Kenya National Deworming Programme

Year 1 (2012-2013) Impact Analysis

October 14th, 2013

Introduction

The Kenya National School-Based Deworming Programme began in 2012 and is implemented by the Ministry of Education, Science, and Technology (MoEST) in collaboration with the Ministry of Health (MoH) and with technical assistance from Deworm the World Initiative (DtWi). Personnel from MoEST and MoH play a joint leadership role in ensuring that the Programme is implemented in every public and private primary school within the targeted treatment area, with the goal of treating every child aged 2-14 years whether they are enrolled or not enrolled in school. With funding from the Children's Investment Fund Foundation (CIFF UK) for the first five years, the goal is to reduce prevalence and intensity of soil-transmitted helminths and schistosomiasis by routine, systematic school-based mass drug administration within the context of a long-term, evidence-based control strategy.

In order to achieve this goal, the routine collection of prevalence and intensity data is critical to understand the impact of the school-based deworming programme on school children as well as the re-infection and transmission dynamics in the population to inform future evidence-based programme planning. The Kenya Medical Research Institute (KEMRI) is responsible for the national parasitological data collection to monitor changes in prevalence and intensity in a sample of schools in the four provinces where treatment is being delivered. Prevalence and intensity data is collected for hookworm, *Ascaris lumbricoides*, *Trichuris trichiura* and *Schistosomiasis mansoni* using stool samples and Kato Katz method. Data for *Schistosomiasis haematobium* is collected using urine filtration method. This data collection is structured in the following way:

1) **Long-term (5 year) impact:**
    - Prevalence and intensity data will be collected for STH and schistosomiasis (where it is present) in 200 randomly sampled schools[1] before mass drug administration at baseline (year 1), midline (year 3) and endline (year 5).
    - The objective of this is to understand what the *long-term impact* is on STH and schistosomiasis prevalence and intensity.
2) **Annual effectiveness:**
    - Prevalence and intensity data will be collected for STH and schistosomiasis (where it is present) before and after mass drug administration in 60 randomly sampled schools (in years 1, 3, and 5 these 60 schools are a sub-sample of the 200 schools).
    - The objective of this is to understand *annual* programme effectiveness in terms of reductions in prevalence and intensity and monitor re-infection *across years*.
3) **Transmission dynamics and re-infection:**
    - Prevalence and intensity data will be collected for STH and schistosomiasis (where it is present) at four time points each year in a cohort of 10 randomly sampled schools (in years 1, 3, and 5 these 10 schools are a sub-sample of the 200 schools).
    - The objective of this is to monitor transmission dynamics *within each year* to understand re-infection, seasonality and, where possible, causation.

[1] 100 children are sampled in each school during data collection.

Overall, the year one data collection went well and the data collection teams were able to adapt to multiple waves of treatment and shifting schedules. The teams were easily assembled at short notice, re-trained and dispatched to the field for data collection. Supplies and reagents were also purchased in time due to the availability of reliable, timely funding. There were a few challenges to the data collection, including the unpredicted teachers' strikes in the Fall of 2012, which delayed access to some schools for data collection. Additionally, inadequate record-keeping in schools made it difficult to get school attendance records for educational outcome data in the 10 high frequency schools and signs of reluctance to give samples in some schools (especially among the 10 schools which were visited 4 times in year for sample collection, including blood). Otherwise, there was generally good communication across partners, including the cooperation of ministry staff.

Analysis

Baseline Prevalence and Intensity in 200 Schools

Prevalence and intensity of all three STH species and both schistosomiasis species was collected in 200 schools before the first year of deworming treatment occurred in Western, Nyanza, Rift and Coast Provinces. A full discussion of the methodology and findings of the baseline are presented in the article published in the journal *Parasites & Vectors* in July of 2013[2].

Overall, STH infection prevalence in the 200 sampled schools was 32.4% (95% CI 30.1-34.8%). *A. lumbricoides* was the most prevalent STH species (18.0%, 95% CI 15.7- 20.6%), followed by hookworm (15.6%, 95%CI 13.7-17.7%) and then *T. trichiura* (6.6%, 95% CI 5.4- 8.1%). The overall mean intensity of *A. lumbricoides* was 1,653 epg (95% CI 1372-1991), mean hookworm intensity was 64 epg (95% CI 51-81) and mean *T. trichiura* intensity was 33 epg (95% CI 10-104). The overall prevalence of *S. mansoni* was 2.1% (95% CI 1.2- 3.5) with a mean infection intensity of 12 epg (95%CI 4-36). In the Coast Province, where urine samples were collected in 33 schools, the prevalence of *S. haematobium* was 14.8% (95% CI 11.3-19.5) and the mean infection intensity was 16 eggs/10 ml urine (95% CI 10-26).

Going forwards, this same prevalence and intensity data will be collected in 200 schools[3] in year 3 and in year 5 (midline and endline). These numbers present the average across the four provinces, further detail on province and species-specific baseline prevalence and intensity can be found in the published article.

Prevalence and Intensity Pre/Post Treatment in 60 Schools

Prevalence and intensity of all three STH species and both schistosomiasis species was collected both before and after the first year deworming treatment in 60 of the 200 baseline schools in Western, Nyanza, Rift and Coast Provinces. Analysis was done with school-level data (using averages of individual student data at each school). A list of the districts in which the schools were sampled from can be found in Annex 1.

Pre-treatment data collection was between January and April of 2012 and post-treatment data was collected between September and October of 2012. Further post-treatment data, primarily in the high frequency schools and schools in Coast Province, was collected through March 2013 due to the additional post-treatment time points for the high frequency schools and the disruption due to the teachers strike in the Fall of 2012 which closed schools for data collection.

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[2] Mwandawiro CS, Nikolay B, Kihara JH, Ozier O, Mukoko DA, Mwanje MT, Hakobyan A, Pullan RL, Brooker SJ, Njenga SM: **Monitoring and Evaluating the Impact of National School-based Deworming in Kenya: Study Design and Baseline Results.** *Parasites and Vectors* 2013, **6:**198.

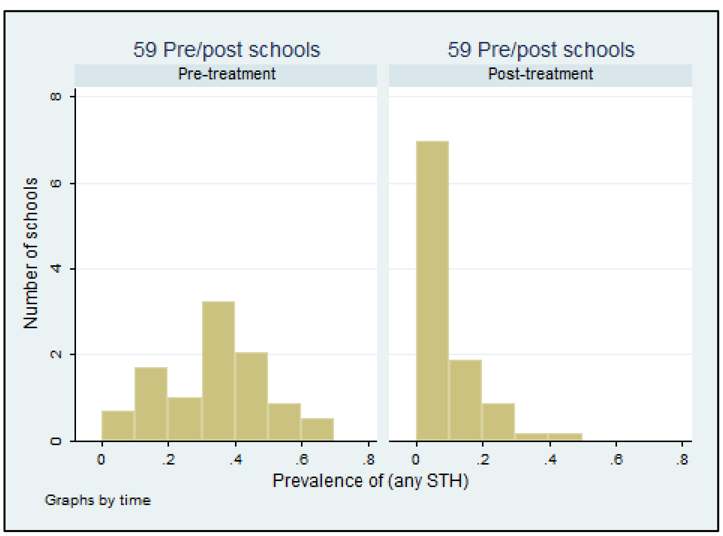
[3] Not a cohort – 200 schools will be randomly sampled again in years 3 and 5.

Table 1. Summary of Pre/Post Prevalence and Intensity in 59 schools

	Prevalence (percent)		Mean intensity (epg)		Moderate-to-heavy infections (percent)	
Time:	Pre-treatment	Post-treatment	Pre-treatment	Post-treatment	Pre-treatment	Post-treatment
Any STH	**34.5**	**10.4**	--	--	**8.08**	**0.75**
Hookworm	**17.0**	**3.1**	**65.5**	**7.3**	**0.36**	**0.05**
A. lumbricoides	**18.8**	**2.1**	**1617**	**94**	**7.71**	**0.55**
T. trichiura	5.3	4.2	9.4	11.8	1.26	1.73
Schistosomiasis	1.8	2.3	5.6	27.8	1.04	1.33

Statistically significant reductions are indicated in shaded cells with bold text.

The pre and post prevalence and intensity (both mean eggs per gram and percent of moderate-to-heavy infections as defined by the WHO[4]) is presented in the table above. This data is based on school-level averages from 59 of the 60 schools[5]. Additional district-specific pre/post data can be found in Annex 1. In the baseline survey, *A. lumbricoides* and hookworms were the most common STH species among the 60 pre/post surveyed schools, with 17.0% and 18.8% prevalence in children sampled respectively. Only 5.3% of children sampled were infected with *T. trichiura*. In the post MDA survey, however, *T. trichiura* prevalence was highest with 4.2%, followed by hookworm and *A. lumbricoides* with 3.1% and 2.1% respectively. This was not surprising given that *T. trichiura* is the most stubborn infection among the three STH species and is usually the least responsive to albendazole treatment.



Average STH prevalence
(All Provinces)

Before treatment: 34.5 percent
After treatment: 10.4 percent
Reduction: 24.1 percent
(p<0.01 significance)

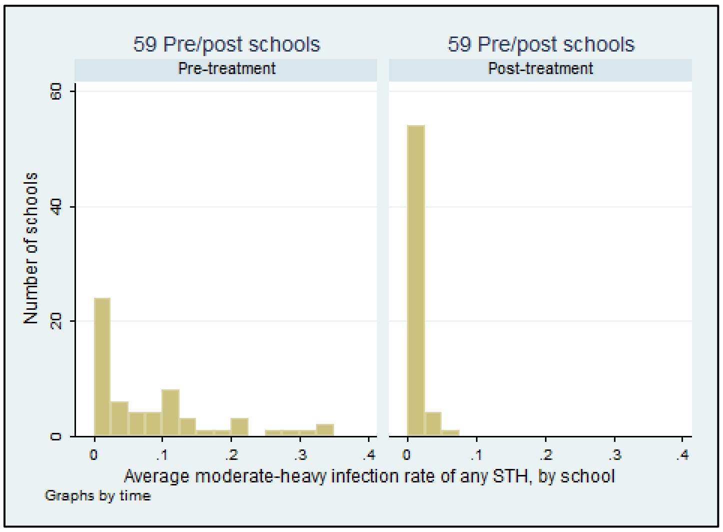
Figure 1. Pre/Post STH Prevalence in 59 schools

[4] Moderate-to-heavy infection thresholds are taken from Montresor, A., T.W. Gyorkos, D.W.T. Crompton, and D.A.P. Bundy. *Monitoring helminth control programmes: Guidelines for monitoring the impact of control programmes aimed at reducing morbidity caused by soil-transmitted helminths and schistosomes, with particular reference to school-age children.* World Health Organization: Geneva, 1999.

[5] Data from one school in the sample is being looked into further and will be included in the analysis when ready.

Overall, the pre/post treatment data shows an obvious shift in average STH prevalence in schools after treatment, with a statistically significant ($p<0.01$) reduction of 24.1% in prevalence of all three STH species seen across the programme from a baseline of 34.5%.

When this pre/post prevalence and intensity data is looked at by species, it is apparent that treatment appears to have been particularly effective against *A. lumbricoides* and hookworm. However, *T. trichiura* and both species of schistosomiasis had considerably low intensities in the pre/post sample, so effects are not significant. Table 1C in Annex 1 provides district-specific prevalence reductions by species.



Average STH intensity: moderate-to-heavy infection (All Provinces)

Before treatment:	8.08 percent
After treatment:	0.75 percent
Reduction:	**7.33 percent**

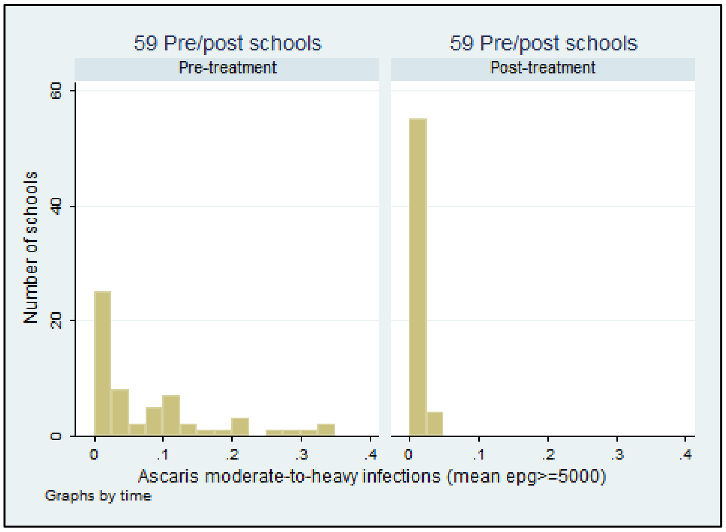
($p<0.01$ significance)

Figure 2. Pre/Post STH Intensity (moderate-to-heavy infection) in 59 schools

In addition to these reductions in prevalence, significant reductions in intensity and, most importantly, in the percent of moderate-to-heave infections were seen after treatment. A statistically significant ($p<0.01$) reduction of 7.33% with moderate-to-heavy STH infections was seen across the programme from a baseline of 8.08%.

As seen in the graphs and tables below, the strongest intensity reductions were seen for *A. Lumbricoides.* Baseline rates of moderate-to-heavy infection of this species exceeded 2.5% in more than half of the schools sampled. After treatment, moderate-to-heavy infections across the four provinces fell from 7.71% to 0.55% ($p<0.01$). A similar pattern was seen for hookworm, with a statistically significant reduction of moderate-to-heavy infections falling from 0.36% to 0.05% ($p<0.01$).

Most of the sampled schools had very low rates of intense infections of *T. trichiura* at baseline and change after treatment was not significant. As previously mentioned, *T. trichiura* is not as greatly affected by albendazole treatment as *A. lumbricoides* according to some findings which could be an explanation for these findings. Similarly, the baseline intensity of *S. mansoni* was low and a change was not significant.

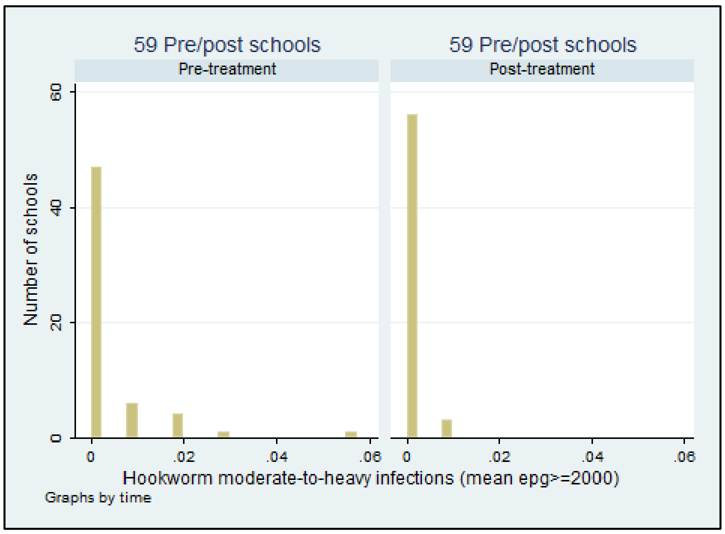


Average *A. lumbricoides* intensity: moderate-to-heavy infection (All Provinces)

Before treatment:	7.71 %
After treatment:	0.55 %
Reduction:	**7.16%**

(p<0.01 significance)

Figure 3. Pre/Post *A. lumbricoides* intensity (moderate-to-heavy infection) in 59 schools

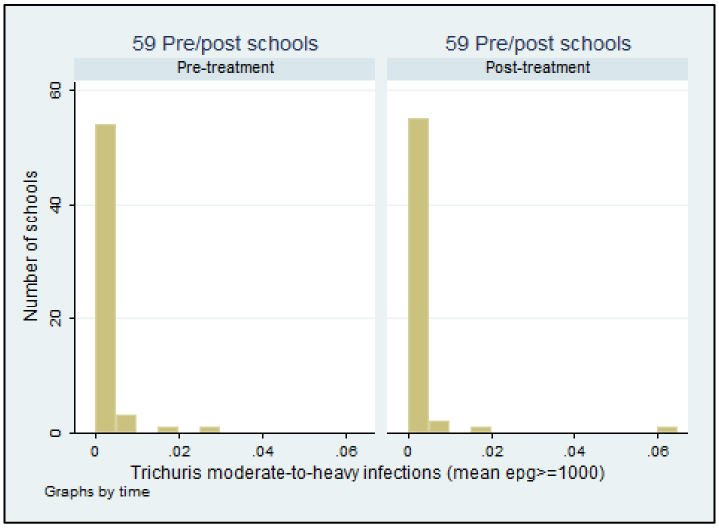


Average hookworm intensity: moderate-to-heavy infection (All Provinces)

Before treatment:	0.36 %
After treatment:	0.05 %
Reduction:	**0.31 %**

(p<0.01 significance)

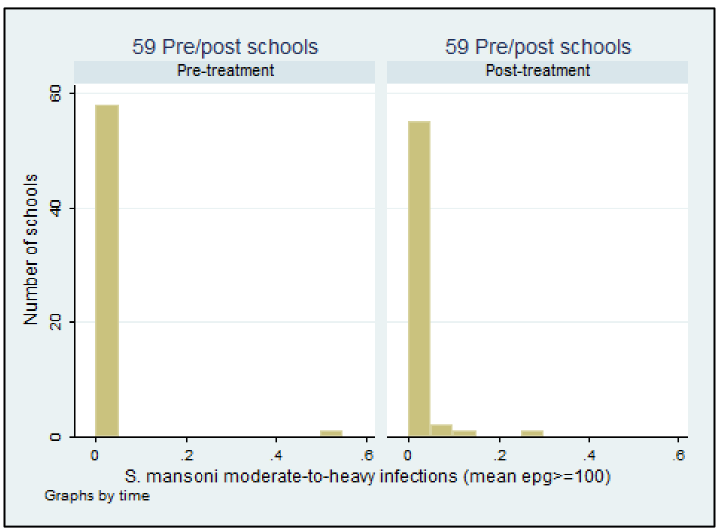
Figure 4. Pre/Post hookworm intensity (moderate-to-heavy infection) in 59 schools



Average *T. trichiura* intensity: moderate-to-heavy infection (All Provinces)

Before treatment: 1.26 %
After treatment: 1.73 %
Increase: 0.47 %
(not significant)

Figure 5. Pre/Post *T. trichiura* intensity (moderate-to-heavy infection) in 59 schools



Average *S. mansoni* intensity: moderate-to-heavy infection (All Provinces)

Before treatment: 1.04 %
After treatment: 1.33 %
Increase: 0.30 %
(not significant)

Figure 6. Pre/Post *s.mansoni* intensity (moderate-to-heavy infection) in 59 schools

Spatial Variation in Prevalence and Intensity Reductions in 60 Schools

In addition to the overall national prevalence and intensity reductions for each species after treatment, district level data is available and can be found in Annex 1. The following spatial patterns of prevalence reduction (PR) and average intensity of infection reduction (IR) were observed.

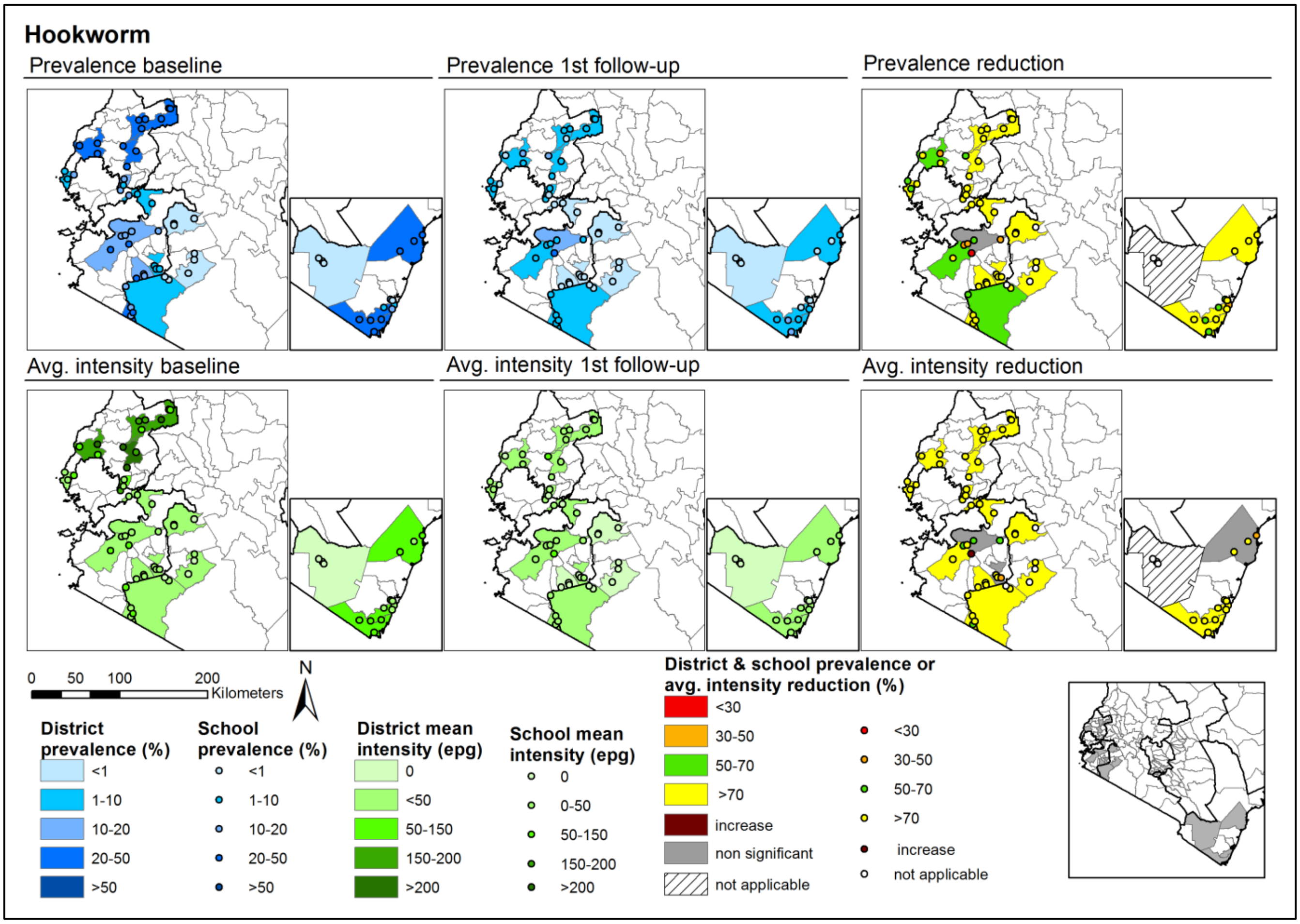


Figure 7. School and district hookworm prevalence and intensity at baseline and first follow up and school and district PR and IR

Hookworm prevalence reduction was lowest in Rachuonyo district (PR 32%; 95%CI non significant-61) and the district average infection intensity increased insignificantly (IRR 1.2; 95%CI 0.4-4.3), see Figure 7 above. Rachuonyo was also the district with highest hookworm prevalence and average intensity of infection in the follow up survey, while in the baseline survey prevalence and intensity was average. All three surveyed schools in Rachuonyo showed low prevalence and intensity reductions. Moreover, in Malindini and Masaba district the decrease in average infection intensity was not significant. In both districts one of three surveyed schools showed a low intensity reduction while the others had nearly 100% intensity reduction.

While *A. lumbricoides* prevalence and intensity reductions at district level were overall high, a change in infection prevalence in Msambweni district was insignificant while the intensity of infection increased significantly (Figure 8 below). This seems to be due to an outlier school with very low baseline prevalence (0.9%) where prevalence remained unchanged and infection intensity increased. Nevertheless, *A. lumbricoides* prevalence in Msambweni remains very low (<1%).

The reduction of prevalence was insignificant for Kuria East district and reduction of average infection intensity was insignificant for Kwale district. Kuria East contains an outlier school where prevalence and intensity of infection increased; the school had a baseline prevalence of 0%. One of the surveyed schools in Kwale district had low prevalence and intensity reductions (50% and 33%) while all other schools remained infection free or had reductions of 100%.

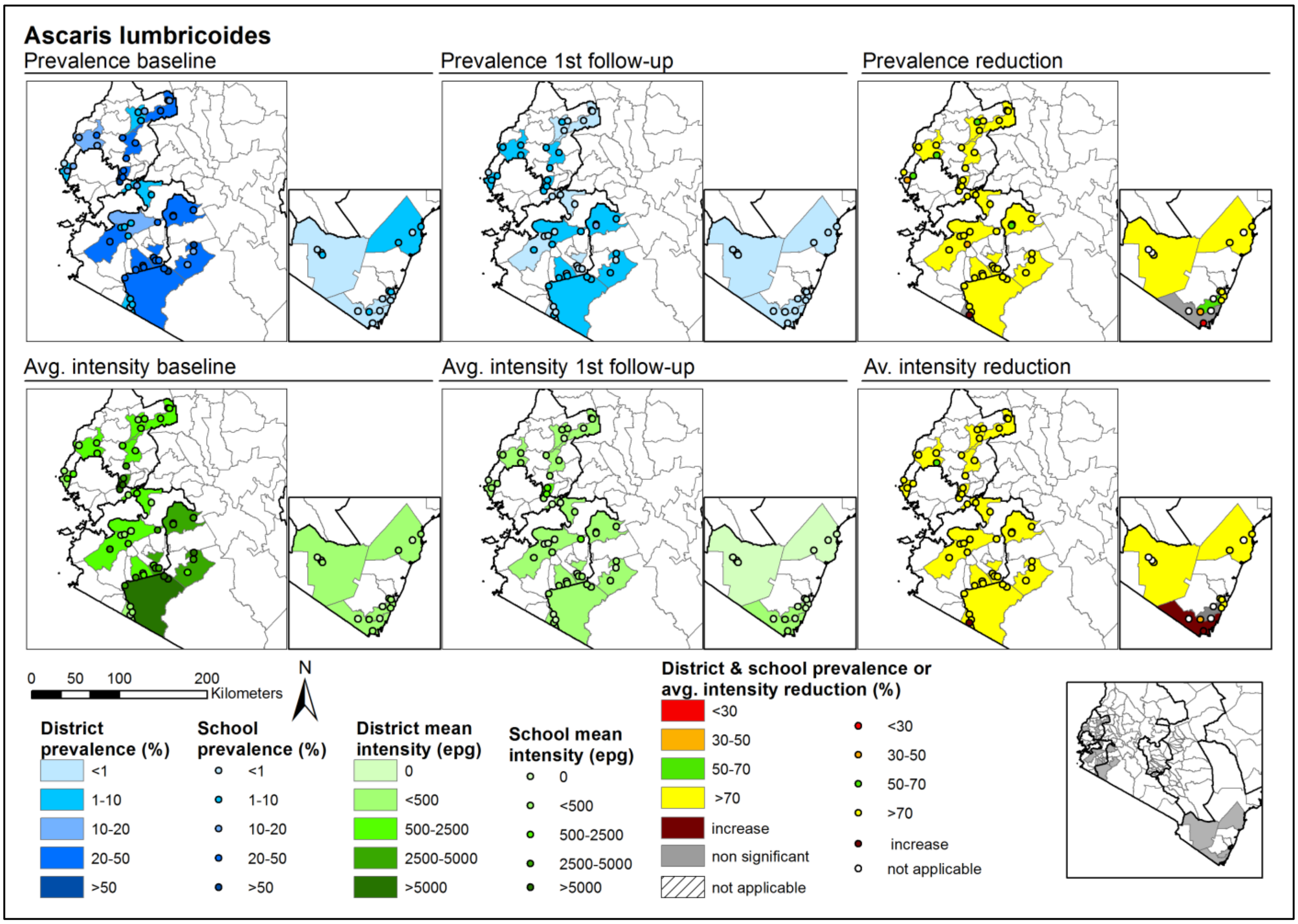


Figure 8. School and district *A. lumbricoides* prevalence and intensity at baseline and first follow up and school and district PR and IR

T. trichiura was the least prevalent STH species in the baseline survey (see Figure 9 on next page). However, prevalence and intensity reductions were overall lowest and vary importantly between districts and between schools within a district. Significant decreases in prevalence were observed only in Kwale, Bungoma, Kakamega, Kuria East and Msamba districts. Significant decreases in average infection intensity in Kericho, Bungoma, Kakamega, Kisumu East, Kuria East and Msamba districts. Prevalence increased significantly in Transmara and Emuhaya, and average infection intensity in Kilindini, Bomet, Transmara, and Gucha districts.

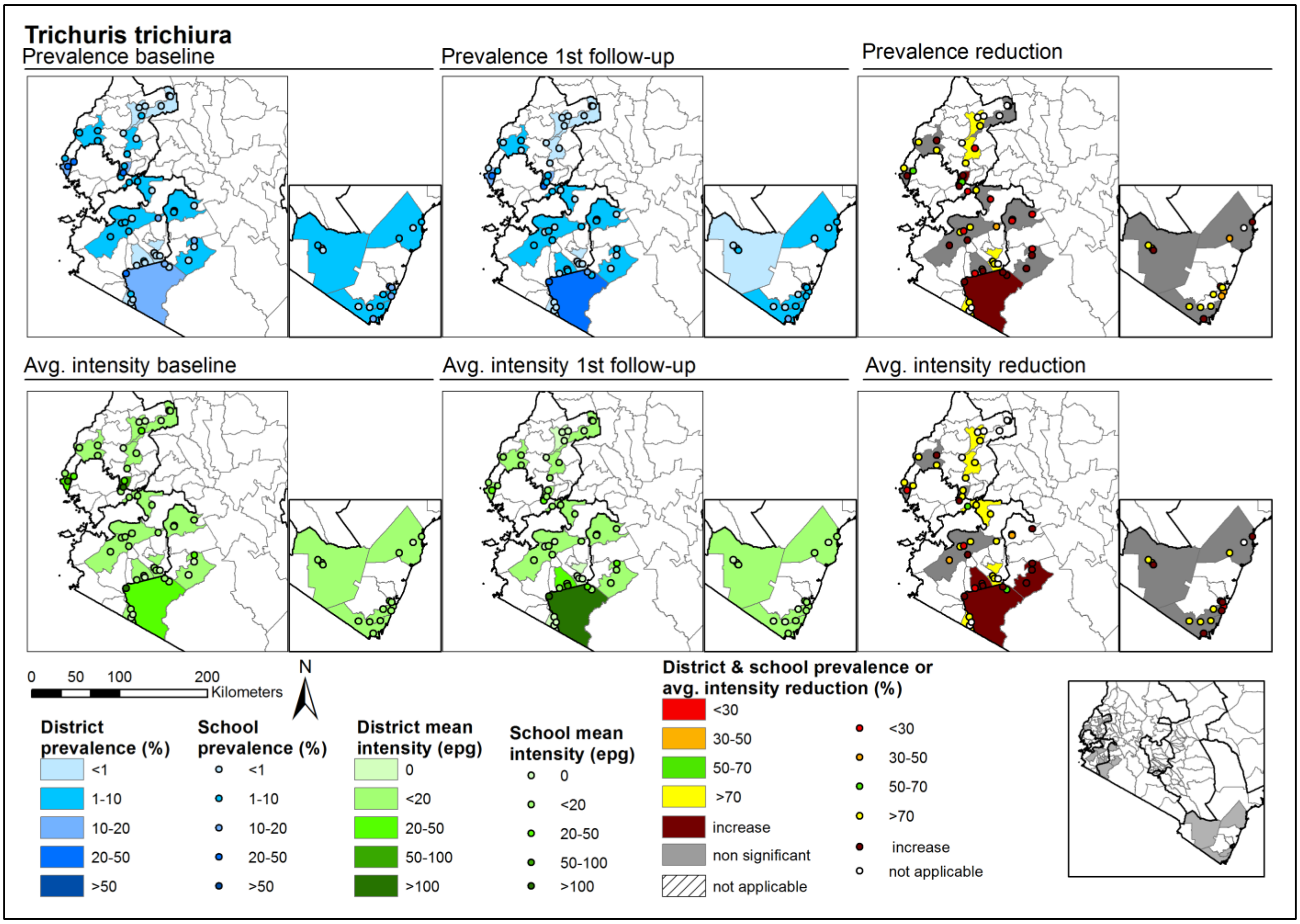


Figure 9. School and district *T. trichiura* prevalence and intensity at baseline and first follow up and school and district PR and IR

Significant decrease in *S. mansoni* prevalence and average intensity of infection was observed in Homa Bay, Masaba and Gucha district. *S. mansoni* prevalence increased significantly in Malindini, Msambweni, Kwale, Busia, Kisumu East and Rachuonyo district (p<0001) (Figure 10 on next page).

In the baseline survey, only one school in Bunyala district had >20% *S. mansoni* prevalence while five further schools (one in Malindini and Msambweni district and three in Kwale district) had *S. haematobium* prevalence above 20% and therefore should have received treatment with praziquantel. *S. mansoni* prevalence and average intensity of infection decreased significantly in the school in Bunyala (PR 46%, IR 79%, p<0.001), however, it remains the only school with >20% prevalence (35.2%, 95%CI 27.2-45.4).

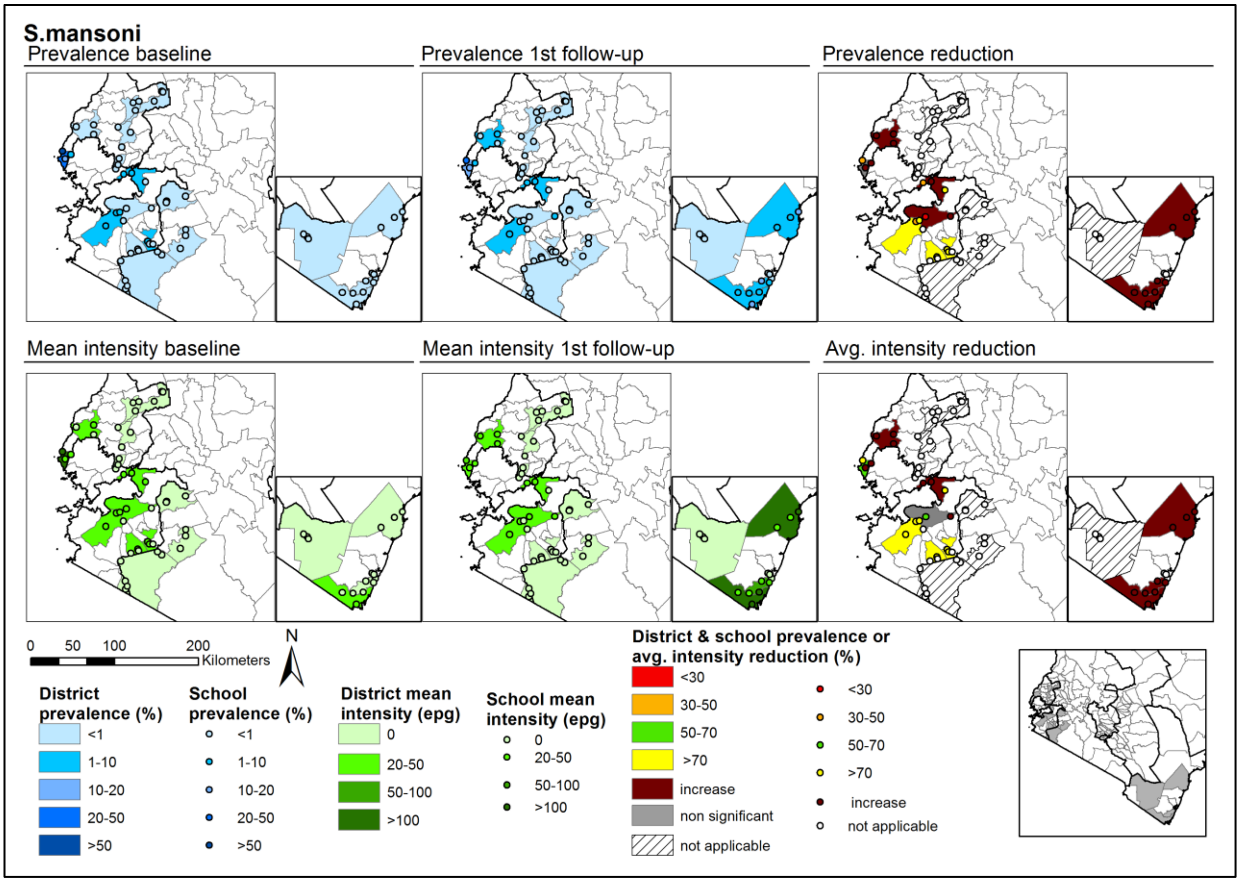


Figure 10. School and district *S. mansoni* prevalence and intensity at baseline and first follow up and school and district PR and IR.

Prevalence and Intensity Pre/Post Treatment in 10 High Frequency Schools

A sub-sample cohort of 10 'high frequency' schools was selected out of the 200 baseline schools in Western, Nyanza, Rift and Coast Provinces in addition to the 60 pre/post schools. In these 10 schools, data collection for prevalence and intensity was collected at four time points. Prevalence and intensity of all three STH species and both schistosomiasis species was collected both before and after the mass drug administration in the first year.

The purpose of this high frequency sample was to quantify seasonality and re-infection, and to attempt to establish causation. All schools in this sample had prevalence and intensity data collected for at least one pre-treatment time point. The number of pre and post treatment data collection time points varies across provinces due accessibility of schools for testing due to holidays and school closures and the programme roll-out schedule, with some provinces receiving treatment later in the year. Analysis was done with individual student-level data.

Overall, in these 10 high frequency schools there was a statistically significant ($p<0.05$) reduction in average STH prevalence of 4% from 28% to 24%[6]. However, when disaggregated regionally it is obvious that there is a wide variation across provinces in the prevalence and intensity levels across time and pre/post treatment.

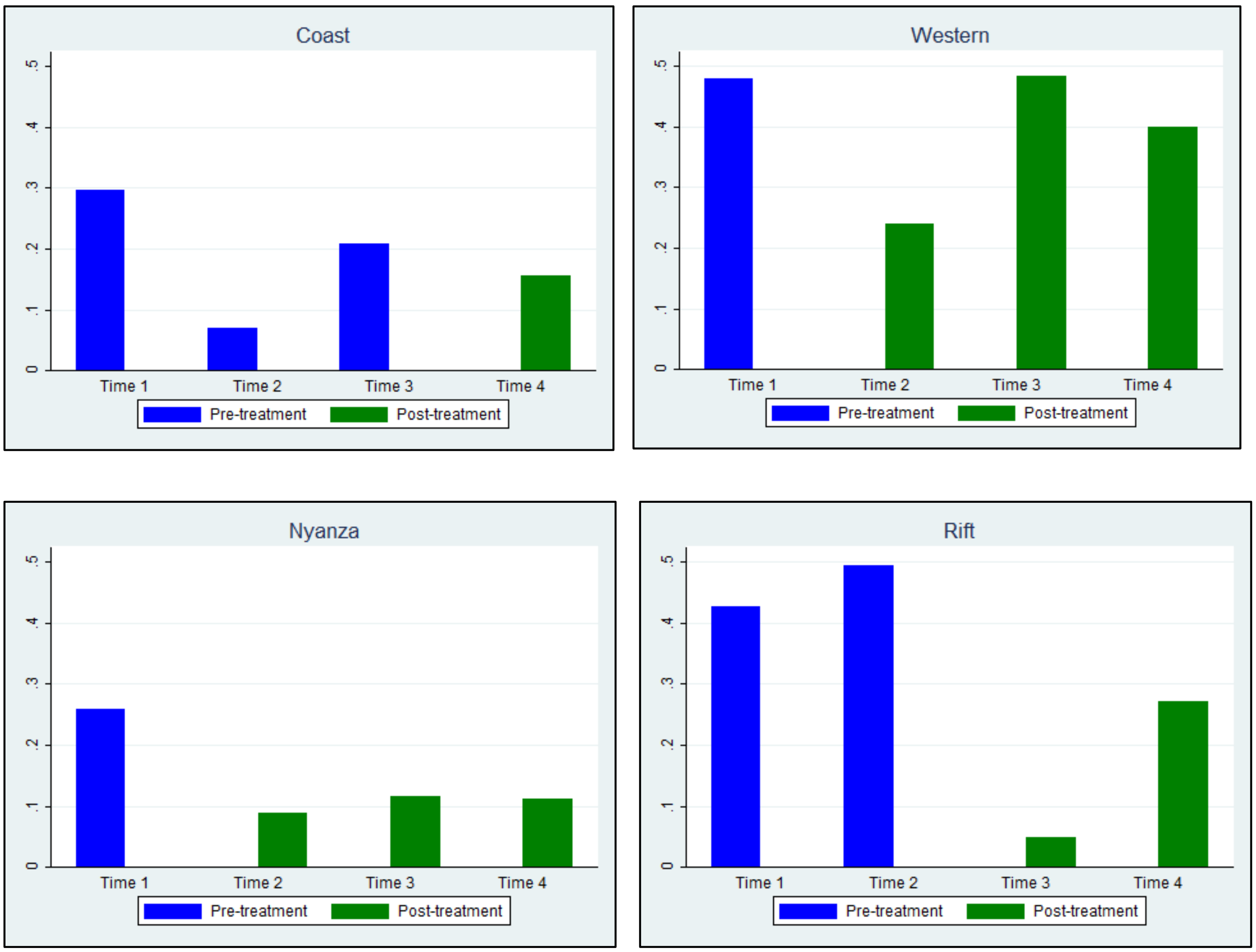


Figure 11. Province-level STH prevalence at 4 time points

[6] Multiple analyses on prevalence reduction were done. Student-level fixed effects analysis at 4 time points found an average reduction of 11% ($p<0.05$). Time-point fixed effects analysis at 4 time points found an average *increase* of 6% (not significant) and time-point and student-level fixed effects analysis at 4 time points found an average reduction of 7% (not significant).

Figure 12. Province-level STH intensity (% moderate infections) at 4 time points

While the analysis conducted with the student-level data does help to show patterns in seasonality and re-infection, causation was difficult due to two factors. First, due to the dramatic dynamics we observe within individuals, the analysis was under-powered – an individual with a moderate-to-heavy infection only stands a 20 percent chance of being observed with a moderate-to-heavy infection the next time we collect a sample from them, even without deworming reaching their school. Second, according to the analysis, there were no moderate-to-heavy infections in the sampled schools in Coast province at all. This makes estimates further under-powered, since low-intensity infections are harder to measure. As the prevalence data shows, STH prevalence in the Coast seems to have dropped sharply prior to the arrival of the school deworming programme. This suggests that either seasonality is of a surprisingly large magnitude or that the lymphatic filariasis programme may have been ongoing in the area and had an impact on STH prevalence in school-children prior to treatment by this programme.

There are some additional difficult-to-explain phenomena in the data: one school in Nyanza, for example, has some cases of all four species of STH in the pre-treatment period; it has no infections of any kind in the post-treatment period.

Conclusions

Overall, the results from the parasitological data collection in the first year have provided us with a useful set of data to inform the National School-Based Dewomring Programme. The baseline data collected demonstrated the need for a national deworming programme to address the high burden of hookworm, *A. lumbricoides*, *T. trichiura* and schistosomiasis across Western, Nyanza, Rift Valley, and Coast Provinces of Kenya. The pre/post data found a widespread reduction of prevalence and intensity of the three STH and two schistome species in the majority of the surveyed districts, demonstrating both the efficacy of the deworming drugs as well as the effectiveness of the programme to deliver treatment and reduce worm prevalence and intensity at a large-scale. The high frequency sample demonstrated an unexpected variability in individual worm burden dynamics and the prevalence and intensity ranges across provinces and seasons, including re-infection rates.

While intensity reductions for *T. trichiura* and *S. mansoni* were not observed and the high frequency group was under-powered to draw strong conclusions, this analysis has highlighted the range of baseline prevalence and intensity and efficacy of treatment drugs across species and the need to continue to collect parasitological data in future years of the programme to monitor prevalence and intensity reductions.

Annex 1. District-level data

Table 1A: STH prevalence at district level during first follow up and baseline surveys

			Hookworm		***A. lumbricoides***		***T. Trichuria***	
Province	District	Nr tested	Prev (%)	95%CI[1]	Prev (%)	95%CI	Prev (%)	95%CI[1]
				First follow up				
	Kilindini	313	2.6	0.5 -12.4	0.0	0.0-0.0	10.5	3.1-35.8
	Kwale	429	5.1	1.5-17.9	0.2	0.0-1.6	2.8	0.6-13.2
	Malindini	316	1.6	0.7-3.6	0.0	0.0-0.0	1.6	0.4-6.7
	Msambweni	213	8.0	1.8-34.8	0.5	0.1-3.2	5.6	0.8-38.9
Coast	Taita	311	0.0	0.0-0.0	0.0	0.0-0.0	1.0	0.1-6.6
	Bomet	324	0.0	0.0-0.0	3.4	0.8-14.6	3.1	0.8-12.2
Rift Valley	Kericho	324	0.0	0.0-0.0	6.2	2.4-15.7	1.5	0.7-3.4
	Transmara	324	2.5	0.3-17.5	2.8	2.8-2.8	21.0	6.1-7.2
	Bungoma East	286	1.7	0.9-3.5	0.7	0.2-2.2	0.0	0.0-0.0
	Bunyala	324	1.5	0.5-4.4	4.3	1.6-11.9	10.2	3.0-34.3
	Busia	324	7.4	2.2-24.8	4.0	2.3-6.9	3.1	0.8-12.2
	Emuhaya	324	1.9	0.6-5.7	8.0	6.9-9.3	13.6	7.3-25.3
	Kakamega Central	324	8.3	3.7-19.0	2.8	1.9-4.1	0.6	0.2-1.6
Western	Lugari	324	1.5	1.0-2.3	0.9	0.3-2.9	0.3	0.0-2.2
	Gucha	324	0.0	0.0-0.0	4.0	1.2-13.0	1.9	0.7-4.9
	Homa Bay	321	6.5	4.9-8.7	0.9	0.1-6.6	3.1	0.9-10.3
	Kisumu East	324	0.6	0.2-1.6	0.3	0.0-2.2	1.2	0.8-2.0
	Kuria East	226	2.2	1.4-3.6	0.4	0.1-2.6	0.0	0.0-0.0
	Masaba	324	0.3	0.0-2.2	0.6	0.2-1.6	0.0	0.0-0.0
Nyanza	Rachuonyo	321	12.8	4.8-34.0	4.7	1.5-14.5	5.0	1.8-13.7
Baseline								
	Kilindini	324	7.4	1.5-36.5	1.5	1.0-2.3	17.3	8.5-35.2
	Kwale	428	21.0	10.1-43.6	0.7	0.2-2.4	6.5	2.6-16.5
	Malindini	324	30.9	28.3-33.6	1.2	0.5-3.3	1.9	0.6-5.7
	Msambweni	216	34.7	32.1-37.6	0.5	0.1-3.3	5.6	1.1-28.4
Coast	Taita	318	0.0	0.0-0.0	0.9	0.1-6.6	1.9	0.7-5.2
	Bomet	324	0.3	0.0-2.2	29.6	12.9-68.1	3.4	0.5-24.1
Rift Valley	Kericho	324	0.6	0.2-1.6	31.5	26.2-37.9	1.5	0.7-3.4
	Transmara	324	5.9	1.0-35.7	41.4	30.5-56.1	17.0	4.4-65.8
	Bungoma East	312	42.3	38.1-47.0	7.7	4.5-13.2	0.6	0.1-4.4
	Bunyala	324	9.6	4.9-18.7	9.3	3.8-22.4	17.0	9.2-31.2
	Busia	324	22.5	20.5-24.8	18.2	10.2-32.4	4.9	3.2-7.7
	Emuhaya	324	10.8	5.2-22.4	49.4	41.2-59.1	12.0	6.1-23.8
	Kakamega Central	324	42.0	37.8-46.6	40.1	37.2-43.3	2.2	0.5-10.3
Western	Lugari	324	32.7	24.3-44.1	28.1	18.7-42.3	0.3	0.0-2.2
Nyanza	Gucha	324	15.7	11.3-22.0	38.0	27.9-51.6	0.9	0.3-2.9

Homa Bay	324	15.4	9.4-25.5	20.7	5.9-72.7	4.3	3.8-5.0
Kisumu East	324	7.7	3.2-18.7	8.0	4.5-14.5	3.4	1.1-10.9
Kuria East	324	21.0	12.8-34.3	1.5	0.5-4.4	0.9	0.1-6.6
Masaba	324	4.0	3.5-4.7	37.3	28.8-48.5	0.6	0.2-1.6
Rachuonyo	324	18.8	12.4-28.6	18.2	5.4-61.4	5.9	1.5-22.7

[1] 95%CI obtained by binomial regression taking into account clustering by schools

Table 1B: STH average infection intensity at district level during first follow up and baseline surveys

			Hookworm		***A. lumbricoides***		***T. trichiura***	
				First follow up				
Province	District	Nr tested	Average intensity (epg)	95%CI[1]	Average intensity (epg)	95%CI[1]	Average intensity (epg)	95%CI[1]
	Kilindini	313	11	2-54	0	NA	16	5-52
	Kwale	429	9	2-33	0	0-0	3	1-19
	Malindini	316	10	2-62	0	NA	1	0-5
	Msambweni	213	18	3-93	113	16-779	9	1-64
Coast	Taita	311	0	NA	0	NA	1	0-4
	Bomet	324	0	NA	11	2-59	11	2-78
	Kericho	324	0	NA	274	103-726	0	0-1
Rift Valley	Transmara	324	4	1-30	159	61-415	126	21-746
	Bungoma East	286	16	5-56	89	16-486	0	NA
	Bunyala	324	2	1-10	54	9-334	14	3-66
	Busia	324	10	3-30	212	91-490	1	0-4
	Emuhaya	324	3	1-7	588	284-1220	14	4-55
	Kakamega Central	324	24	7-90	112	34-369	0	0-1
Western	Lugari	324	2	1-4	9	2-36	0	0-1
	Gucha	324	0	NA	131	43-401	33	5-225
	Homa Bay	321	6	4-8	87	12-619	1	0-4
	Kisumu East	324	0	0-0	4	1-28	0	0-1
	Kuria East	226	1	1-2	3	1-17	0	NA
	Masaba	324	0	0-2	3	1-10	0	Na
Nyanza	Rachuonyo	321	32	7-145	277	60-1289	2	1-6
				Baseline				
	Kilindini	324	78	14-438	94	20-443	11	4-31
	Kwale	428	58	22-150	1	0-3	5	1-15
	Malindini	324	51	32-81	0	0-1	2	1-5
	Msambweni	216	84	40-176	0	0-0	5	1-16
Coast	Taita	318	0	NA	34	5-238	1	0-3
Rift Valley	Bomet	324	0	0-0	4227	1981-9021	8	1-59

	Kericho	324	0	0-1	3855	3057-4862	1	0-2
	Transmara	324	19	3-133	5795	3391-9902	45	8-263
	Bungoma East	312	167	139-200	655	315-1361	10	1-68
	Bunyala	324	42	15-122	479	181-1270	32	14-75
	Busia	324	151	68-339	1010	571-1784	4	2-8
	Emuhaya	324	67	19-245	4685	3310-6630	53	15-186
	Kakamega Central	324	301	169-535	2268	1402-3668	4	1-21
Western	Lugari	324	162	102-258	1105	617-1980	0	0-3
	Gucha	324	17	10-30	2436	1622-3658	0	0-1
	Homa Bay	324	31	16-61	1331	239-7423	2	1-4
	Kisumu East	324	15	3-73	837	200-3502	1	0-3
	Kuria East	324	25	7-92	79	21-293	0	0-2
	Masaba	324	2	1-6	2652	1807-3892	0	0-1
Nyanza	Rachuonyo	324	30	14-66	1485	381-5787	5	1-25

Table 1C: STH prevalence reduction (PR) at district level

		Hookworm		***A. lumbricoides***		**T. trichiura**	
Province	District	PR (%)	95%CI[1]	PR (%)	95%CI[1]	PR (%)	95%CI[1]
	Kilindini	65	62-69	100	100-100	39	*-65
	Kwale	76	48-89	67	3-89	57	3-81
	Malindini	95	88-98	100	100-100	15	*-47
	Msambweni	77	7-94	*	*	*	*-25
Coast	Taita	NA	NA	100	100-100	49	*-96
	Bomet	100	100-100	89	78-94	9	*-50
	Kericho	100	100-100	80	57-91	0	0-0
Rift Valley	Transmara	58	50-65	93	91-95	*	*-*
	Bungoma East	96	92-98	91	59-98	100	100-100
	Bunyala	84	19-97	53	42-62	40	*-76
	Busia	67	0-89	78	69-84	38	*-90
	Emuhaya	83	74-89	84	79-87	*	*-*
	Kakamega Central	80	58-91	93	90-95	71	4-92
Western	Lugari	95	91-98	97	88-99	0	NA
	Gucha	100	100-100	89	75-96	*	*-74
	Homa Bay	58	19-78	95	91-98	28	*-78
	Kisumu East	92	86-95	96	53-100	64	*-91
	Kuria East	89	73-96	71	*-98	100	100-100
Nyanza	Masaba	92	41-99	98	97-99	100	100-100

	Rachuonyo	32	*-61	74	55-85	15	*

[1] 95%CI obtained by binomial regression adjusting for clustering by school
*increase in average prevalence

Table 1D: STH average intensity reduction (IR) at district level

		Hookworm		***A. lumbricoides***		**T. trichiura**	
Province	District	IR (%)	95%CI[1]	IR (%)	95%CI[1]	IR (%)	95%CI[1]
	Kilindini	86	85-88	100	100-100	*	*-*
	Kwale	84	59-94	90	*-99	24	*-63
	Malindini	81	*-97	100	100-100	32	*-86
	Msambweni	79	47-92	*	*-*	*	*-4
Coast	Taita	NA	NA	100	100-100	19	*-96
	Bomet	100	100-100	100	99-100	*	*-*
Rift Valley	Kericho	100	100-100	93	84-97	56	1-81
	Transmara	78	77-78	97	96-98	*	*-*
	Bungoma East	90	70-97	86	52-96	100	100-100
	Bunyala	95	52-99	89	48-98	55	*-83
	Busia	94	89-96	79	47-92	77	*-97
	Emuhaya	96	88-99	87	70-95	73	*-97
	Kakamega Central	92	82-96	95	76-99	96	68-100
Western	Lugari	99	97-100	99	95-100	55	NA
	Gucha	100	NA	95	89-97	*	*-*
	Homa Bay	80	62-90	93	92-95	56	*-86
	Kisumu East	100	98-100	100	90-100	73	61-81
	Kuria East	95	67-99	96	36-100	100	100-100
	Masaba	88	*-99	100	100-100	100	100-100
Nyanza	Rachuonyo	*	*-50	81	78-84	59	*-90

[1] 95%CI obtained by negative binomial regression adjusting for clustering by school
*increase in average intensity

Table 1E: *S. mansoni* district prevalence and average intensity of infection in baseline and follow up surveys

		Baseline				Follow up			
Province	District	Prev (%)	95%CI[1]	Avg. Intensity (epg)	95%CI[2]	Prev (%)	95%CI[1]	Avg. Intensity (epg)	95%CI[2]
	Kilindini	0.0	0.0-0.0	0	-	0.0	0.0-0.0	0	-
	Kwale	0.0	0.0-0.0	0	-	7.2	4.6-11.3	65	33-128
	Malindini	0.0	0.0-0.0	0	-	7.0	2.1-23.1	249	38-1652
	Msambweni	0.5	0.1-3.3	0	0-2	8.0	1.8-34.8	246	36-1656
Coast	Taita	0.0	0.0-0.0	0	-	0.0	0.0-0.0	0	-
	Bomet	0.0	0.0-0.0	0	-	0.0	0.0-0.0	0	-
Rift	Kericho	0.0	0.0-0.0	0	-	0.0	0.0-0.0	0	-
Valley	Transmara	0.0	0.0-0.0	0	-	0.0	0.0-0.0	0	-

	Bungoma East	0.0	0.0-0.0	0	-	0.0	0.0-0.0	0	-
	Bunyala	26.2	6.2-100.0	107	18-625	17.6	6.5-47.4	35	15-79
	Busia	0.3	0.0-2.2	0	0-1	2.5	0.7-8.4	3	1-10
	Emuhaya	0.0	0.0-0.0	0	-	0.0	0.0-0.0	0	-
	Kakamega Central	0.0	0.0-0.0	0	-	0.0	0.0-0.0	0	-
Western	Lugari	0.0	0.0-0.0	0	-	0.0	0.0-0.0	0	-
	Gucha	0.3	0.0-0.0	0	0-0	0.0	0.0-0.0	0	-
	Homa Bay	4.9	2.0-11.9	2	1-4	1.2	0.3-4.6	0	0-1
	Kisumu East	1.9	1.1-3.3	1	0-3	2.2	0.6-7.3	4	1-14
	Kuria East	0.0	0.0-0.0	0	-	0.0	0.0-0.0	0	-
	Masaba	1.2	0.3-4.5	0	0-1	0.0	0.0-0.0	0	-
Nyanza	Rachuonyo	0.3	0.0-2.2	0	0-1	0.9	0.3-2.9	1	0-4

[1] 95%CI obtained by binomial regression taking into account clustering by schools
[2] 95%CI obtained by negative binomial regression adjusting for clustering by school

Annex 2. Mean intensity (eggs per gram) by species

Average hookworm arithmetic mean intensity:	Before treatment:	65.5 epg
	After treatment:	7.3 epg
	Reduction:	**58.3 epg (p<0.01 significance)**
Average *A. lumbricoides* arithmetic mean intensity:	Before treatment:	1617 epg
	After treatment:	94 epg
	Reduction:	**1523 epg (p<0.01 significance)**
Average *T. trichiura* arithmetic mean intensity:	Before treatment:	9.4 epg
	After treatment:	11.8 epg
	Increase:	***2.3 epg (not significant)***
Average S. mansoni arithmetic mean intensity:	Before treatment:	5.6 epg
	After treatment:	27.8 epg
	Increase:	***22.2 epg (not significant)***