BURUNDI REPORT FOR PILOT STUDIES OF 4 YEARS AND NATIONAL STUDIES OF 2 YEARS

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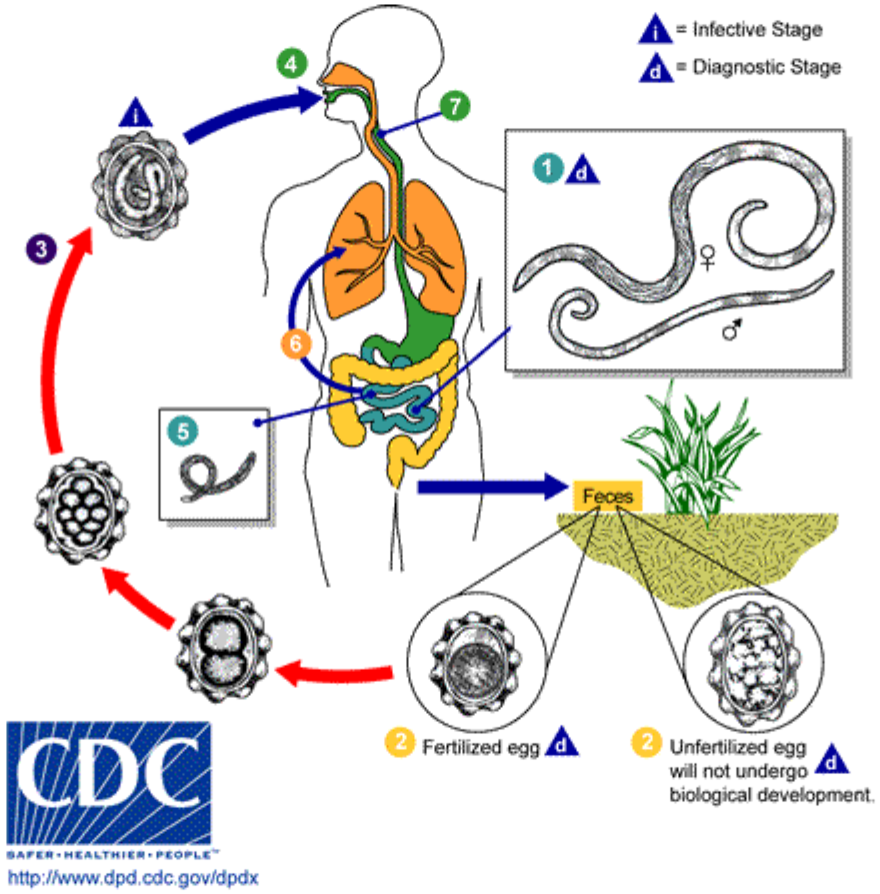
1. Introduction

This report contains data from 4 years pilot surveys and 2 years of national studies in Burundi. Section 1 contains information that might aid in the interpretation of displayed results. Sections 2 & 3 contain results from the pilot and national studies respectively. Section 4 discusses problems encountered and lessons learnt with data collection, management and entry during these 4 years. Calculated and discussed measures are prevalence and mean intensity of parasitic infections as well as anaemia as an indicator of morbidity caused by these Neglected Tropical Diseases (NTDs). Results are presented for both sets of studies for successfully followed-up children and newly recruited children at each follow-up year of these surveys. Newly recruited children were included in these surveys in order to determine if transmission for schistosomiasis and other helminth infections has been reduced by assessing prevalence and arithmetic mean intensity measures in 6 year olds and comparing these to 6 year olds recruited at baseline in 2007 for the pilot studies and baseline in 2008 for the national studies.

Figures 1.1-1.4 display the life cycle of the examined parasites here as this was a request from Geneva Global at a meeting held in London during March 2011.

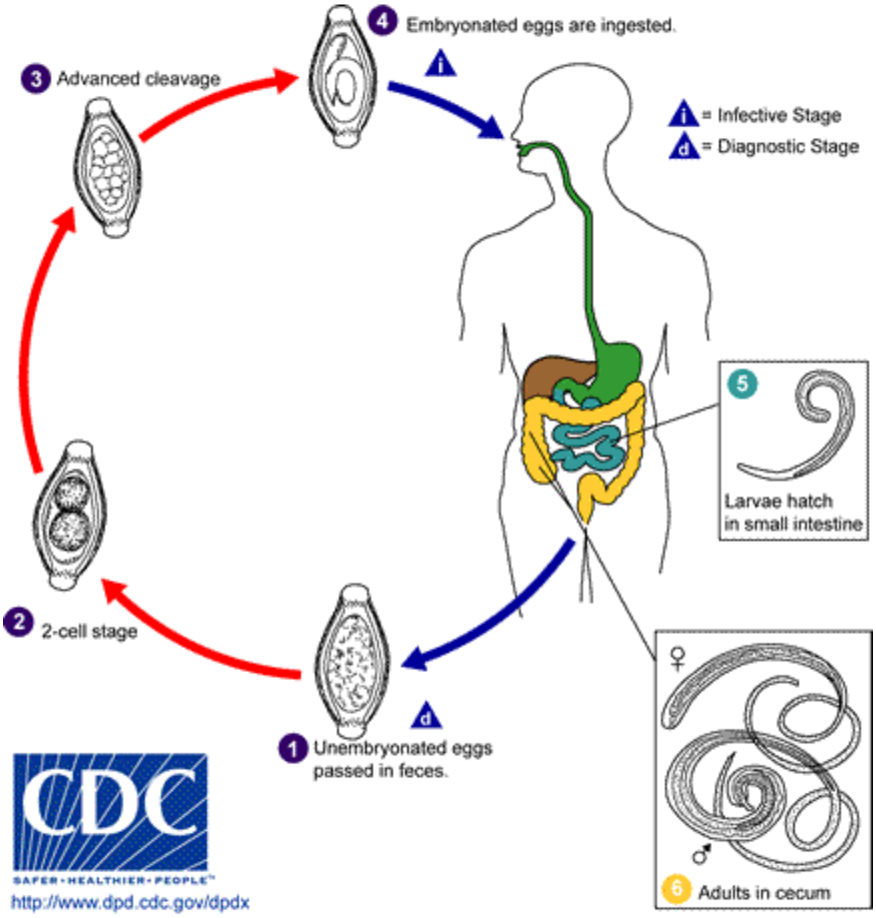
Figure 1.1 The Life Cycle of *A. lumbricoides*



Adult worms ① live in the lumen of the small intestine. A female may produce approximately 200,000 eggs per day, which are passed with the feces ②. Unfertilized eggs may be ingested but are not infective. Fertile eggs embryonate and become infective after 18 days to several weeks ❸, depending on the environmental conditions (optimum: moist, warm, shaded soil). After infective eggs are swallowed

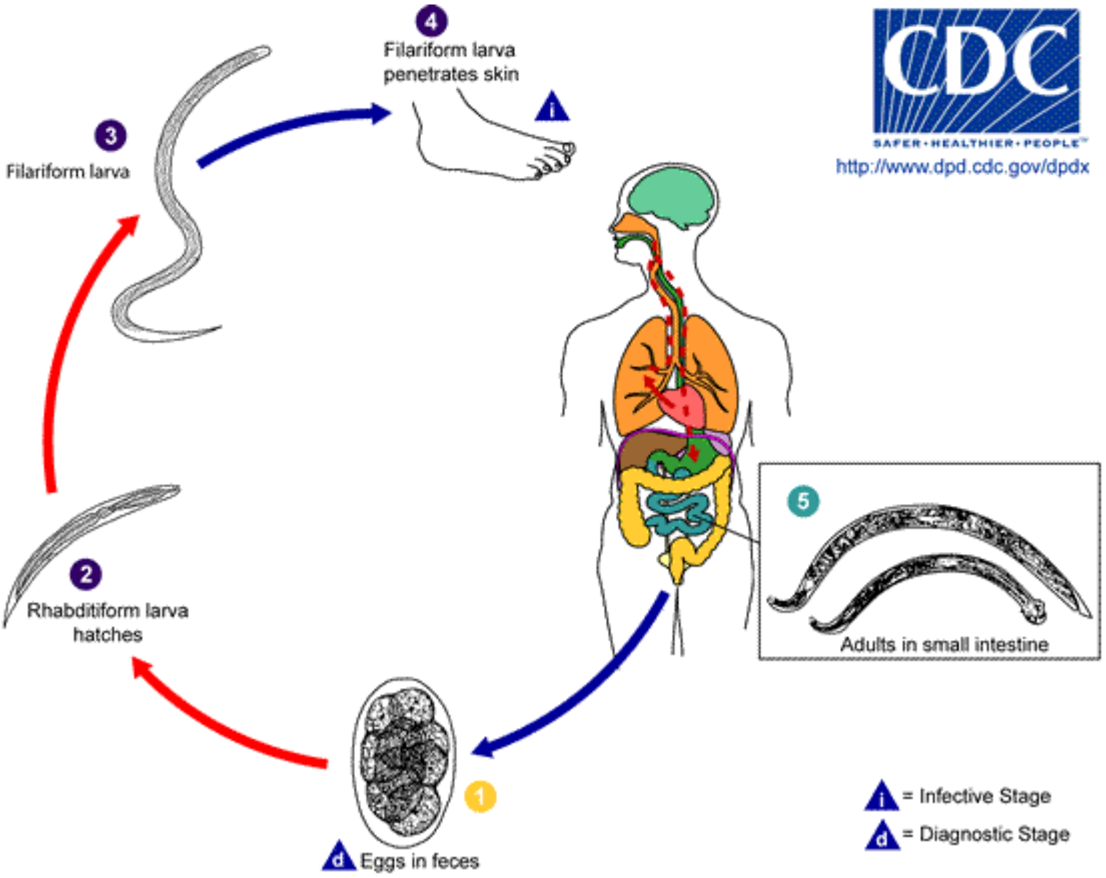
④, the larvae hatch ⑤, invade the intestinal mucosa, and are carried via the portal, then systemic circulation to the lungs ⑥. The larvae mature further in the lungs (10 to 14 days), penetrate the alveolar walls, ascend the bronchial tree to the throat, and are swallowed ⑦. Upon reaching the small intestine, they develop into adult worms ①. Between 2 and 3 months are required from ingestion of the infective eggs to oviposition by the adult female. Adult worms can live 1 to 2 years. Lifecycle and annotations are adapted from the Center for Disease Control and Prevention (CDC) website http://www.dpd.cdc.gov/dpdx/html/Ascariasis.htm (accessed May 2011).

Figure 1.2 The Life Cycle of *T. trichiura*



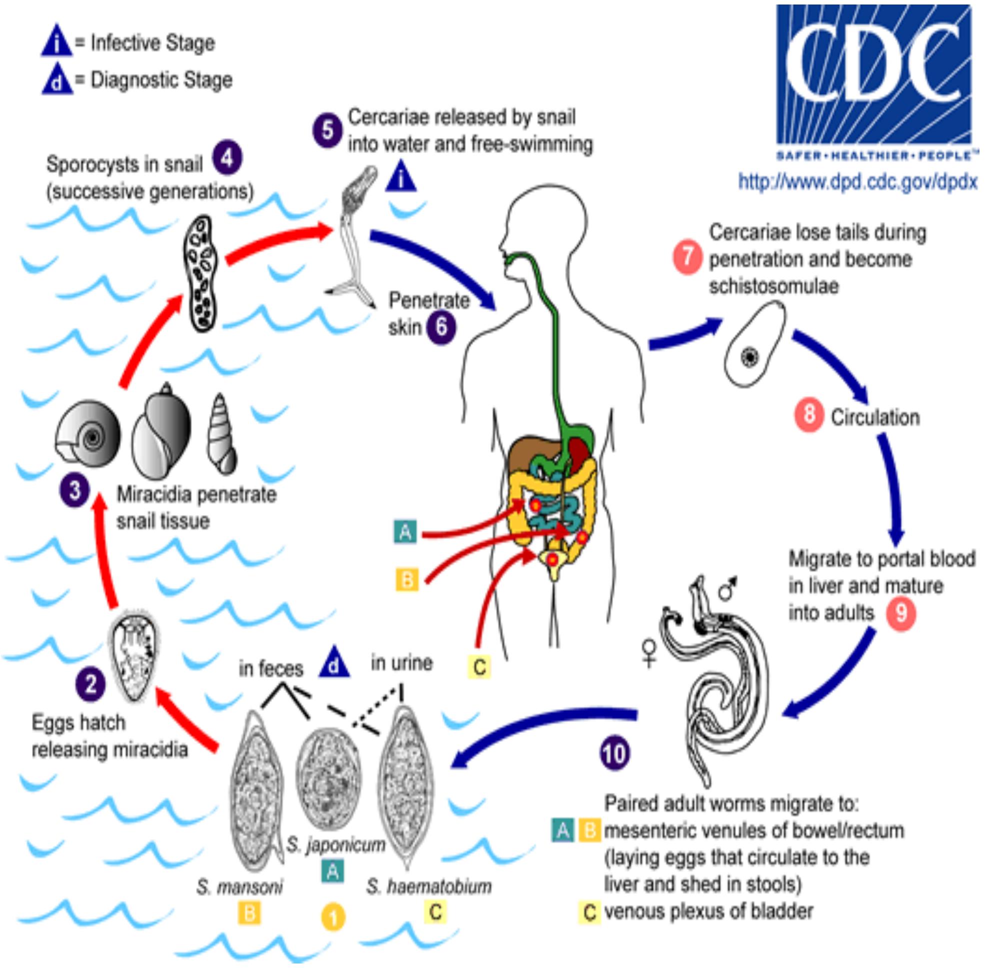
The unembryonated eggs are passed with the stool ①. In the soil, the eggs develop into a 2-cell stage ②, an advanced cleavage stage ③, and then they embryonate ④; eggs become infective in 15 to 30 days. After ingestion (soil-contaminated hands or food), the eggs hatch in the small intestine, and release larvae ⑤that mature and establish themselves as adults in the colon ⑥. The adult worms (approximately 4 cm in length) live in the cecum and ascending colon. The adult worms are fixed in that location, with the anterior portions threaded into the mucosa. The females begin to oviposit 60 to 70 days after infection. Female worms in the cecum shed between 3,000 and 20,000 eggs per day. The life span of the adults is about 1 year.

Figure 1.3 The Life Cycle of intestinal hookworm infection



Eggs are passed in the stool ❶, and under favorable conditions (moisture, warmth, shade), larvae hatch in 1 to 2 days. The released rhabditiform larvae grow in the feces and/or the soil ❷, and after 5 to 10 days (and two molts) they become filariform (third-stage) larvae that are infective ❸. These infective larvae can survive 3 to 4 weeks in favorable environmental conditions. On contact with the human host, the larvae penetrate the skin and are carried through the blood vessels to the heart and then to the lungs. They penetrate into the pulmonary alveoli, ascend the bronchial tree to the pharynx, and are swallowed ❹. The larvae reach the small intestine, where they reside and mature into adults. Adult worms live in the lumen of the small intestine, where they attach to the intestinal wall with resultant blood loss by the host ❺. Most adult worms are eliminated in 1 to 2 years, but the longevity may reach several years. Lifecycle and annotations are adapted from the Center for Disease Control and Prevention (CDC) website http://www.dpd.cdc.gov/dpdx/html/hookworm.htm (accessed May 2011)

Figure 1.4 The Life Cycle of human schistosomiasis



Eggs are eliminated with feces or urine ①. Under optimal conditions the eggs hatch and release miracidia ②, which swim and penetrate specific snail intermediate hosts ③. The stages in the snail include 2 generations of sporocysts ④and the production of cercariae ⑤. Upon release from the snail, the infective cercariae swim, penetrate the skin of the human host ⑥, and shed their forked tail, becoming schistosomulae ⑦. The schistosomulae migrate through several tissues and stages to their residence in the veins (⑧, ⑨). Adult worms in humans reside in the mesenteric venules in various locations, which at times seem to be specific for each species ⑩. Lifecycle and annotations are adapted from the Center for Disease Control and Prevention (CDC) website http://www.dpd.cdc.gov/dpdx/HTML/Schistosomiasis.htm (accessed August 2008).

Table 1 shows World Health Organization (WHO) thresholds for the intensity of the examined parasite infections

Table 1

WHO Intensity thresholds for light, moderate, and heavy infections with *Ascaris lumbricoides, Trichuris trichiura*, hookworms, and schistosomes

Helminth	**Intensity threshold**		
	Light	**Moderate**	**Heavy**
A. lumbricoides	1–4999epg	5000–49999epg	≥50000epg
T. trichiura	1–999epg	1000–9999epg	≥10000epg
Hookworms	1–1999epg	2000–3999epg	≥4000epg
S. mansoni	1–99epg	100–399epg	≥400epg
S. haematobium	1–50 eggs/10ml urine		≥50 eggs/10ml urine visible haematuria

*epg stands for eggs per gram

2. Pilot studies

Baseline data collection started in 3 provinces in Burundi during 2007 where 12 schools were surveyed. SCI statistician gave recommendations with regards to the sample size at the school level for the longitudinal studies and then based on financial and epidemiological reasons the Burundian team in the field together with the SCI Programme Manager have decided on the study design. More precisely, the 12 schools were chosen based on 3 zones-believed at the time that they would have the majority of NTDs. 4 schools were selected randomly so that they represent the 'STHs +Schisto +oncho' zone (these were Musenyi, Nyamibu, Munyika, Rukinga); then another 4 schools were selected randomly so that they represent the 'STHs +oncho' zone (Mirombero, Kizuga, Ruzibira, Mudende) and finally 4 schools were selected randomly so that they represent STHs only endemic areas (Gatwe, Ruko, Condi, Gitobo). Such decisions were based on available historic data. Thus, SCI Programme Manager advised not to stratify the statistical analysis by province and so such results (i.e. stratification by province) are not presented anywhere in this report.

Without taking into consideration the parasitological exams, at baseline (2007) there were recruited 3616 children. At 2008 the 1st follow-up took place where 1188 children were retraced since baseline (i.e. follow-up rate=32.85 %). At 2nd follow-up (2009) there were 1004 children successfully followed up since baseline (i.e. follow-up rate=27.77%). Finally at 3rd follow-up (2010) there were 713 children successfully followed-up (i.e. follow-up rate=19.71%). Longitudinal analyses for the 4 years are presented in the next pages for these 713 children.

In addition to the longitudinal studies at each follow-up newly recruited children were added to these surveys. At 1st follow-up (2008) 2288 newly recruited children were added to these surveys with range age: 6-21 years old and median age: 12 years old. Of these 2288, only 210 i.e. (9.18 %), were of age 6 and eligible to be included in the specific cross sectional data analysis. At 2nd follow-up (2009) 2311 newly recruited children were added to these surveys with range age: 5-20 years old and median age: 11 years old. Of these 2311, only 160 i.e. (6.92 %), were of age 6 and eligible to be included in this specific data analysis. Finally, at 3rd follow-up (2010) 2224 newly recruited children were added to these surveys with range age: 6-20 years old and median age: 12 years old. Of these 2224 only 189 i.e. (8.50 %) were of age 6 and eligible to be included in this specific data analysis.

It should be noted here that complete analysis of these data could happen only in December 2010 due to timing of data entry and data management prior to this. Consequently, with regards to the numbers referring to the cross-sectional studies, they were calculated only recently and so the problem could become apparent also only very recently. Cross sectional analysis is presented in this report only for children of age of 6 years old for the 4 years of these studies.

2.1.Parasitological exams

Parasitological exams were available for 710children during the period of 4 years.

2.1.1 Prevalence of STHs and schistosomiasis

In the next pages the prevalence of STHs and schistosomiasis infections are first presented for these 710 children who were successfully followed-up during 4 years. Figure 2 shows the overall prevalence of the 4 parasitic infections of interest here. For all of these infections there seems to be a significant decrease in the prevalence at the 3rd follow-up compared to baseline. Statistical modelling which takes into account adjustment for age and gender also confirms this trend (see for further details at the end of this section under the heading 'Statistical modelling results').

Figures 3-5 show prevalence of *S. mansoni*, hookworm and Ascaris infections by school and they highlight as expected the focality of these diseases. Trichuris prevalence by school is not presented here since numbers of positive surveyed children remained very low during all the 4 years of studies. However, one should always keep in mind that measurement of prevalence alone is not a useful indicator of impact because of the non-linear relationship between prevalence and mean intensity of infection within a school or community, which depends on the degree of worm aggregation within the host populations. It has been well documented in literature that changes in intensity in response to treatment might not be reflected in changes in prevalence, such that intensity of infection should always be used for the parasitological assessment of impact.

Figure 2

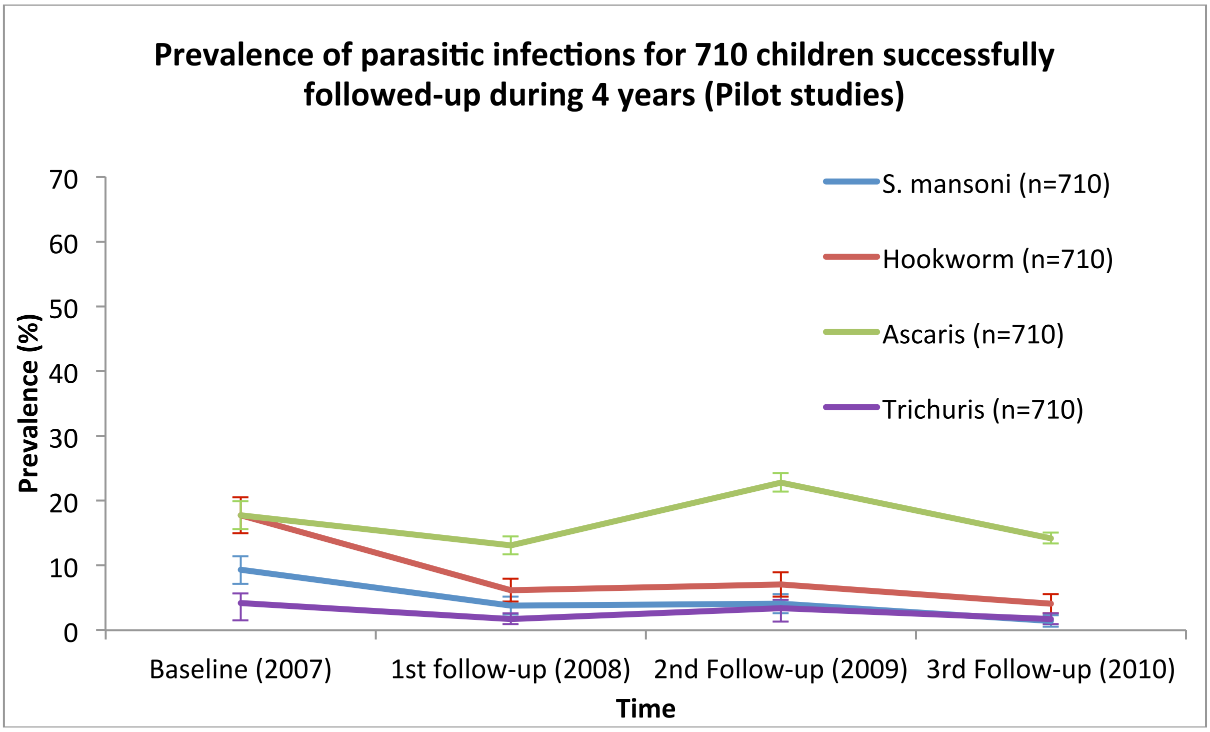


Figure 3

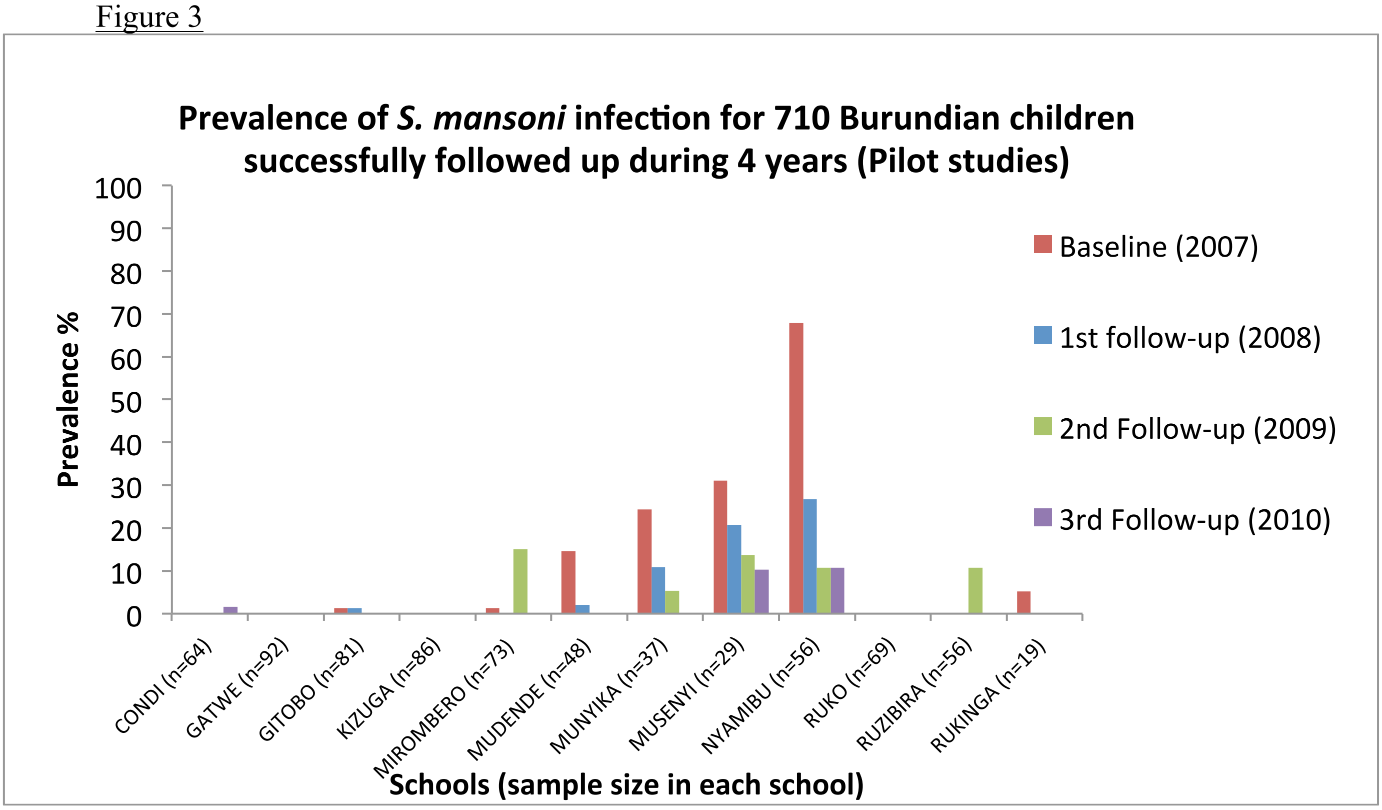


Figure 4

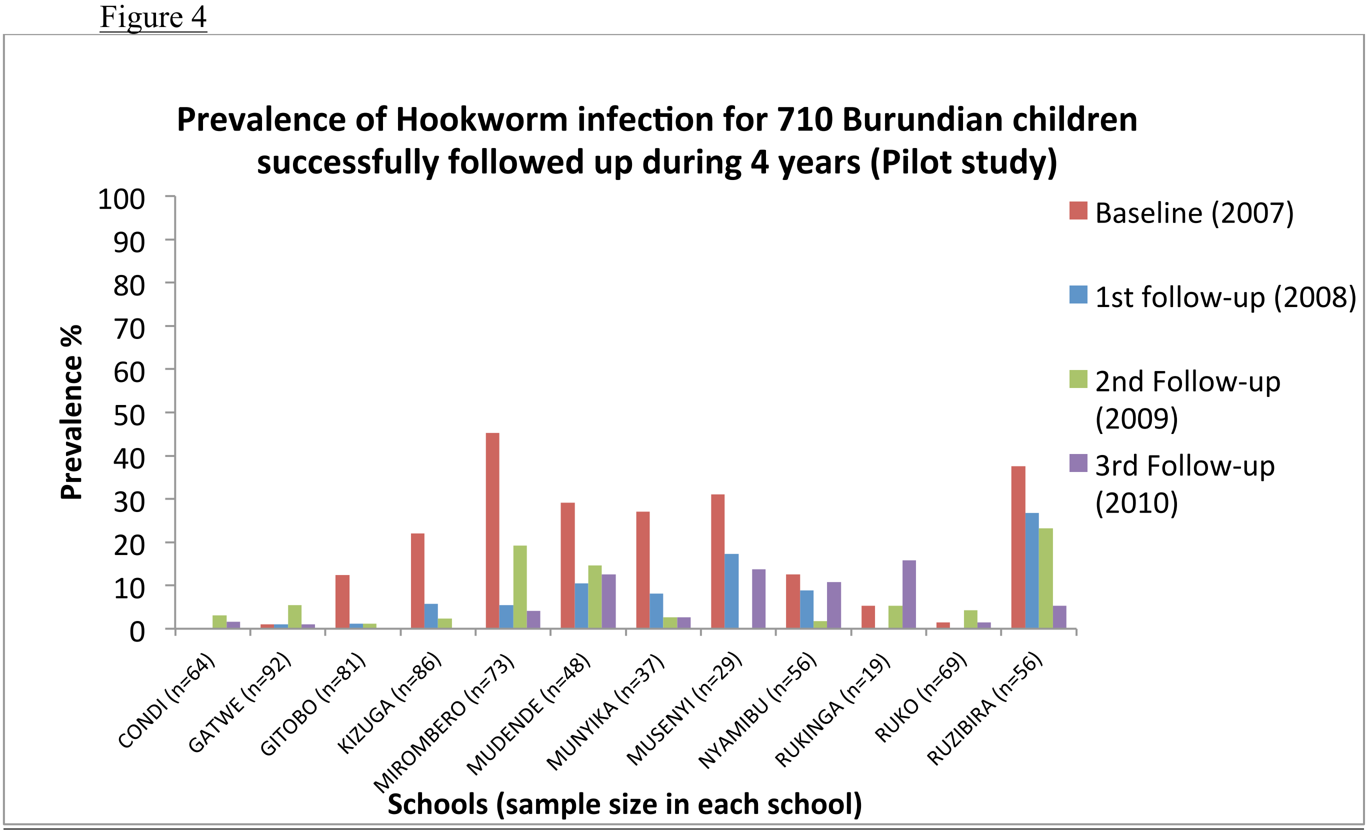
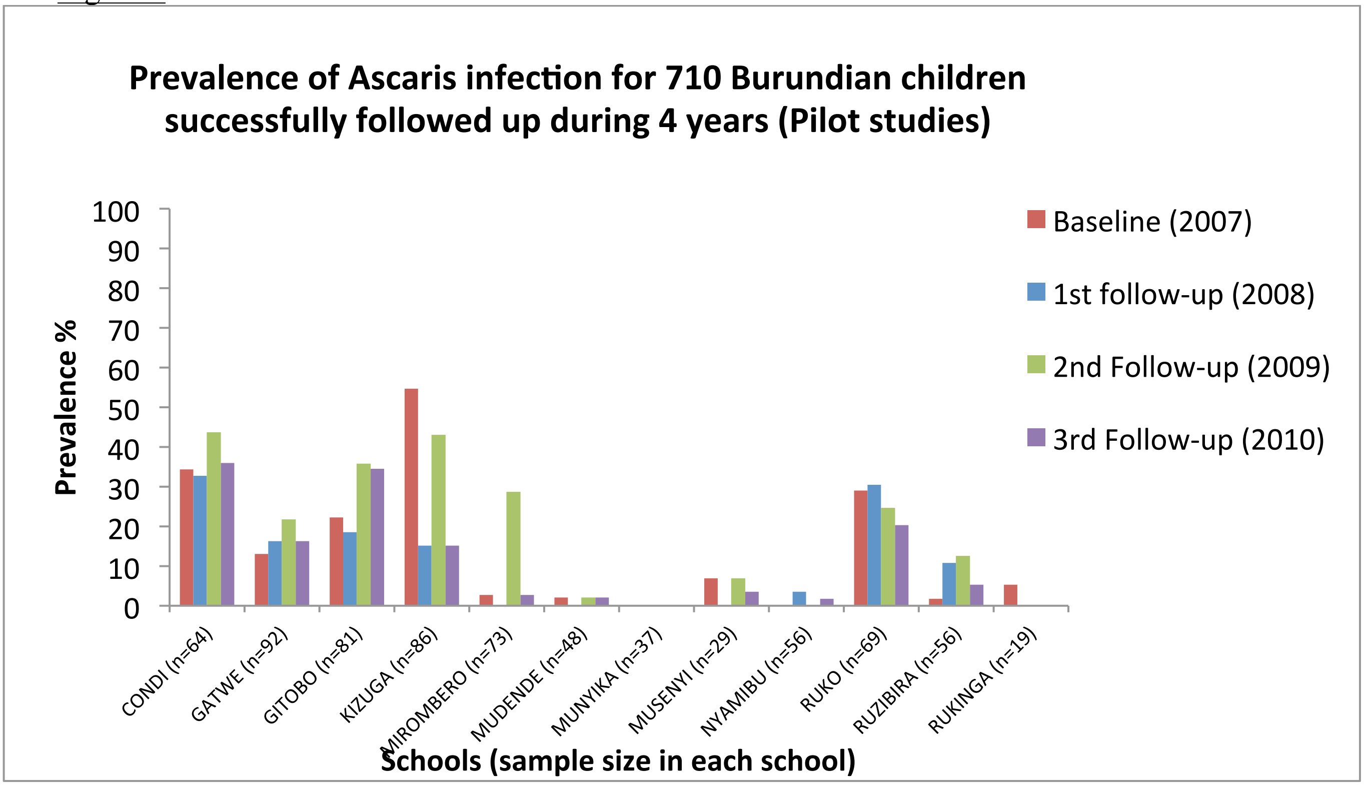


Figure 5



2.1.2 Intensity of STHs and schistosomiasis

In the next pages the intensity of STHs and schistosomiasis infections are first presented for these 710 children who were successfully followed-up during 4 years. Figure 6 shows the overall prevalence of the 4 parasitic infections of interest here. For Ascaris infection at the 3rd follow-up there was an increase in the eggs per gram compared to 1st and 2nd follow-up. However the mean intensity indicated here and the WHO thresholds (see Table 1) show that the majority of these infections are light infections. (See for further details at the end of this section under the heading ‘Statistical modelling results’ for direction of trends in the mean egg counts). Then Figures 7-9 show intensity of Hookworm, *S. mansoni* and Ascaris infections per school during the 4 years of studies. Arithmetic mean Intensity of Trichuris infection by school is not presented here since the mean eggs per gram for the surveyed children remained very low during all the 4 years of studies.

Figure 6

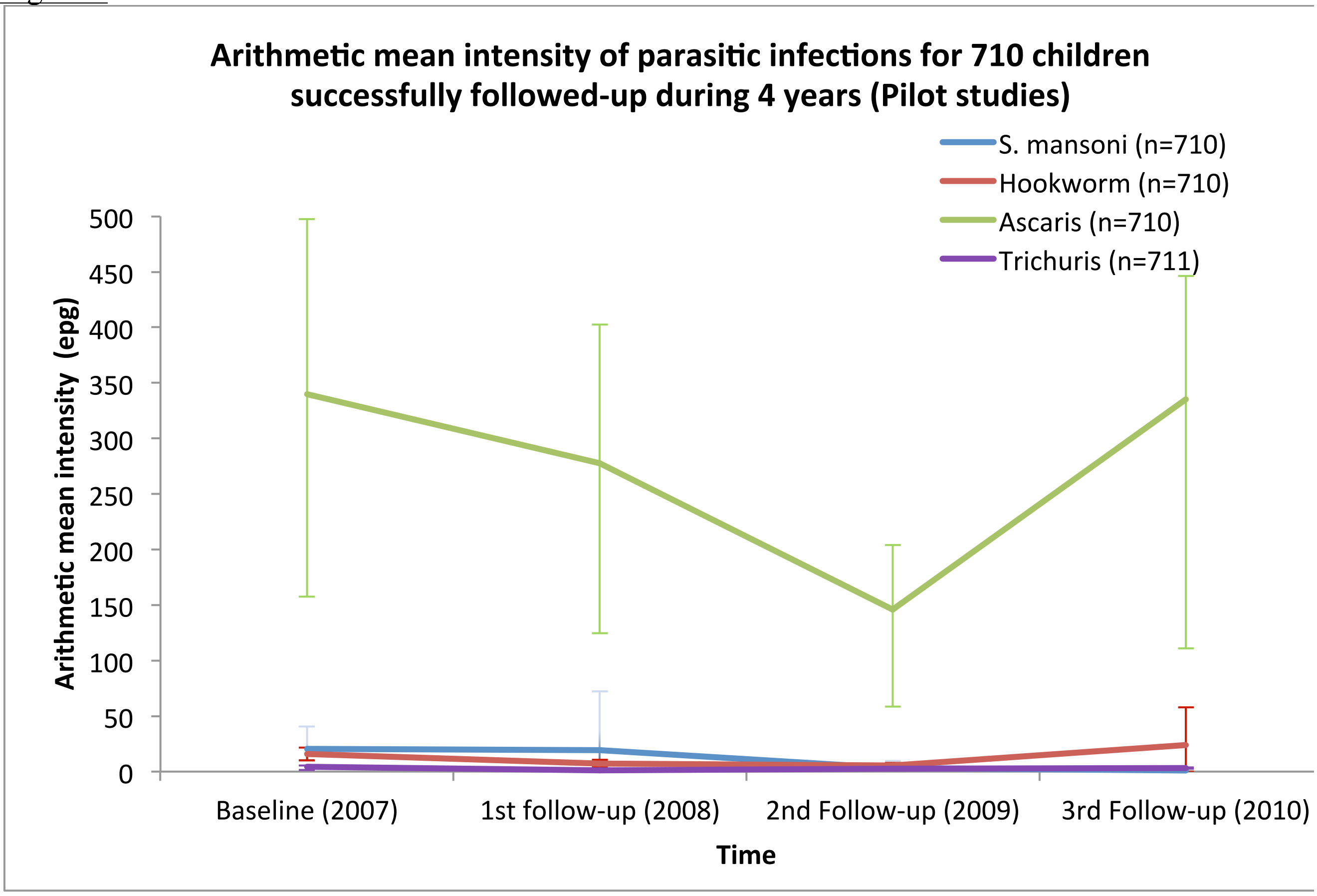


Figure 7

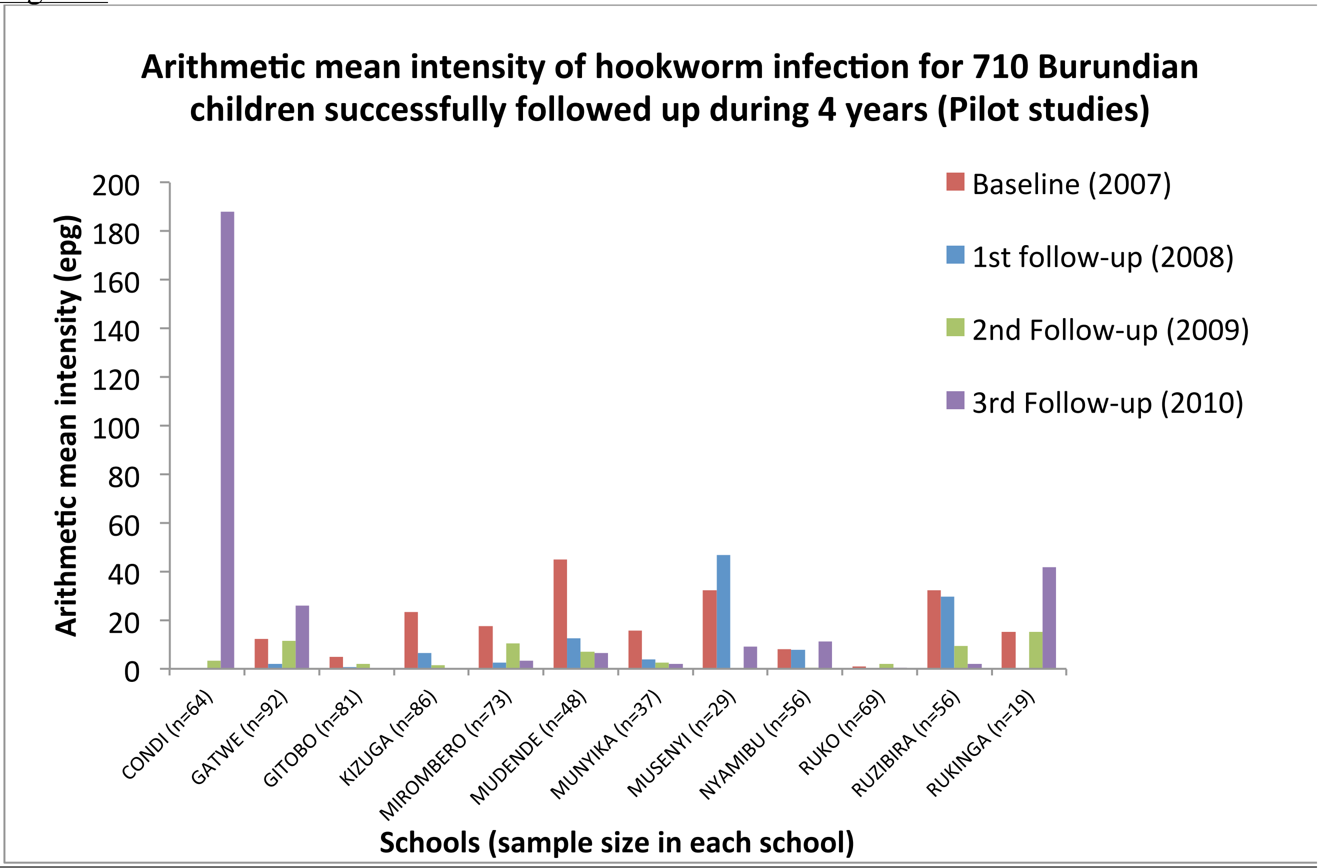


Figure 8

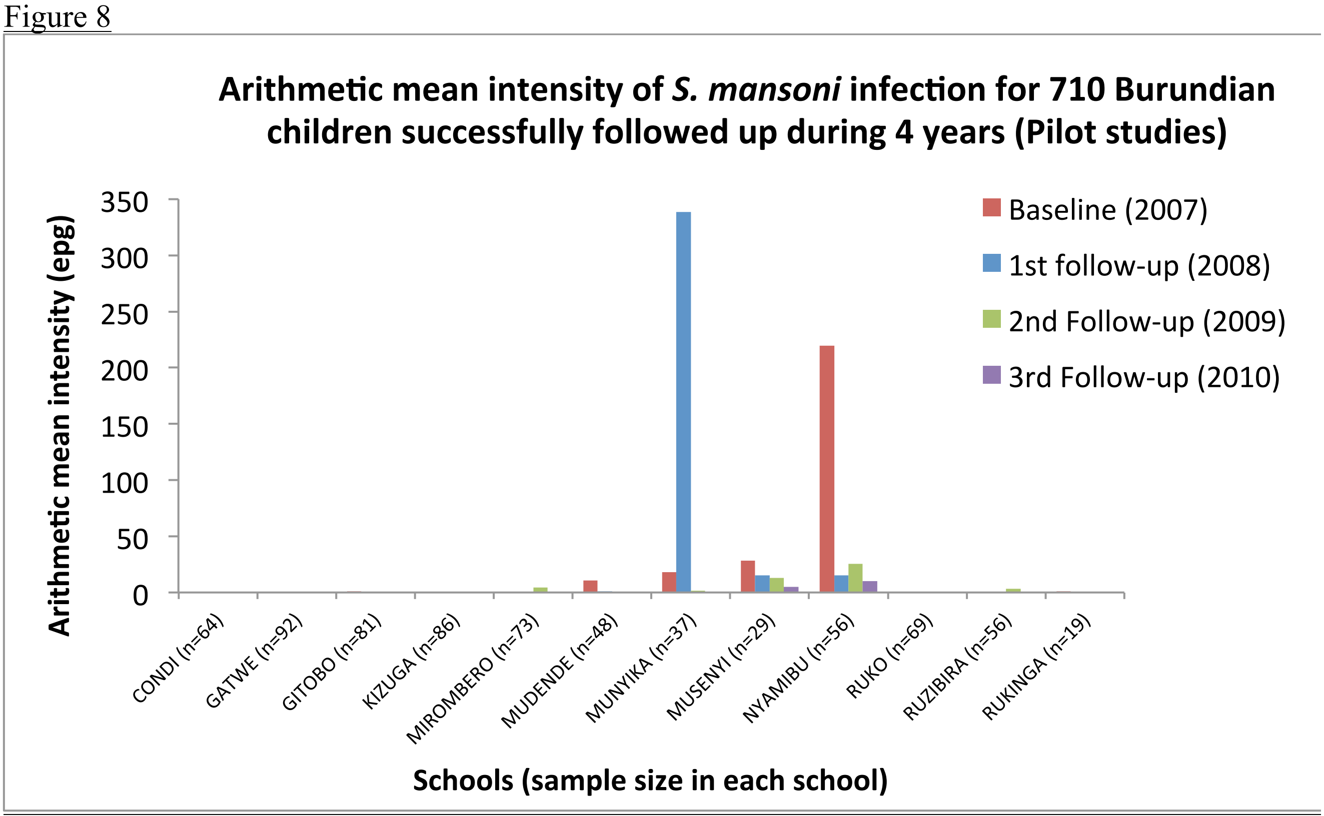
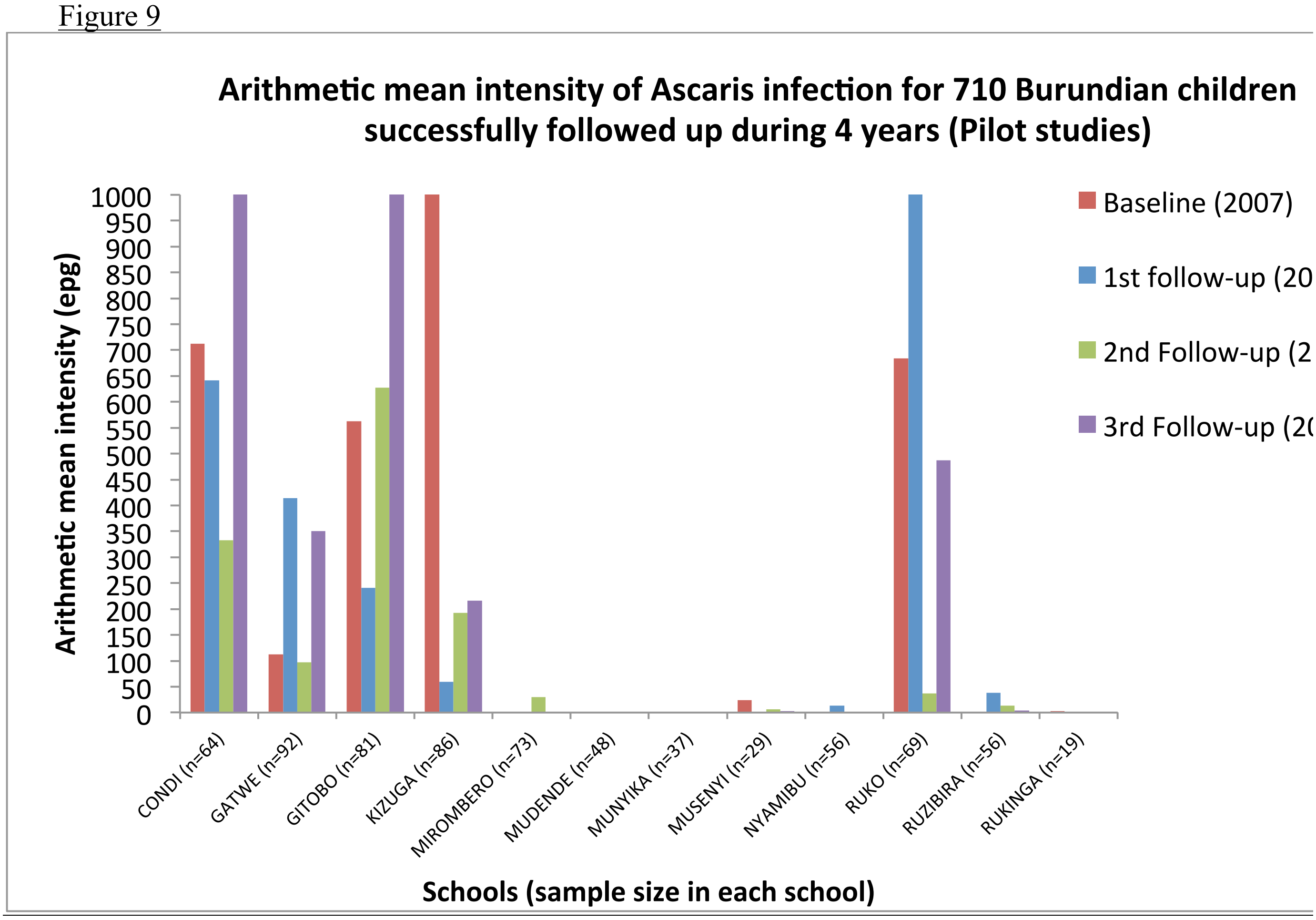


Figure 9



2.2. Anaemia

For children who are less than 11 years, anaemia is defined as Haemoglobin (Hb) being less than 115 g/l. For children aged between 12 and 14 years anaemia is defined as Hb being less than 120 g/l. These values were taken from the WHO 2001 "Iron Deficiency Anaemia-Assessment Prevention and Control".

Only 10 schools (n=576 children) have contributed Hb data during the 4 years of the study. In fact Nyamibu and Mirombero schools did not have any Hb data at baseline and so these two schools were excluded from the whole part of the longitudinal analysis.

Figure 10

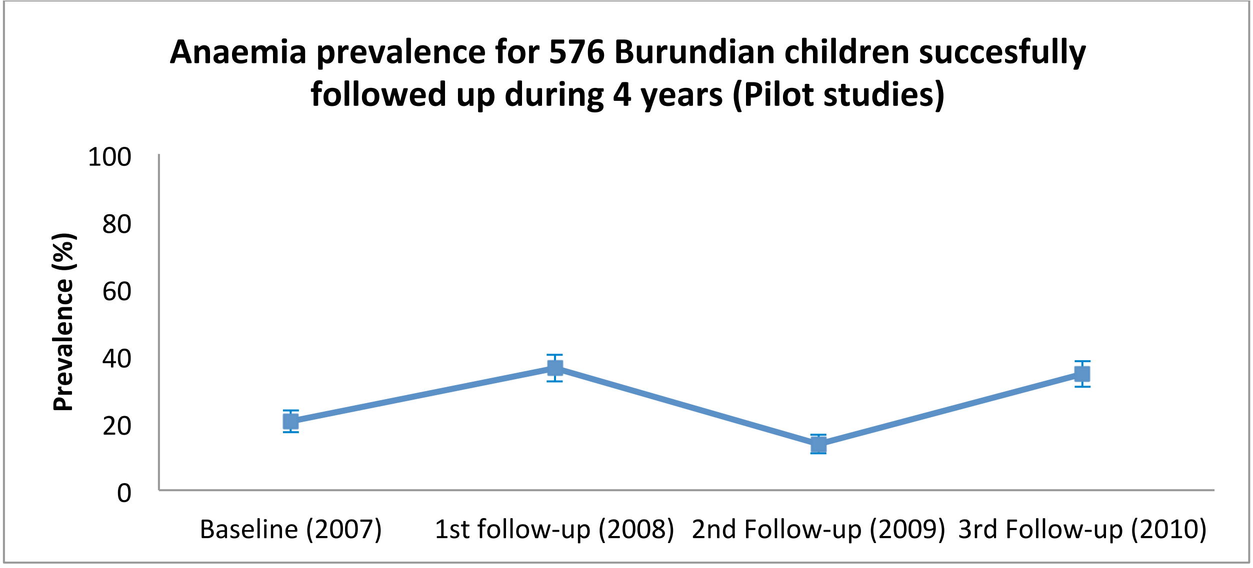
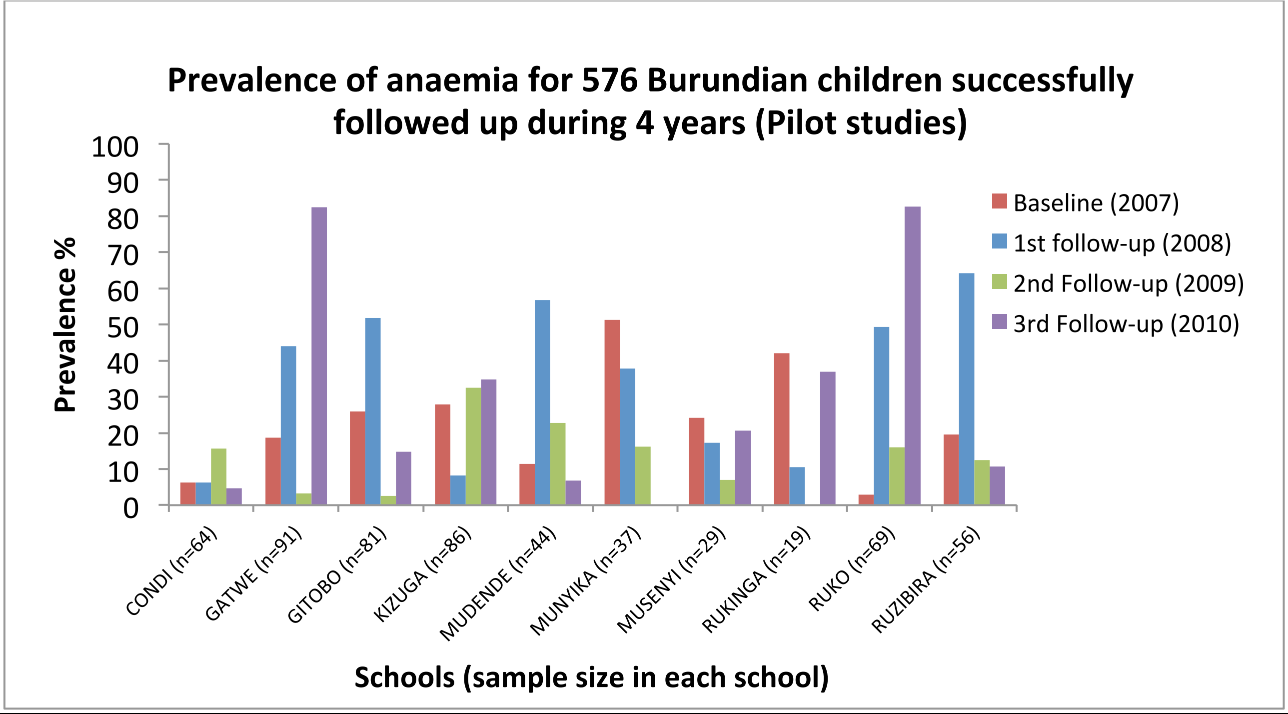


Figure 11



Figures 10 and 11 do not suggest any great improvement in surveyed schools with regards to the prevalence of anaemia for the 4 years of study. However, one should keep in mind that anaemia is a multifactorial public health problem and anti-chemotherapeutic treatment only, might not help to make it decrease. In general, the etiology of anaemia is very complex, making the effect of any one factor difficult to assess. Malaria plays also a key causative role for anemia among young African children, although HIV infection, hemoglobinopathies, intestinal helminths, in particular that of hookworm infection, poor nutritional status, and micronutrient deficiencies are also likely to make important additional contributions

In Burundi, there is an extremely alarming global hunger index for the country according to the International Food Policy Research Institute (IFPRI). More precisely, there are several threads to food security in the country like: recurrent population displacement, poor infrastructure and insecurity, loss of soil productivity, erratic rainfall and climatic changes and plant diseases. Malaria risk is present year-round throughout Burundi, including urban areas. Although all of these facts are speculative and we were not able to assess such relationships based on the current data they might contain some explanations for the observed trends highlighted in Figures 10 and 11.

2.3. Newly recruited children/cross sectional data analysis

Table 2: Parasitologic measures for 6 years old newly recruited children during the 4 years of the studies (sample sizes are included in parentheses)

		Prevalence (expressed as percentage)		
arasitic nfections	*2007*	*2008*	*2009*	*2010*
.mansoni	6.76; 95 % CI: 2.71-10.80 (n=148)	2.86; 95 % CI: 0.60-5.11 (n=210)	3.75; 95 % CI: 0.81-6.69 (n=160)	1.08; 95 % CI: 0.00-2.56 (n=186)
ookworm	14.71; 95 % CI: 2.80-26.61 (n=148)	4.76; 95 % CI: 1.88-7.64 (n=210)	7.50; 95 % CI: 3.42-11.5 (n=160)	5.91; 95 % CI: 2.52-9.30 (n=186)
scaris	17.65; 95 % CI: 4.83-30.46 (n=148)	11.00; 95 % CI: 6.76-15.25 (n=209)	13.13; 95 % CI: 7.89-18.36 (n=160)	11.83; 95 % CI: 7.19-16.47 (n=186)
richuris	3.38; 95 % CI: 0.47-6.29 (n=148)	2.38; 95 % CI: 0.32-4.44 (n=210)	3.75; 95 % CI: 0.81-6.69 (n=160)	2.69; 95 % CI: 0.36-5.01 (n=186)
		Arithmetic mean intensity (expressed as eggs per gram)		
.mansoni	9.41; 95 % CI: 0.00-22.65 (n=148)	4.69; 95 % CI:0.00-10.09 (n=210)	1.88; 95 % CI:0.20-3.55 (n=160)	0.90; 95 % CI:0.00-2.35 (n=186)
ookworm	18.35; 95 % CI: 0.00-45.86 (n=148)	25.03; 95 % CI:0.00-66.11 (n=210)	4.35; 95 % CI: 0.43-8.27 (n=160)	4.52; 95 % CI: 1.22-7.81 (n=186)
scaris	31.76; 95 % CI: 0.00-22.65 (n=148)	739.13; 95 % CI: 208.81-1269.45 (n=209)	134.85; 95 % CI: 19.41-250.29 (n=160)	399.74; 95 % CI: 83.38-716.10 (n=186)
richuris	1.62; 95 % CI: 0.14-3.11 (n=148)	16.34; 95 % CI: 0.00-45.89 (n=210)	1.80; 95 % CI: 0.25-3.35 (n=160)	1.29; 95 % CI: 0.11-2.47 (n=186)

2.4 Statistical modelling results

Generalized estimating equations (GEE) generalized linear models provide a practical method with reasonable statistical efficiency to analyze the repeated measurements data from the longitudinal pilot studies. The GEE method does not explicitly model between-cluster variation like random effects models; instead it focuses on and it estimates its counterpart, the within-cluster similarity of the residuals; it then uses this estimated correlation to reestimate the regression parameters and to calculate standard errors which are reasonably accurate and hence lead to the generation of confidence intervals with the correct coverage rates. With GEE, correlated data can be modeled with output that looks similar to generalized linear models (GLMs) with independent observations; the primary difference is their ability to account for the within-subject covariance structure for the various types of response data. The interpretation of the parameter does not depend on the respective subject but rather is valid for the whole population of potential subjects in the study. This is why the parameters from marginal models are also called population-averaged parameters.

574 children have contributed data to these analyses as we took into account children who had complete data on anaemia and parasitic infections during the 4 years of the studies. With GEE logistic regressions we have modelled the Odds Ratios (ORs) of being anaemic or being infected with *S. mansoni* or hookworm or Ascaris or Trichuris infections at the 3rd follow-up if compared to baseline, having adjusted also for the sex and age of the children included in this analysis. With GEE linear regressions we have estimated the percentage by which the mean egg counts of the afore mentioned parasitic infections changed at the 3rd follow-up if compared to baseline having adjusted also for the sex and age of the children included in this analysis. The results follow below.

The average OR of being infected at the 3rd follow-up if compared to baseline were: for Ascaris OR= 0.61, p-value<0.001; hookworm OR=0.17, p-value<0.001; *S. mansoni* OR=0.13, p-value<0.001; Trichuris OR=0.35, p-value<0.001 and anaemia OR=2.09, p-value<0.001. This means that the average risk of being infected with any of these parasitic infections significantly decreased at the 3rd follow-up if compared to baseline but the average risk of being anaemic significantly increased at the 3rd follow-up if compared to baseline.

Mean egg counts for Ascaris infection were estimated to have decreased at the 3rd follow-up if compared to baseline by 57.12 %, p-value= 0.056; mean egg counts for hookworm infection were estimated to have decreased significantly at the 3rd follow-up if compared to baseline by 71.05 %, p-value<0.001; mean egg counts for *S. mansoni* infection were estimated to have decreased significantly at the 3rd follow-up if compared to baseline by 33.04 %, p-value<0.001 and finally mean egg counts for Trichuris infection were estimated to have decreased at the 3rd follow-up if compared to baseline by 21.55 % p-value=0.042.

2.5 Hygienic state of schools

Tables 3-6 contain information for the hygienic state of schools during the 1st year of the pilot studies.

Table 3: Number of toilets in schools (Indicated frequencies and percentages are for numbers of schools)

2 toilets	1 (8.33 %)
4 toilets	2 (16.67 %)
6 toilets	1 (8.33 %)
8 toilets	3 (25.00 %)
9 toilets	1 (8.33 %)
10 toilets	1 (8.33 %)
12 toilets	1 (8.33 %)
16 toilets	1 (8.33 %)
24 toilets	1 (8.33 %)

Table 4: State of the toilets (Indicated frequencies and percentages are for numbers of schools)

Bad	7 (58.33%)
Mediocre	4 (33.33 %)
Good	1 (8.33 %)

In all 12 schools it was reported that the type of the toilet was ‘latrine + cess + pit’.

Table 5: Principal type of water supply in the school (Indicated frequencies and percentages are for numbers of schools)

Tap	4 (36.36 %)
Well	1 (9.09 %)
Steam/river	2 (18.18 %)
None	3 (27.27 %)
Other	1 (9.09 %)

Note: 1 school had missing data on the question: Principal type of water supply in the school

Table 6: Is there a place in the school to wash the hands? (Indicated frequencies and percentages are for numbers of schools)

No	6 (54.54 %)
Yes	5 (45.46 %)

Note: 1 school had missing data on this question

3. National studies

At baseline (2008) there were recruited 5700 children while the follow-up rate one year later was 53.42 % (3045/5700). For these set of studies as they were designed to cover almost all of the country, it is worthwhile to also examine stratifications of analyses by district and such results are also presented in the following subsections. However, in most of the districts the children were coming only from 1 school (see relevant graphs for district whenever n<200; when this is the case then this is only 1 school per district and thus results should be treated there with caution and programmatic decisions to be taken with reservations). Whenever/wherever this is the case, results should be interpreted with caution as just 1 school would be quite ‘risky’ to represent inference/decisions for a whole district.

Similarly as in the pilot studies, in addition to the longitudinal studies at the the first follow-up of the national studies (2009) newly recruited children were added to these surveys. 3331 newly recruited children were added to these surveys with range age: 6-20 years old and median age: 11 years old. Of these 3331, only 259 i.e. (7.78 %), were of age 6 and eligible to be included in this specific data analysis.

Likewise, as mentioned before complete analysis of these data could happen only in December 2010 due to timing of data entry in the field and data management in SCI prior to this. Consequently, with regards to the numbers referring to the cross-sectional studies, they were calculated only recently and so the problem could become apparent also only very recently. Cross sectional analysis is presented in this report only for children of age of 6 years old for the 2 years of these studies.

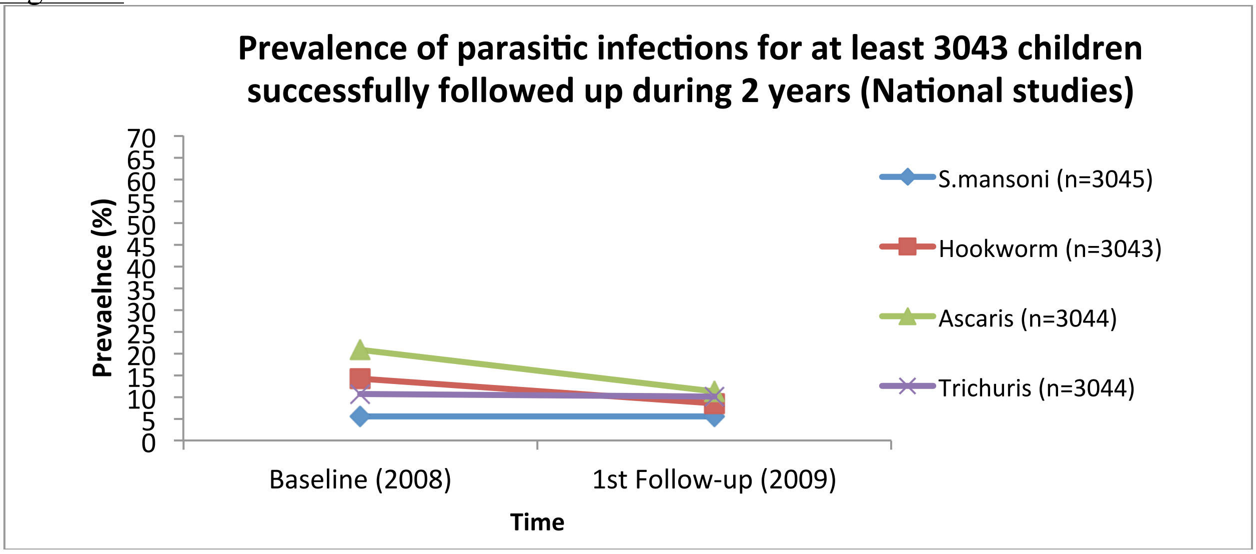
3.1.Parasitological exams

Parasitological exams were available for: 3043 children with regards to Hookworm infection, 3044 children for Ascaris and Trichuris infections and 3045 children with regards to *S. mansoni* infection during the period of 2 years of these surveys.

3.1.1 Prevalence of STHs and schistosomiasis

In the next pages the prevalence of STHs and schistosomiasis infections are first presented for the children who were successfully followed-up during 2 years. Figure 12 shows the overall prevalence of the 4 parasitic infections of interest here. For all of these infections there seems to be a decrease in the prevalence at the 3rd follow-up compared to baseline. Statistical modelling which takes into account adjustment for age and gender also confirms this trend (see for further details at the end of this section under the heading ‘Statistical modelling results’).

Figure 12



Figures 13-16 show prevalence of *S. mansoni*, hookworm, Ascaris and Trichuris infections by school. Figures 17-20 show prevalence of *S. mansoni*, hookworm, Ascaris and Trichuris infections by district. As expected one can notice that they all highlight the focality of these diseases.

However, as mentioned before in the section of the pilot studies one should always keep in mind that measurement of prevalence alone is not a useful indicator of impact because of the non-linear relationship between prevalence and mean intensity of infection within a school or community, which depends on the degree of worm aggregation within the host populations

Figure 13

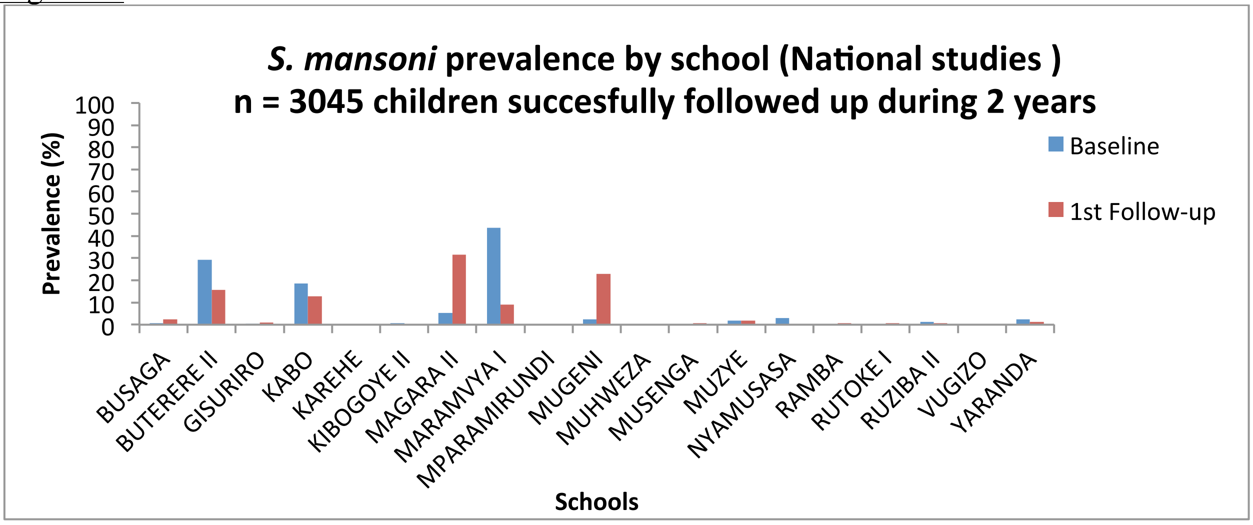


Figure 14

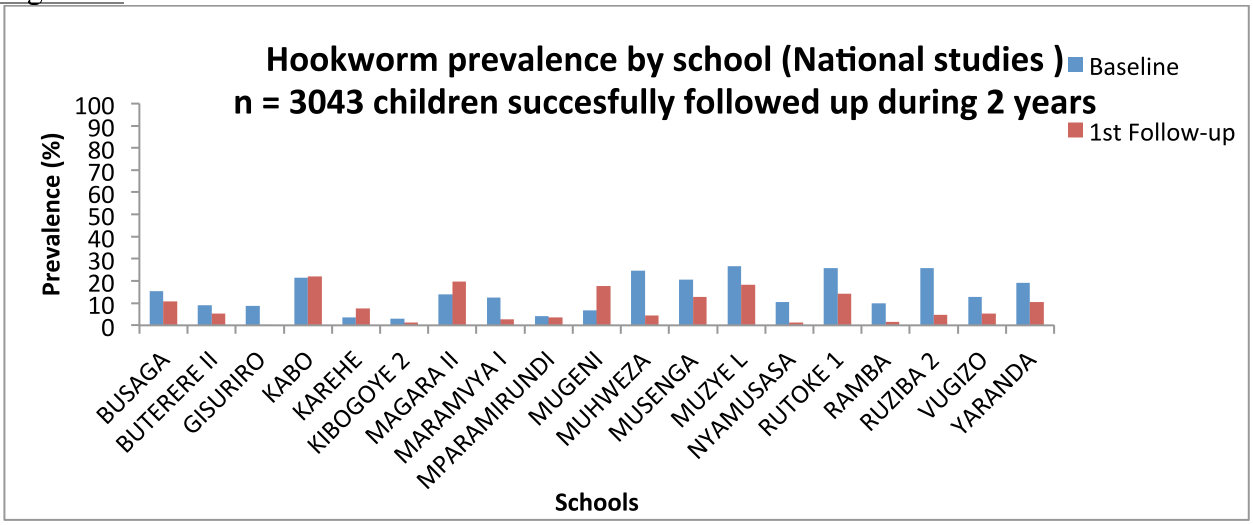


Figure 15

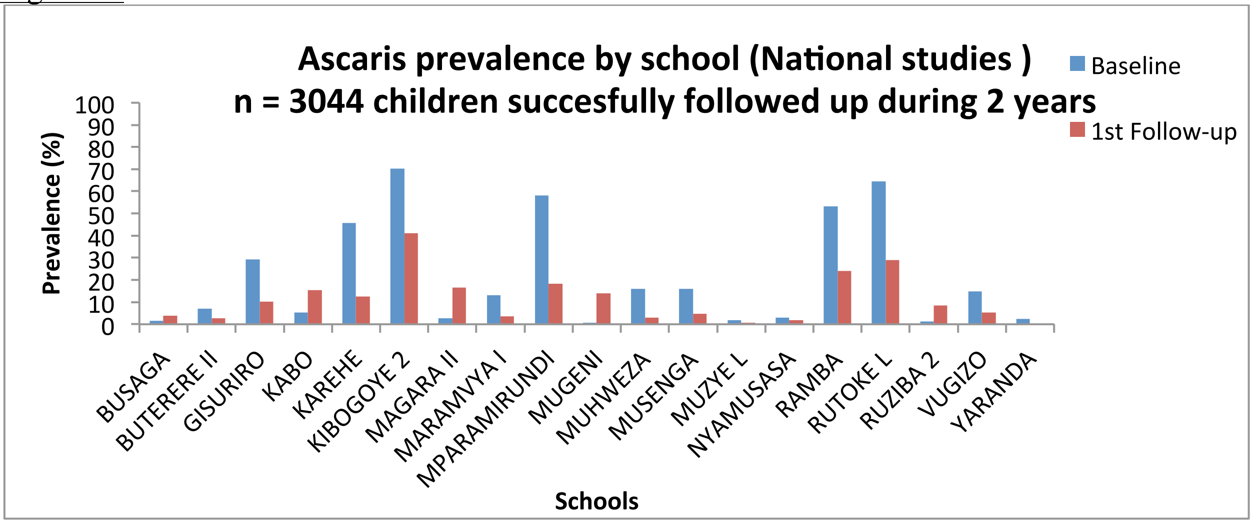


Figure 16

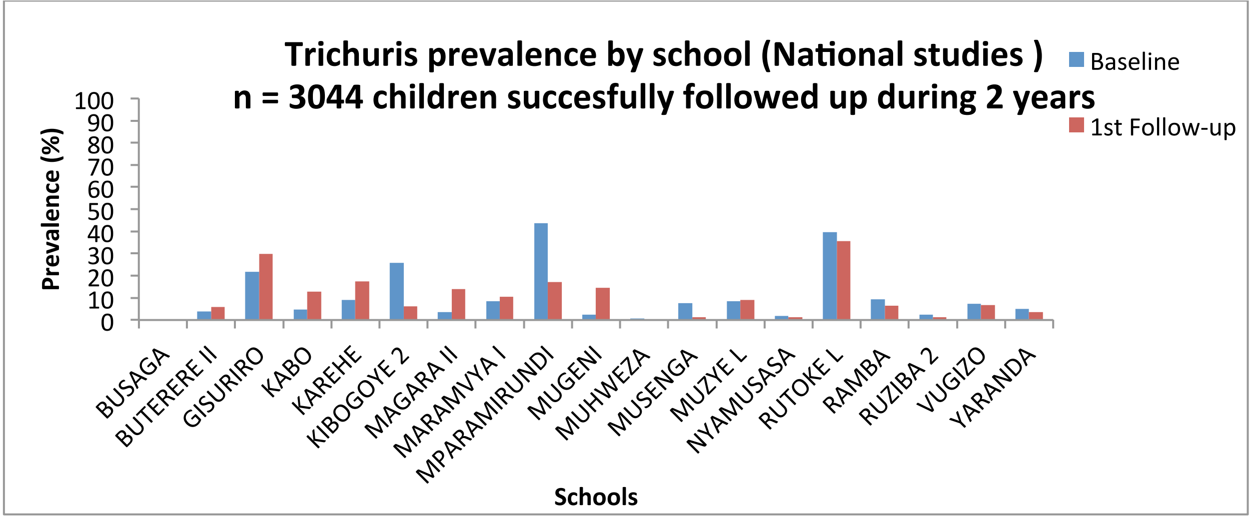


Figure 17

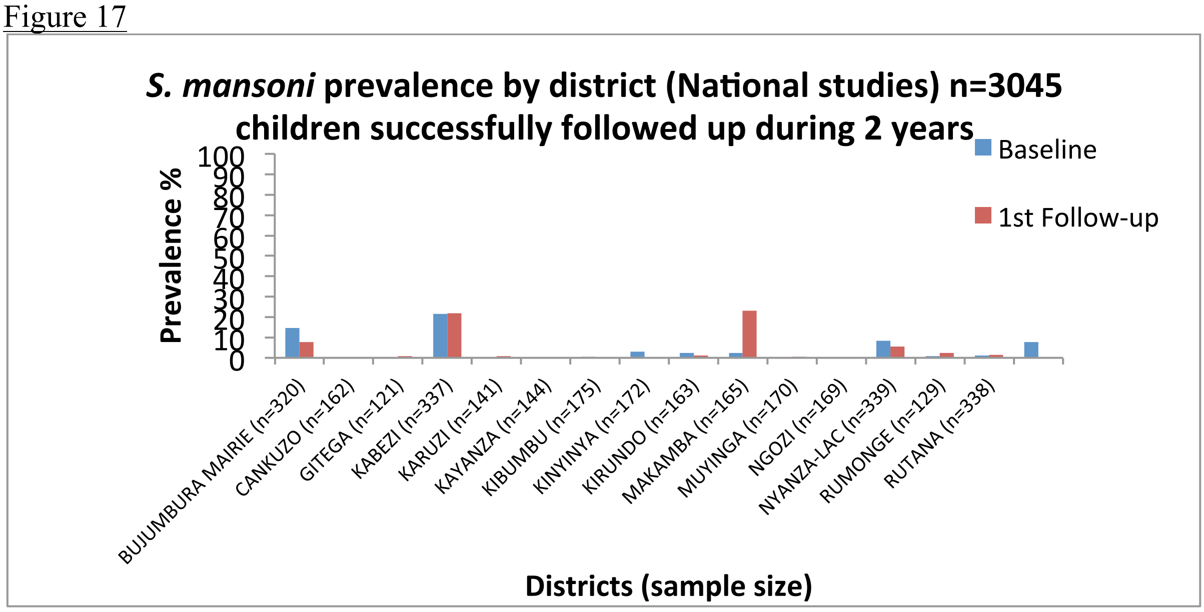


Figure 18

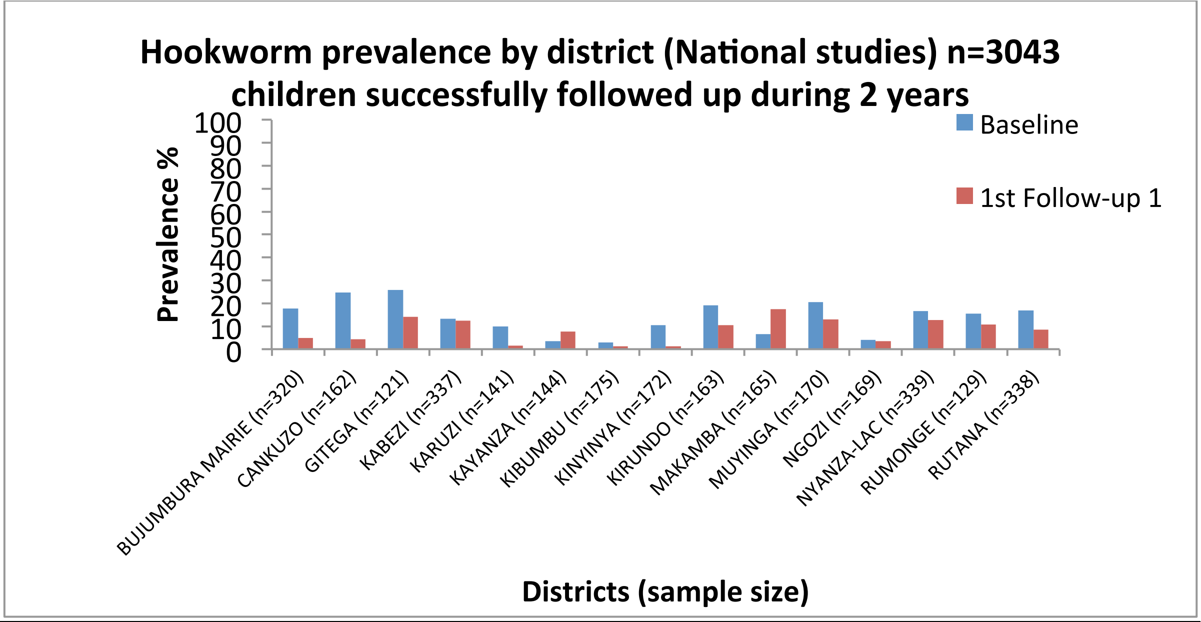


Figure 19

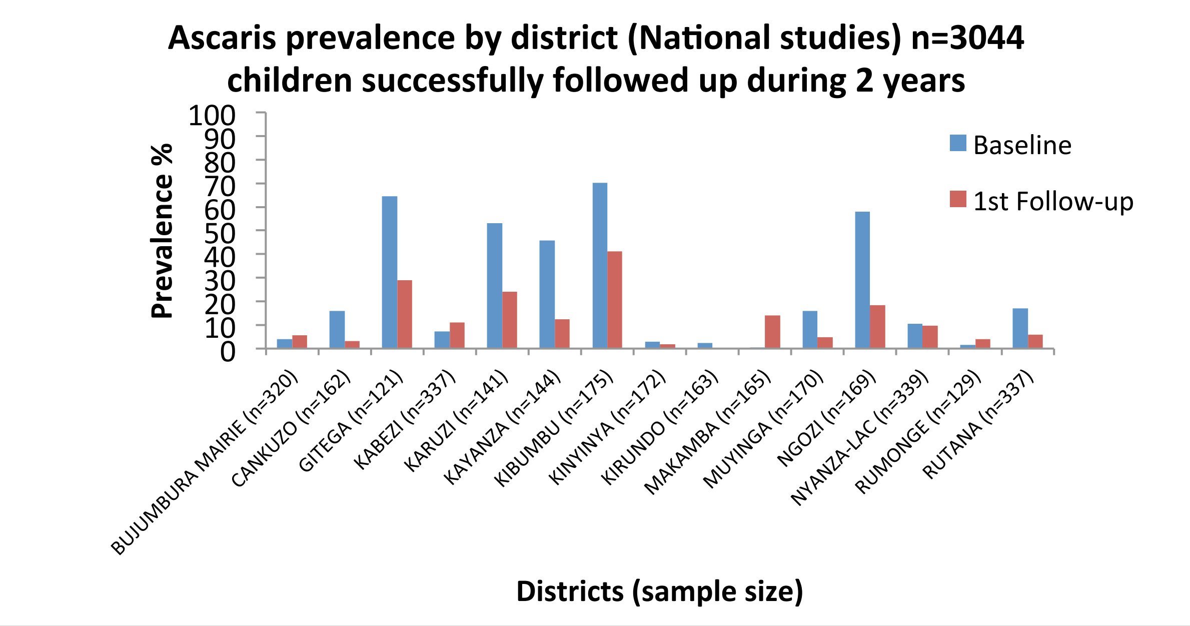
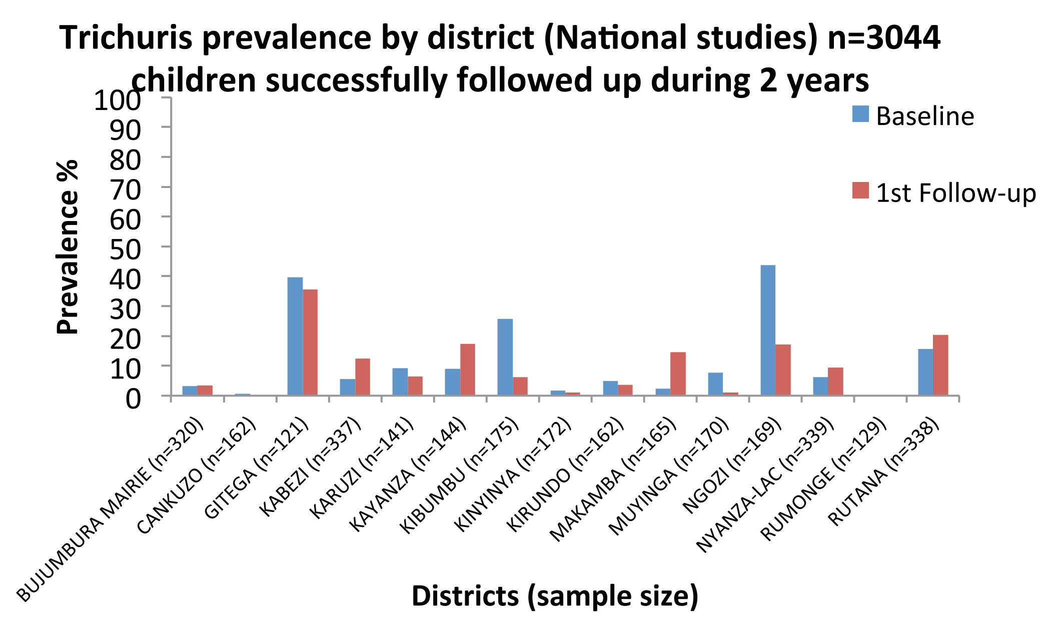


Figure 20



3.1.2 Intensity of STHs and schistosomiasis

In the next pages the intensity of STHs and schistosomiasis infections are first presented for the children who were successfully followed-up during 2 years. Figure 21 shows the overall prevalence of the 4 parasitic infections of interest here. For Ascaris infection at the 3rd follow-up there was a significant decrease in the eggs per gram compared to baseline. (See for further details at the end of this section under the heading ‘Statistical modelling results’ for direction of trends in the mean egg counts for all 4 parasitic infections examined here).

Then Figures 22-25 show intensity of *S. mansoni,* Hookworm, Ascaris and Trichuris infections per school during the 2 years of studies while Figures 26-29 show intensity of *S.mansoni*, Hookworm, Ascaris and Trichuris infections per district during the 2 years of studies.

Figure 21

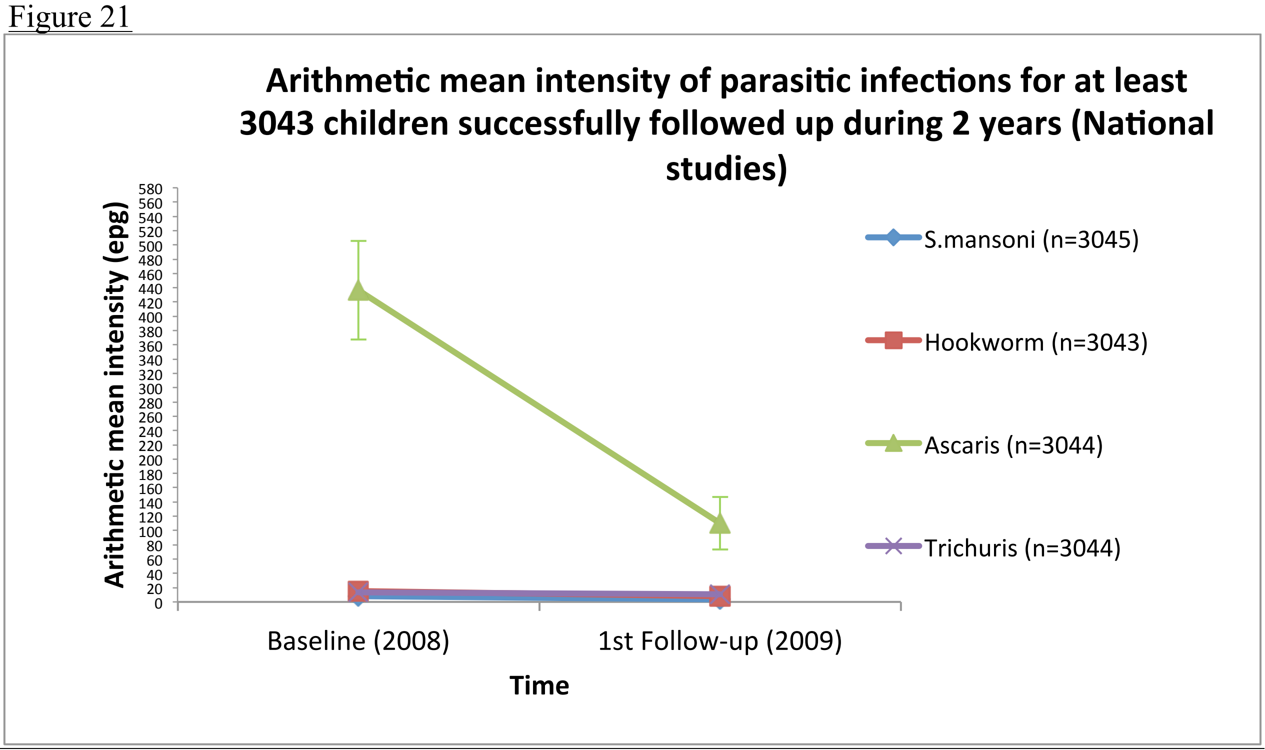


Figure 22

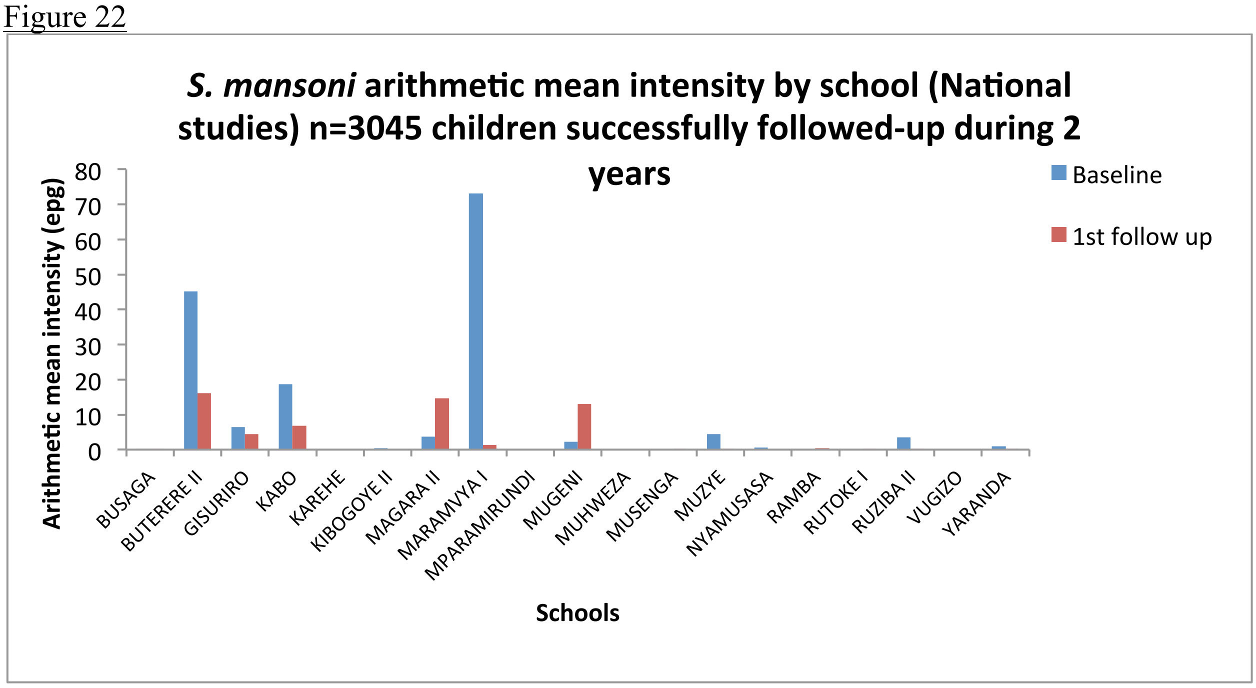


Figure 23

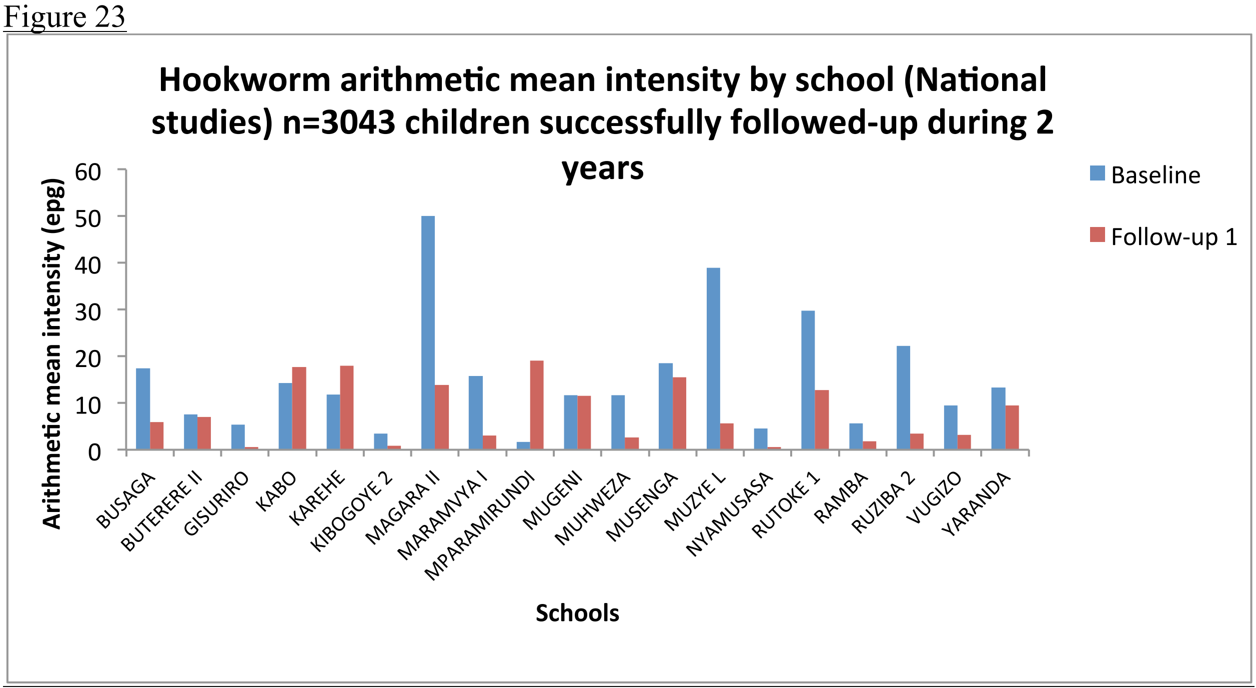


Figure 24

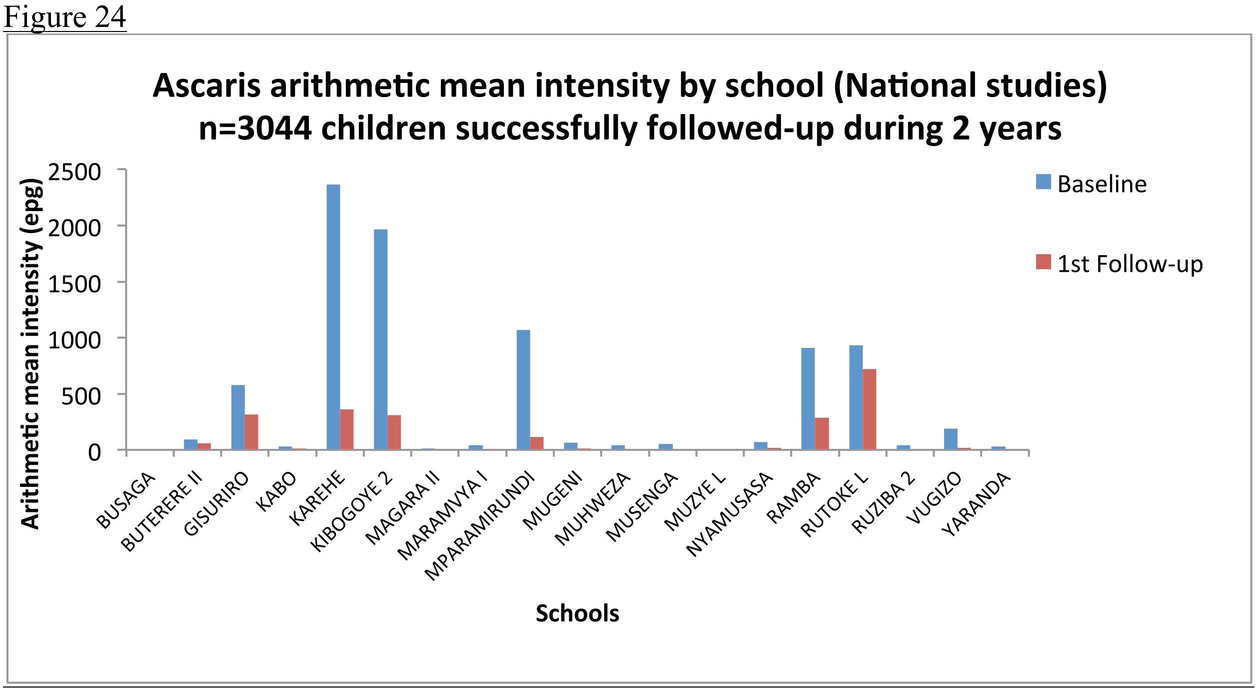


Figure 25

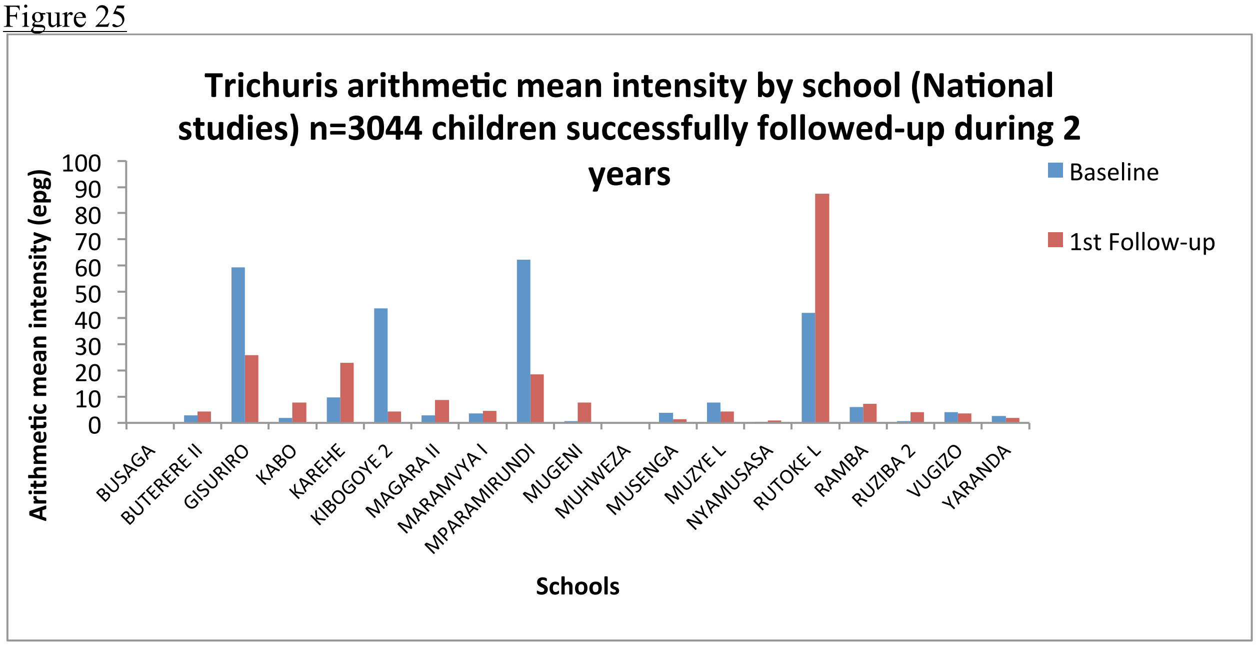


Figure 26

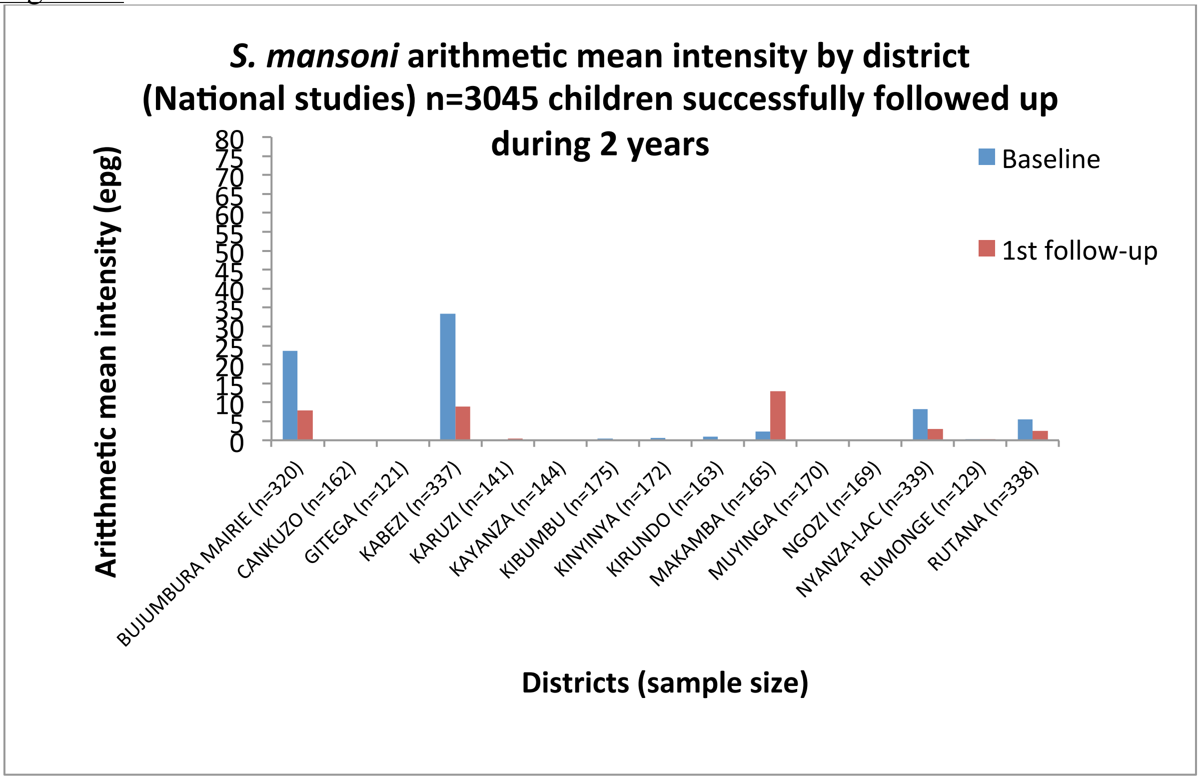


Figure 27

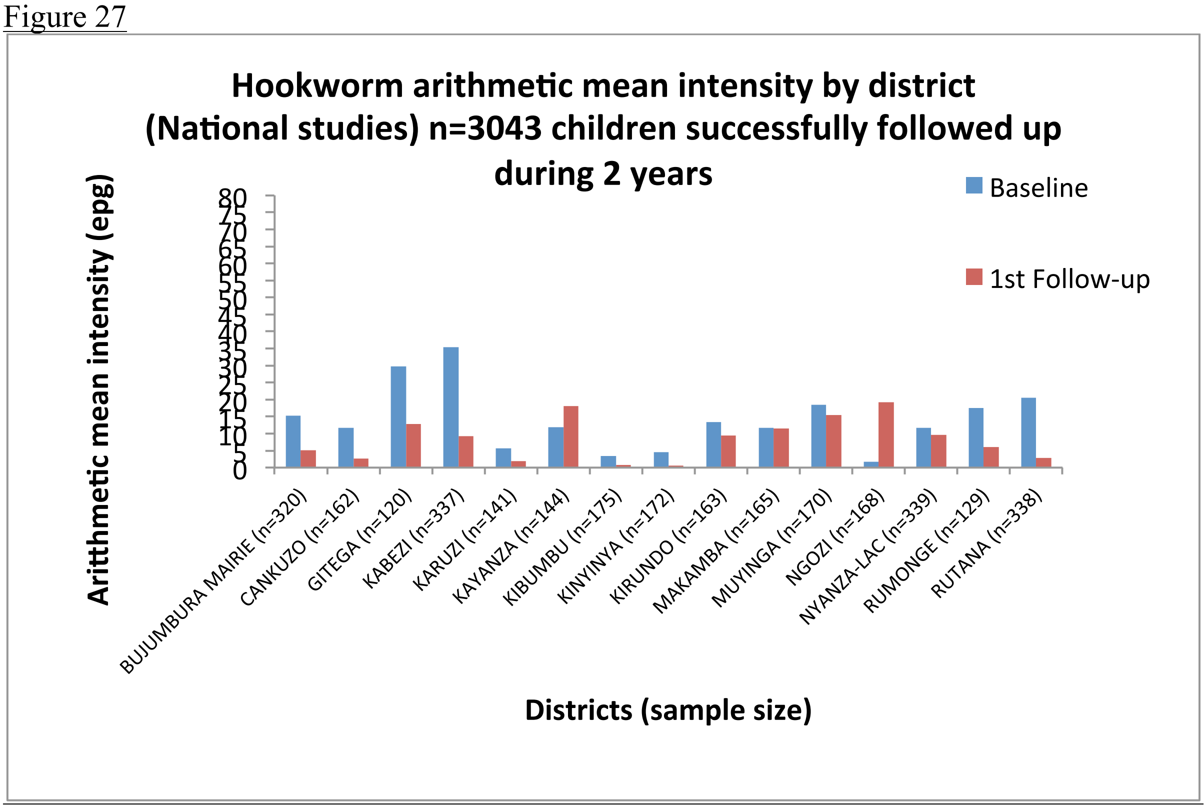


Figure 28

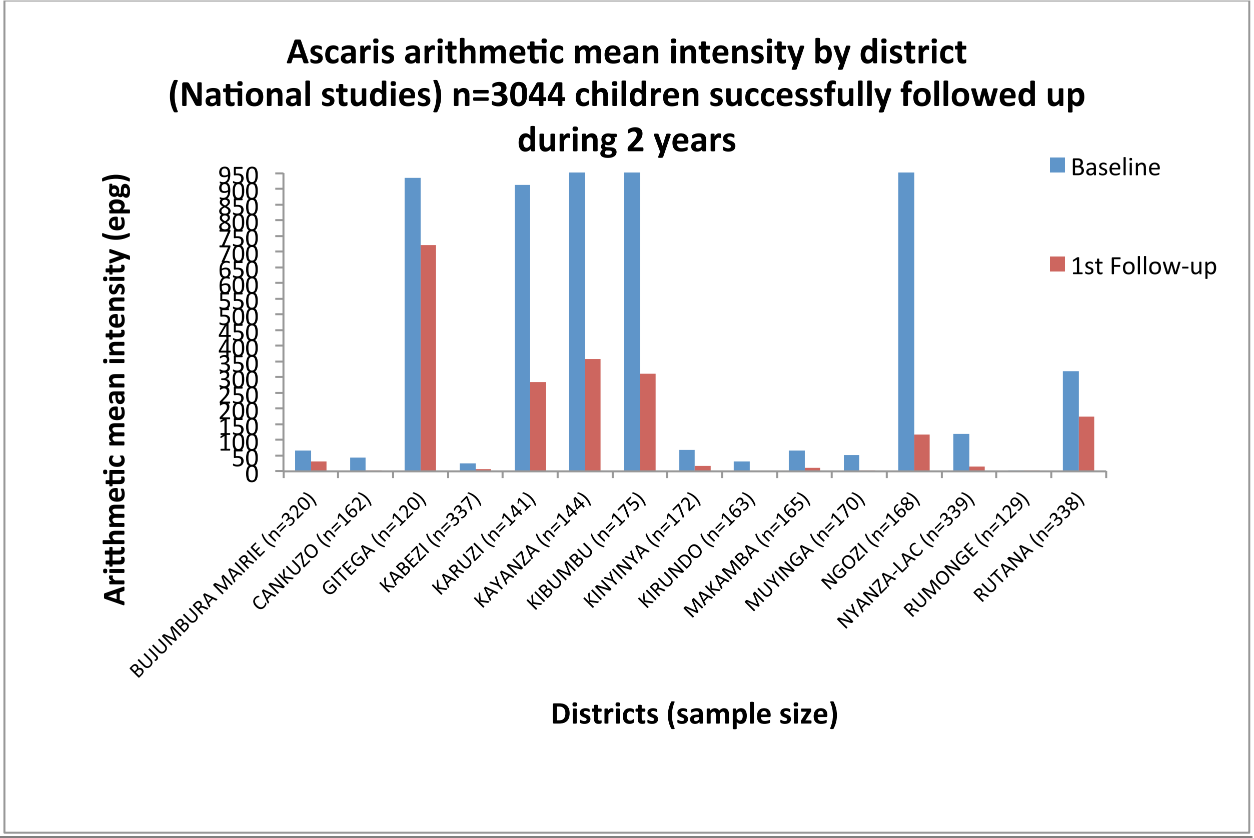
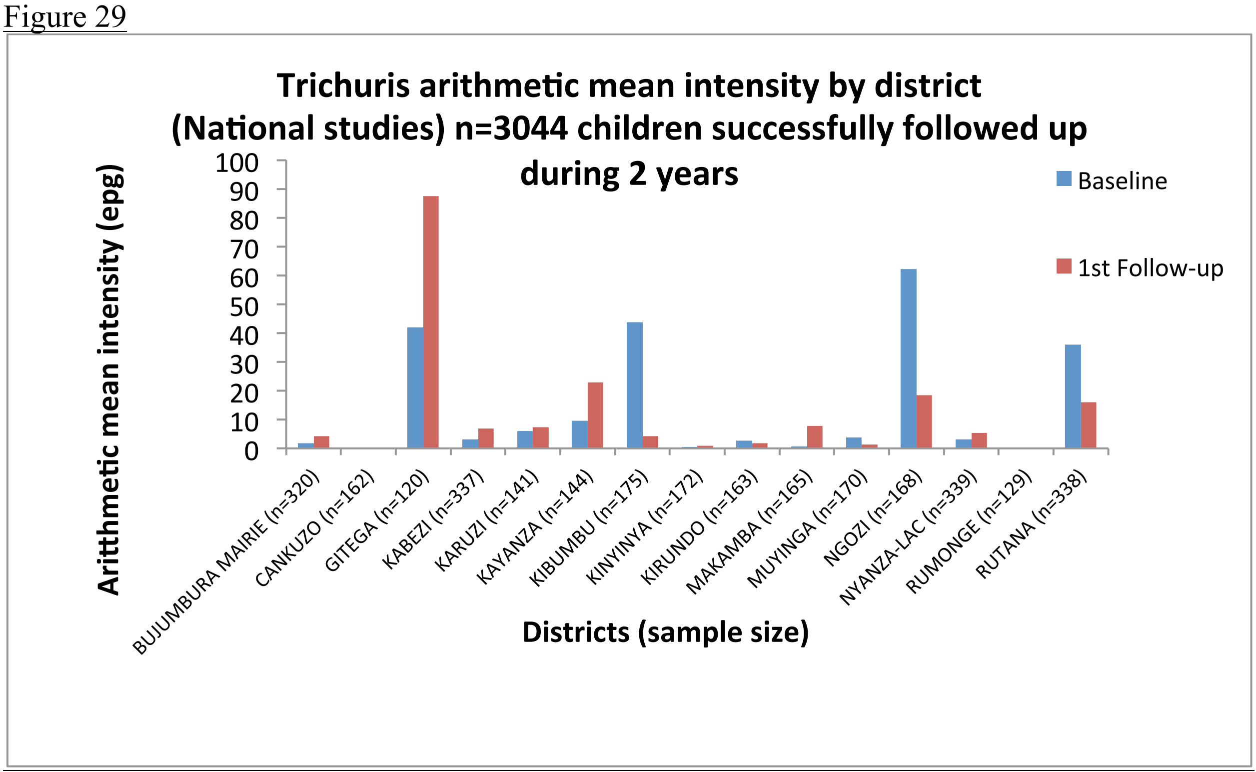


Figure 29



3.2.Anaemia

Similarly as in the pilot studies, for children who are less than 11 years, anaemia is defined as Hb being less than 115 g/l. For children aged between 12 and 14 years anaemia is defined as Hb being less than 120 g/l. These values were taken from the WHO 2001 “Iron Deficiency Anaemia-Assessment Prevention and Control”.

3041 children contributed Hb data during the 2 years of studies.

Figure 30

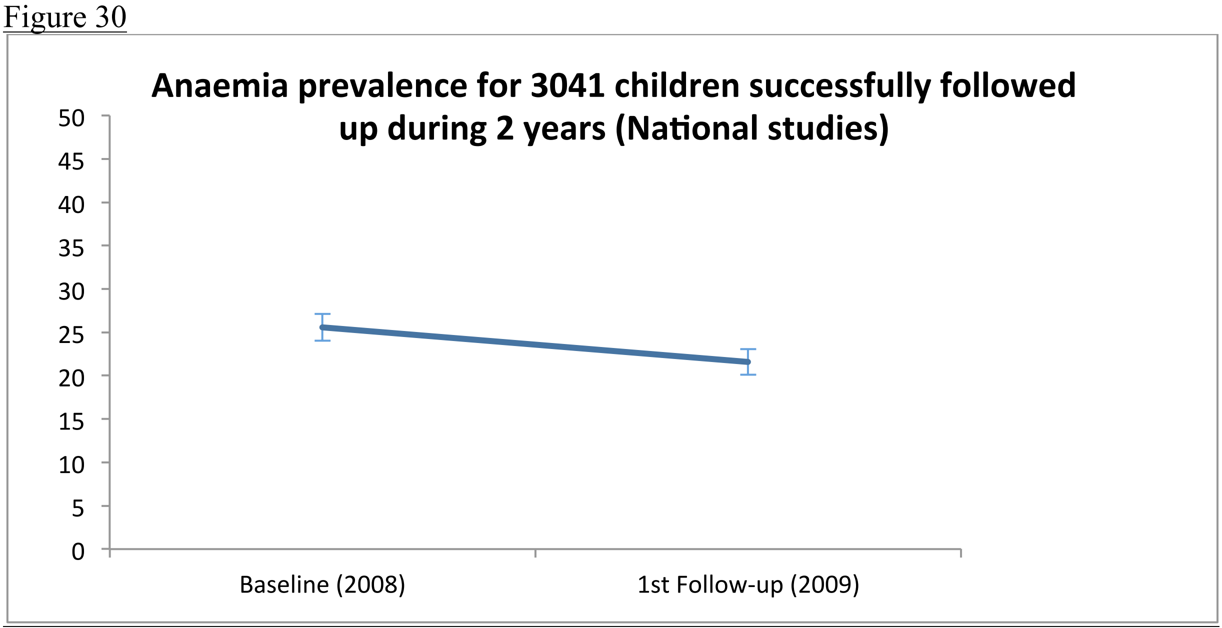


Figure 31

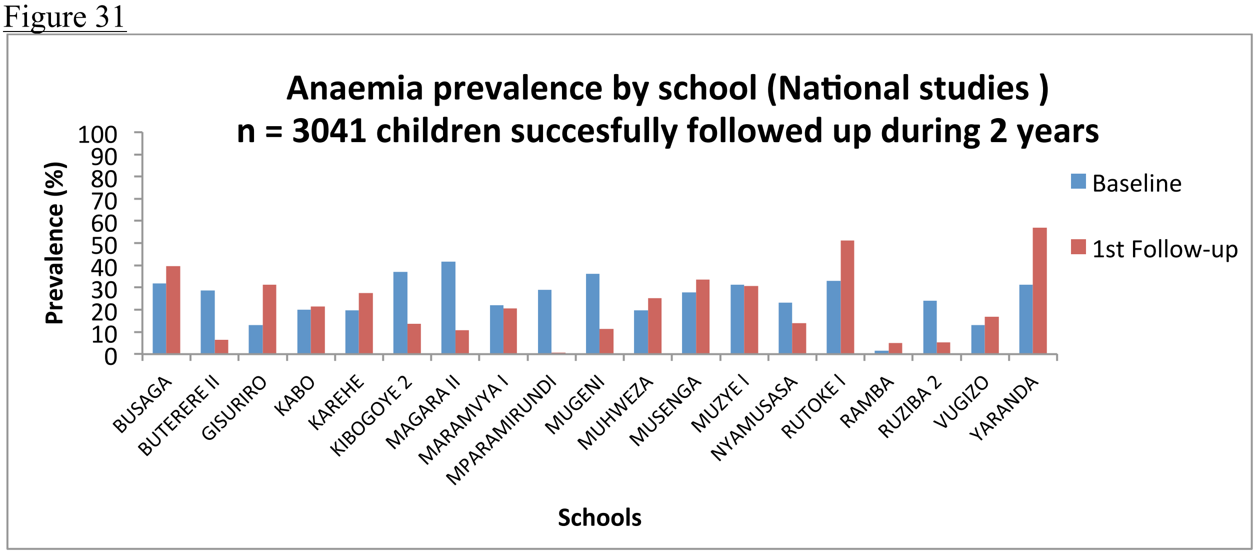
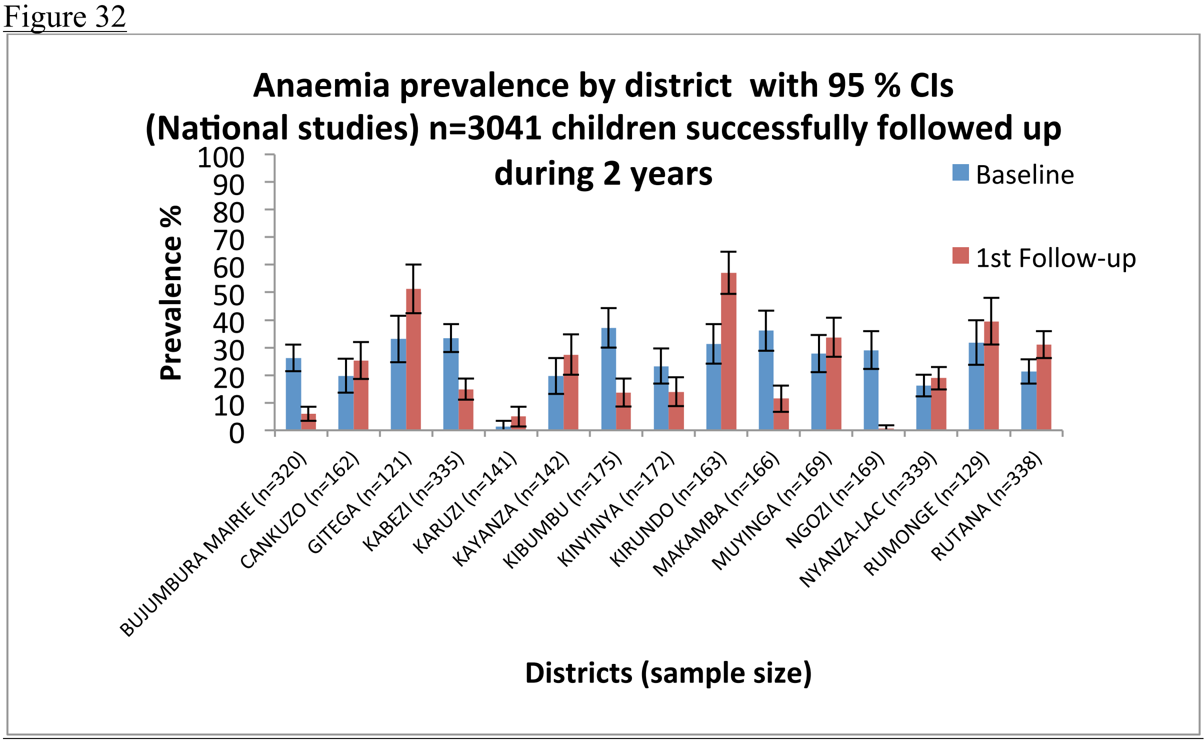


Figure 32



3.3 Newly recruited children/cross sectional data analysis

Table 7: Parasitologic measures for 6 years old newly recruited children during the 2 years of the studies (sample sizes are included in parentheses)

Prevalence (expressed as percentage)		
Parasitic infections	*2008*	*2009*
S.mansoni	3.38; 95 % CI: 0.47-6.29 (n=148)	4.65;95 % CI: 2.08-7.22 (n=258)
Hookworm	9.52; 95 % CI: 4.78-14.27 (n=147)	7.69; 95 % CI: 4.37-11.02 (n=247)
Ascaris	21.62; 95 % CI: 14.99-28.25 (n=148)	10.12; 95 % CI: 6.36-13.88 (n=247)
Trichuris	8.78; 95 % CI: 4.22-13.34 (n=148)	8.10; 95 % CI: 4.70-11.50 (n=247)
Arithmetic mean intensity (expressed as eggs per gram)		
S.mansoni	1.46; 95 % CI: 0.00-3.05 (n=148)	2.42; 95 % CI:0.84-4.00 (n=258)
Hookworm	11.59; 95 % CI: 0.00-24.59 (n=147)	5.64; 95 % CI:1.65-9.62 (n=247)
Ascaris	424.22; 95 % CI: 171.14-677.30 (n=148)	53.64; 95 % CI: 0.00-131.94 (n=247)
Trichuris	10.70; 95 % CI: 1.65-19.76 (n=148)	5.15; 95 % CI: 2.32-7.98 (n=247)

3.4 Statistical modelling results

3035 children have contributed data to these analyses as we took into account children who had complete data on anaemia and parasitic infections during the 2 years of the longitudinal national studies. With GEE logistic regressions we have modelled the Odds Ratios (ORs) of being anaemic or being infected with *S. mansoni* or hookworm or Ascaris or Trichuris infections at the 1st follow-up if compared to baseline, having adjusted also for the sex and age of the children included in this analysis. With GEE linear regressions we have estimated the percentage by which the mean egg counts of the afore mentioned parasitic infections changed at the 1st follow-up if compared to baseline having adjusted also for the sex and age of the children included in this analysis. The results follow below.

The average OR of being infected at the 1st follow-up if compared to baseline were: for Ascaris OR= 0.51, p-value<0.001; hookworm OR=0.50, p-value<0.001; *S. mansoni* OR=0.95, p-value=0.675; Trichuris OR=1.10, p-value=0.229 and anaemia OR=0.68, p-value<0.001. This means that the average risk of being infected with Ascaris or Hookworm infections or being anaemic significantly decreased at the 1st follow-up if compared to baseline.

Mean egg counts for Ascaris infection were estimated to have decreased significantly at the 1st follow-up if compared to baseline by 78.43 %, p-value<0.001; mean egg counts for hookworm infection were estimated to have decreased significantly at the 1st follow-up if compared to baseline by 45.26 %, p-value<0.001; mean egg counts for *S. mansoni* infection were estimated to have decreased at the 1st follow-up if compared to baseline by 9.22 %, p-value=0.064 and finally mean egg counts for Trichuris infection were estimated to have decreased at the 1st follow-up if compared to baseline by 9.53 % p-value=0.153.

3.5 Hygienic state of schools

Tables 8-11 contain information for the hygienic state of schools during the last year of the national studies.

Table 8: Number of toilets in schools (Indicated frequencies and percentages are for numbers of schools)

	2009
2 toilets	1 (5.26 %)
4 toilets	1 (5.26 %)
6 toilets	1 (5.26 %)
7 toilets	2 (10.53)
8 toilets	8 (42.11 %)
10 toilets	1 (5.26 %)
12 toilets	2 (10.53 %)
16 toilets	2 (10.53 %)
24 toilets	1 (5.26 %)

Table 9: State of the toilets (Indicated frequencies and percentages are for numbers of schools)

	2009
Bad	3 (15.79%)
Mediocre	11 (57.89 %)
Good	5 (26.32 %)

In all 19 schools it was reported that the type of the toilet was 'latrine + cess + pit'.

Table 10: Principal type of water supply in the school (Indicated frequencies and percentages are for numbers of schools)

	2009
Tap	10 (52.63 %)
Steam/river	3 (15.79 %)
Pond	1 (5.26 %)
None	3 (15.79 %)
Other	2 (10.53 %)

Table 11: Is there a place in the school to wash the hands? (Indicated frequencies and percentages are for numbers of schools)

	2009
No	12 (63.16 %)
Yes	7 (36.84 %)

Acknowledgments

Great thanks are due to the Burundian field and CBM team for all their work with regards to these data, and the school-children participating in these surveys as well as the Burundian Ministry of Public Health.