Report

# NAMIBIA: Mapping of Schistosomiasis and Soil-Transmitted Helminths. Phase 2 - Ohangwena, Omusati, Oshana and Oshikoto

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**Jose C. Sousa-Figueiredo**
**Lead Technical Consultant**
Liverpool School of Tropical Medicine
Pembroke Place, L3 5QA, UK
josf@liverpool.ac.uk
+44 795 779 0231

**A collaboration between:**

**Liverpool Associates in Tropical Health, Liverpool School of Tropical Medicine, Geneva Global, University of Namibia, Polytechnic of Namibia and the Namibian Ministry of Health and Social Services**

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**Cover photograph taken by José C. Sousa-Figueiredo at Namyindu Primary School, Kabe, Caprivi**

Liverpool Associates
in Tropical Health
Pembroke Place
Liverpool L3 5QA
United Kingdom
**www.lath.com**

Tel: +44 (0) 151 705 3340

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## 1. 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 |
| WHO | World Health Organisation |

## 2. 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 Namibia. With the availability of deworming drugs, the Government of Namibia 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. Phase 2 of mapping was conducted in November 2013 using rapid and microscopy-based protocols. This included 11,978 students from 200 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 the four regions targeted was found to be extremely low and focalized while STH infections were largely absent with the exception of hookworms. The high quality disease map, with increased sampling density, will allow the government to better plan chemotherapy strategies at the regional or constituency level, maximizing efficiency and minimizing drug wastage.

## 3. Background

Schistosomiasis and soil-transmitted helminth (STH) infections are believed to be endemic in Namibia (http://www.thiswormyworld.org/maps/namibia). The World Health Organization (WHO) estimates that all Namibian children are at risk for STH (i.e. 750,000) and that 275,000 children are at risk for schistosomiasis. However, these estimates are based on very few epidemiological surveys and not based on accurate and systematically gathered data. Due to this lack of up-to-date information, a mapping initiative was initiated in 2012 (Phase 1 took place in November 2012). The protocol for the mapping of schistosomiasis and STHs in Namibia calls for a phased approach. Figure 1 below shows these phases geographically, with Phase 2 covering the Ohangwena, Omusati, Oshana and Oshikoto regions.

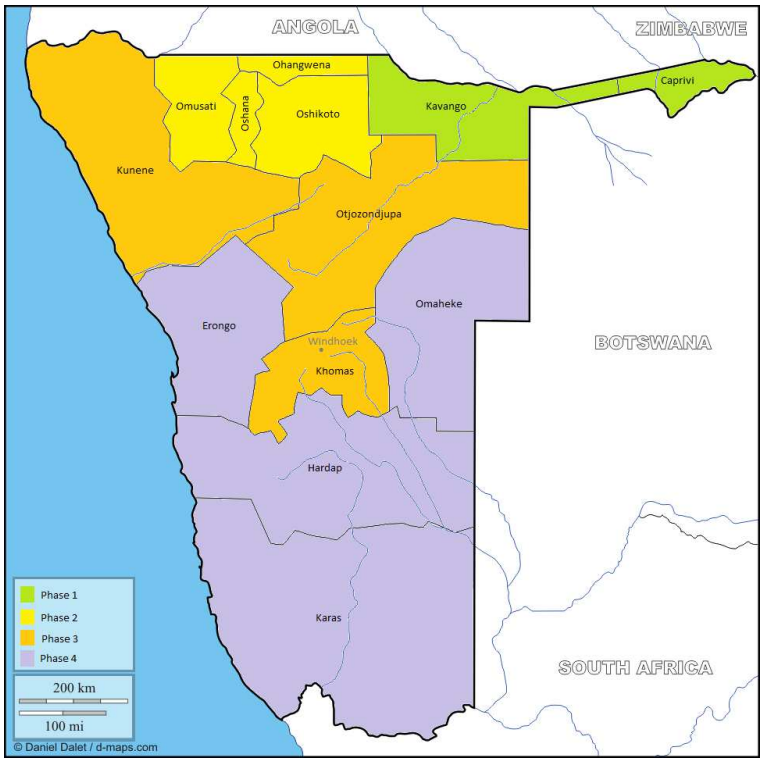



**Figure 1:** Map of Namibia's governmental regions, mapping phases and hydrographic details

The mapping protocol has the following primary objectives:

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

## 4. Fieldwork

Prior to setting our to the field, meetings were held in Windhoek with representatives from the several departments of the MoHSS. Ethical approval was granted by both LSTM and the Namibian MoHSS. Fieldwork took place between the 26th of October and 16th of November 2013. Prior to the field work, the team from LATH (José Figueredo, Moses Arinaitwe and Moses Adriko) held a training workshop from Oshana Regional Hospital on schistosomiasis and STH, the morbidity caused by these diseases, their diagnosis, treatment and control. Participants included four Ministry of Health and Social Services (MoHSS) staff from central level and nineteen regional staff, along with two graduate volunteers. All sampled children were provided with praziquantel and albendazole by members of the mapping team.

### 4.1. Set up in the field

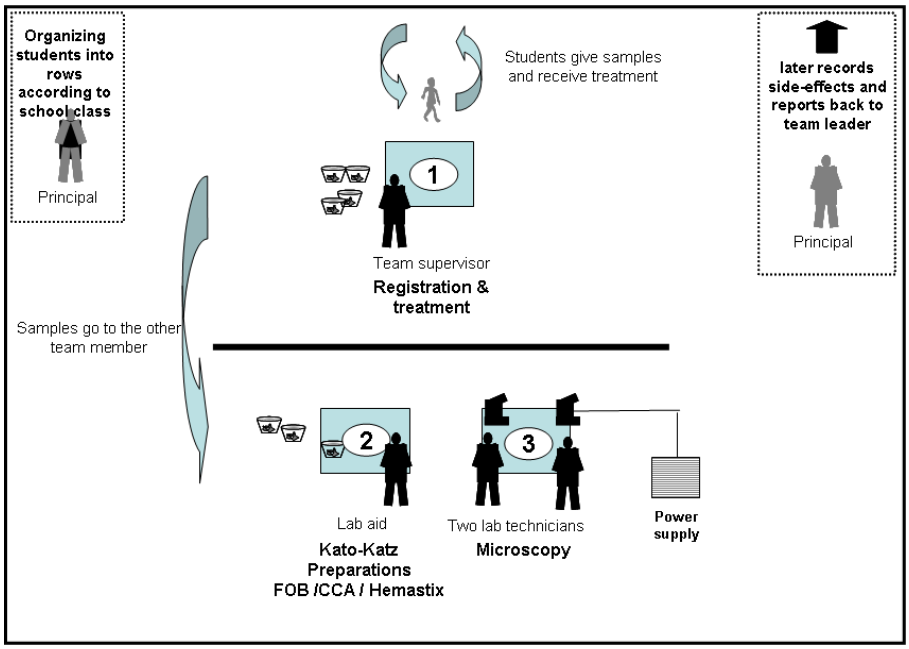



**Figure 2:** Schools surveyed with rapid diagnostic tests and microscopy. Team is composed of a team leader, one laboratory aid and two lab technicians. The team was mobile using a single 4x4 vehicle and spent a full day at each school for processing samples. The Questionnaire applied by the team supervisor 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.

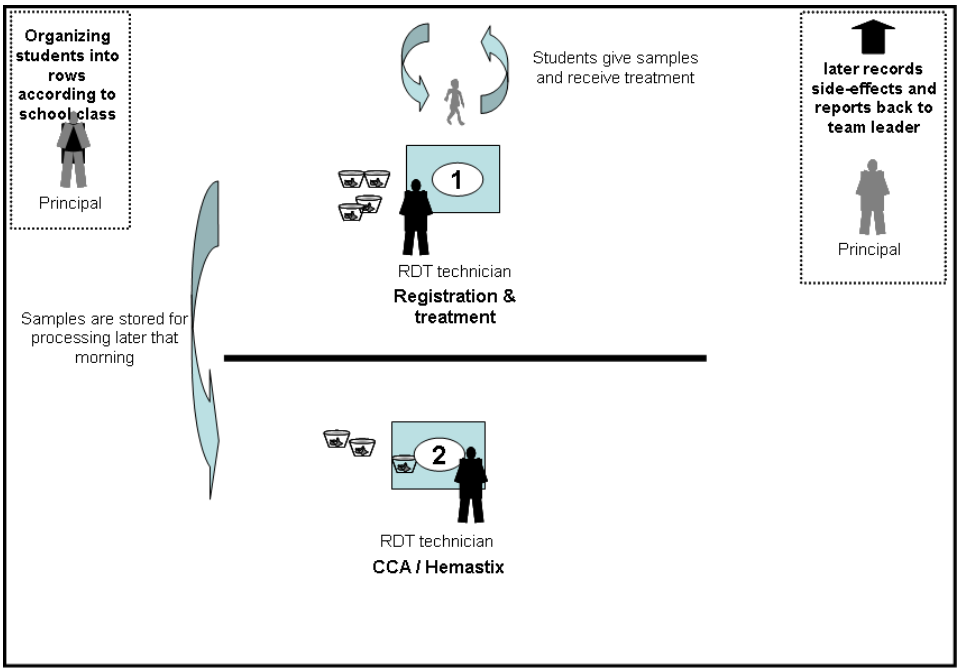



**Figure 3:** Schools surveyed by a rapid diagnostician. Team composed of a single person whom is dropped off at the school by a vehicle (meaning a single vehicle can carry four technicians and work at four schools each day). A working day is finished by lunch-time. The questionnaire applied can be seen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

# 5. Results from school surveys

## 5.1. Questionnaire

Of the 829 schools registered in Ohangwena, Omusato, Oshana and Oshikoto regions (2013 census), a total of 200 schools were visited by the mapping teams (i.e., sampling one in every four), 58 in Ohangwena, 65 in Omusati, 32 in Oshana and 45 in Oshikoto regions. For a full list of the schools visited, please see Appendix 1. At each school, a questionnaire (for complete data by region see Appendix 4) was implemented and data gathered informs us that overall 96% of schools had latrines, despite the fact that only 82% had latrines in good working condition, and that 96% of schools had a safe water source. All the four regions are very rural (for the most part) and far away from the capital, therefore one would expect lower standards of hygiene and sanitation but these numbers are very encouraging. With this in mind, however, there is still work to be done, especially in provision of good quality latrines, as well as annual maintenance. In the schools with safe water source, 81% had access to tap water and 19% had access to borehole water. See Fig. 4 for questionnaire data detailed by region and overall.

LATH was informed that Namibia had implemented an albendazole distribution campaign in 2012/2013 targeting school-aged children. Data gathered during the questionnaire informs us that coverage of this campaign was minimal, with only 13% of school having received treatment in 2012/2013 and 22% of schools having received treatment in the recent past.

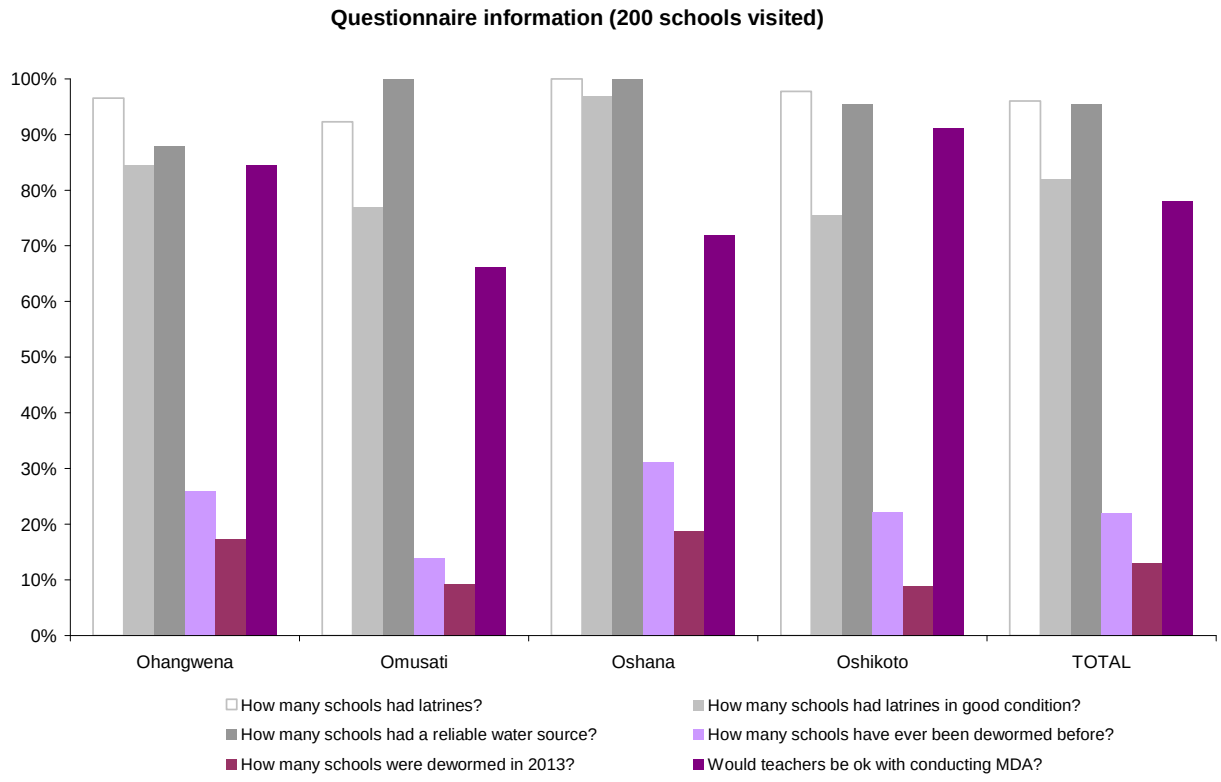



**Figure 4:** Percentage of positive responders to each questions (each bar colour) by region and overall. Note that these teachers have now been primed and assessed in their future participation in MDA exercises; in short, teachers are willing to assist.

## 5.2. Population studied

In the 200 schools visited, 11,978 children were screened using rapid diagnostic tests for schistosomiasis. The mean age of students surveyed was 9.7 years and ranged between 3 and 19 years. There was an equal proportion of boys and girls in the survey and an equal proportion of young (3-7 year olds) and older (8-17 year olds) school-aged children. All children were recruited from primary school. Of these 200 schools, 41 schools were additionally surveyed using microscopy techniques with the main objective of detecting levels of soil-transmitted helminths and other parasitic worms. Intestinal and urogenital schistosomiases were also diagnosed during microscopy surveys to confirm that rapid diagnostic tests were working correctly. A total of 2458 students were included in this subset. These children were also surveyed for non-visual blood in faeces as a proxy for bowel morbidity using faecal occult blood tests.

## 5.3. Schistosomiasis

Results from the rapid diagnostic tests show that schistosomiasis, although prevalent, does not reach alarming levels (see Fig. 5). Prevalence of schistosomiasis (both intestinal and urogenital) was found to be 4.1% in Ohangwena, 5% in Omusati, 6.7% in Oshana and 3.4% in Oshikoto (overall prevalence of 4.7%). Recorded levels varied from 1.3% (Eengondi consituency) to 11.7% (Ongwediva and Guinas constituencies).

Prevalence of urogenital schistosomiasis (as measured by microhaematuria) reached 3.0% in Ohangwena, 4.1% in Omusati, 5.6% in Oshana and 2.9% in Oshikoto (overall prevalence 3.7%). Nevertheless, it is important to note that due to the nature of this infection, distribution is often focalized or heterogeneous, and Namibia is no exception. This will in turn affect the way we interpret the results. In this case for example, even though overall or even constituency levels are low (<10%), we were able to identify higher foci of infection such as Mamanya Primary School in Ondangwa constituency (Oshana region). See Appendix 7 for details on school-level prevalence.

As for intestinal schistosomiasis (measure using the CCA rapid diagnostic test), prevalence reached 1.2% in Ohangwena, 1.0% in Omusati, 1.3% in Oshana and 0.7% in Oshikoto (overall prevalence 1.0%). Unlike urogenital schistosomiasis, the distribution was overall low (<10%) with no foci identified.

The treatment needs of pre-school children do not appear to be a priority given the low levels of encountered disease.

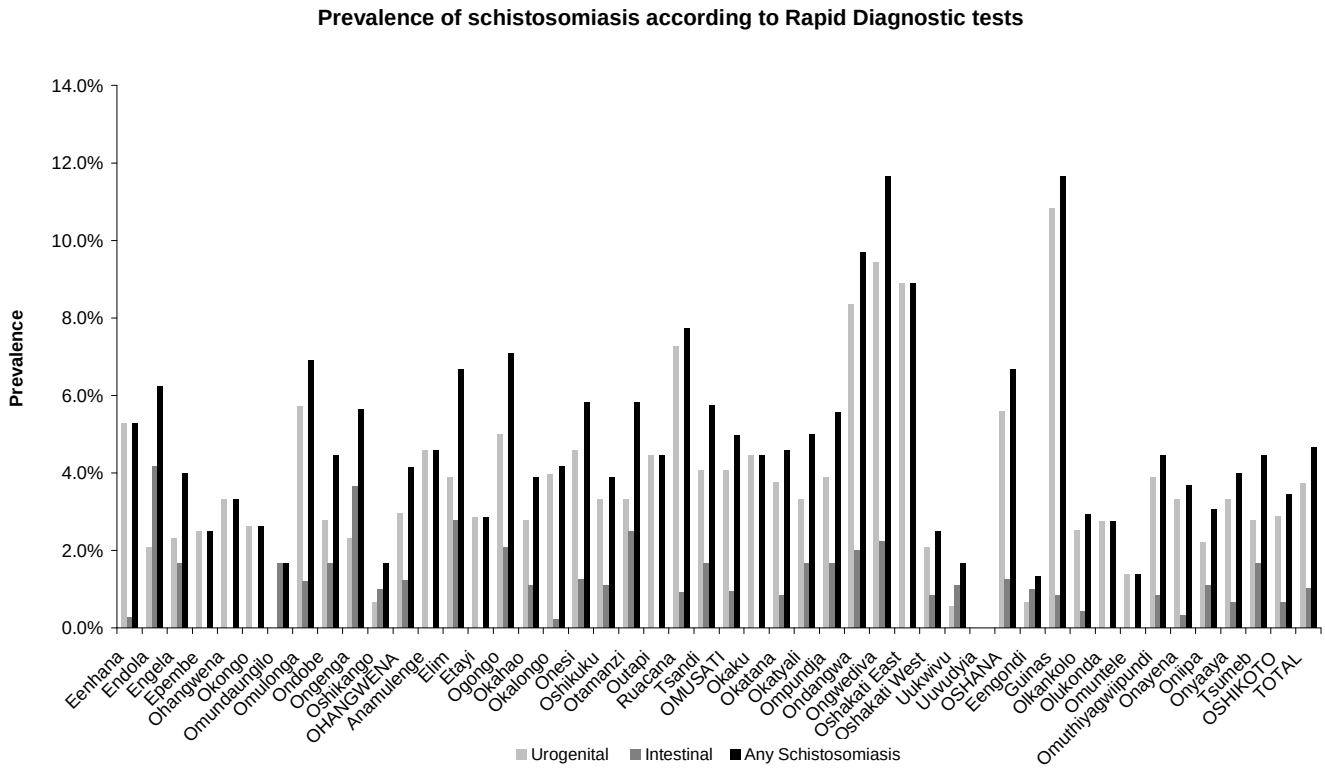



**Figure 5:** Prevalence of schistosomiasis (both types and any) according to rapid diagnostic tests in each of the constituencies, by region and total. For actual data and confidence intervals, see tables in Appendix 4.

## 5.4. Soil Transmitted Helminths and other worms

No cases *Trichuris* was identified, and only one case of *Ascaris lumbricoides* found in nine year old boy from Ongenga English primary school, Ohangwena region. This suggest that these diseases are not endemic locally and the environment is not suitable for their future establishment. Hookworm, however, was fairly common among school-children, especially in Ohasngwena region where prevalence reached 16% as opposed to the 2.1% in Omusati, 4.7% in Oshana and 5.4% in Oshikoto (overall prevalence of 7.3%).

Hookworm prevalence levels within Ohangwena varied between 0% in Ongenga and 55% in Omundaungilo. The highest prevalence level was recorded at Onehova Primary School, Omundaungilo constituency, Ohangwena region, where 55% of the schoolchildren surveyed were found to have hookworm eggs in their faeces.

Apart from the standard STH infections, this mapping survey also identified significant levels of *Hymenolepsis nana* (dwarf tapeworm) and *Enterobius vermicularis* (threadworm). The prevalence of

these other worms reached 1.1% in Ohangwena, 1.8% in Omusati, 1.4% in Oshana and 0.9% in Oshikoto (overall prevalence of 1.3%), where the highest recorded prevalence was at Tsumeb constituency (Oshikoto region) and Otamanzi constituency (Omusati region), with levels reaching 5%. The most common worm was *H. nana*, see Fig. 6 for graphical representation of prevalence levels recorded for STHs and other worms.

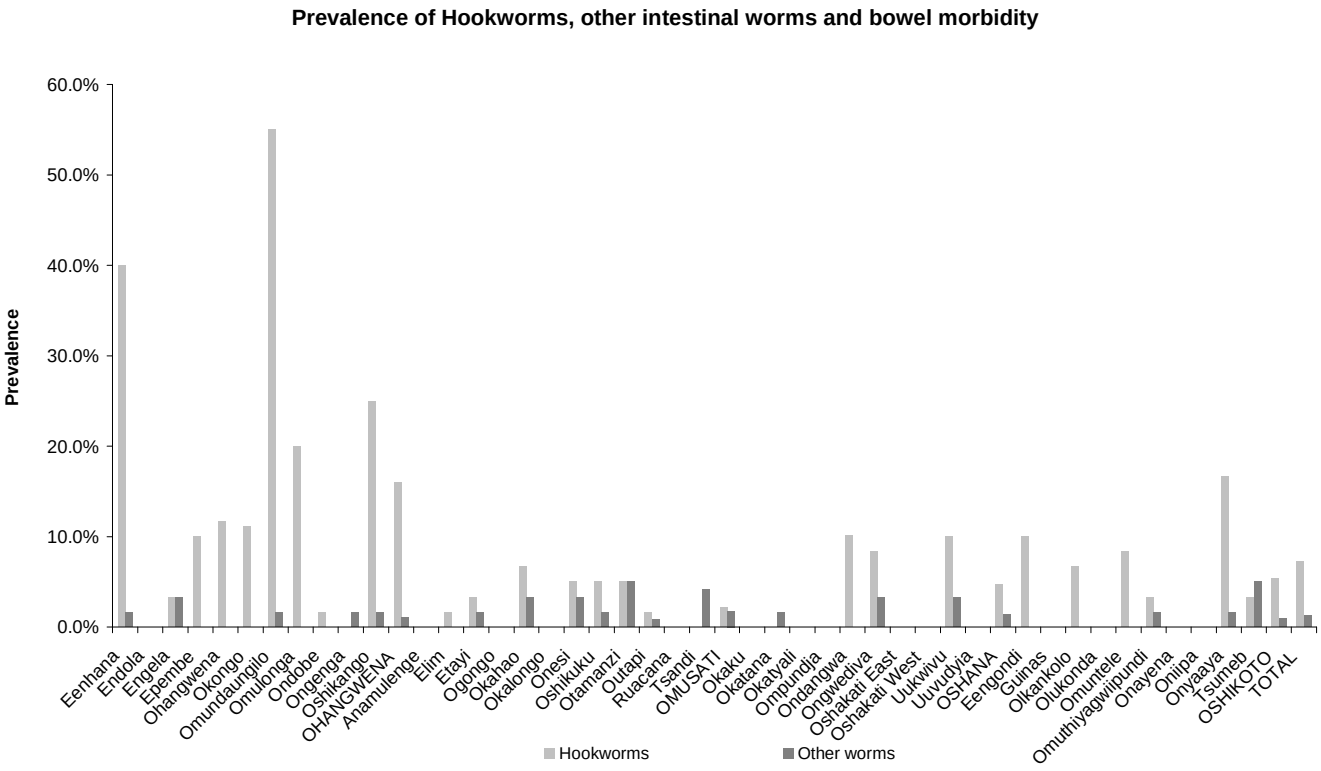



**Figure 6:** Prevalence of hookworms and other worms according to microscopy in each of the constituencies, by region and total. For actual data and confidence intervals, see tables in Appendix 4.

## 6. Results from snail surveys

*Ad hoc* surveys were undertaken by Moses Arinaitwe and Moses Adriko during Phase 2 of mapping. The results of the snail surveys reflect the same disease distribution as that revealed by the school surveys: very few sites contained a snail population (i.e. *Biomphalaria* or *Bulinus*) capable of transmitting disease, but those sites that did, had abundant snail populations representative of these genera. Only five of forty one sites visited had live snails in which only three sites had intermediate hosts for schistosomiasis. Most of the sites visited were highly contaminated and were used by both people and animals

The main species of snails found were *Bulinus forskali*, the intermediate host for urogenital schistosomiasis. These results indicate that transmission potential for urogenital schistosomiasis is low in these regions, but the fact that snails were not found at every site suggests that disease distribution will not be homogeneous. This is largely different from the situation in the Great African Lakes or in the river systems of Western Africa, where snails are ubiquitous.

As a side note, another very important snail was found in these regions – *Lymnaea*. These snails serve as the host for human and veterinary fascioliasis. Cattle fascioliasis is a disease of enormous economic importance, therefore animal welfare departments (such as the Namibian Regional Veterinary Services) should liaise with the MoHSS to better tackle this disease. Importantly, due to the abundance of snails and cattle in these two regions, Veterinary Services should also consider investigating into cattle schistosomiasis (*Schistosoma bovis*), as they will also pose a burden into the local economy. In the future, the issue of species hybridization (cattle and human schistosomiasis) should also be investigated as cattle may be posing as a reservoir for human infections. This is particularly important as presently the performance of praziquantel on killing hybrid schistosomes is not known.

# 7. Recommendations for treatment, the protocol and future work

Overall, Phase 2 of mapping was a success and brought together a new dialogue between teachers, researchers and all local health stakeholders. Indeed, those involved were excited to take part in the work, and for many this type of field work was a new experience. Phase 2 was very different from Phase 1 in one particular aspect: this time we did not use students from the Polytechnic of Namibia, instead we relied solely on MoHSS staff, which means that capacity building was even larger this time around. The MoHSS (central level) provided vehicles, fuel and drugs, which were extremely useful, and the regional offices were incredibly supportive.

## 7.1. Recommendations for future field-work activities

From Phase 1 (included in this report to continue the message):

- In future phases, a pre-visit should be conducted by LATH staff to organize the in-country procurement, as not to overburden the local Geneva Global staff.
- In preparation for Phase 1, cars and drugs were only confirmed at the last-minute; a stressful issue that could have been avoided if we knew the system.
- Appropriate letters should be sent well in advance requesting cars, drugs and regional assistance.
- A visit should also be paid to the regions where the work will take place to assess and inform schools of the work to come, and assess existence of camps or hostels to stay overnight. proved to be incredibly important in Phase 2

From Phase 2:

- More technical staff should participate in the training and mapping initiative. This time around we had many nurses and environmental officers doing technical work in the microscopy teams and this proved to be extremely challenging

## 7.2. Previous deworming initiatives

The information gathered by the questionnaire indicates that the coverage numbers achieved by previous albendazole distribution campaigns are unacceptable according to WHO guidelines (22% of schools covered). In a future vertical integrated control programme, Namibia should aim for at least 75% coverage. Importantly, Namibia also distributes albendazole directly to the community (which includes any school aged child) during their National Immunization Days, which will likely have better coverage than the previous school-based campaign. One aspect that could be hindering the performance of past campaigns is the fact that despite treatment being school-based; it is being administered by nurses from constituency/regional level, and not by the teachers themselves. It is very hard for a single nurse to cover all the schools in the area and therefore better activation of local teachers is needed. It would be advisable to follow the guidelines set by WHO that state that treatment against STHs and schistosomiasis should be done in a school-based fashion using the teachers as drug administrators. Data from this survey suggests that close to 80% of teachers would be very receptive to training and would like to be involved in such a campaign, as shown in Fig. 4.

## 7.3. Schistosomiasis and praziquantel administration

Data from the rapid diagnostic tests showed that schistosomiasis was present in every constituency surveyed, albeit at very low levels. Furthermore, Very few co-infections were identified. Apart from two constituencies (Ongwediva - 12%, and Guinas - 12%), prevalence of schistosomiasis never exceeded 10% (low risk according to WHO), meaning mass treatment is only necessary twice during school years (i.e. every five years) (See Fig. 7). Deworming guidelines by WHO are in Appendix 5.

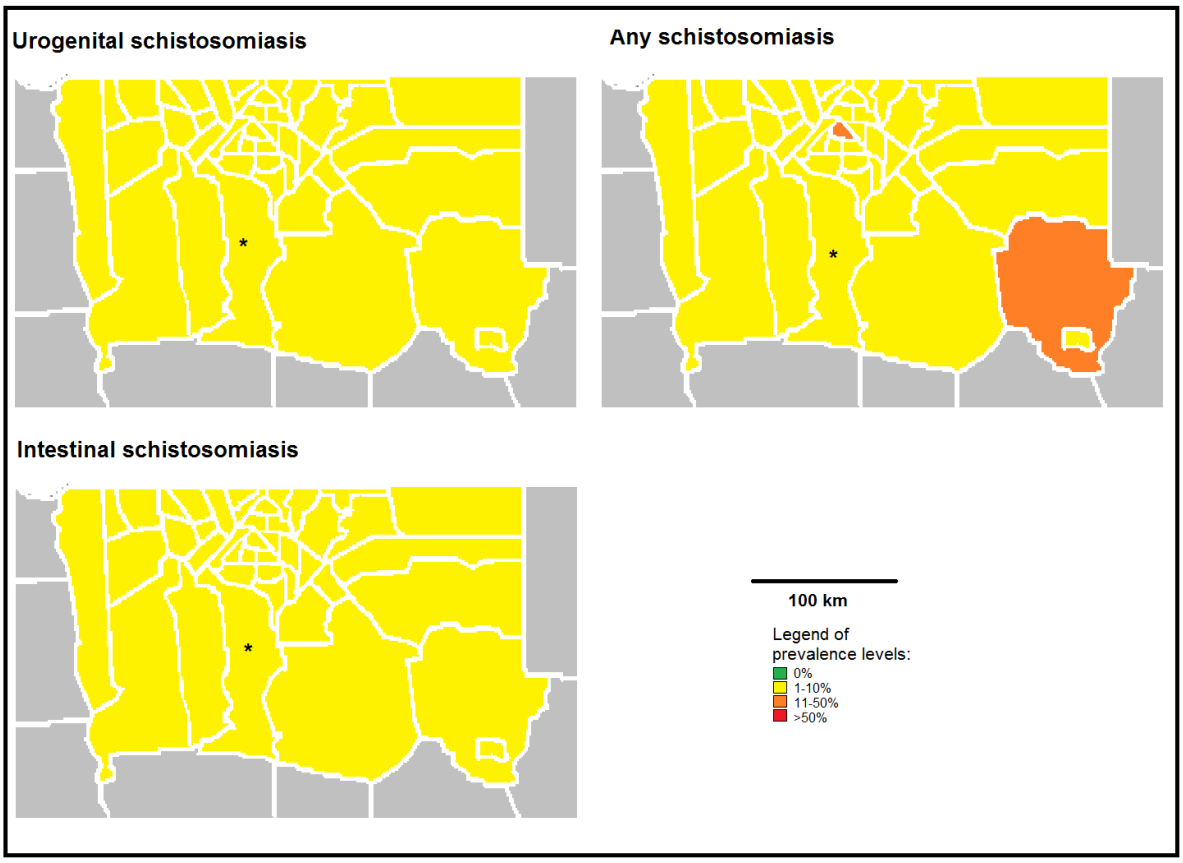



**Figure 7:** Prevalence of schistosomiasis (urogenital, intestinal and any type) by constituency. For constituency names, please see Appendix 2. * Random selection did not select any schools in Uuvudyia (only 4 schools were available). Therefore prevalence is by approximation.

The overall low risk of schistosomiasis (prevalence between 0-10%) and the fact that transmission is highly focalised makes this area a "low hanging fruit" for transmission elimination. Importantly, not only did levels of schistosomiasis fail to reach alarming levels at a constituency level, but also heavy schistosomiasis infections were uncommon.

## 7.4. STH AND OTHER WORM INFECTIONS AND ALBENDAZOLE DISTRIBUTION

Of the three common STH infections, only hookworm was present in these regions of Namibia. Hookworm infection was most prevalent in the north (see Fig. 8). Of particular importance are Eenhana and Omundaungilo constituencies in Ohangwena region, were prevalence levels reached 40% and 55% respectively constituency.

These results suggest that albendazole distribution at a school-level is not absolutely necessary (or could be conducted every five years) in Omusati, Oshana and Oshikoto and should be conducted every year in Ohangwena, whereby in Omundaungilo constituency treatment should be done twice yearly and includ the whole community during one of the yearly rounds. Deworming guidelines by WHO are in Appendix 5.

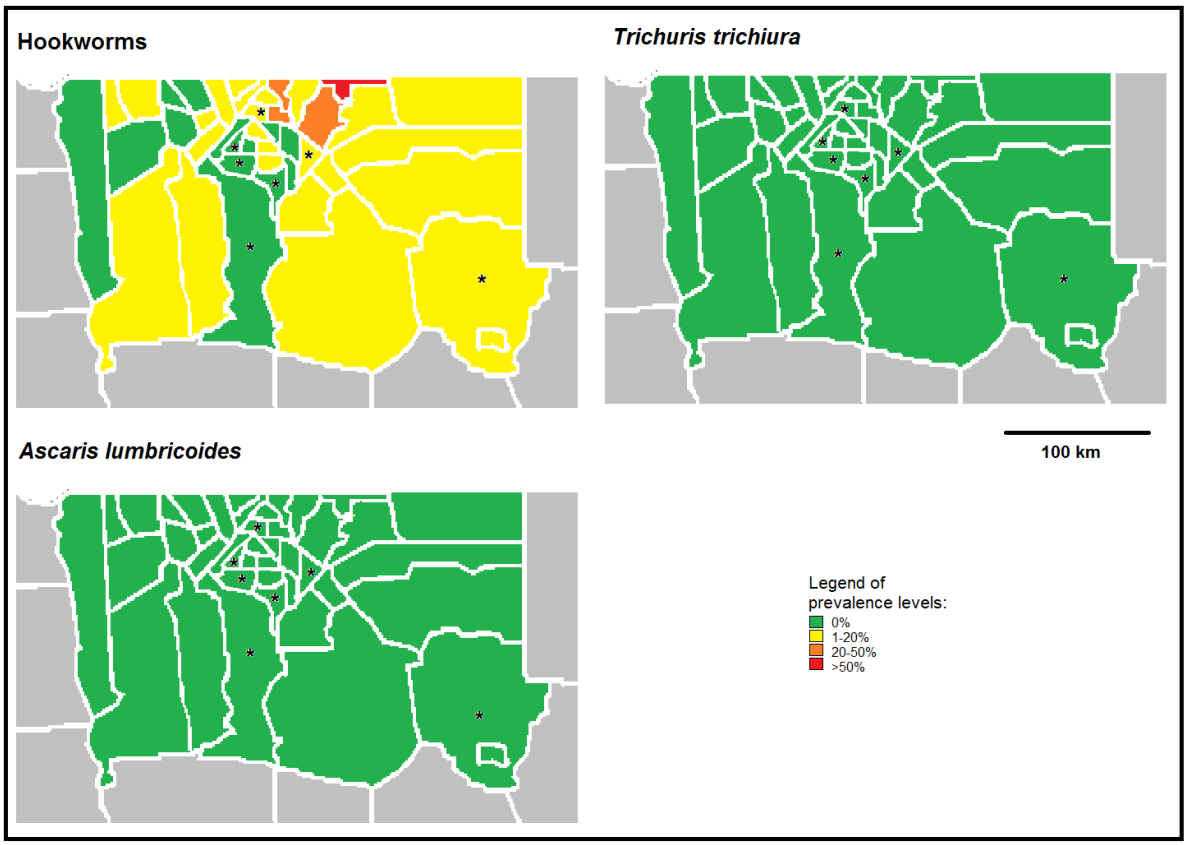



**Figure 8:** Prevalence of STH infections (Hookworms, *Ascaris lumbricoides and Trichuris trichiura)* by constituency. For constituency names, please see Appendix 2. * Random selection did not select any schools in these regions, therefore estimation of prevalence took place by approximation.

*H. nana* and *E. vermicularis* infections were largely from Phase 2 regions (See Fig. 9). Of note are Tsumeb constituency (Oshikoto region) and Otamanzi constituency (Omusati region), where prevalence of these worms reached 5%.

*H. nana*, the dwarf tapeworm, can be treated using single dose praziquantel, much like schistosomiasis, while *E. vermicularis*, the threadworm, can be treated using albendazole. This means that a successful deworming campaign can have incredible impact on these diseases. Infections such as these, even though known for causing morbidity among children, tend to go

under-diagnosed and untreated, especially in school-children whom are not targeted by national control campaigns.

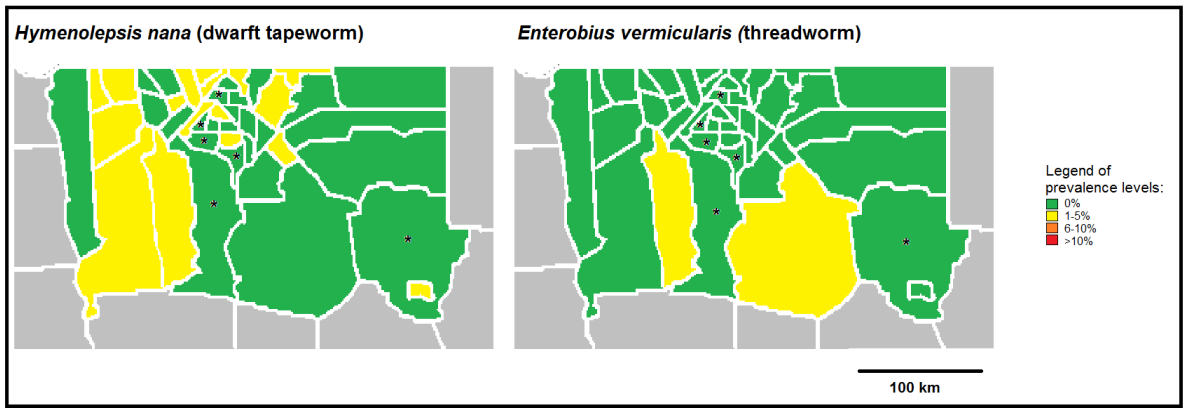



**Figure 9:** Prevalence of *H. nana* (dwarf tapeworm) and *E. vermicularis* (threadworm) by constituency. For constituency names, please see Appendix 2. * Random selection did not select any schools in these regions, therefore estimation of prevalence took place by approximation.

## 8. Ten ways in which this mapping intitiative (Phases 1 and 2) were revolutionary

### *1. The use of rapid diagnostic tests for schistosomiasis*

Rapid Diagnostic Tests (RDTs) for intestinal schistosomiasis had never been used during large-scale mapping activities. In fact, the protocol was approved and implemented six months before the WHO recommended (unofficially) the need for further research into the use of RDTs during mapping. RDTs for urogenital schistosomiasis had already been used before and were already part of WHO guidelines. The use of RDTs decreased the price of mapping from around $12 (US) to $5.5 (US) per person mapped. This also means that far more schools can be covered using less staff, and for a shorter period of time in the field, making it a far more cost-effective mapping protocol.

### *2. Mapping resolution of one in every four schools*

Because of point 1, i.e. reduced cost per person sample because of RDTs, we were able, for the same price as a normal WHO protocol, to cover a larger amount of schools. This is an issue of particular importance for schistosomiasis where the identification of hot-stops of transmission is very important. Schistosomiasis is a very focal disease incredibly dependent on the environment, especially the aquatic environment, since transmission of schistosomiasis is intricately related the intermediate host – a freshwater aquatic snail.

### *3. The use of morbidity markers during mapping*

During mapping in Namibia we were able to estimate the prevalence of visual and non-visual blood in urine, clear indicators of urinary tract pathology caused by urogenital schistosomiasis. Moreover, we were able, using the faecal occult blood (FOB) tests, to estimate the amount of non-visual blood in the faeces of the children surveyed, an indicator of morbidity caused directly by intestinal schistosomiasis and soil-transmitted helminth (STHs) infections.

### *4. Ability to ascertain infection prevalence AND intensity during mapping*

Standard mapping activities stray away from counting the number of eggs per person diagnosed. In Namibia, however, we were able to identify areas of high intensity infections of STHs and schistosomiasis from the get go, using the mapping protocol to serve has a good baseline for future surveillance initiatives.

### *5. Survey included older and younger school aged children*

Namibia mapping was the first ever initiative to include young school age children (5-7 year olds), knowing that whatever infection intensity and prevalence was found among this age group would serve as proxy to infection among preschool-aged children. Pre-school aged children had previously been neglected but are now considered by WHO to be important targets for mass or selective drug administration if at risk, but at the moment no WHO-sanctioned protocol exists to identify this risk. In Namibia we attempted to establish exactly that: what is the most cost-effective way of estimating infection risk among younger children. Additionally, the use of young school-aged children serves as a good baseline of how the population entering school was prior to regular treatment. If, in 5 or 10 years we can re-estimate the infection prevalence and intensity of infection among those entering school we will have a clear metric to indicate how effective drug administration (or any other measures implemented) were in impacting the health of the community.

### *6. Malacological (Snail) sampling alongside baseline mapping to determine where snails are, as a proxy for potential of transmission*

Since information on schistosomiasis was not up-to-date in Namibia, we knew we had to start from scratch, which means we needed to identify the potential for transmission by identification of snails. For example, if humans are infected but snails are absent, it is safe to assume that infections are imported to neighbouring areas. In Namibia, we were able to survey more than 20 water bodies for snails and found intermediate hosts for both types of schistosomiasis, which tells us transmission potential is clear. Furthermore it allowed us to identify potential of transmission for other human and veterinary tropical infections, such as Fasciola.

### *7. Collection and DNA analysis of worm and snail samples at baseline*

Usually, collection and DNA analysis of snails or worms never occurs during mapping, and may never actually happen during control campaigns. And even if it does take place, it will happen after the first few rounds of treatment have been give out. Treatment, however, will confound the “baseline” population of worms so Namibia pioneered this integrated effort of understanding infection, disease and transmission potential. In Namibia collection of snails and worms was completed but funds are still lacking for DNA analysis. What is important however, is that the biological samples are already stored and ready to be worked on.

***8. Complete cooperation between MoHSS and donor***

Very few governments have been proactive enough to be involved financially during their first NTD mapping activity. In Namibia, on the other hand, the mapping activity had financial support from the MoHSS through provision of drugs, vehicles and fuel, the cost of which probably amounts to over one hundred thousand dollars (15-20% of an usual mapping budget).

***9. South-to-south cooperation for capacity building, training and field work***

Capacity building and field work involved cooperation from a Ugandan MoH expert on Mapping and mass drug administration. This, once again, is a new thing to most mapping protocols, and fosters South-to-South cooperation.

***10. Lack of an official implementing partner***

Usually, the funder contacts the government about the need of an MDA programme, a mapping project is then scratched our and implemented through a local implementing partner. In Namibia, the donor – The END Fund - provided the government with a liaison officer, a Geneva Global employee, who served as an asset to the MoHSS, and as a link between the MoHSS, the technical advisors and the donor.

## 8.1. Studying young children during schistososmiasis mapping

Depending on the transmission environment, the peak risk for infection with *Schistosoma* parasites varies in age, but it is believed that for schistosomiasis as a whole, it is somewhere between 10 and 14 years of age. This is why World Health Organization guidelines for schistosomiasis mapping include only children from this age bracket. Therefore, the risk of infection (and therefore prevalence) before that "risky" age bracket is somewhat of a mystery as most mapping protocols neglect the young school-aged children. This was acceptable until very recent research has found that, in certain environments, even infants can be at risk of infection. It all depends on the environment for transmission; i.e. the type of water bodies (can younger children play without fear), the water contact behaviour (is it mainly water collection or do kids play, swim and fish) and health and sanitation conditions (are all children bathed in locally sourced and untreated freshwater). If all the conditions are there, then prevalence of schistosomiasis among those out of school could be high. To avoid this health inequity, a new way to detect level of transmission among preschoolers is to sample younger school aged children as a proxy.

If children between the ages of six and nine are as much at risk of infection as those between ten and fourteen, then one can safely presume that those entering school were already at risk of infection beforehand and could be at risk for morbidity even before they were eligible to treatment during school-based programmes. Recent work in Uganda has estimated that children below the age of six live at half the risk of infection as those in school, and in Uganda where school-based mapping has identified areas exceeding in 70% prevalence means that preschool-aged children are at moderate to high risk of infection and need treatment urgently to avoid morbidity developing in school-years.

In this survey, and for the first time in recent history, we have decided to survey young (from first two grades) and older (ten year olds and above) children during a schistosomiasis mapping initiative. From the complete sample size of 11,978 children, 5817 were young (ages ranging between 3 and 9, mean age of 7) and 6161 were older (ages ranging between 10 and 19, mean age of 12), meaning both age ranges were equally represented in our dataset. Ours results show that prevalence of urogenital and intestinal schistosomiasis were equally distributed between both age groups. For data see Table 1. Overall prevalence of both infections was low, and therefore treatment of preschool-aged children is not warranted in these four regions.

| | Young school-aged children | | | Older school-aged children | | | *P*-value |
|---|---|---|---|---|---|---|---|
| | **No. Positive** | **No. surveyed** | **Prevalence** | **No. Positive** | **No. surveyed** | **Prevalence** | |
| *Infections* | | | | | | | |
| Urogenital schistosomiasis | 198 | 5817 | 3.4% | 248 | 6161 | 4.0% | 0.091 |
| Intestinal schistosomiasis | 65 | 5817 | 1.1% | 57 | 6161 | 0.9% | 0.32 |
| *Morbidities* | | | | | | | |
| Visual blood in urine | 11 | 5817 | 0.2% | 25 | 6161 | 0.4% | **0.044** |
| Microscopic blood in stool | 225 | 1141 | 19.7% | 308 | 1317 | 23.4% | 0.084 |

**Table 1:** Prevalence of schistosomiasis and morbidities associated with it in Ohangwena, Omusati, Oshana and Oshikoto according to age

## 8.2. 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. 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. 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 amount of worm compounds which are passed out through the child's urine. This mapping initiative is at the forefront of research, and it constitutes the first 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 91% and specificity 98%; CCA sensitivity 57% and specificity 99%. These performances were estimated based on the few schools where both microscopy and the rapid diagnostic tests were employed (41 schools) and it clearly indicates that the infections identified by these two tests in the schools where microscopy was not employed (remaining 159 schools) were correctly diagnosed.

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 (60 children) in less than three 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 Phase 2 mapping indicated that each child surveyed using rapid diagnostic tests cost $3.65, while the same child to be surveyed using standard microscopy methods would cost $11.85. If we remove the rapid diagnostic component from the microscopy schools (FOB testing) we are still looking at a budget of around $10 per child surveyed. 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. The issue of costings has been covered thoroughly in the Phase 1 report.

## 8.3. 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). This M&E project usually costs 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 Namibian Government to decide not to conduct a standard M&E and therefore save time and money. 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 (microscopic blood in urine and stool), measured intensity of infection (quantified infections) and its geographical reach is in excess of any M&E protocol.

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 region 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 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.

## 9. Cost effectiveness analysis and cost-comparison

Mapping according to LATH protocol cost **$72,828.27** (includes consumables, equipments, tests, communication and per diems), which included **11,978** students from **200** schools (resolution of 1 in 4 schools) in the survey. There were a total of 829 schools in the four regions sampled. This means that the average cost per child sampled was **$6.08**. As mentioned in section 8.2 of this report, one of the biggest weights on a mapping protocol are the per diems of field teams. We estimate that the average cost of each child surveyed would have been 55% lower (i.e. $2.76 per child) if per diems were not considered (see Table 2).

| | **Actual cost** | **Students sampled** | **Cost per student** |
|---|---|---|---|
| Rapid mapping | $23,702.04 | 11978 | $1.98 |
| Microscopy mapping | $9,360.12 | 2458 | $3.81 |
| Sub-total | $33,062.17 | 11978 | $2.76 |
| | **Per diems** | **Students sampled** | **Cost per student** |
| Rapid mapping | $23,857.86 | 11978 | $1.99 |
| Microscopy mapping | $15,905.24 | 2458 | $6.47 |
| Sub-total | $39,763.11 | 11978 | $3.32 |
| | **TOTAL COST** | **Students sampled** | **Cost per student** |
| Rapid mapping | $43,695.16 | 11978 | $3.65 |
| Microscopy mapping | $29,130.11 | 2458 | $11.85 |
| **Grand Total** | $72,825.27 | 11978 | $6.08 |

**Table 2** - Costs of Phase 2 mapping initiative. "Actual cost" includes consumables, equipment for testing, rapid tests, training and communication costs

According to our results, the average cost per child sampled using microscopy was significantly higher than that of a child sampled using RDTs ($11.85 v. $3.65, respectively). These values will now be used to estimate the cost of other mapping protocols, namely those recommended by the World Health Organization (WHO)

Presently, WHO guidelines for schistosomiasis mapping are very vague. In a recent 'informal' publication by WHO [1], experts state that "for school-level targeting, there are various options for rapid surveys. One approach is to go to **every school** and take samples, e.g. 15 (lot quality assurance sampling – LQAS). Or the approach can be at sub-district level or district level; in either case, **a number of schools** in a district are sampled, with 50 children selected per school." For the latter option, the exact number of schools to be targeted is never made clear, but it is believed that this can either be determined by total area dimensions, whereby one should sample one school every $10km^2$ to accurately identify transmission areas, or that mapping resolution should be based on a ratio of all available schools (somewhere between 1 in 6 and 1 in 10 is usually acceptable, but higher ratios of 1 in 20 schools have been used before).

According to our estimates, mapping using microscopy protocols and following the WHO classic guidelines (50 students per school) would have cost between **$30,156.64** (1 in 10 schools) and **$50,261.06** (1 in 6 schools). Either options are based on less sensitive diagnostic protocols than those used by the LATH protocol and because they would be sampling fewer schools than what was actually completed, data gathered would have been of lower quality. If, on the other hand, we had followed WHO classic guidelines (50 students per school) and sampled one school every $10km^2$ the final cost would have been **$301,566.37**. Clearly this method of estimating sample size is inapplicable in Namibia, a sparsely populated country with relatively few school. Finally, if we had followed WHO rapid-mapping guidelines (15 students per school - LQAS) and sampled all schools, the final cost would have been **$90,469.91**. Even though the term rapid is included in the description of this protocol, the guidelines ask for microscopy and not rapid diagnostic tests, which means that a sub-optimal diagnostic told would have been used. One variation that could have also been explored would be a merge between the LATH protocol and the WHO rapid-mapping guidelines (15 students

[1] WHO, 2011. Report of an informal consultation on schistosomiasis control. WHO, Geneva. http://apps.who.int/iris/bitstream/10665/78066/1/9789241505017_eng.pdf

per school - LQAS), whereby we would go to every school, sample 15 students but use rapid diagnostic tests instead of microscopy. If we had followed such guidelines, the total cost would have been **$45,362.28**. However, using this protocol we would be unable to survey STH infections, as there are presently no RDTs for these infection. For more details, see Table 3.

| | Mapping resolution | Tests employed | Sensitivity of tests | Quality of evidence | Time in field | Cost |
|---|---|---|---|---|---|---|
| LATH | 1 in 4 | RDTs | High | Good | Low | $72,825 |
| WHO classic by ratio | 1 in 10 | microscopy | Low | Poor | Low | $30,156 |
| WHO classic by ratio | 1 in 6 | microscopy | Low | Medium | Medium | $50,261 |
| WHO classic by area | All (1 to 1) | microscopy | Low | Very Good | High | $301,566 |
| WHO LQAS | All (1 to 1) | microscopy | Low | Good | Medium | $90,470 |
| WHO/LATH (LQAS) | All (1 to 1) | RDTs | High | Good | Medium | $45,362 |

**Table 3** - Differences between different protocols and guidelines. RDT stands for rapid diagnostic tests

## 10. Conclusions

It is clear that the previous school-based albendazole distribution campaign did not meet the WHO requirement and therefore greater support should be given to raise the performance of this programme. LATH/LSTM has experience with advising on and directing MDA campaigns for NTDs, including schistosomiasis and STH, and can offer this support to the End Fund to provide effective and cost efficient drug administration to combat these diseases in Namibia, to ensure WHO targets are achieved with direct supporting evidence. Importantly, Namibia also distributes albendazole through their National Immunization Days, and that may be having a larger impact (better coverage) than any school-based initiative.

The data gathered suggests that the need for praziquantel treatment in Phase 2 schools is far lower than that for Phase 1 schools. For a summary of the recommendations see Table 4. Although transmission varied between constituencies, even more so for schistosomiasis due to its focalized nature, to target the treatment regimen on a school-by-school basis would be highly costly and would involve many assumptions (as many schools were not surveyed and the exact prevalence levels remain unknown). What we do know, however, is that due to the overall prevalence of these diseases, for the first five years at least, a praziquantel and albendazole distribution campaign should use the regions as implementation units. After five years, the implementation unit may then be downscaled to the constituency-level as some areas will be free of infection while other will need continued deworming.

Due to the overall good school-enrolment numbers in Namibia and obvious political will, Phase 2 results suggest that a successful school-based campaign will have tremendous impact on burden of schistosomiasis and soil-transmitted helminths (including *H. nana* and *E. vermicularis*). The fact that Namibia lies on the southern fringe of the schistosomiasis-endemic regions of Africa, the fact that transmission is likely seasonal and associated with rains and floods, the fact that morbidity is low and that transmission is only low puts these four regions puts Namibia in a great position to be one of the first areas to successfully eliminate schistosomiasis. Like some areas of the Sahel, the island of Zanzibar and some irrigation schemes in Egypt and Sudan where elimination is thought to be achievable, so it should be in Ohangwena, Oshana, Omusati and Oshikoto regions of Namibia.

The protocol developed and deployed by LATH in Namibia led to the successful mapping of just under 12,000 children, representing just over 280,000 students in the regions of Ohangwena, Omusati, Oshana and Oshikoto. The mapping cost $142k, a significant saving from the 165k budgeted (14% savings). This spending incurred now enabled treatment recommendations which

will subsequently lead to significant saving in Albendazole and Praziquantel purchase and distribution. See Appendix 6 for cost breakdown.

| | Recorded Prevalence | Praziquantel | Albendazole | Hygiene and Sanitation improvements |
|---|---|---|---|---|
| **Ohangwena** | Schistosomiasis 4% STH infections 16% | Treatment at least once during primary school years (e.g. every five years) | Annual treatment * | Eenhana, Okongo, Omundaungilo and Oshikango constituencies |
| **Omusati** | Schistosomiasis 5% STH infections 2% | Treatment at least once during primary school years (e.g. every five years) | No mass treatment needed ** | none |
| **Oshana** | Schistosomiasis 7% STH infections 5% | Treatment at least once during primary school years (e.g. every five years) | No mass treatment needed ** | none |
| **Oshikoto** | Schistosomiasis 3% STH infections 5% | Treatment at least once during primary school years (e.g. every five years) | No mass treatment needed ** | none |

**Table 4:** Recommendations. * Although the overall prevalence is below 20%, because four constituencies are moderate to high risk, we shoiuld. Deworming guidelines by WHO are in Appendix 5. ** Could also be given out once every five years (accompanying PZQ treatment) to control any new infections

## Appendix 1: List of schools visited

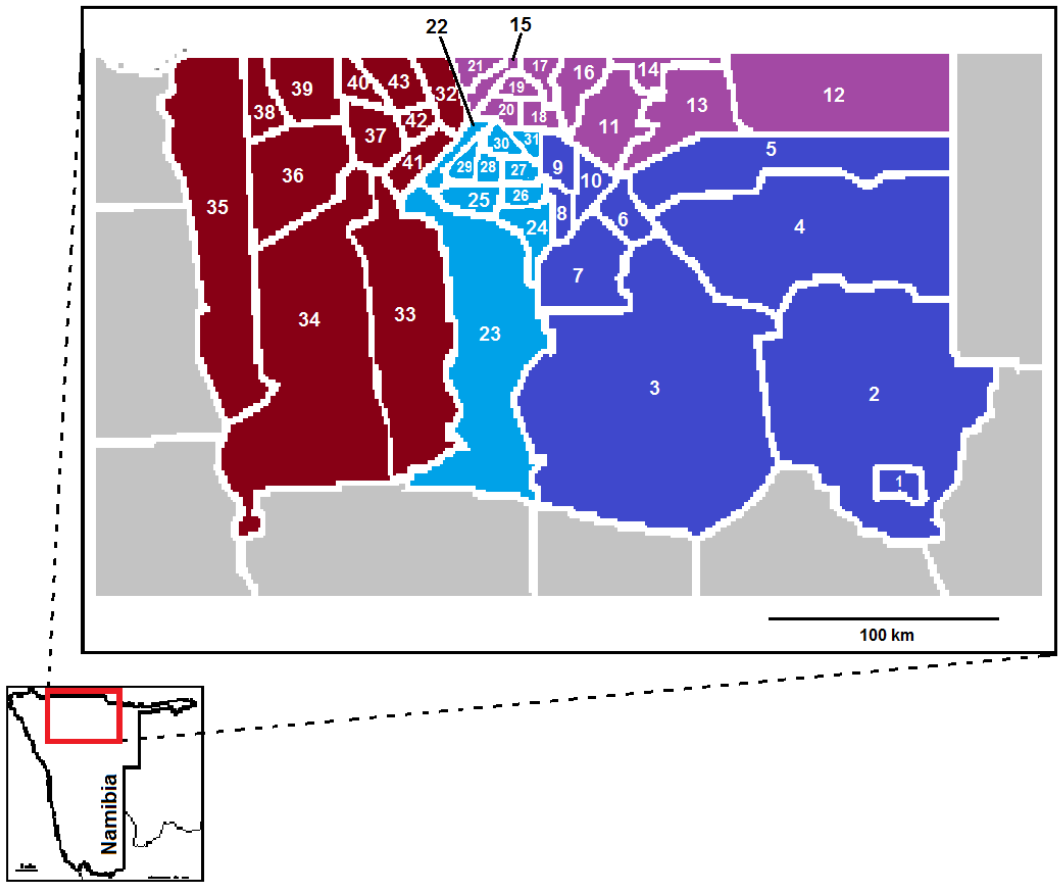
| | Region | Constituency | Name of school (alphabetical order) | GPS coordinate | | No. of students surveyed |
|---|---|---|---|---|---|---|
| | | | | South | East | |
| 1 | OMUSATI | OUTAPI | AKATI PS | -17.4006 | 14.75528 | 224 |
| 2 | OMUSATI | ETAYI | AKAYUPA CS | -17.5503 | 15.45667 | 579 |
| 3 | OMUSATI | OKAHAO | AMBROSIUS AMUTENYA PRS | -17.8465 | 15.06703 | 322 |
| 4 | OSHIKOTO | OLUKONDA | AMUNIME CS | -18.0537 | 16.03712 | 274 |
| 5 | OSHIKOTO | ONIIPA | AMUPAPALA PS | -17.8093 | 16.14012 | 182 |
| 6 | OMUSATI | OKAHAO | AMWAANDA PS | -18.0092 | 15.03972 | 568 |
| 7 | OSHIKOTO | OMUTHIYAGWIIPUNDI | AMWEELO PS | -18.3022 | 16.62194 | 252 |
| 8 | OMUSATI | TSANDI | AMWEENDE CS | -17.8806 | 14.92227 | 426 |
| 9 | OHANGWENA | EPEMBE | AMWIIMBI CS | -17.6772 | 16.45889 | 409 |
| 10 | OMUSATI | ANAMULENGE | ANAMULENGE PS | -17.4922 | 15.00909 | 542 |
| 11 | OMUSATI | TSANDI | ANKONGA PS | -17.8905 | 15.00718 | 296 |
| 12 | OMUSATI | TSANDI | ASHIKOTO PS | -17.9632 | 14.98128 | 88 |
| 13 | OSHIKOTO | ONIIPA | CHRIS J PS | -17.9299 | 16.02667 | 406 |
| 14 | OSHANA | OMPUNDJA | DR. CHIEFS ANKAMA PS | -17.7152 | 14.66492 | 64 |
| 15 | OHANGWENA | EENHANA | EENHANA PS | -17.4898 | 16.32239 | 573 |
| 16 | OMUSATI | TSANDI | EEWANDI CS | -17.4808 | 14.81437 | 405 |
| 17 | OHANGWENA | ONDOBE | EFINDI PS | -17.5078 | 16.12444 | 252 |
| 18 | OSHANA | ONDANGWA | EHEKE PS | -17.9306 | 15.86694 | 525 |
| 19 | OSHANA | OSHAKATI EAST | EHENYE PS | -17.7796 | 15.71355 | 604 |
| 20 | OSHANA | OKATANA | EKAMBA JR PS | -17.7911 | 15.56278 | 175 |
| 21 | OMUSATI | ETAYI | EKANGOLINENE PS | -17.4703 | 15.49972 | 760 |
| 22 | OSHIKOTO | OKANKOLO | EKONGOLA PS | -17.7892 | 17.43111 | 203 |
| 23 | OSHIKOTO | EENGONDI | ELAGO PS | -18.3704 | 16.81828 | 176 |
| 24 | OSHIKOTO | ONAYENA | ELOMBE CS | -17.8457 | 16.22005 | 448 |
| 25 | OSHANA | ONGWEDIVA | ELUWA SS | -17.7811 | 15.76583 | 347 |
| 26 | OSHIKOTO | EENGONDI | EMANYA EAST PS | -18.207 | 17.90018 | 95 |
| 27 | OMUSATI | OGONGO | ENDJENO PS | -17.7089 | 15.24694 | 97 |
| 28 | OMUSATI | OTAMANZI | EPATO CS | -17.8772 | 15.19372 | 341 |
| 29 | OSHIKOTO | OKANKOLO | EPEKE PS | -18.0218 | 16.56529 | 153 |
| 30 | OHANGWENA | EPEMBE | EPEMBE PS | -17.7847 | 16.45056 | NA |
| 31 | OSHIKOTO | OMUNTELE | EPUMBU JR PS | -18.2136 | 16.13028 | 76 |
| 32 | OHANGWENA | ENGELA | EPUNDI PS | -17.6191 | 15.70202 | 314 |
| 33 | OMUSATI | OSHIKUKU | EPYA PS | -17.7139 | 15.35111 | 115 |
| 34 | OSHANA | OSHAKATI EAST | ERUNDU CS | -17.7936 | 15.70056 | 1184 |
| 35 | OHANGWENA | EPEMBE | ETAKAYA PS | -17.5772 | 16.79694 | 104 |
| 36 | OMUSATI | ETAYI | ETAYI CS | -17.5238 | 15.57795 | 544 |
| 37 | OHANGWENA | ONDOBE | ETOMBA | -17.4419 | 16.06556 | 848 |
| 38 | OMUSATI | ELIM | ETOPE PS | -17.8917 | 15.41944 | 109 |
| 39 | OMUSATI | OTAMANZI | ETSILIKO PS | -17.9541 | 15.30481 | 201 |
| 40 | OMUSATI | ONESI | ETUNDA CS | -17.4328 | 14.58111 | 506 |
| 41 | OHANGWENA | ONGENGA | EUDAFANO CS | -17.5267 | 15.61389 | 507 |
| 42 | OMUSATI | ONESI | EUNDA CS | -17.5428 | 14.66361 | 282 |
| 43 | OHANGWENA | ENDOLA | EVATELO CS | -17.6491 | 15.72825 | 572 |
| 44 | OHANGWENA | EPEMBE | EWANIFO CS | -17.6968 | 16.50439 | 250 |
| 45 | OMUSATI | TSANDI | EYAKULO PS | -17.6772 | 15.05302 | 74 |
| 46 | OSHIKOTO | TSUMEB | FRANCIS GALTON PS | -19.2546 | 17.71423 | 922 |
| 47 | OHANGWENA | OHANGWENA | GABRIEL NDADI | -17.5082 | 15.84243 | 803 |
| 48 | OSHANA | ONGWEDIVA | GOLDEN MAGGY PS | -17.7844 | 15.75869 | 510 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 49 | OHANGWENA | OMULONGA | HAIXUXWA PS | -17.681 | 16.13313 | 105 |
| 50 | OSHIKOTO | ONYAANYA | HALLELUYA PS | -18.1274 | 16.32703 | 135 |
| 51 | OSHIKOTO | EENGONDI | HEDIMBI PS | -18.1769 | 17.20611 | 155 |
| 52 | OHANGWENA | OKONGO | HELAO NAFIDI CS | -17.7252 | 17.16129 | 366 |
| 53 | OMUSATI | OUTAPI | IILYATEKO PS | -17.6636 | 14.78279 | 456 |
| 54 | OSHIKOTO | OMUNTELE | IIPOPO CS | -18.1786 | 16.09556 | 410 |
| 55 | OMUSATI | OUTAPI | IISHANAPUTA CS | -17.4736 | 14.72222 | 512 |
| 56 | OSHANA | OKATANA | IIVIYONGO CS | -17.7189 | 15.62778 | 458 |
| 57 | OMUSATI | RUACANA | IK TJIMUHIVA CS | -18.1145 | 14.31659 | 537 |
| 58 | OMUSATI | OKALONGO | ITAMALO CS | -17.587 | 15.31483 | 285 |
| 59 | OMUSATI | OKAHAO | J PUWEYA KANDOMBO | -17.9031 | 15.11958 | 89 |
| 60 | OSHIKOTO | OMUTHIYAGWIIPUNDI | JOHANNES AMWALWA PS | -18.3725 | 16.53453 | 203 |
| 61 | OSHANA | OKATANA | JOSEPH MBANGULA | -17.7492 | 15.73918 | 302 |
| 62 | OMUSATI | ELIM | KAMPELO CS | -17.8681 | 15.27528 | 481 |
| 63 | OHANGWENA | OMULONGA | KAULUMA CS | -17.72 | 16.14111 | 645 |
| 64 | OSHIKOTO | EENGONDI | KING KAULUMA PS | -18.7164 | 17.3994 | 521 |
| 65 | OMUSATI | OSHIKUKU | KOOMA PS | -17.6467 | 15.39667 | 125 |
| 66 | OHANGWENA | OMULONGA | LINEEKELA NANKUSHU CS | -17.4411 | 16.06528 | 563 |
| 67 | OSHANA | ONDANGWA | MAMANYA PS | -17.9103 | 15.89944 | 191 |
| 68 | OHANGWENA | OSHIKANGO | MENNONITE BRETHREN CS | -17.4476 | 15.8935 | 748 |
| 69 | OSHIKOTO | EENGONDI | MUNGANDJELA PS | -18.3231 | 16.77444 | 377 |
| 70 | OMUSATI | ONESI | MUPOLO PS | -17.5161 | 14.635 | 190 |
| 71 | OHANGWENA | OMULONGA | MWADINOMHO CS | -17.6614 | 15.94667 | 776 |
| 72 | OMUSATI | ELIM | NAANGO PS | -17.7272 | 15.49889 | 330 |
| 73 | OMUSATI | TSANDI | NAKAHEKE CS | -17.8013 | 15.03475 | 457 |
| 74 | OSHIKOTO | ONAYENA | NAKAMBALE PS | -17.9939 | 16.2081 | 131 |
| 75 | OHANGWENA | OHANGWENA | NAKAMBUDA PS | -17.4728 | 15.88694 | 512 |
| 76 | OSHIKOTO | OLUKONDA | NAMUTIDHA PS | -18.0267 | 16.11253 | 227 |
| 77 | OHANGWENA | OMUNDAUNGILO | NDADI PS | -17.394 | 16.6806 | 112 |
| 78 | OSHIKOTO | OMUNTELE | NELADO JPS | -18.2802 | 16.32118 | 80 |
| 79 | OSHANA | OSHAKATI WEST | NIIMWANDI PS | -17.7903 | 15.64194 | 296 |
| 80 | OSHANA | ONGWEDIVA | NIITEMBU JR PS | -17.7571 | 15.81581 | 286 |
| 81 | OSHIKOTO | TSUMEB | NOMTSOUB PS | -19.2453 | 17.69944 | 777 |
| 82 | OHANGWENA | OSHIKANGO | ODIBO CS | -17.408 | 15.94146 | 827 |
| 83 | OSHIKOTO | OKANKOLO | OHAHATI JR PS | -17.8978 | 17.11378 | 99 |
| 84 | OSHANA | OSHAKATI EAST | OHAKWEENYANGA CS | -17.8589 | 15.79007 | 248 |
| 85 | OSHANA | ONDANGWA | OIKANGO CS | -17.8378 | 15.81306 | 647 |
| 86 | OHANGWENA | EPEMBE | OKADIDIYA PS | -17.6228 | 16.71333 | 118 |
| 87 | OHANGWENA | OSHIKANGO | OKADILA PS | -17.4728 | 15.96806 | 359 |
| 88 | OSHIKOTO | ONYAANYA | OKAHANYA PS | -18.0694 | 16.34139 | 161 |
| 89 | OMUSATI | OKAHAO | OKAHAO JR PS | -17.885 | 15.06854 | 60 |
| 90 | OSHANA | OKAKU | OKAKU PS | -17.8129 | 15.92575 | 577 |
| 91 | OMUSATI | OKAHAO | OKAKUTUWA PS | -17.8836 | 15.02528 | 135 |
| 92 | OMUSATI | OKALONGO | OKANDO PS | -17.575 | 15.38439 | 275 |
| 93 | OSHIKOTO | OMUTHIYAGWIIPUNDI | OKANGOROROSA CS | -18.4048 | 16.53963 | 310 |
| 94 | OSHIKOTO | OKANKOLO | OKANKOLO CS | -17.96 | 16.41952 | 442 |
| 95 | OMUSATI | OUTAPI | OKAPOPO CS | -17.4603 | 14.96018 | 304 |
| 96 | OMUSATI | OGONGO | OKAPYA PS | -17.6678 | 15.22556 | 277 |
| 97 | OMUSATI | ONESI | OKOMAKWIYA PS | -17.5934 | 14.57724 | 313 |
| 98 | OHANGWENA | OKONGO | OLUHAPA PS | -17.5794 | 17.30722 | 131 |
| 99 | OSHANA | ONDANGWA | OLUNO PS | -17.9244 | 15.99167 | 714 |
| 100 | OSHIKOTO | OMUTHIYAGWIIPUNDI | OLUPALE CS | -18.2928 | 16.55028 | 495 |
| 101 | OMUSATI | ETAYI | OLUPANDU PS | -17.5722 | 15.59472 | 370 |
| 102 | OHANGWENA | OKONGO | OLUWAYA | -17.5331 | 17.05989 | 394 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 103 | OSHANA | ONGWEDIVA | OMAALALA PS | -17.8364 | 15.86333 | 346 |
| 104 | OHANGWENA | EPEMBE | OMAHAHI CS | -17.7665 | 16.72288 | 386 |
| 105 | OMUSATI | ANAMULENGE | OMAHILA CS | -17.5597 | 15.09584 | 308 |
| 106 | OMUSATI | TSANDI | OMALAGO PS | -17.8752 | 14.9161 | 96 |
| 107 | OHANGWENA | EENHANA | OMATHA CS | -17.6322 | 16.39444 | 403 |
| 108 | OSHIKOTO | GUINAS | OMBAHE PS | -18.4371 | 16.83201 | 190 |
| 109 | OMUSATI | OUTAPI | OMBANDJELE PS | -17.507 | 14.94166 | 234 |
| 110 | OSHIKOTO | GUINAS | OMBILI PS | -18.7167 | 17.39861 | 206 |
| 111 | OSHIKOTO | OMUTHIYAGWIIPUNDI | OMBOTO PS | -18.445 | 16.47718 | 263 |
| 112 | OSHIKOTO | ONYAANYA | OMBUNDU PS | -18.2194 | 16.34281 | 273 |
| 113 | OHANGWENA | EENHANA | OMHANDA CS | -17.535 | 16.34278 | 382 |
| 114 | OHANGWENA | EENHANA | OMISHE PS | -17.7436 | 16.40972 | 196 |
| 115 | OMUSATI | OUTAPI | OMPAKOYA CS | -17.5767 | 14.89556 | 349 |
| 116 | OMUSATI | RUACANA | OMUDHUWAHAUWANGA JR PS | -17.4933 | 14.34677 | 206 |
| 117 | OMUSATI | ANAMULENGE | OMUFITO PS | -17.5056 | 15.10467 | 432 |
| 118 | OSHANA | UUKWIYU | OMUKANDU CS | -18.0525 | 15.85861 | 355 |
| 119 | OSHANA | OMPUNDJA | OMULUNGA PS | -17.9753 | 15.63028 | 77 |
| 120 | OHANGWENA | EPEMBE | OMUNDAUNGILO PS | -17.5042 | 16.68556 | 160 |
| 121 | OHANGWENA | ENGELA | OMUNDUDU CS | -17.5525 | 15.70056 | 469 |
| 122 | OHANGWENA | ONDOBE | OMUNGHOLYO CS | -17.4278 | 16.15806 | 750 |
| 123 | OHANGWENA | ONGENGA | OMUNGWELUME PS | -17.5061 | 15.6325 | 442 |
| 124 | OMUSATI | OUTAPI | OMUNYELE PS | -17.543 | 14.94292 | 150 |
| 125 | OSHANA | OKATANA | OMUSHESHE CS | -17.7071 | 15.7623 | 486 |
| 126 | OHANGWENA | OKONGO | OMUUNI PS | -17.4578 | 17.33806 | 274 |
| 127 | OHANGWENA | OSHIKANGO | OMUUVA MUTILIFA PS | -17.4495 | 15.97043 | 220 |
| 128 | OMUSATI | OGONGO | ONAHOLONGO CS | -17.5989 | 15.02961 | 308 |
| 129 | OSHANA | UUKWIYU | ONAKAMWANDI CS | -18.0253 | 15.79528 | 560 |
| 130 | OSHIKOTO | OMUNTELE | ONAMAVO PS | -18.305 | 16.265 | 205 |
| 131 | OSHIKOTO | OMUTHIYAGWIIPUNDI | ONAMBUNDU JPS | -18.2436 | 16.547 | 94 |
| 132 | OHANGWENA | OKONGO | ONAMIHONGA PS | -17.5891 | 17.03337 | 309 |
| 133 | OSHIKOTO | ONIIPA | ONAMPADHI PS | -17.8811 | 16.02889 | 195 |
| 134 | OSHIKOTO | ONIIPA | ONAMUPALULA PS | -17.9311 | 16.09389 | 160 |
| 135 | OSHANA | ONGWEDIVA | ONAMUTAI PS | -17.7296 | 15.83986 | 370 |
| 136 | OHANGWENA | OMULONGA | ONAMUTEMO CS | -17.6656 | 16.10528 | 388 |
| 137 | OSHIKOTO | ONAYENA | ONAMUTENE CS | -17.8356 | 16.17194 | 327 |
| 138 | OMUSATI | TSANDI | ONANGALO PS | -17.8025 | 14.91892 | 288 |
| 139 | OSHIKOTO | ONYAANYA | ONANKALI SOUTH CS | -18.1769 | 16.37028 | 669 |
| 140 | OMUSATI | OUTAPI | ONAYELUKA PS | -17.6395 | 14.90565 | 60 |
| 141 | OSHIKOTO | ONAYENA | ONAYENA PS | -17.9567 | 16.19444 | 267 |
| 142 | OSHANA | ONDANGWA | ONDANGWA PROFESSIONAL PS | -17.9112 | 15.97112 | 168 |
| 143 | OHANGWENA | OMULONGA | ONDEIKELA CS | -17.5672 | 15.55632 | 281 |
| 144 | OMUSATI | OKALONGO | ONDEIPANDA PS | -17.4297 | 15.24673 | 224 |
| 145 | OMUSATI | ANAMULENGE | ONDEITOTELA PS | -17.4069 | 15.08538 | 418 |
| 146 | OSHIKOTO | OMUNTELE | ONDJAMBA CS | -18.1743 | 16.25716 | 420 |
| 147 | OHANGWENA | EPEMBE | ONDOBEMUFIYA PS | -17.7031 | 16.50611 | 77 |
| 148 | OSHIKOTO | TSUMEB | ONDUNDU PS | -19.2414 | 17.72861 | 462 |
| 149 | OMUSATI | OKALONGO | ONEEYA CS | -17.6092 | 15.24266 | 568 |
| 150 | OHANGWENA | OMUNDAUNGILO | ONEHOYA PS | -17.4158 | 16.56444 | 218 |
| 151 | OSHANA | OKATYALI | ONEKANDU PS | -18.0711 | 15.93111 | 170 |
| 152 | OMUSATI | OKALONGO | ONELAGO CS | -17.4597 | 15.13446 | 587 |
| 153 | OMUSATI | OKALONGO | ONENBABA PS | -17.4246 | 15.20779 | 605 |
| 154 | OHANGWENA | ENDOLA | ONEPANDAULO PS | -17.6614 | 15.68972 | 471 |
| 155 | OHANGWENA | ONGENGA | ONGENGA ENGLISH PPS | -17.4479 | 15.67188 | 512 |
| 156 | OHANGWENA | ONGENGA | ONGHALA CS | -17.4158 | 15.81556 | 399 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 157 | OHANGWENA | ENDOLA | ONGONGA PS | -17.5733 | 15.8325 | 231 |
| 158 | OMUSATI | OGONGO | ONGULUGUMBE PS | -17.7899 | 15.20609 | 151 |
| 159 | OHANGWENA | ONGENGA | ONHENGA PS | -17.4781 | 15.70278 | 181 |
| 160 | OHANGWENA | OKONGO | ONHUMBA PS | -17.6131 | 17.13694 | 152 |
| 161 | OSHIKOTO | ONIIPA | ONIIPA PS | -17.9169 | 16.04013 | 761 |
| 162 | OHANGWENA | ENGELA | ONIYOFI PS | -17.4667 | 15.83306 | 355 |
| 163 | OMUSATI | OUTAPI | ONKUNGA PS | -17.6369 | 14.87049 | 101 |
| 164 | OSHANA | OKAKU | ONYEKA CS | -17.7147 | 15.99389 | 370 |
| 165 | OHANGWENA | ONDOBE | OSHAAMA PS | -17.5216 | 16.20807 | 256 |
| 166 | OSHANA | OSHAKATI WEST | OSHAKARI WEST PS | -17.7774 | 15.68595 | 1012 |
| 167 | OSHANA | OSHAKATI WEST | OSHAKATI PS | -17.7753 | 15.69111 | 1022 |
| 168 | OHANGWENA | OKONGO | OSHAMUKWENI | -17.6544 | 17.54639 | 328 |
| 169 | OHANGWENA | ONDOBE | OSHANDI CS | -17.4692 | 16.15278 | 424 |
| 170 | OSHIKOTO | OLIKONDA | OSHAPAPA CS | -17.9808 | 16.09917 | 247 |
| 171 | OMUSATI | OKALONGO | OSHATOTWA CS | -17.4753 | 15.26028 | 414 |
| 172 | OSHIKOTO | ONIIPA | OSHIGAMBO PS | -17.7953 | 16.07167 | 462 |
| 173 | OSHIKOTO | ONYAANYA | OSHILUNGI CS | -18.1236 | 16.37611 | 603 |
| 174 | OMUSATI | TSANDI | OSHITUMBE JR PS | -17.7153 | 14.66472 | 74 |
| 175 | OMUSATI | OSHIKUKU | OSHITUTUMA CS | -17.6601 | 15.34802 | 460 |
| 176 | OSHIKOTO | OMUNTELE | OSHIYAGAYA CS | -18.1257 | 16.19085 | 363 |
| 177 | OSHANA | OKAKU | OTALA CS | -17.8382 | 15.96101 | 546 |
| 178 | OMUSATI | OTAMANZI | OTAMANZI CS | -17.9952 | 15.2611 | 431 |
| 179 | OHANGWENA | EENHANA | OTAUKONDJELE PS | -17.5169 | 16.28889 | 150 |
| 180 | OMUSATI | ETAYI | OTSHIPIYA PS | -17.612 | 15.52828 | 530 |
| 181 | OSHANA | ONGWEDIVA | OUNONGE PS | -17.731 | 15.78606 | 175 |
| 182 | OMUSATI | RUACANA | OVIKANGE PS | -17.4411 | 14.36889 | 367 |
| 183 | OMUSATI | ETAYI | PANDULENI PS | -17.5053 | 15.52694 | 182 |
| 184 | OHANGWENA | ENGELA | PEUMBA CS | -17.5519 | 15.74333 | 518 |
| 185 | OMUSATI | ETAYI | SAMUEL SHITONGO PS | -17.4139 | 15.41386 | 528 |
| 186 | OSHIKOTO | ONAYENA | SHIKANYANDI PS | -18.024 | 16.20761 | 129 |
| 187 | OHANGWENA | OHANGWENA | SHIKEVA CS | -17.5117 | 15.80694 | 348 |
| 188 | OHANGWENA | ENDOLA | SHIKUDULE CS | -17.5747 | 15.89694 | 768 |
| 189 | OHANGWENA | ENGELA | TULIHONGENI CS | -17.6422 | 15.65444 | 291 |
| 190 | OHANGWENA | OSHIKANGO | TUYOLEMI PS | -17.4288 | 16.03269 | 389 |
| 191 | OHANGWENA | ONDOBE | TWALULILWA PS | -17.4095 | 16.30634 | 289 |
| 192 | OMUSATI | RUACANA | UAHEKUA HERUNGA PS | -17.4702 | 14.33121 | 40 |
| 193 | OHANGWENA | EENHANA | UUHAHE CS | -17.7844 | 16.39028 | 193 |
| 194 | OHANGWENA | OMULONGA | UUKELO CS | -17.5933 | 16.10833 | 669 |
| 195 | OSHANA | OSHAKATI WEST | UUKWIYOONGWE CS | -17.188 | 15.6404 | 213 |
| 196 | OSHANA | UUKWIYU | UUKWIYUUSHONA CS | -18.0158 | 15.91583 | 498 |
| 197 | OSHANA | OMPUNDJA | UUPEKE PS | -18.0533 | 15.70083 | 79 |
| 198 | OMUSATI | OKALONGO | UUSHWA CS | -17.5203 | 15.27167 | 648 |
| 199 | OMUSATI | OKAHAO | UUTSATHIMA PS | -18.4672 | 14.82972 | 270 |
| 200 | OMUSATI | OTAMANZI | UVUTHYIA PS | -18.1364 | 15.46972 | 100 |

## Appendix 2: Constituencies




**Oshikoto (1-10)**
1 - Tsumeb
2 - Guinas
3 - Omuthiyagwiipundi
4 - Eengondi
5 - Okankolo
6 - Onyaanya
7 - Omuntele
8 - Olukonda
9 - Oniipa
10 - Onayena

**Ohangwena (11-21)**
11 - Eenhana
12 - Okongo
13 - Epembe
14 - Omundaungilo
15 - Engela
16 - Ondobe
17 - Oshikango
18 - Omulonga
19 - Ohangwena
20 - Endola
21 - Ongenga

**Oshana (22-31)**

22 - Okatana
23 - Uuvudhiya
24 - Okatyali
25 - Opundja
26 - Uukwiyo
27 - Ondangwa
28 - Oshakati East
29 - Oshakati West
30 - Ongwediva
31 - Okaku

**Omusati (32-43)**

32 - Etayi
33 - Otamanzi
34 - Okahao
35 - Ruacana
36 - Tsandi
37 - Ogongo
38 - Onesi
39 - Outapi
40 - Anamulenge
41 - Elim
42 - Oshikuku
43 - Okalongo

## Appendix 3: Mapping School Questionnaire

### School Information Form

| **A. Site Details** | | |
|---|---|---|
| 1. Date of visit | *(DD-MMM-YYYY)* | \|___\|___\|-\|___\|___\|___\|-\|___\|___\|___\|___\| |
| 2. Team Leader Initials | | \|___\|___\|___\| |
| 3. Region Name | | |
| Constituency Name | | |
| 4. Constituency Code | *(CCC)* | \|___\|___\|___\| |

| **B. GPS** | |
|---|---|
| 1. Arrival decimal degrees **east** | \|___\|___\|___\|.\|___\|___\|___\|___\|___\|___\|___\|___\|___\|___\| |
| 2. Arrival decimal degrees **south** | \|___\|___\|___\|.\|___\|___\|___\|___\|___\|___\|___\|___\|___\|___\| |

| **C. School details** | | |
|---|---|---|
| School Name | | |
| 1. School Code | *(SSS)* | \|___\|___\|___\| |
| 2. Name and contact of Principal | Cell: | |
| 4. Number of classes taught | | \|_____\| |
| 5. Number of teachers | | \|_____\| |

| **D. Enrolment numbers** | | |
|---|---|---|
| | **Boys** Enrolled | **Girls** Enrolled |
| Total | 1. \|___\|___\|___\|___\| | 2. \|___\|___\|___\|___\| |

| **E. Questionnaire** | |
|---|---|
| 1. Any latrines at the school-site? (0=No; 1=YES) | \|___\| |
| 2. If YES, please specify condition of latrines (e.g. in working condition) | \|_____\| |
| 3. Is there a source of water at the school? (0=No; 1=YES) | \|___\| |
| 4. If YES, which? (specify, e.g. water-pump) | \|_____\| |
| 5. Have the children in the school ever been de-wormed? (0=No; 1=YES) | \|___\| |
| 6. If YES, was it this year? (0=No; 1=YES) | \|___\| |
| 7. Would the teacher be OK with conducting treatment without a nurse present? (0=No; 1=YES) | \|___\| |

## Appendix 4: Result tables

| | | | Urogenital (haematuria test) | | Intestinal (CCA test) | | Any (both tests) | |
|---|---|---|---|---|---|---|---|---|
| **Constituencies** | **No. schools** | **No. students surveyed** | **prevalence** | **95% CI** | **prevalence** | **95% CI** | **prevalence** | **95% CI** |
| Eenhana | 6 | 360 | 5.3% | 3.2 – 8.1 | 0.3% | 0.0 – 1.5 | 5.3% | 3.2 – 8.1 |
| Endola | 4 | 240 | 2.1% | 0.7 – 4.8 | 4.2% | 2.0 – 7.5 | 6.3% | 3.5 – 10.1 |
| Engela | 5 | 301 | 2.3% | 0.9 – 4.7 | 1.7% | 0.5 – 3.8 | 4.0% | 2.1 – 6.9 |
| Epembe | 8 | 480 | 2.5% | 1.3 – 4.3 | 0.0% | 0.0 – 0.8 | 2.5% | 1.3 – 4.3 |
| Ohangwena | 3 | 180 | 3.3% | 1.2 – 7.1 | 0.0% | 0.0 – 2.0 | 3.3% | 1.2 – 7.1 |
| Okongo | 7 | 418 | 2.6% | 1.3 – 4.7 | 0.0% | 0.0 – 0.9 | 2.6% | 1.3 – 4.7 |
| Omundaungilo | 2 | 120 | 0.0% | 0.0 – 3.0 | 1.7% | 0.2 – 5.9 | 1.7% | 0.2 – 5.9 |
| Omulonga | 7 | 420 | 5.7% | 3.7 – 8.4 | 1.2% | 0.4 – 2.8 | 6.9% | 4.7 – 9.8 |
| Ondobe | 6 | 359 | 2.8% | 1.3 – 5.1 | 1.7% | 0.6 – 3.6 | 4.5% | 2.6 – 7.1 |
| Ongenga | 5 | 301 | 2.3% | 0.9 – 4.7 | 3.7% | 1.8 – 6.4 | 5.6% | 3.3 – 8.9 |
| Oshikango | 5 | 300 | 0.7% | 0.1 – 2.4 | 1.0% | 0.2 – 2.9 | 1.7% | 0.5 – 3.8 |
| **OHANGWENA** | **58** | **3479** | **3.0%** | **2.4 – 3.6** | **1.2%** | **0.9 – 1.7** | **4.1%** | **3.5 – 4.9** |
| Anamulenge | 4 | 240 | 4.6% | 2.3 – 8.1 | 0.0% | 0.0 – 1.5 | 4.6% | 2.3 – 8.1 |
| Elim | 3 | 180 | 3.9% | 1.6 – 7.8 | 2.8% | 0.9 – 6.4 | 6.7% | 3.5 – 11.4 |
| Etayi | 7 | 420 | 2.9% | 1.5 – 4.9 | 0.0% | 0.0 – 0.9 | 2.9% | 1.5 – 4.9 |
| Ogongo | 4 | 240 | 5.0% | 2.6 – 8.6 | 2.1% | 0.7 – 4.8 | 7.1% | 4.2 – 11.1 |
| Okahao | 6 | 360 | 2.8% | 1.3 – 5.0 | 1.1% | 0.3 – 2.8 | 3.9% | 2.1 – 6.4 |
| Okalongo | 8 | 480 | 4.0% | 2.4 – 6.1 | 0.2% | 0.0 – 1.2 | 4.2% | 2.6 – 6.4 |
| Onesi | 4 | 240 | 4.6% | 2.3 – 8.1 | 1.3% | 0.3 – 3.6 | 5.8% | 3.2 – 9.6 |
| Oshikuku | 3 | 180 | 3.3% | 1.2 – 7.1 | 1.1% | 0.1 – 4.0 | 3.9% | 1.6 – 7.8 |
| Otamanzi | 4 | 240 | 3.3% | 1.4 – 6.5 | 2.5% | 0.9 – 5.4 | 5.8% | 3.2 – 9.6 |
| Outapi | 9 | 540 | 4.4% | 2.9 – 6.5 | 0.0% | 0.0 – 0.7 | 4.4% | 2.9 – 6.5 |
| Ruacana | 4 | 220 | 7.3% | 4.2 – 11.5 | 0.9% | 0.1 – 3.2 | 7.7% | 4.6 – 12.1 |
| Tsandi | 9 | 540 | 4.1% | 2.6 – 6.1 | 1.7% | 0.8 – 3.1 | 5.7% | 3.9 – 8.0 |
| **OMUSATI** | **65** | **3880** | **4.1%** | **3.5 – 4.7** | **1.0%** | **0.7 – 1.3** | **5.0%** | **4.3 – 5.7** |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Okaku | 3 | 180 | 4.4% | 1.9 – 8.6 | 0.0% | 0.0 – 2.0 | 4.4% | 1.9 – 8.6 |
| Okatana | 4 | 240 | 3.8% | 1.7 – 7.0 | 0.8% | 0.1 – 3.0 | 4.6% | 2.3 – 8.1 |
| Okatyali | 1 | 60 | 3.3% | 0.4 – 11.5 | 1.7% | 0.0 – 8.9 | 5.0% | 1.0 – 13.9 |
| Ompundja | 3 | 180 | 3.9% | 1.6 – 7.8 | 1.7% | 0.3 – 4.8 | 5.6% | 2.7 – 10.0 |
| Ondangwa | 5 | 299 | 8.4% | 5.5 – 12.1 | 2.0% | 0.7 – 4.3 | 9.7% | 6.6 – 13.6 |
| Ongwediva | 6 | 360 | 9.4% | 6.6 – 12.9 | 2.2% | 1.0 – 4.3 | 11.7% | 8.5 – 15.4 |
| Oshakati East | 3 | 180 | 8.9% | 5.2 – 14 | 0.0% | 0.0 – 2.0 | 8.9% | 5.2 – 14.0 |
| Oshakati West | 4 | 240 | 2.1% | 0.7 – 4.8 | 0.8% | 0.1 – 3.0 | 2.5% | 0.9 – 5.4 |
| Uukwivu | 3 | 180 | 0.6% | 0.0 – 3.1 | 1.1% | 0.1 – 4.0 | 1.7% | 0.3 – 4.8 |
| Uuvudyia | 0 | NA | NA | NA | NA | NA | NA | NA |
| **OSHANA** | **32** | **1919** | **5.6%** | **4.6 – 6.7** | **1.3%** | **0.8 – 1.9** | **6.7%** | **5.6 – 7.9** |
| Eengondi | 5 | 300 | 0.7% | 0.1 – 2.4 | 1.0% | 0.2 – 2.9 | 1.3% | 0.4 – 3.4 |
| Guinas | 2 | 120 | 10.8% | 5.9 – 17.8 | 0.8% | 0.0 – 4.6 | 11.7% | 6.5 – 18.8 |
| Olkankolo | 4 | 239 | 2.5% | 0.9 – 5.4 | 0.4% | 0.0 – 2.3 | 2.9% | 1.2 – 5.9 |
| Olukonda | 3 | 181 | 2.8% | 0.9 – 6.3 | 0.0% | 0.0 – 2.0 | 2.8% | 0.9 – 6.3 |
| Omuntele | 6 | 359 | 1.4% | 0.5 – 3.2 | 0.0% | 0.0 – 1.0 | 1.4% | 0.5 – 3.2 |
| Omuthiyagwiipundi | 6 | 360 | 3.9% | 2.1 – 6.4 | 0.8% | 0.2 – 2.4 | 4.4% | 2.6 – 7.1 |
| Onayena | 5 | 300 | 3.3% | 1.6 – 6.0 | 0.3% | 0.0 – 1.8 | 3.7% | 1.8 – 6.5 |
| Oniipa | 6 | 361 | 2.2% | 1.0 – 4.3 | 1.1% | 0.3 – 2.8 | 3.0% | 1.5 – 5.4 |
| Onyaaya | 5 | 300 | 3.3% | 1.6 – 6.0 | 0.7% | 0.1 – 2.4 | 4.0% | 2.1 – 6.9 |
| Tsumeb | 3 | 180 | 2.8% | 0.9 – 6.4 | 1.7% | 0.3 – 4.8 | 4.4% | 1.9 – 8.6 |
| **OSHIKOTO** | **45** | **2700** | **2.9%** | **2.3 – 3.6** | **0.7%** | **0.4 – 1.1** | **3.4%** | **2.8 – 4.2** |
| **TOTAL** | **200** | **11978** | **3.7%** | **3.4 – 4.1** | **1.0%** | **0.8 – 1.2** | **4.7%** | **4.3 – 5.1** |

**Table 5:** Number of students and schools per constituency 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.

| Constituencies | No. schools | No. students surveyed | Hookworm infections | | Other intestinal worms | | Faecal occult blood | |
|---|---|---|---|---|---|---|---|---|
| | | | prevalence | 95% CI | prevalence | 95% CI | prevalence | 95% CI |
| Eenhana | 1 | 60 | 40.0% | 27.6 – 53.5 | 1.7% | 0.0 – 8.9 | 6.7% | 1.8 – 16.2 |
| Endola | 0 | 0 | NA | NA | NA | NA | NA | NA |
| Engela | 2 | 120 | 3.3% | 0.9 – 8.3 | 3.3% | 0.9 – 8.3 | 10.8% | 5.9 – 17.8 |
| Epembe | 1 | 60 | 10.0% | 3.8 – 20.5 | 0.0% | 0.0 – 6.0 | 33.3% | 21.7 – 46.7 |
| Ohangwena | 1 | 60 | 11.7% | 4.8 – 22.6 | 0.0% | 0.0 – 6.0 | 13.3% | 5.9 – 24.6 |
| Okongo | 2 | 117 | 11.1% | 6.1 – 18.3 | 0.0% | 0.0 – 3.1 | 12.8% | 7.4 – 20.3 |
| Omundaungilo | 1 | 60 | 55.0% | 41.6 – 67.9 | 1.7% | 0.0 – 8.9 | 11.7% | 4.8 – 22.6 |
| Omulonga | 1 | 60 | 20.0% | 10.8 – 32.3 | 0.0% | 0.0 – 6.0 | 30.0% | 18.8 – 43.2 |
| Ondobe | 1 | 60 | 1.7% | 0.0 – 8.9 | 0.0% | 0.0 – 6.0 | 16.7% | 8.3 – 28.5 |
| Ongenga | 1 | 61 | 0.0% | 0.0 – 5.9 | 1.6% | 0.0 – 8.8 | 37.7% | 25.6 – 51.0 |
| Oshikango | 1 | 60 | 25.0% | 14.7 – 37.9 | 1.7% | 0.0 – 8.9 | 16.7% | 8.3 – 28.5 |
| **OHANGWENA** | **12** | **718** | **16.0%** | **13.4 – 18.9** | **1.1%** | **0.5 – 2.2** | **17.8%** | **15.1 – 20.8** |
| Anamulenge | 1 | 60 | 0.0% | 0.0 – 6.0 | 0.0% | 0.0 – 6.0 | 31.7% | 20.3 – 45.0 |
| Elim | 1 | 60 | 1.7% | 0.0 – 8.9 | 0.0% | 0.0 – 6.0 | 31.7% | 20.3 – 45.0 |
| Etayi | 1 | 60 | 3.3% | 0.4 – 11.5 | 1.7% | 0.0 – 8.9 | 20.0% | 10.8 – 32.3 |
| Ogongo | 1 | 60 | 0.0% | 0.0 – 6.0 | 0.0% | 0.0 – 6.0 | 26.7% | 16.1 – 39.7 |
| Okahao | 1 | 60 | 6.7% | 1.8 – 16.2 | 3.3% | 0.4 – 11.5 | 28.3% | 17.5 – 41.4 |
| Okalongo | 1 | 60 | 0.0% | 0.0 – 6.0 | 0.0% | 0.0 – 6.0 | 25.0% | 14.7 – 37.9 |
| Onesi | 1 | 60 | 5.0% | 1.0 – 13.9 | 3.3% | 0.4 – 11.5 | 36.7% | 24.6 – 50.1 |
| Oshikuku | 1 | 60 | 5.0% | 1.0 – 13.9 | 1.7% | 0.0 – 8.9 | 26.7% | 16.1 – 39.7 |
| Otamanzi | 1 | 60 | 5.0% | 1.0 – 13.9 | 5.0% | 1.0 – 13.9 | 31.7% | 20.3 – 45.0 |
| Outapi | 2 | 120 | 1.7% | 0.2 – 5.9 | 0.8% | 0.0 – 4.6 | 22.5% | 15.4 – 31.0 |
| Ruacana | 1 | 60 | 0.0% | 0.0 – 6.0 | 0.0% | 0.0 – 6.0 | 0.0% | 0.0 – 6.0 |
| Tsandi | 2 | 120 | 0.0% | 0.0 – 3.0 | 4.2% | 1.4 – 9.5 | 21.7% | 14.7 – 30.1 |
| **OMUSATI** | **14** | **840** | **2.1%** | **1.3 – 3.4** | **1.8%** | **1 – 2.9** | **24.8%** | **21.9 – 27.8** |
| Okaku | 1 | 60 | 0.0% | 0.0 – 6.0 | 0.0% | 0.0 – 6.0 | 0.0% | 0.0 – 6.0 |
| Okatana | 1 | 60 | 0.0% | 0.0 – 6.0 | 1.7% | 0.0 – 8.9 | 28.3% | 17.5 – 41.4 |
| Okatyali | 0 | 0 | NA | NA | NA | NA | NA | NA |
| Ompundja | 0 | 0 | NA | NA | NA | NA | NA | NA |
| Ondangwa | 1 | 59 | 10.2% | 3.8 – 20.8 | 0.0% | 0.0 – 6.1 | 42.4% | 29.6 – 55.9 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Ongwediva | 1 | 60 | 8.3% | 2.8 – 18.4 | 3.3% | 0.4 – 11.5 | 11.7% | 4.8 – 22.6 |
| Oshakati East | 1 | 60 | 0.0% | 0.0 – 6.0 | 0.0% | 0.0 – 6.0 | 0.0% | 0.0 – 6.0 |
| Oshakati West | 0 | 0 | NA | NA | NA | NA | NA | NA |
| Uukwivu | 1 | 60 | 10.0% | 3.8 – 20.5 | 3.3% | 0.4 – 11.5 | 20.0% | 10.8 – 32.3 |
| Uuvudyia | NA | NA | NA | NA | NA | NA | NA | NA |
| **OSHANA** | **6** | **359** | **4.7%** | **2.8 – 7.5** | **1.4%** | **0.5 – 3.2** | **17.0%** | **13.3 – 21.3** |
| Eengondi | 1 | 60 | 10.0% | 3.8 – 20.5 | 0.0% | 0.0 – 6.0 | 21.7% | 12.1 – 34.2 |
| Guinas | 0 | 0 | NA | NA | NA | NA | NA | NA |
| Olkankolo | 1 | 60 | 6.7% | 1.8 – 16.2 | 0.0% | 0.0 – 6.0 | 46.7% | 33.7 – 60.0 |
| Olukonda | 1 | 61 | 0.0% | 0.0 – 5.9 | 0.0% | 0.0 – 5.9 | 21.3% | 11.9 – 33.7 |
| Omuntele | 1 | 60 | 8.3% | 2.8 – 18.4 | 0.0% | 0.0 – 6.0 | 16.7% | 8.3 – 28.5 |
| Omuthiyagwiipundi | 1 | 60 | 3.3% | 0.4 – 11.5 | 1.7% | 0.0 – 8.9 | 48.3% | 35.2 – 61.6 |
| Onayena | 0 | 0 | NA | NA | NA | NA | NA | NA |
| Oniipa | 2 | 120 | 0.0% | 0.0 – 3.0 | 0.0% | 0.0 – 3.0 | 20.0% | 13.3 – 28.3 |
| Onyaaya | 1 | 60 | 16.7% | 8.3 – 28.5 | 1.7% | 0.0 – 8.9 | 20.0% | 10.8 – 32.3 |
| Tsumeb | 1 | 60 | 3.3% | 0.4 – 11.5 | 5.0% | 1 – 13.9 | 11.7% | 4.8 – 22.6 |
| **OSHIKOTO** | **9** | **541** | **5.4%** | **3.6 – 7.6** | **0.9%** | **0.3 – 2.1** | **25.1%** | **21.5 – 29** |
| **TOTAL** | **41** | **2458** | **7.3%** | **6.3 – 8.4** | **1.3%** | **0.9 – 1.9** | **21.7%** | **20.1 – 23.4** |

**Table 6:** Number of students and schools per constituency involved in the microscopy mapping. Prevalence values (and confidence intervals) for hookworm infections, infections by other intestinal worms (*Hymenolepsis nana* and *Enterobius vermicularis*) and prevalence of faecal occult blood (proxy for bowel morbidity).

| | | Ohangwena | Omusati | Oshana | Oshikoto | TOTAL |
|---|---|---|---|---|---|---|
| **N schools surveyed** | | 58 | 65 | 32 | 45 | 200 |
| **N students surveyed** | | 3479 | 3880 | 1919 | 2700 | 11978 |
| **How many schools had latrines?** | | 97% | 92% | 100% | 98% | 96% |
| **How many schools had latrines in good condition?** | | 84% | 77% | 97% | 76% | 82% |
| **How many schools had a reliable water source?** | | 88% | 100% | 100% | 96% | 96% |
| **Type of water source?** | **Tap** | 66% | 85% | 84% | 76% | 77% |
| | **Borehole** | 22% | 15% | 16% | 20% | 19% |
| **How many schools have ever been dewormed before?** | | 26% | 14% | 31% | 22% | 22% |
| **How many schools were dewormed in 2013?** | | 17% | 9% | 19% | 9% | 13% |
| **Would teachers be ok with conducting MDA?** | | 84% | 66% | 72% | 91% | 78% |

**Table 7** - Results from the questionnaire

## Appendix 5: 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<br>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<br>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<br>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<br>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<br>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 8:** Adapted from WHO (2011). Helminth Control in School-Aged Children. A guide for managers of control programmes. Second Edition. WHO, Geneva

## Appendix 6: Finances

**SCHISTO MAPPING IN NAMIBIA - PHASE 2**

**Financial report**

| Activity | Budget as per Proposal $ (USD) | Actual Expenditure $ (USD) |
|---|---|---|
| Personnel | 45,873.60 | 36,362.96 |
| Travel | 6,049.60 | 6,011.60 |
| LATH Accommodation & Subsistence | 11,035.20 | 10,065.44 |
| Ethical Approval | 0 | 0 |
| Mapping | 82,729.04 | 72,462.96 |
| Malacology | 0 | 0 |
| **Sub Total** | 145,687.44 | 124,902.96 |
| Management Fee | 19962.16 | 17708.00 |
| **TOTAL LATH EXPENDITURE** | 165,649.6 | 142,610.96 |

**Table 9:** Financial report. Exchange rate used: £1 - $ 1.5276 (22/7/13 XE)

## Appendix 7: Results of rapid diagnostic tests by school

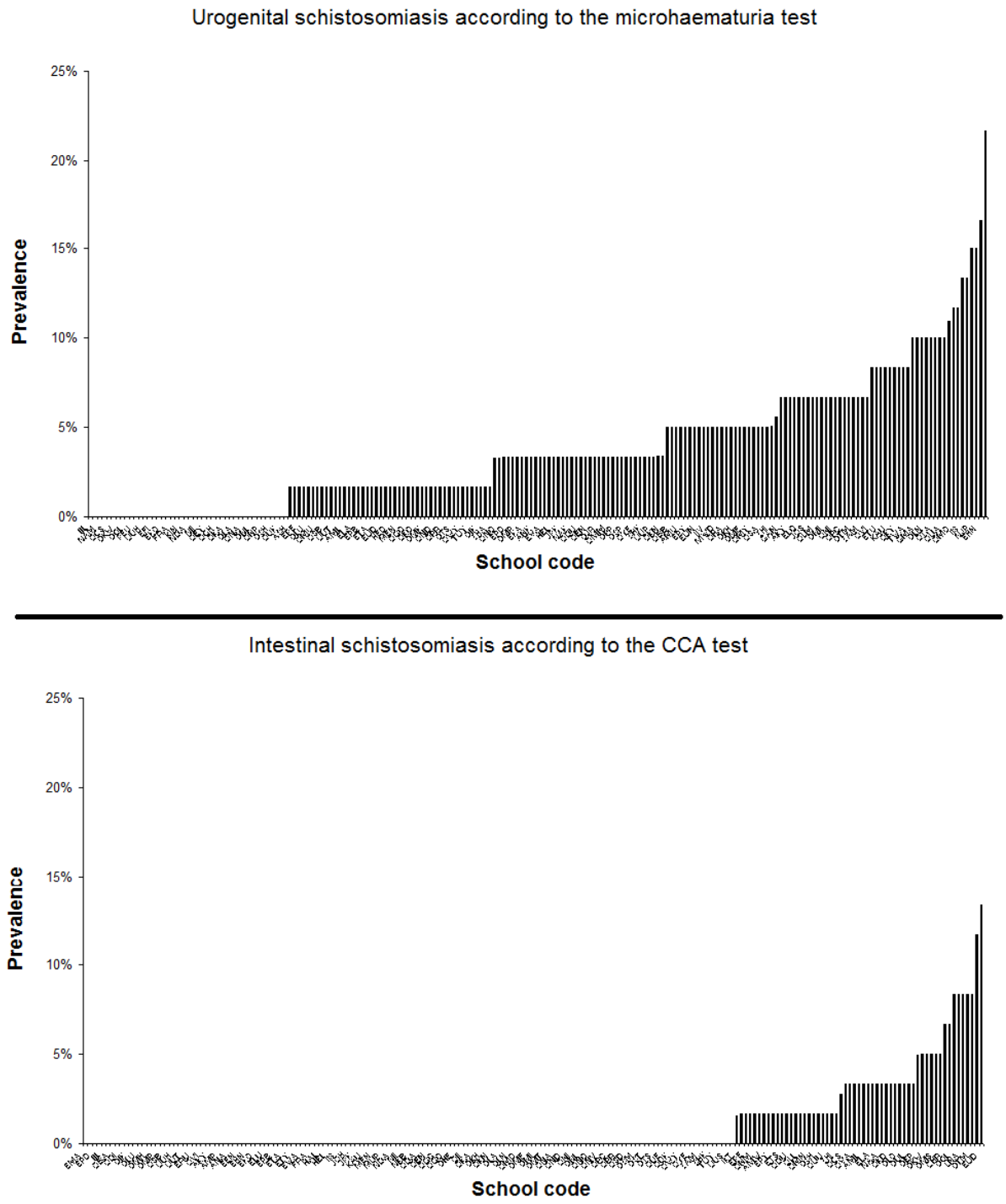



**Figure**: Distribution of urogenital and intestinal schistosomiasis by school in the four regions. The school codes are non-identical between the two graphs, they are simply sequential numbers.

## Appendix 8: List of Participants in training and field

| Name | Job | Region | Phone no. | Email |
|---|---|---|---|---|
| Arinaitwe Moses | T/A | - | 0814585389 | Moses0772359814@gmail.com |
| Adriko Moses | T/A | - | 0814641445 | adrikomoses@gmail.com |
| José Figueiredo | T/A | - | 0814493723 | josf@liverpool.ac.uk |
| Mark Reiff | GG | - | 0814355059 | mreiff@end.org |
| Bruno Veii | Driver | Central | 0812892137 | N/A |
| William Kawasha | Driver | Central | 0812021427 | N/A |
| Ester Haipinge | Driver | Central | 0812694022 | N/A |
| Stark Katokele | Med. Parasitologist | Central | 0812928754 | katokeles@nacop.net |
| Iitula S. Iitula | Insectory manager | Central | 0812191136 | iitulaiitula@yahoo.com |
| Sophia Nicodemus | SHPA | Central | 0812714777 | sophienicodemus@yahoo.com |
| Leena Haidula | SHPA | Central | 0812723240 | leenahaidula@yahoo.com |
| Riitha Kanuni | Vollunteer | Khomas | 0812755368 | rmritzy4@gmail.com |
| Tobey Berriault | Vollunteer | Khomas | 0813789598 | Tobey.berriault@gmail.com |
| Helena Hakwenye | EHO | Ohangwena | 0814030019 | hhakwenye5@gmail.com |
| Muzanima Samuel K. | R/N | Ohangwena | 0813300480 | Skyamuzanima@gmail.com |
| Frans Shifundo | EN/A | Ohangwena | 0812217654 | shifundof@gmail.com |
| Festus Kuushomwa | SHPA | Ohangwena | 0812834232 | festuskuushomwa@yahoo.com |
| Hilda T. Sheetekela | R/N | Omusati | 0812183780 | hildasheetekela@yahoo.com |
| Aina Nghitongo | R/N | Omusati | 0813086348 | Ainak3.ndapandula@gmail.com |
| Sophia N. Negonga | R/N | Omusati | 0813970553 | N/A |
| Shikongo Mikael | EHO | Omusati | 0812890430 | N/A |
| Helena L. Sakarias | R/N | Oshana | 0811499529 | 2khallenah86@gmail.com |
| Fares Kambowe | OHS | Oshana | 0816383911 | N/A |
| Anneli Livia Ekaudjo | EHP | Oshana | 0814745979 | nelagoella@yahoo.com |
| Lucia Nghishongwa | COEHP | Oshana | 0812877674 | nghishongwal@hotmail.com |
| Klaudia Iiyambu | R/N | Oshikoto | 0818283109 | Iiyambo.86@gmail.com |
| Casper Tarumbwa | CEHP | Oshikoto | 0813906806 | farai40@yahoo.co.uk |
| Alugodhi Selma | SHPA | Oshikoto | 0812424574 | evangeli@iway.na |
| Ndahongoudja Pehovelo | R/N | Oshikoto | 0811476699 | npehovelondalala@yahoo.com |
| Siebelo Adrian | EN/A | Zambezi | 0818728740 | Chomiez85@yahoo.com |
| Clarina Kawana | ENM | Zambezi | 0812078846 | clarinakawana@yahoo.com |
| Proper Nyoni | EHP | Zambezi | 0813593848 | Propella1962@yahoo.ac.o.uk |

## Appendix 9: Photos from the mapping

**Moses Arinaitwe during the training workshop with MoHSS employees**

**Team picture**

**RDT team logistics. Each individual would carry one basin, two boxes and a dose pole**

**MoHSS employee holding the RDT result sheet and wearing a project polo shirt**

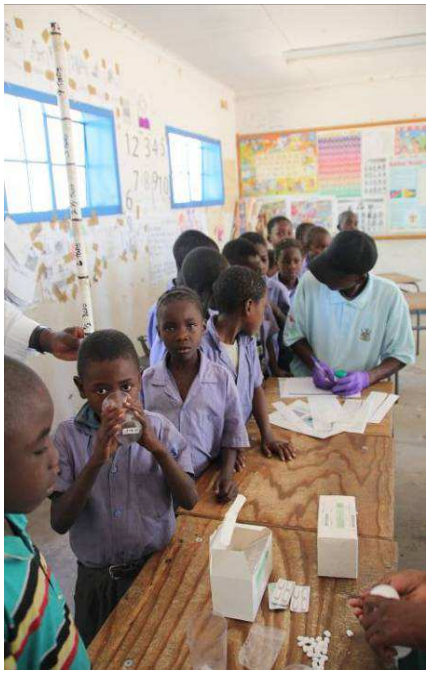
**MoHSS staff doing RDT tests in the field**


**Driving to a school**

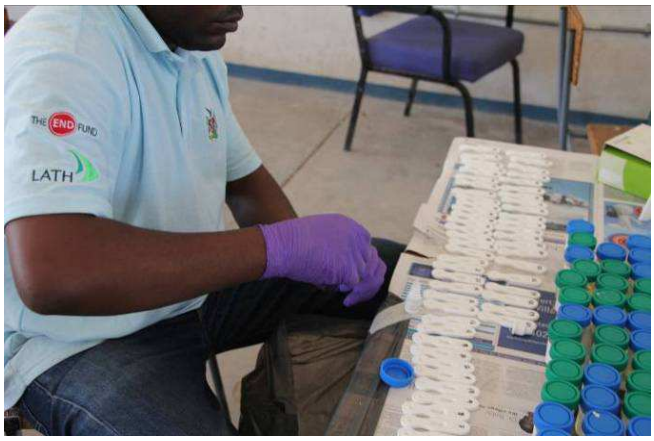

**MoHSS staff performing the questionnaire at a school**

**MoHSS staff distributing urine cups to students**

**Children returning with urine samples**



**A child receiving treatment: on the left is a teacher holding the praziquantel dose pole; and on the right is one of the field RDT technicians, registering the child**




**Field RDT technician conducting CCA tests (for intestinal schistosomiasis)**

**One of the many churches/youth hostels we stayed in (Oshikoto region)**