	13.61023	NA
40	Zaire	Soyo	Escola nº210	-6.14384	12.56124	NA
41	Zaire	Soyo	Escola nº260	-6.17134	12.36248	244
42	Zaire	Soyo	Escola 1º Ciclo	-6.71368	12.621	133
43	Zaire	Soyo	Escola nº147	-6.45083	12.72907	242
44	Zaire	Soyo	Escola nº142	-6.14361	12.56118	NA
45	Zaire	Soyo	Escola nº8	-6.13386	12.36906	1170
46	Zaire	Soyo	Escola nº74	-6.13386	12.36903	56
47	Zaire	Soyo	Escola nº92	-6.14769	12.37333	778

48	Zaire	Soyo	Escola nº20	-5.09904	12.93096	NA
49	Zaire	Soyo	Escola nº231	-6.60162	12.55843	120
50	Zaire	Soyo	Escola nº198	-6.14744	12.69098	139
51	Zaire	Tomboco	Escola nº60	-6.71772	13.64371	318
52	Zaire	Tomboco	Escola nº108	-6.77966	12.67671	425
53	Zaire	Tomboco	Escola nº280	-7.00151	12.83926	49
54	Zaire	Tomboco	Escola nº120	6.88968	12.80239	135
55	Zaire	Tomboco	Escola nº130	-6.59444	13.49875	355
56	Zaire	Tomboco	Escola nº30	-6.74614	13.35142	332

Appendix 5: Result tables

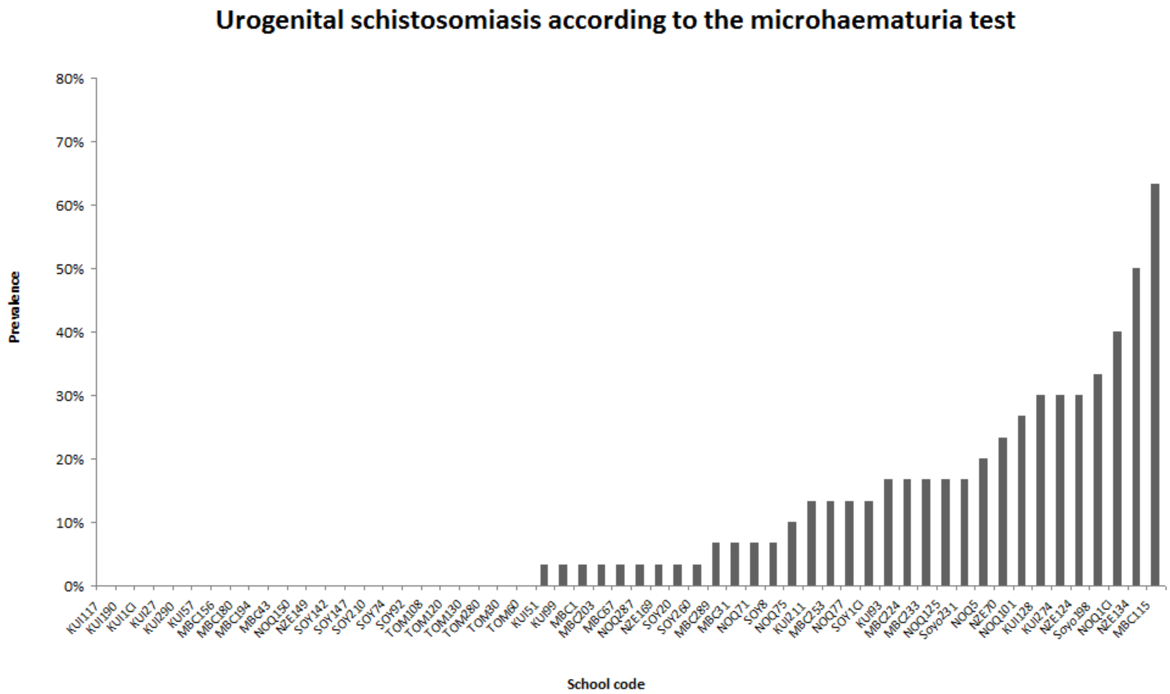
			Urogenital (haematuria test)		Intestinal (CCA test)		Any (both tests)	
Municipalities	**No. schools**	**No. students surveyed**	**prevalence**	**95% CI**	**prevalence**	**95% CI**	**prevalence**	**95% CI**
Cuimba	12	360	8.1%	5.5–17.6%	13.6%	10.2–17.6%	20.0%	16.0–24.5%
Mbanza Congo	13	390	11.8%	8.8–15.4%	21.0%	17.1–25.4%	28.2%	23.8–33.0%
Noqui	9	270	15.2%	11.1–20.0%	1.5%	0.4–3.7%	16.3%	12.1–21.3%
Nzeto	5	150	22.0%	15.7–29.5%	6.0%	2.8–11.1%	26.0%	19.2–33.8%
Soyo	11	330	8.5%	5.7–12.0%	0.0%	0.0–1.1%	8.5%	5.7–12.0%
Tomboco	6	180	0.0%	0.0–2.0%	1.7%	0.3–4.8%	1.7%	0.3–4.8%
TOTAL Zaire Province	**56**	**1680**	**10.5%**	**9.1–12.1%**	**8.8%**	**0.8 – 1.2**	**17.6%**	**4.3 – 5.1**

Table S1: Number of students and schools per municipality involved in the rapid mapping. Prevalence values (and confidence intervals) for urogenital and intestinal schistosomiasis. "Any" to the prevalence of having one or the other type of infection. The difference between the prevalence of any and the sum of both infections is the prevalence of co–infections.

			Hookworm infections		*Ascaris lumbricoides*		*Trichuris trichiura*	
Municipalities	**No. schools**	**No. students surveyed**	**prevalence**	**95% CI**	**prevalence**	**95% CI**	**prevalence**	**95% CI**
Cuimba	2	60	0.0%	0.0–6.0%	20.0%	10.8–32.3%	0.0%	0.0–6.0%
Mbanza Congo	2	120	0.0%	0.0–6.0%	8.3%	2.8–18.4%	3.3%	0.4–11.5%
Noqui	2	60	16.7%	8.3–28.5%	11.7%	4.8–22.6%	1.7%	0.0–8.9%
Nzeto	1	30	0.0%	0.0–11.6%	0.0%	0.0–11.6%	6.7%	0.8–22.1%
Soyo	3	90	4.4%	1.2–11.0%	33.3%	23.7–44.1%	7.8%	3.2–15.4%
Tomboco	1	30	6.7%	0.8–22.1%	13.3%	3.8–30.7%	0.0%	0.0–11.6%
TOTAL	11	**330**	**4.8%**	**2.8–7.8 %**	**17.6%**	**13.6–22.1%**	**3.6%**	**1.9–6.3%**

Table S2: Number of students and schools per municipality involved in the microscopy mapping. Prevalence values (and confidence intervals) for STH infections.

Appendix 6: Results of rapid diagnostic tests by school



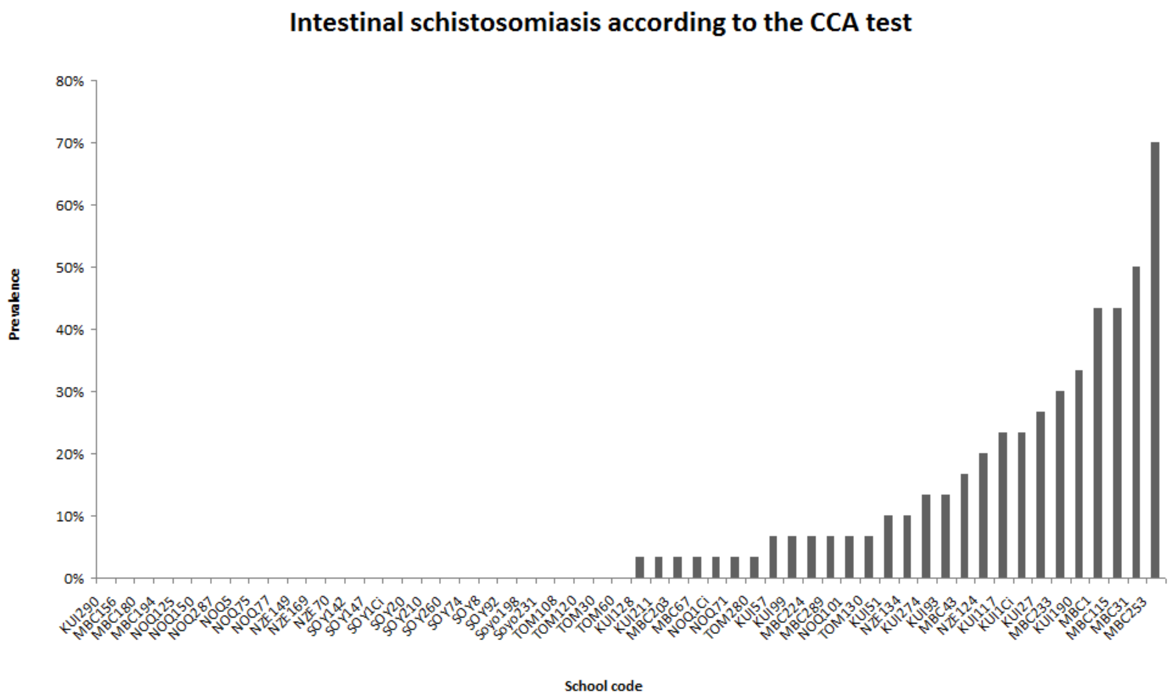


Figure: Distribution of urogenital and intestinal schistosomiasis by school in Zaire. The school codes are non-identical between the two graphs, they are simply sequential numbers.

Appendix 7: World Health Organization (WHO) treatment guidelines

Table 2.2 Recommended control strategies for schistosomiasis in school-age children

Category	Prevalence of schistosomiasis among school-age children at baseline	Control strategy	
		Preventive chemotherapy	Additional interventions
Schools in high-risk areas	≥50% if based on parasitological methods *or* ≥30% if based on questionnaires for visible haematuria	Treat all school-age children (enrolled and non-enrolled) once a year	Improve sanitation and water supply Provide health education
Schools in moderate-risk areas	≥10% and <50% if based on parasitological methods or >1% and <30% if based on questionnaires for visible haematuria	Treat all school-age children (enrolled and non-enrolled) once every two years	Improve sanitation and water supply Provide health education
Schools in low-risk areas	≥1% and <10% if based on parasitological methods	Treat all school-age children (enrolled and non-enrolled) twice during their primary-school years (e.g. once on entry and once on exit)	Improve sanitation and water supply Provide health education

Table 2.3 Recommended control strategies for soil-transmitted helminth (STH) infections in school-age children[a]

Category	Prevalence of any STH infection at baseline	Control strategy	
		Preventive chemotherapy	Additional interventions
Schools in high-risk areas	≥50%	Treat all school-age children (enrolled and non-enrolled) twice a year[b]	Improve sanitation and water supply Provide health education
Schools in low-risk areas	≥20% and <50%	Treat all school-age children (enrolled and non-enrolled) once a year	Improve sanitation and water supply Provide health education

[a] When the prevalence of any STH infection is under 20%, large-scale preventive chemotherapy interventions are not recommended. Affected individuals should be treated on a case-by-case basis.

[b] If the resources are available and the prevalence is towards the higher end of the interval, a third drug distribution might be added (in this case, the frequency will be every 4 months).

Table S3: Adapted from WHO (2011). Helminth Control in School-Aged Children. A guide for managers of control programmes. Second Edition. WHO, Geneva

Appendix 8: Finances

SCHISTO MAPPING IN ANGOLA - PILOT

Financial report

Activity	**Actual Expenditure** **$ (USD)**
Personnel (per diems for training and field work)	
Training costs (location, food and drinks)	
Travel (airplane, cars and fuel)*	
MENTOR Accommodation & Subsistence*	
Mapping procurement (Zaire ONLY)	
Other miscellaneous (please give detail)	
Sub Total	
Consultancy fee	
TOTAL LATH EXPENDITURE	

Table S4: Financial report. Exchange rate used: $1 - AOA 100. *includes consultant

Appendix 9: Photos from the mapping

Logistics at MENTOR Zaire HQ. Preparing the items for the field.

Each basin and box is everything that a RDT technician needs to map a single school

Each box in this picture contains all the items a microscope team needs (along with microscopes)

Official opening of the training workshop, with Mr. Diabanza (Zaire NTD coordinator for the MoH, standing)

Training workshop: epidemiology and control

Workshop: making the dose poles

Training workshop: Diagnostics

The drugs needed

The team

Team arriving at a school

Random sample selection

Urine and stool sample containers waiting to be given out.

Teacher holding the praziquantel dose pole to estimate dose.

Child receiving treatment

The use of power inverters instead of a generator to operate the microscopes (far cheaper and less maintenance)

REFERENCES:

[1] Yamey G. The world's most neglected diseases. *BMJ* 2002; **325**: 176–77

[2] Gryseels B, Polman K, Clerinx J, Kestens L. Human schistosomiasis. *Lancet* 2006; **368**: 1106–18

[3] Bethony, J., Brooker, S., Albonico, M., Geiger, S. M., Loukas, A., Diemert, D. & Hotez, P. J. (2006). Soiltransmitted helminth infections: ascariasis, trichuriasis, and hookworm. Lancet, 367, 1521–1532

[4] WHO. The evidence is in: deworming helps meet the Millennium Development Goals. Geneva; 2005.

[5] WHO. World Health Assembly endorses WHO's strategic priorities. Geneva: WHO; 2001

[6] Hotez PJ, Molyneux DH, Fenwick A, Ottesen E, Ehrlich Sachs S, Sachs JD. Incorporating a rapid-impact package for neglected tropical diseases with programs for HIV/AIDS, tuberculosis, and malaria. *PLoS Med* 2006; **3**: e102

[7] Fenwick A. New initiatives against Africa's worms. *Trans R Soc Trop Med Hyg* 2006; **100**: 200–07

[8] WHO. 2010. Angola country profile. Geneva http://www.who.int/neglected_diseases/preventive_chemotherapy/databank/CP_Angola.pdf?ua=1

[9] MENTOR (2014). Report for the mass drug administration campaign for schoolchildren in Zaire. Huambo, Angola.

[10] Katz, N., Chaves, A., Pellegrino, J., 1972, A simple device for quantitative stool thick-smear technique in Schistosomiasis mansoni. Rev Inst Med Trop Sao Paulo 14, 397-400.

[11] Dazo, B.C., Biles, J.E., 1974, Two new field techniques for detection and counting of Schistosoma haematobium eggs in urine samples, with an evaluation of both methods. Bull World Health Organ 51, 399-408.

[12] WHO (2011). Helminth control in school age children: a guide for managers of control programmes - 2nd ed. Geneva.

[13] Tchuem Tchuente LA, Kuete Fouodo CJ, Kamwa Ngassam RI, Sumo L, Dongmo Noumedem C, et al. (2012) Evaluation of Circulating Cathodic Antigen (CCA) Urine-Tests for Diagnosis of *Schistosoma mansoni* Infection in Cameroon. PLoS Negl Trop Dis 6: e1758

[14] Lwambo NJS, Savioli L, Kisumku UM, Alawi KS, Bundy DAP. (1997) Control of *Schistosoma haematobium* morbidity on Pemba Island: validity and efficiency of indirect screening tests. Bull World Health Organ. ;75:247–252

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