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Prevalence and intensity of infection of Soil-transmitted Helminths in Latin America and the Caribbean Countries

Mapping at second administrative level 2000-2010

Pan American Health Organization
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Acronyms

CD49.R19:	PAHO's 49th Directing Council Resolution 19 on "Elimination of Neglected Diseases and Other Poverty-Related Infections"
GIS:	Geographical Information System
LAC:	Latin America and the Caribbean
MDA:	Mass Drug Administration
NID:	Neglected Infectious Diseases
PAHO/WHO:	Pan American Health Organization / World Health Organization
PSAC:	Preschool-age children
SAC:	School-age children
STH:	Soil-Transmitted Helminths or Soil-Transmitted Helminthiases
AD:	*Ancylostoma duodenale*
AL:	*Ascaris lumbricoides*
HW:	*Hookworms*
NA:	*Necator americanus*
TT:	*Trichuris trichiura*
y.o.:	Years old

Executive summary

Infections by *Ascaris lumbricoides*, *Trichuris trichiura* and hookworm (*Necator americanus or Ancylostoma duodenale*) occur all over the world, transmitted to humans through soil, vegetation, food and water contaminated by fecal matter that contain the eggs of the parasites.

At the global level it is estimated that intestinal parasite infections affect more than one-third of the world's population with the highest rates in school-age children (SAC). Stunting usually occurs between 6 months and 2 years of age, which overlaps with the period in which the soil-transmitted helminths begin to emerge. STH have been documented as causing impairment of growth and nutrition. The hookworms damage the intestinal mucosa leading to bleeding, loss of iron and anemia. Infections by *Trichuris trichiura* produce chronic reduction of food intake. During pregnancy, mild or severe infections with hookworms can cause anemia to the mother and damage to the fetus, leading to low birth weight. In areas where helminths are common, deworming activities can be done once or twice per year to the population at risk (without access to improved sanitation facilities), including deworming for pregnant women after the first trimester. Deworming during pregnancy also has been found useful to reduce severe maternal anemia, increase birth weight and reduce infant mortality.

To know the geographical distribution of neglected tropical diseases it is necessary to understand the distribution of each of the diseases, to identify areas with overlapping and to focalize areas for integrated interventions (preventive chemotherapy, health education, water and sanitation, etc.). The epidemiological distribution of some neglected tropical diseases is well known in Latin America and the Caribbean countries (LAC) (e.g. lymphatic filariasis and onchocerciasis); however the distribution of schistosomiasis and soil-transmitted helminths is less well mapped.

The main objective of this study was to map the prevalence and intensity of infection by soil-transmitted helminths for pre-school and school-age children in Latin America and the Caribbean countries (LAC) at the second subnational administrative level for the period 2000-2010, based on bibliographic review of papers published for this time period. Data were restricted to two age groups only: pre-school (1-4 years old) and school-age children (5-14 years old).

Online databases of scientific medical literature from MEDLINE (through PubMed's website), LILACS (including SciELO), BIREME, the Cochrane Library, the websites of Ministries of Health, websites of PAHO country offices and websites of NGOs (that have reported deworming activities in LAC since 2005) were searched for papers published in the last 10 years in LAC (2000-2010). Papers in French, English, Spanish and Portuguese with free online access for the full text were included. However, when abstracts were found for countries or areas without information on STH surveys and the paper in full text was not available online, the main author was contacted to obtain a full text copy.

The searches were made using terms used by health libraries. All searches were restricted for studies in humans and for the period 2000-2010, and were defined inclusion criteria.

As a result of this review, 236 papers were selected and reviewed of which 120 met the inclusion criteria for this study; of these papers data were found for 18 countries at the second administrative level (Argentina, Belize, Bolivia, Brazil, Colombia, Costa Rica, Cuba, Ecuador, Guatemala, Guyana, Haiti, Honduras, Mexico, Nicaragua, Paraguay, Peru, Saint Lucia and Venezuela). The low number of data available on prevalence of STH for PSAC (40 data, 11.9%) as compared to the data published for SAC (190, 56.7%) and for children between 1-14 years old (105, 31.3%) is worth highlighting. This situation is a challenge for the LAC countries to plan the necessary interventions such as deworming it is necessary to know the prevalence in order to define how many times per year the anti-parasitic drugs should be given, and to conduct monitoring and evaluation of progress in drug coverage.

An important finding was that 34.9% of the data for prevalence of STH published and selected for this study showed values between >20-50% and 27.8% above 50% of prevalence, which indicates that massive deworming is required, once or twice per year, respectively. The data obtained are important in order to define the intervention in some areas within the countries included in this document, and might be used either as a proxy of the baseline data or as a proxy of the evaluation of progress towards the achievement of the deworming goals in the America's Region (Figs. 1 and 2).

The low number of data published for intensity of infection of STH in LAC for the period 2000-2010 is highlighted in this study, and especially the lack of data published for this indicator since 2006 at second administrative level, taking into account that this information is important to track the diseases and to evaluate their impact on children's health. 151 data for intensity of STH infection were found for 7 countries: Argentina, Bolivia, Brazil, Colombia, Ecuador, Honduras and Venezuela. Of these data, 28.5% (43 data) showed heavy intensity (28 for *Ascaris lumbricoides*) and 34.4% (52 data) moderate intensity of infection. The data for heavy intensity of infection were found mainly for SAC, due to the higher number of published data that were found for this age group. After reviewing the data found for prevalence and intensity of infection of STH in LAC, Tables 1 and 2 shows a summary of the main findings and also allows us to view the gaps in the information needed to make fully informed decisions in LAC countries.

Figure 1. Data published for prevalence of STH for PSAC in LAC 1995-2009

Figure 2. Data published for prevalence of STH for SAC in LAC 1995-2009.

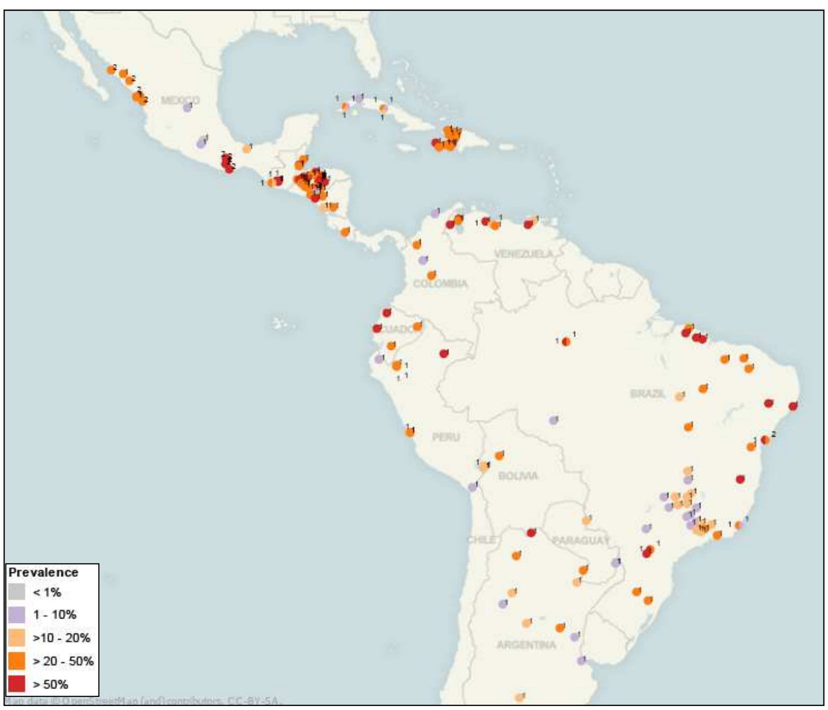

Table 1. Threshold of percentage of STH prevalence and species of STH related with heavy intensity of infection found by country and by age group, 1995-2009.

Country	*Threshold of Percentage of STH prevalence*						*Heavy intensity of infection*		
	PSAC		**SAC**		**1-14**		**PSAC**	**SAC**	**1-14**
	Min.	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Species**	**Species**	**Species**
Argentina	20.3	66.7	6.0	71.4	0	88.9	-	-	AL
Belize	55.0		34.4	77.0	66.2		-	AL, TT	-
Bolivia	16.1		11.6	24.3	2.0	76.1	-	-	-
Brazil	0	80.3	1.2	9.3	0.7	85.3	AL, HW	AL, HW	AL, HW
Chile	-	-	-	-	-	-	-	-	-
Colombia	0.9	26.2	5.17	43.1	2.0	9.9	-	AL, TT, HW	-
Costa Rica	21.0		41.0		26.8	36.0	-	-	-
Cuba	0.8		1.8	24	40.5		-	-	-
Dominica	-	-	-	-	-	-	-	-	-
Dominican Republic	-	-	-	-	-	-	-	-	-
Ecuador	19.6	35.5	3.7	63.4	20.1	55.3	-	AL, TT, HW	
El Salvador	-	-	-	-	-	-	-	-	-
French Guiana	-	-	-	-	-	-	-	-	-
Guadeloupe	-	-	-	-	-	-	-	-	-
Guatemala	-	-	10.2	63.3	42.0	47.0	-	-	-
Guyana	-	-	-	-	28.2		-	-	-
Haiti	-	-	20.6	73.7	29.3		-	-	-
Honduras	7.4	78.0	6.6	93.0	11.7	89.2	AL	AL	AL
Jamaica	-	-	-	-	-	-	-	-	-
Martinique	-	-	-	-	-	-	-	-	-
Mexico	6.9		0.8	53.0	3.7	6.0	-	-	-
Nicaragua	-	-	10.9	84.4	-	-	-	-	-
Panama	-	-	-	-	-	-	-	-	-
Paraguay	-	-	5.1		-	-	-	-	-
Peru	-	-	1.6	77.9	6.8	18.4	-	-	-
Puerto Rico	-	-	-	-	-	-	-	-	-
Saint Lucia	-	-	-	-	8.5	22.5	-	-	-
Suriname*	-	-	2.1		-	-	-	-	-
Trinidad & Tobago	-	-	-	-	-	-	-	-	-
Uruguay	-	-	-	-	-	-	-	-	-
Venezuela	1.96	11.0	5.07	82.5	2.86	70.3	-	AL, TT, AD	-

AD: *Ancylostoma duodenale*, AL: *Ascaris lumbricoides*, HW: *Hookworms*, TT: *Trichuris trichiura*

*Suriname developed a national survey during 2010 for STH, however the data are without publication by February 2011.

For other Non-Latin Caribbean countries was not found data: Anguila, Antigua & Barbuda, Aruba, Bahamas, Barbados, Cayman Islands, Grenada, Monserrat, Netherlands Antilles, Saint Kitts and Nevis, Saint Vincent and the Grenadines, Turks & Caicos Islands, Virgin Islands (UK), Virgin Islands (US)

Table 2. Number of data for prevalence and intensity of infection included by country and by age group, 1995-2009.

Country	*Data published for prevalence of STH*						*Data published for intensity of infection*					
	PSAC		**SAC**		**1-14**		**PSAC**		**SAC**		**1-14**	
	# of data	**Year of most recent data**	**# of data**	**Year of most recent data**	**# of data**	**Year of most recent data**	**# of data**	**Year of most recent data**	**# of data**	**Year of most recent data**	**# of data**	**Year of most recent data**
Argentina	2	2007	11	2007	19	2007	-	-	-	-	2	2001
Belize	1	2004	3	2005	1	2004	-	-	-	-	-	-
Bolivia	1	2004	5	2004	6	2008	-	-	24	1997	-	-
Brazil	18	2008	50	2009	20	2009	6	2004	7	2005	11	2005
Chile	-	-	-	-	-	-	-	-	-	-	-	-
Colombia	4	2008	4	2008	3	2000	-	-	9	1999	-	-
Costa Rica	1	1998	1	1998	2	2005	-	-	-	-	-	-
Cuba	1	1998	7	2004	1	2007	-	-	-	-	-	-
Dominica	-	-	-	-	-	-	-	-	-	-	-	-
Dominican Republic	-	-	-	-	-	-	-	-	-	-	-	-
Ecuador	2	2005	5	2003	4	2003	-	-	6	2003	4	2003
El Salvador	-	-	-	-	-	-	-	-	-	-	-	-
French Guiana	-	-	-	-	-	-	-	-	-	-	-	-
Guadeloupe	-	-	-	-	-	-	-	-	-	-	-	-
Guatemala	-	-	7	2007	7	2009	-	-	-	-	-	-
Guyana	-	-		-	1	2002	-	-	-	-	-	-
Haiti	-	-	11	2002	1	2001	-	-	-	-	-	-
Honduras	7	1999	36	2005	23	2001	21	1998	21	1998	21	1998
Jamaica	-	-	-	-	-	-	-	-	-	-	-	-
Martinique	-	-	-	-	-	-	-	-	-	-	-	-
Mexico	1	2007	25	2005	2	1998	-	-	-	-	-	-
Nicaragua	-	-	5	2005	-	-	-	-	-	-	-	-
Panama	-	-	-	-	-	-	-	-	-	-	-	-
Paraguay	-	-	2	2001	-	-	-	-	-	-	-	-
Peru	-	-	9	2005	2	2007	-	-	-	-	-	-
Puerto Rico	-	-	-	-	-	-	-	-	-	-	-	-
Saint Lucia	-	-	-	-	8	2005	-	-	-	-	-	-
Suriname*	-	-	7	2010	-	-	-	-	7	2010	-	-
Trinidad & Tobago	-	-	-	-	-	-	-	-	-	-	-	-
Uruguay	-	-	-	-	-	-	-	-	-	-	-	-
Venezuela	2	2008	9	2008	5	2008	-	-	20	2003	-	-

*Suriname developed a national survey during 2010 for STH, however the data are without publication by February 2011.

For other Non-Latin Caribbean countries was not found data: Anguila, Antigua & Barbuda, Aruba, Bahamas, Barbados, Cayman Islands, Grenada, Monserrat, Netherlands Antilles, Saint Kitts and Nevis, Saint Vincent and the Grenadines, Turks & Caicos Islands, Virgin Islands (UK), Virgin Islands (US)

The data found for children between 1-14 years old for prevalence of STH (105 data, 31.3%) could be used as a proxy for the prevalence of STH at second administrative level if there were no data disaggregated by PSAC and SAC available. However it could be difficult to plan the deworming activities, due to the difference between children who are enrolled in the education system (5-14 years old) vs. children under 5 years who are not. Hence, different strategies are required to reach different age groups with deworming activities.

The gaps in the prevalence and intensity of infection data result in a weakness in information to make evidence-based decisions at national and subnational levels for improving child health, especially to reduce the burden of intestinal parasitic worms. This situation could be due to the lack of interest in this issue by health authorities, research groups and other groups in LAC that have greater interest in other public health issues. It could also be caused by a reduction in data published in journals, or absence of publication of some studies done at the local level.

Understanding where the populations at-risk are located, including their socio-economic and environmental conditions, is fundamental for appropriate allocation of resources and to develop cost-effective control interventions. In particular, it allows for reliable estimation of the overall drug needs of programs and for efficient geographical targeting of control efforts[1]. The precise global distribution of STH infections and how many people are infected and at risk of morbidity, however, remains poorly defined. This in turn, limits how national governments and international organizations define and target resources to combat the disease burden due to STH infections[2].

Mapping of data for prevalence and intensity of infection of STH in LAC for 2000-2010 by sub-region and countries provided information regarding gaps on mapping, and also important information regarding areas that need deworming activities for PSAC and SAC. The results of this study show some countries with absence of information for prevalence and intensity of STH infections, as well as others with no updated or recent data published. Differences in the observed prevalence of STH infection within municipalities were also illustrated.

It is necessary and urgent to update the mapping for prevalence and intensity of infection of STH in order to make better evidence-based decisions regarding deworming activities. The data available for PSAC are insufficient to know the real situation of STH prevalence and intensity of infection, and although more data for SAC population were found, these data are only from some countries and some second administrative levels.

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[1] Brooker S, Michael E. The potential of geographical information systems and remote sensing in the epidemiology and control of human helminth infections. *Adv Parasitol.* 2000;47:245–288.

[2] Brooker, S, Clements, A, Bundy, D. Global epidemiology, ecology and control of soil-transmitted helminth infections. *Adv Parasitol*. 2006 ; 62: 221–261.

It is also necessary to push the operational research agenda with governments and groups of interest in order to develop STH mapping activities. The mapping is necessary in order to know where the populations at risk are, which age groups are at risk of STH infection, the municipalities in which the authorities need to focus their work (if these data are available), and also for monitoring and evaluation purposes throughout time in order to know the impact of interventions, not only deworming, but also nutrition, education, and environmental interventions and integrated actions to reduce child morbidity and mortality and to improve child development.

Without enough, accurate and specific data about STH prevalence and intensity of infection by age group (PSAC and SAC) in LAC it will be difficult to identify with certainty the main gaps, resources needed and places where focus integrated actions, including deworming, must be focused, in order to reach the regional and global goals for deworming children at risk.

Prevalence and intensity of infection of Soil-transmitted Helminths in Latin America and the Caribbean Countries: Mapping at second administrative level 2000-2010

Introduction

This document presents the results of a descriptive study of prevalence and intensity of infection of soil-transmitted helminth (STH) infections for 2000-2010 in LAC carried out by the Regional Program of Neglected and Parasitic Diseases of the Pan American Health Organization, as an initiative to advance on the mapping for some Neglected Diseases in order to make better evidence-based decisions regarding deworming activities for at risk populations.

This report has three purposes: 1) show the distribution, throughout mapping, of the data published for pre-school age children (PSAC) and school-age children (SAC) for prevalence and intensity of infection of STH in the last 10 years, as a means to identify the gaps on surveys, 2) identify areas where deworming might be necessary, once or twice per year, based in the prevalences found at the second administrative level in LAC, using the data published as a proxy of the current epidemiological situation in the Region, and 3) serve as a reference document for consultation by governments, research groups, organizations and those interested on epidemiological information as a proxy for defining deworming needs at local level.

This document presents results of 120 papers included (236 reviewed) and data for 18 countries. The results are presented by sub-regions in LAC, according with the sub-regional classification made by PAHO for the annual publication of the "Health Situation in the Americas: Basic indicators", in order to organize the information and to facilitate its reading and do specific consultations. Data within each sub-region are presented by country.

The reader can find tables that show data disaggregated at local level, which contains information about the study place, year and the prevalence found, including prevalence by species, and some data about intensity of infection. This information is complemented by maps by sub-region to facilitate the geographical overview of the data.

This is a first descriptive approach with this database, because PAHO expects to use it in a second phase where prevalence data will be analyzed and triangulated with socio-economic and environmental variables in order to extrapolate data from areas with known prevalence to predict the prevalence in areas without data but with similar social, economic and environmental conditions.

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1. Background

Helminth infections impose a great burden on poor populations in the developing world – yet robust, low-cost and effective public health interventions are available to relieve that burden and provide a better quality of life for people in poor settings[3].

The four most common soil-transmitted helminths are roundworm (*Ascaris lumbricoides*), whipworm (*Trichuris trichiura*), and the anthropophilic hookworms (*Necator americanus* and *Ancylostoma duodenale*). Recent worldwide estimates suggest that *A. lumbricoides* infects 1.221 billion people, *T. trichiura* 795 million, and hookworms 740 million. The greatest numbers of STH infections occur in the Americas, China and East Asia, and Sub-Saharan Africa. *Strongyloides stercoralis* is also a common STH in some of these regions, although detailed information on the prevalence of strongyloidiasis is lacking because of the difficulties in diagnosing human infection. The life cycles of *Ascaris, Trichuris*, and hookworm follow a general pattern. The adult parasite stages inhabit the gastrointestinal tract (*Ascaris* and hookworm in the small intestine; *Trichuris* in the colon), reproduce sexually, and produce eggs, which are passed in human feces and deposited in the external environment[4].

At the global level it is estimated that intestinal parasite infections affect more than one-third of the world's population with the highest rates in school-age children. Stunting usually occurs between 6 months and 2 years of age, which overlaps with the period in which the soil-transmitted helminths begin to emerge. STH have been documented as causing impairment of growth and nutrition. The hookworms damage the intestinal mucosa leading to bleeding, loss of iron and anemia. Infections by *Trichuris trichiura* produce chronic reduction of food intake. During pregnancy, mild or severe infections with hookworms can cause anemia to the mother and damage to the fetus, leading to low birth weight. In areas where helminths are common, deworming activities can be done once or twice per year to the population at risk (without access to improved sanitation facilities), including deworming for pregnant women after the first trimester. Deworming during pregnancy also has been found useful to reduce severe maternal anemia, increasing birth weight and reducing infant mortality.

There is now evidence that clearly demonstrates that regular treatment of helminth

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[3] WHO. Preventive chemotherapy in human helminthiasis: coordinated use of anthelminthic drugs in control interventions: a manual for health professionals and programme managers. Geneva, 2006.

[4] Peter J. Hotez, Donald A. P. Bundy, Kathleen Beegle, Simon Brooker, Lesley Drake, Nilanthi de Silva, Antonio Montresor, Dirk Engels, Matthew Jukes, Lester Chitsulo, Jeffrey Chow, Ramanan Laxminarayan, Catherine M. Michaud, Jeff Bethony, Rodrigo Correa–Oliveira, Xiao Shu–Hua, Alan Fenwick, and Lorenzo Savioli, "Helminth Infections: Soil–Transmitted Helminth Infections and Schistosomiasis." 2006. *Disease Control Priorities in Developing Countries (2nd Edition),ed.* , 467-482. New York: Oxford University Press. DOI: 10.1596/978-0-821-36179-5/Chpt-24.

infections produces both immediate and long-term benefits, contributing significantly to the growth and development of the affected individuals, especially children.

The most striking epidemiological features of human helminth infections are aggregated distributions in human communities, predisposition of individuals to heavy (or light) infection, rapid reinfection following chemotherapy, and age-intensity profiles that are typically convex (with the exception of hookworms). As a rule, 20 percent of the host population harbors approximately 80 percent of the worm population. This over dispersion has many consequences, both with regard to the population biology of the helminths and the public health consequence for the host, because heavily infected individuals are simultaneously at the highest risk of disease and constitute the major source of environmental contamination. One feature that may help explain over dispersion is that individuals tend to be predisposed to heavy (or light) infections[5].

To know the geographical distribution of neglected tropical diseases it is necessary to understand the distribution of each of the diseases, to identify areas with overlapping and to focalize areas for integrated interventions (preventive chemotherapy, health education, water and sanitation, etc.). The epidemiological distribution of some neglected tropical diseases is well known in Latin America and the Caribbean countries (LAC) (e.g. Lymphatic filariasis and onchocerciasis), however the distribution of schistosomiasis and soil-transmitted helminths is less well mapped.

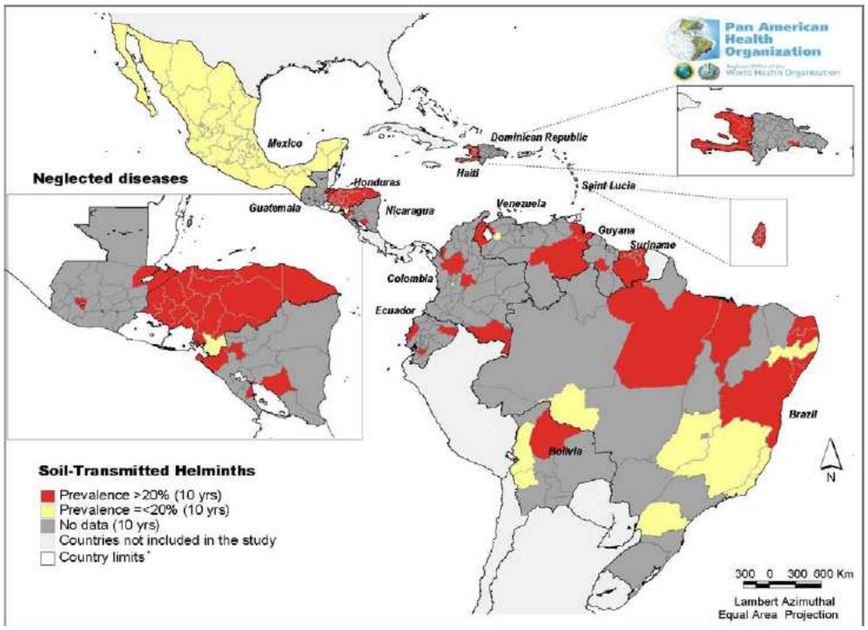
In 2009 PAHO published the epidemiological profiles of NTDs in LAC as an initiative to do advance towards the mapping of NIDs. This document showed data of STH prevalence from 526 studies reviewed in the Region at first subnational administrative level. The main findings regarding STH were: 1) Only 8 of 35 countries had recently completed national level parasitological surveys (principally prevalence studies) for STH between 2002-2006, with the following prevalence ranges at the first administrative level: Argentina 9.0-38.7%; Belize: 43.6-52.2%; Brazil: 2-36%, Haiti: 15-87%; Honduras: 12.2-97%, México: 0.01-16.3%, Nicaragua 27-80% and Venezuela: 3-19%. Of them, only Venezuela and México reported prevalence under 20%. 2) For the other countries, point-prevalence studies have been carried out in several places, with the following prevalence ranges: Bolivia: 4.5-65.4%, Colombia: 10.7-49.3%, Cuba: 4.5-47.3%, Dominican Republic: 5.3-55.3%; Ecuador: 28.5-71%, Guatemala: 12.7-68%, Guyana: 12.3-38%, Peru: 1.8-80.4%, Saint Lucia: 35-45%, Suriname: 36-43%.[6] In this document data were analyzed at country level and mapping gaps and needs were evidenced

[5] Disease Control Priorities in Developing Countries. Peter J. Hotez, Donald A. P. Bundy, Kathleen Beegle, and others. Helminth Infections: Soil-Transmitted Helminth Infections and Schistosomiasis

[6] PAHO. Epidemiological profiles of neglected diseases and other infections related to poverty in Latin America and the Caribbean. 2009, Washington, DC. Available at (include link to website).

especially in some countries without reports or data published regarding STH prevalence (See Fig. 1).

Figure 1. Prevalence of soil-transmitted helminths according to existing studies, LAC, 1998-2007.



Source: PAHO/HSD/CD. Soil-Transmitted Helminths Prevalence Database. Washington, DC: PAHO; 2008. Unpublished.

In 2001, the World Health Assembly through Resolution WHO/54.19, urged all Member States where soil-transmitted helminthiases are endemic to attain “a minimum target of regular administration of chemotherapy to at least 75% and up to 100% of all SAC at risk of morbidity by 2010”.

On October 2009 PAHO’s Directing Council approved the Resolution CD49.R19 which expresses the commitment of PAHO’s member States for the elimination or reduction of neglected diseases and other infectious diseases to certain levels such as these diseases are no longer considered public health problems by the year 2015, and help to achieve the Millennium Development Goals - MDG 1 and MDG 6 related to health, amongst other MDGs.[7]

In the PAHO Resolution two groups of NIDs were defined: Group 1: ten diseases that have a greater potential for being eliminated with available cost-effective interventions (Chagas disease [domestic vector borne-transmission], congenital syphilis, human rabies transmitted by dogs, leprosy, lymphatic filariasis, malaria [in the island of la Hispaniola, in Central America and in Southern Cone], neonatal tetanus, onchocerciasis, plague and

[7] PAHO. Resolution CD49.R19. Elimination of neglected diseases and other poverty - related infections. October 2009.

trachoma) and Group 2: two diseases whose prevalence can be drastically reduced with available cost-effective interventions (schistosomiasis and soil-transmitted helminthiases). Regarding STH the following goals to be reached by 2015 were defined: to reduce prevalence among SAC in high risk areas (prevalence >50%) to less than 20% prevalence as measured by quantitative egg count[8].

One of the main strategies to reduce the prevalence of STH in PSAC and SAC population is preventive chemotherapy through mass drug administration of deworming drugs in areas with population at risk (without access to improved sanitation facilities) and with prevalence values between >20 and 50% (once per year) or >50 (twice per year); otherwise the treatment is indicated as an individualized intervention.

In LAC there are 13 million of PSAC and 32 million of SAC at risk of suffering soil-transmitted helminth infections[9]. However, it is necessary to know the values of prevalence and intensity of infection of STH at second administrative level in order to focus the deworming activities as well as other important interventions to reduce the burden of morbidity due to STH infections.

2. Objectives

2.1. General objective

To map the prevalence and intensity of infection by soil-transmitted helminths for pre-school and school-age children in Latin America and the Caribbean countries (LAC) at the second subnational administrative level.

2.2. Specific objectives

- To obtain information regarding prevalence and intensity of STH infections at second administrative level (municipalities) for LAC in the period 2000-2010 based on the review of papers published in databases such as MEDLINE, LILACS, BIREME, the Cochrane library, the websites of Ministries of Health (MoH), websites of PAHO's country offices and websites of NGOs which have reported deworming activities in LAC since 2005.
- To map the prevalence and intensity of STH infections at second administrative level to advance the epidemiological profiles for Neglected Infectious Diseases in LAC, as a

[8] PAHO. Resolution CD49.R19. Elimination of neglected diseases and other poverty - related infections. October 2009.

[9] The estimation of PSAC and SAC population at risk was made by PAHO based on the number of total population by country and by age group (UN population databases, Rev. 2008), and applying the percentage of population without access to improved sanitation facilities by country reported in the Health Situation in the Americas: Basic indicators, 2009.

tool to support countries to focalize deworming and other interventions at the local level (i.e. sanitation, health education, etc.).
- To identify gaps on STH mapping in LAC countries and to identify priority areas for implementation of deworming activities.

3. Methodology

3.1. Study design

A cross-sectional descriptive study of prevalence and intensity of infection of STH for 2000-2010 in LAC was designed based on bibliographic review of papers published for this time period. Data were restricted to two age groups only: pre-school (1-4 years old) and school-age children (5-14 years old).

3.2. Information sources

Online databases of scientific medical literature from MEDLINE (through PubMed's website), LILACS (including SciELO), BIREME, the Cochrane Library, the websites of Ministries of Health, websites of PAHO country offices and websites of NGOs (that have reported deworming activities in LAC since 2005) were searched for papers published in the last 10 years in LAC (2000-2010). Papers in French, English, Spanish and Portuguese with free online access for the full text were included. However, when abstracts were found for countries or areas without information on STH surveys and the paper in full text was not available online, the main author was contacted to obtain a full text copy. Some papers were purchased from the publisher when they were considered as having relevant information for the study objectives, and whenever it was not possible to have a free full text version.

The searches were made using terms used by health libraries. All searches were restricted for studies in humans and for the period 2000-2010.

The following Mesh terms and subheadings were used for searches on PubMed:

(("Helminthiasis"[Mesh] OR ("Helminthiasis/epidemiology"[Mesh] OR "Helminthiasis/parasitology"[Mesh] OR "Helminthiasis/statistics and numerical data"[Mesh]))) AND ("Child"[Mesh] OR ("Child/epidemiology"[Mesh] OR "Child/statistics and numerical data"[Mesh]))

The following terms were also used for searches in PubMed to recover more papers:

- 'Prevalence intestinal parasites child' restricted by country, sub-regions in LAC (Central American Isthmus, Latin Caribbean, Andean area, Southern cone, Not-Latin Caribbean) and study year publication.

- 'Soil transmitted helminths prevalence' restricted by country, sub-regions in LAC (Central American Isthmus, Latin Caribbean, Andean area, Southern cone, Not-Latin Caribbean) and study year publication.
- '*Ascaris lumbricoides* or *Trichuris Trichiura* or hookworms or *Necator Americanus* or *Ancylostoma Duodenale*' by country, sub-regions in LAC (Central American Isthmus, Latin Caribbean, Andean area, Southern cone, Not-Latin Caribbean) and study year publication.

For searching papers in BIREME and LILACS databases, the following terms were used additionally:

- "Helminthiasis" AND "prevalence" by country and LAC
- "Intestinal parasites" AND "prevalence" by country and LAC

Once the papers were recovered, a copy was saved copy in Acrobat Reader® or in Microsoft Word® format.

Where surveys had been carried out in several areas within a country, department/state or municipality and the results were presented in a geographical disaggregated manner, these data were treated separately rather than as a single data set. Data on prevalence are usually presented in the form of a percentage, with values ranging from 0 to 100.

Additionally, the percentages of intensity of infection were registered when the study presented these data, by geographical disaggregation, parasite species and age group. The intensity of infection was registered also by intensity levels as defined by WHO guidelines (heavy, moderate and light)[10] (Table 1).

Table 1. Thresholds for intensity of infection by STH species.

Helminth	Intensity of infection threshold		
	Light	Moderate	Heavy
A. lumbricoides	1-4,999 epg	5,000-49,999 epg	≥50,000 epg
T. trichiura	1-999 epg	1,000-9,999 epg	≥10,000 epg
Hookworms	1-1,999 epg	2,000-3,999 epg	≥4,000 epg

Source: WHO. Helminth control in school-age children: a guide for managers of control programmes, 2002, Geneva.

[10] WHO. Helminth control in school-age children: a guide for managers of control programmes, 2002, Geneva.

3.3. Variables

A database in Microsoft Excel ® with a set of variables described in the Table 2 was created.

Table 2. Definition of variables included into the database for prevalence and intensity of infection of STH, 2000-2010.

Variable	Type of Variable	Definition
Identification number	Nominal	Sequence number assigned by data registered
Country name	Nominal	Complete country name
Country name code	Nominal	Acronym by country under PAHO denomination
First administrative level	Nominal	Complete name of first administrative level within each country according with the denomination by country
First administrative level code	Nominal	Serial code (letters and numbers) assigned by country for each first administrative level
Second administrative level	Nominal	Complete name of second administrative level within each country according with the denomination by country
Second administrative level code	Nominal	Serial code (letters and numbers) assigned by country for each second administrative level
Municipality name	Nominal	Complete municipality name where study was conducted.
Locality name	Nominal	Complete locality name where study was conducted. When the study was conducted in a specific community or place (school, hamlet, indigenous territories, etc.) the municipality name was completed with denomination established in the paper.
Latitude	Continuous numerical variable	The angular distance north or south of the earth's equator, measured in degrees along a meridian, as on a map or globe. When latitude was not reported within the paper, this measure was calculated with Google Maps® tools by each specific community or place and municipality name.
Longitude	Continuous numerical variable	The angular distance on the earth's surface measured along any latitude line such as the equator east or west of the prime meridian. When longitude was not reported within the paper, this measure was calculated with Google Maps® tools by each specific community or place and municipality name.
Sample size	Discrete numerical variable	Number of children included within each study by age group
Cumulative prevalence of STH infections (referred in this study as prevalence of STH)	Continuous numerical variable	Prevalence of infection with at least one STH, expressed as percentage of infected individual with any helminth (*Ascaris lumbricoides*, *Trichuris trichiura*, Hookworms: *Necatur americanus* and *Ancylostoma duodenale*). This variable was filled at second administrative level.
Prevalence of infection by helminths species	Continuous numerical variable	Percentage of infected individuals with each helminths species in a population. This variable was filled at second administrative level.
Age group	Ordinal	The age variable was divided within three categories: 1) Pre-school age children-PSAC (1-4 years old), 2) School age children-SAC (5-14 years old), and 3) 1-14 years old. When the paper did not have data

Variable	Type of Variable	Definition
		differentiated by PSAC and SAC, data were registered as 1-14 years old.
Parasitic species	Nominal	It was created an acronym by parasitic specie: AL: *Ascaris lumbrocoides,* TT: *Trichuris trichiura*, HW: Hookworms (includes *Necator Americanus* and *Ancylostoma duodenale)*, NA: *Necator Americanus* and AD: *Ancylostoma duodenale*.
Intensity of infection	Ordinal	The intensity of infection is a measure of the number of worms infecting an individual. The intensity of infection was registered by parasitic species as light, moderate and heavy. This variable was filled at second administrative level.
Year of study	Discrete numerical variable	Data for prevalence and intensity of infection were registered within the database according to the year in which the study was carried out, not to the year of study publication.

3.4. Inclusion criteria for papers:

The inclusion criteria of data regarding prevalence and intensity of infection of STH were the following:

- Studies carried out at second administrative level (municipalities) in LAC in the period 2000-2010.
- Studies with data of prevalence of STH disaggregated by age group, especially if the study also included adults (>18).
- Studies reporting total prevalence of STH or prevalence by STH species or intensity of infection by species.
- Studies in children without eosinofilia. The eosinophilia could cause overestimation of prevalence data by age group.
- There were no restrictions for sample size.

If a paper published in the period 2000 – 2010 included data of samples taken before 1995, the paper was not included. When the report of intensity of infection did not meet the WHO parameters by species[11], theses data were not included.

3.5. Analysis of information

Organization of data

Register of papers: A Microsoft Excel® file was organized, following the Vancouver guidelines established by the International Committee of Medical Journal Editors, in order to have a bibliographic database of papers found for this study. Each paper was named by identification code (country acronyms, year of study and last name of the

[11] WHO. Helminth control in school-age children. A guide for managers and control programmes, 2002. Geneva

main author). Files of papers were organized by country and year, and the papers were organized by files making differentiation between included and excluded papers.

Data entry of prevalence and intensity of infection of STH: A Microsoft Excel® file was organized including the variables described within Table 2. By country, data entry was made according with the data found in each paper. When the paper reported data from more than one place, community or municipality, the data were entered for each place included in the study. This is the reason why the number of data within the study is bigger than the number of papers included.

For each paper, data were registered for the year in which the study was developed and not by year of study publication. Although papers published between 2000 and 2010 were searched, data were found from studies made before 2000. In this case it was decided to include data since 1995. For papers without specific information about year of study, the year of publication was recorded. Data for 2010 were not found because the studies were made before the year of the paper's publication. This explains why the results will be presented for the time period 1995-2009.

Data for prevalence and intensity of infection of STH were registered by age group, PSAC and SAC respectively. If the study did not include data disaggregated for PSAC and SAC population, data were registered for the 1-14 years old age group only if that data were at least presented for children under 18 years old.

In cases in which the studies did not report the prevalence of STH but reported prevalence of helminths (nematodes, cestodes and trematodes), this last data was assumed as prevalence of STH. If the study only reported prevalence of intestinal parasites in general, these data were not assumed as prevalence of STH because they included parasites other than just helminths. If the study only reported prevalence values by species of STH but not prevalence of STH, the highest prevalence among species of STH was registered as prevalence of STH, taking into account that for the study purposes it was important to know the high risk areas that require deworming activities.

When the studies reported prevalence or intensity of infections by STH measured before and after some interventions (e.g. deworming, health education, personal hygiene, etc.), data were registered before the specific intervention mentioned within the study (baseline data). This assumption was also applied if the study included comparisons between two or more communities (with or without intervention); in these cases baseline data for the communities included.

Plan of analysis

A descriptive analysis of papers included within the bibliographic review was made. The mapping and analysis of prevalence and intensity of infection of STH was divided into 7 sub-regions of LAC (Mexico, Central American Isthmus, Latin Caribbean, Andean Area, Brazil, Southern Cone and Non Latin Caribbean) and by age group. A group of maps were created by sub-region, showing prevalence and intensity of infection of STH by age group at local level for data registered between the period 2000-2010. Statistical analysis and mapping was performed using Microsoft Excel® and Tableau 6.0® software.

The following prevalence ranges were defined for mapping: under 1%, 1-10%, >10% - 20%, >20% - 50% and >50%. These parameters were defined according to current guidelines for decision making in order to identify the number of doses per year for deworming needed at local level. The mapping information on the Global Atlas of Helminth Infections (An open-access information resource on the distribution of soil-transmitted helminths and schistosomiasis) was also reviewed in order to use the same range of prevalence and to facilitate the comparisons of data between world regions and countries.[12]

4. Outcomes

4.1. Papers included for analysis: 120 papers, 18 countries

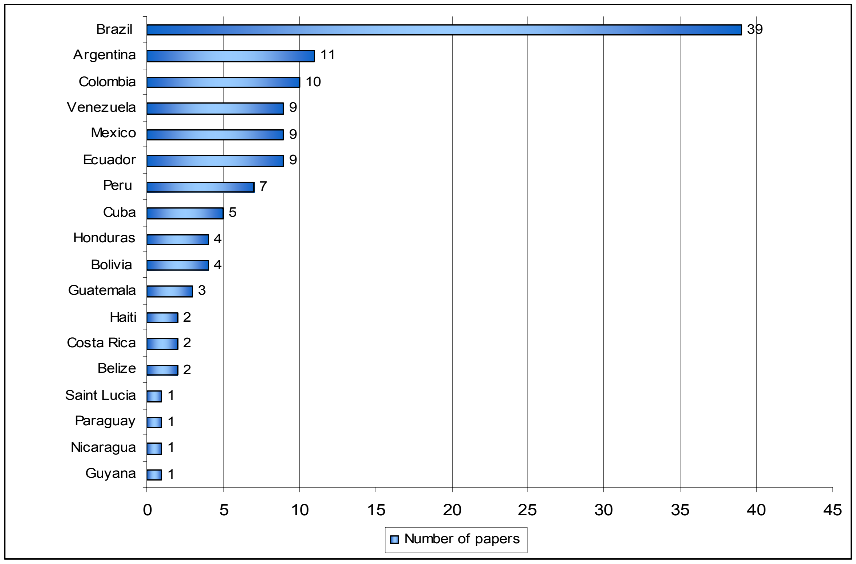
In total 236 papers were found in the review, which included papers for 28 countries in LAC; however, after filtering by inclusion criteria, 120 papers were included within the database for subsequent analysis. In total, information was registered for 18 countries in LAC that correspond to 1,022 data (including prevalence and intensity of infection of STH). These countries were Argentina, Belize, Bolivia, Brazil, Colombia, Costa Rica, Cuba, Ecuador, Guatemala, Guyana, Haiti, Honduras, Mexico, Nicaragua, Paraguay, Peru, Saint Lucia and Venezuela. As was explained in the methodology chapter, the period for this review was 2000-2010; however it was the year in which the study was developed that was registered. As a consequence data since 1995 were registered.

The higher number of papers included within the database was from Brazil with 39.5% (39 papers). For some countries as Saint Lucia, Paraguay, Nicaragua and Guyana only one paper was found and included for each one (Fig. 2).

It is important to note that data for 2010 were not found, because the papers published in 2010 were from studies developed years before their publication.

[12] GAHI, Global Atlas of Helminth Infections. Available on: http://www.thiswormyworld.org/, Consulted October – November 2010.

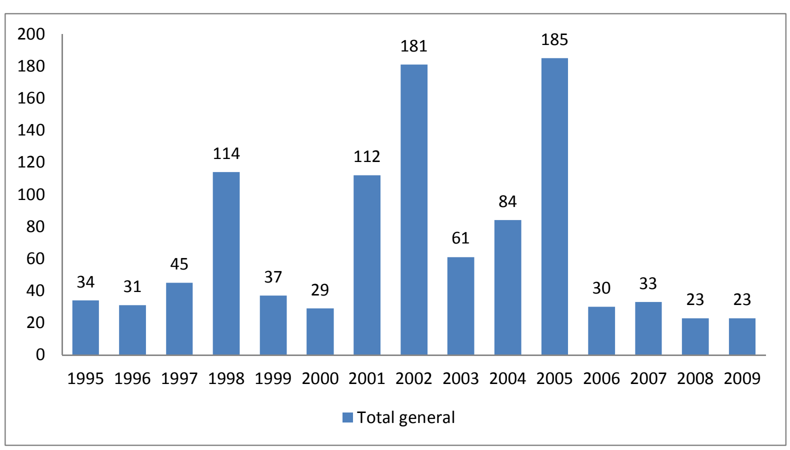
Figure 2. Papers with data for prevalence and intensity of infection of STH included by country in LAC, 2000-2010.



4.2. Data of prevalence and intensity of infection of STH included in this study

As mentioned before, 1022 data for prevalence and intensity of infection of STH were obtained from 120 papers included in the database of prevalence of STH at second administrative level for LAC in the period 2000-2010, and data by age group and species of STH were recorded. The annual distribution of data published in this period shows three peaks: 1998 (114 data), 2002 (181 data) and 2005 (185 data); together these three years represent 47% of the data in the database. An important decrease of data published for prevalence and intensity of infection of STH in LAC was observed since 2006 (Fig. 3).

Figure 3. Number of data included by year for prevalence and intensity of infection by STH, 1995-2009.



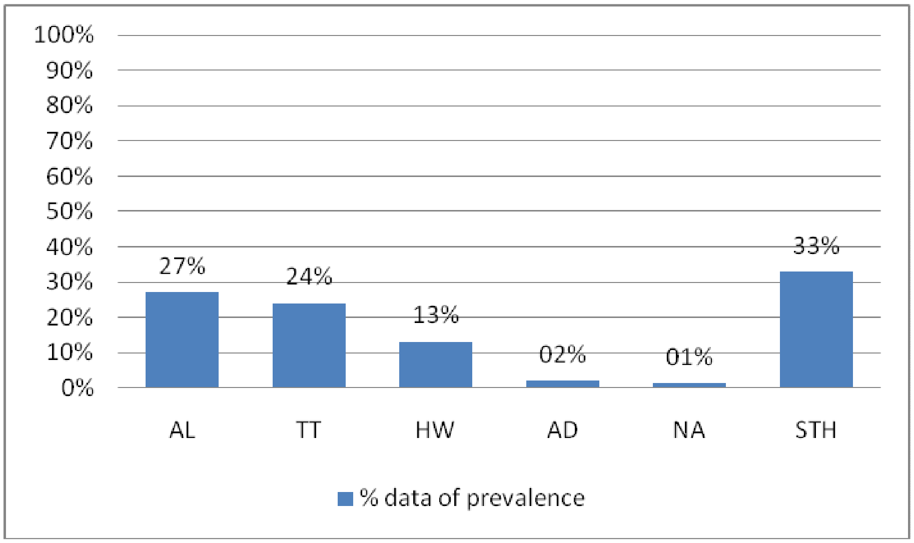
Of the total number of data, 335 (32.8%) data were found for prevalence of STH and 687 for prevalence by species; 27% for *Ascaris lumbricoides*, 23.9% for *Trichuris trichiura*, 13.1% for hookworms, 1.3% for *Necator americanus* and 1.95% for *Ancylostoma duodenale* (Table. 3, Fig 4). As part of this study was data for prevalence and intensity of *Strongyloides stercoralis* infections were registered. However, these data were not included on this analysis because they will be included in future reports.

Table 3. Number of data for prevalence of STH and prevalence by species of STH included in the review, 1995-2009.

Year	AL	TT	HW	AD	NA	STH	Total	%
1995	10	7	5	1	1	10	**34**	**3.3**
1996	8	8	4	3		8	**31**	**3**
1997	14	13	2	2		14	**45**	**4.4**
1998	36	36	5	1		36	**114**	**11.1**
1999	10	7	10			10	**37**	**3.6**
2000	10	4	3	1		11	**29**	**2.8**
2001	30	28	20	4		30	**112**	**10.9**
2002	46	47	30	1	10	47	**181**	**17.7**
2003	21	15	2	2		21	**61**	**5.9**
2004	23	19	18			24	**84**	**8.2**
2005	38	34	26	1	1	85	**185**	**18.1**
2006	9	7	1	4		9	**30**	**2.9**
2007	6	6	8		1	12	**33**	**3.2**
2008	7	6				10	**23**	**2.2**
2009	8	7				8	**23**	**2.2**
Total	**276 (27%)**	**244 (23.9%)**	**134 (13.1%)**	**20 (1.9%)**	**13 (1.3%)**	**335 (32.8%)**	**1022**	

AL: *Ascaris lumbricoides*, TT: *Trichuris trichiura,* HW: *Hookworms*, AD: *Ancylostoma duodenale*, NA: N*ecator americanus*, STH: Soil-transmitted helminths.

Figure 4. Percentage of data for prevalence of STH by species included in the 1995-2009 review in LAC



AL: *Ascaris lumbricoides*, TT: *Trichuris trichiura,* HW: *Hookworms*, AD: *Ancylostoma duodenale*, NA: N*ecator americanus*, STH: Soil-transmitted helminths.

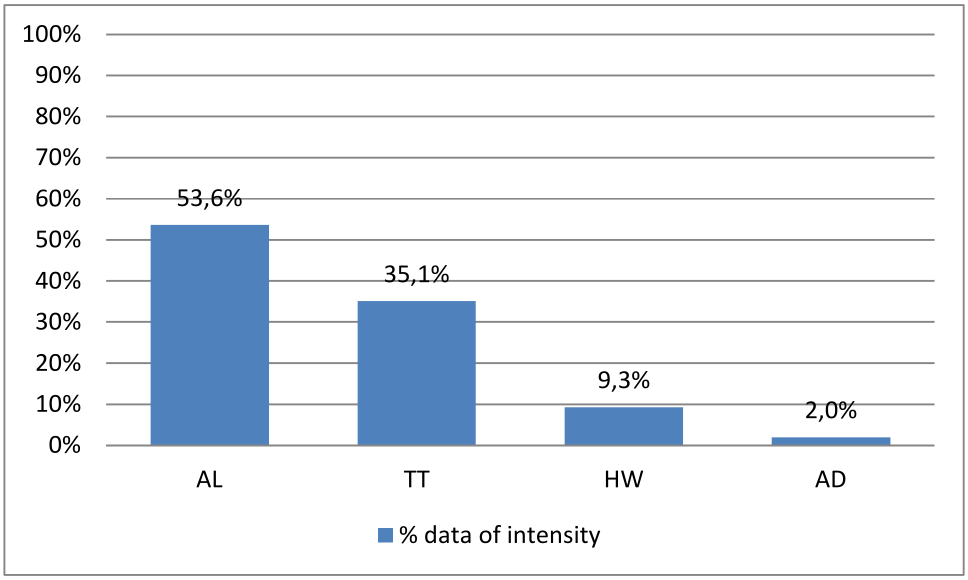
It was also possible to find 151 data for intensity of infection by species of STH; however since 2006 no published data were found for intensity of infection at second administrative level; 39.7% of these data were produced in 1998 (60 data); the highest number of data for intensity of infections by species was found for *Ascaris lumbricoides* (81 data: 53.6%) followed by *Trichuris trichiura* (53 data: 35.1%) (Table 4, Fig. 5).

Table 4. Number of data found for intensity of infection by species of STH included in the review, 1995-2009.

Year	AL	TT	HW	AD	Total	%
1996	3				**3**	**1.9**
1997	18	17			**35**	**23.1**
1998	36	24			**60**	**39.7**
1999	3	3	3		**9**	**5.9**
2001	3	1	1		**5**	**3.3**
2003	6	6		3	**15**	**10**
2004	9		9		**18**	**11.9**
2005	3	2	1		**6**	**3.9**
Total	**81 (53.6%)**	**53 (35%)**	**14 (9.3%)**	**3 (1.9%)**	**151**	

AL: *Ascaris lumbricoides*, TT: *Trichuris trichiura,* HW: *Hookworms*, AD: *Ancylostoma duodenale*, NA: N*ecator americanus*.

Figure 5. Proportion of data for intensity of infection of STH included in the review, 1995-2009 in LAC



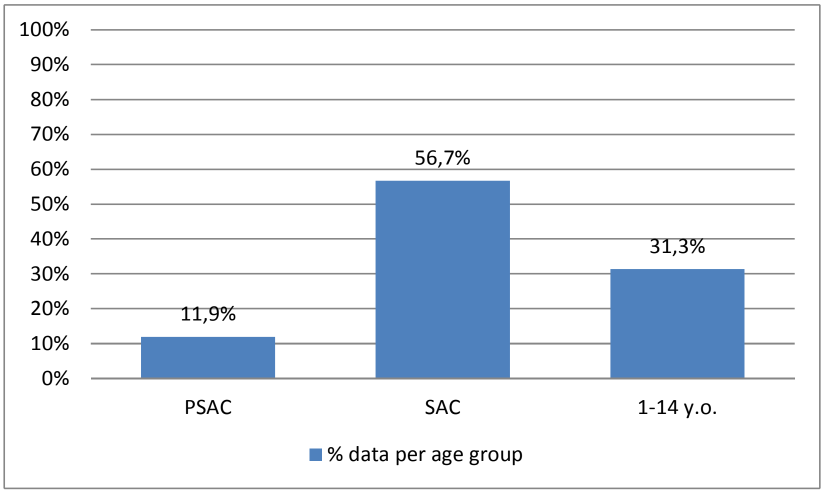
AL: *Ascaris lumbricoides*, TT: *Trichuris trichiura,* HW: *Hookworms*, AD: *Ancylostoma duodenale*.

Of the 335 data for prevalence of STH, data for SAC were found the most frequent (190 data: 56.7%), predominantly in 1998, 2002 and 2005. This distribution is similar when the analysis was made for the age group 1-14 years old with a difference only in 2001. The scarcity of data for prevalence of STH in the PSAC population is highlighted. (Table 5, Fig. 6).

Table 5. Number of data for prevalence of STH by age group included in the review, 1995-2009.

Year	PSAC	SAC	1-14	Total	%
1995	1	2	7	10	2.9
1996	3	3	2	8	2.4
1997		9	5	14	4.2
1998	6	22	8	36	10.7
1999	2	6	2	10	2.98
2000	1	5	5	11	3.3
2001	2	5	23	30	8.9
2002	5	36	6	47	14
2003	2	18	1	21	6.3
2004	6	11	7	24	6.8
2005	4	64	17	85	25.4
2006	1	2	6	9	2.7
2007	4	2	6	12	3.6
2008	3	4	3	10	2.9
2009		1	7	8	2.4
Total	**40 (11.9%)**	**190 (56.7%)**	**105 (31.3%)**	**335**	**100%**

Figure 6. Proportion of data for prevalence of STH by age group included in the review, LAC 1995-2009



The highest numbers of data for prevalence of STH were observed in Brazil (26.3%) and Honduras (19.7%) (Table 6). This is due the greater number of papers found for Brazil; in the case of Honduras although only 4 papers were found, these presented data for various municipalities, increasing the number of data for this country.

For PSAC the countries with more data published for prevalence of STH were Brazil (45%) and Honduras (17.5%); for SAC, Brazil (26.3%), Honduras (18.9%), Mexico (13.2%), Argentina (5.8%) and Haiti (5.8%); for children between 1-14 years old, Brazil (83.8%), Honduras (62.8%), Argentina (30.5%) and Mexico (26.6%) (Table 6).

The frequencies showed in Table 6 are affected by the number of papers found published by country.

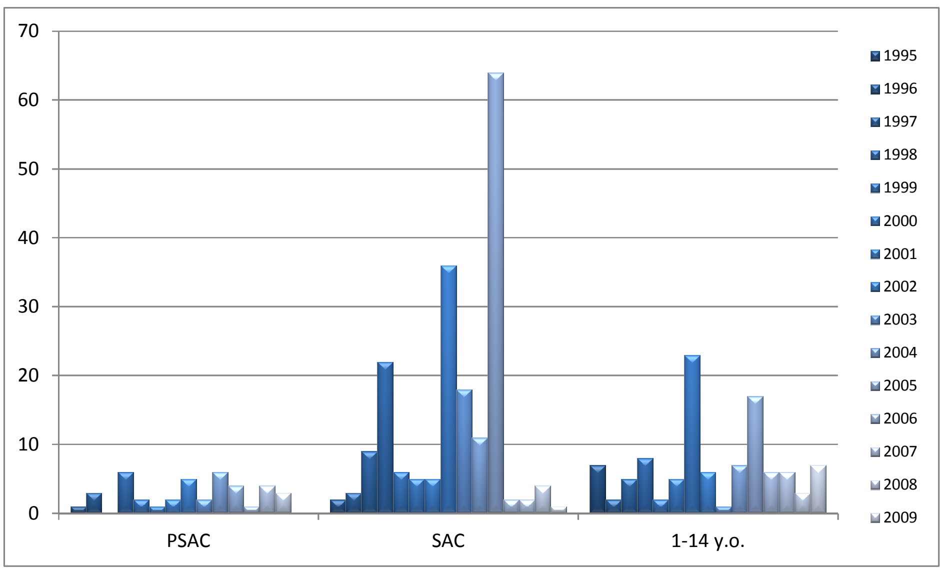
Table 6. Number of data for prevalence of STH by age group and country, included in the review, 1995-2009.

Country	PSAC	SAC	1-14	Total	%
Argentina	2	11	19	32	**9.6**
Belize	1	3	1	5	**1.5**
Bolivia	1	5	6	12	**3.6**
Brazil	18	50	20	88	**26.3**
Colombia	4	4	3	11	**3.3**
Costa Rica	1	1	2	4	**1.2**
Cuba	1	7	1	9	**2.7**
Ecuador	2	5	4	11	**3.3**
Guatemala		7	7	14	**4.2**
Guyana			1	1	**0.3**
Haiti		11	1	12	**3.6**
Honduras	7	36	23	66	**19.7**

Country	PSAC	SAC	1-14	Total	%
Mexico	1	25	2	28	**8.4**
Nicaragua		5		5	**1.5**
Paraguay		2		2	**0.6**
Peru		9	2	11	**3.3**
Saint Lucia			8	8	**2.4**
Venezuela	2	9	5	16	**4.8**
Total	**40**	**190**	**105**	**335**	

Figure 7 shows the number of data for prevalence of STH by age group; it is clear that throughout time there have been more data published for the SAC population and less for PSAC.

Figure 7. Number of data for prevalence of STH by year and age group, included in the review, LAC 1995-2009.



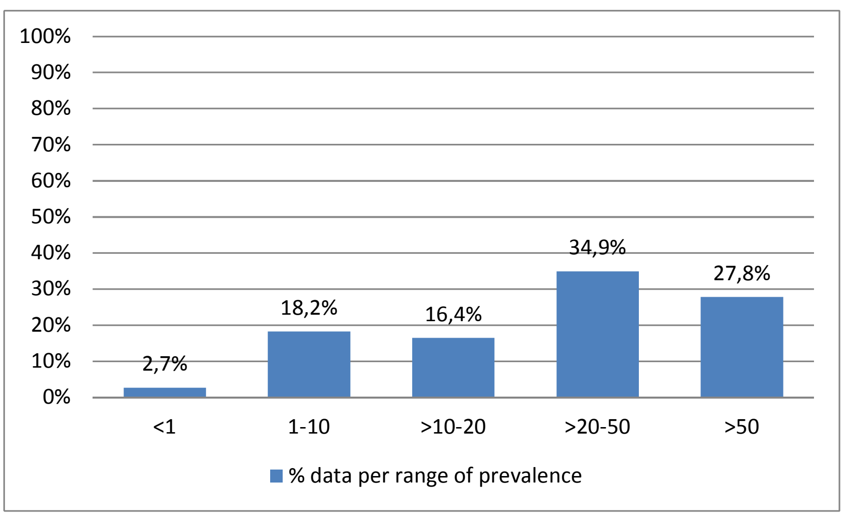
By country, data for prevalence of STH, analyzed by ranges, showed that 34.9% (117 data) and 27.8% (93 data) of the data were between >20-50% and above 50%, respectively. This means that 62.7% of the data reviewed showed prevalences of STH above 20% (Table 7, Fig. 8).

The countries with the higher number of data for prevalence of STH between >20-50% were Honduras (26 data), Brazil (25), Mexico (11) and Haiti (10); and with data >50% were Honduras (29) and Brazil (19); also it is remarkable that for Belize, Ecuador, Guatemala, Honduras, Mexico and Venezuela 35% or more of their prevalence of STH data were above of 50% (Table 7).

Table 7. Number of data by ranges of prevalence of STH, LAC 1995-2009.

Country	<1		1-10		>10-20		>20-50		>50		Total
	N	%	N	%	N	%	N	%	N	%	N
Argentina	1	3.1	6	18.8	7	21.9	7	21.9	11	34.4	**32**
Belize							2	40	3	60	**5**
Bolivia			3	25	6	50	2	16.6	1	8.3	**12**
Brazil	5	5.9	21	23.9	18	20.5	25	28.4	19	21.6	**88**
Colombia	1	9	7	63.6			3	27.3			**11**
Costa Rica							4	100			**4**
Cuba	1	11.1	3	33.3	2	22.2	3	33.3			**9**
Ecuador			1	9	1	9	4	36.4	5	45.5	**11**
Guatemala					1	7.1	8	57	5	35.7	**14**
Guyana							1	100			**1**
Haiti							10	83.3	2	16.7	**12**
Honduras			3	4.5	8	12.1	26	39.4	29	43.9	**66**
Mexico	1	3.6	5	17.9	1	3.6	11	39.3	10	35.7	**28**
Nicaragua					2	40	2	40	1	20	**5**
Paraguay			2	100							**2**
Peru			3	27.3	2	18.2	5	45.4	1	9	**11**
Saint Lucia			3	37.5	4	50	1	12.5			**8**
Venezuela			4	25	3	18.8	3	18.8	6	37.5	**16**
Total	**9**		**61**		**55**		**117**		**93**		**335**

Figure 8. Proportion of data by ranges of prevalence of STH, included in the review in LAC 1995-2009



Data were also obtained for prevalence of STH disaggregated by age group and species of STH. The higher number of data was for SAC (55.7%) and children between 1-14 years (32.3%). By species of STH more data for prevalence of *Ascaris lumbricoides* (276 data, 27%) were found, followed by data for *Trichuris trichiura* (244 data, 23.9%) and hookworms (134 data, 13.1%). For *Ancylostoma duodenale* and *Necator americanus* 20 (2.0%) and 13 data (1.3%) were found, respectively, in this review (Table 8). The proportion of data by species of STH between age groups was similar (32% for PSAC, 33% for SAC and 31.8% for children between 1-14 years old), the data for prevalence of STH being highest, followed by the data of prevalence of *A. lumbricoides* and *T. trichiura* (Fig. 9).

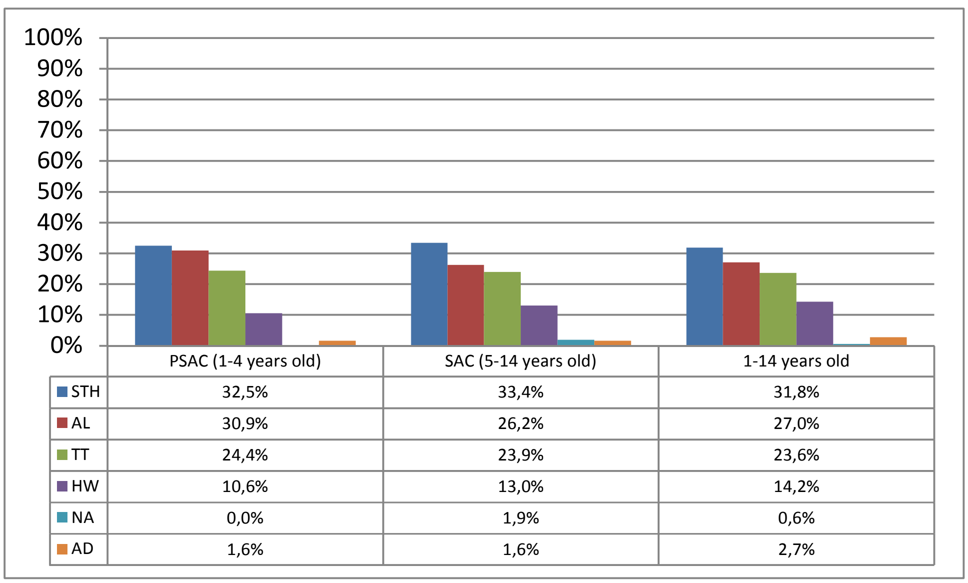
Table 8. Number of data for prevalence of STH by age group, year and species, included in the review, LAC 1995-2009.

Age Group	Year	AL	TT	HW	AD	NA	STH	Total	%
PSAC (1-4 years old)	1995	1	1	1			1	4	**3.3**
	1996	3	3	1	1		3	11	**8.9**
	1998	6	6				6	18	**14.6**
	1999	2	1	2			2	7	**5.7**
	2000	1					1	2	**1.6**
	2001	2	2		1		2	7	**5.7**
	2002	5	5	1			5	16	**13.0**
	2003	2	1				2	5	**4.1**
	2004	6	5	4			6	21	**17.1**
	2005	4	2	2			4	12	**9.8**
	2006	1	1				1	3	**2.4**
	2007	3	2	2			4	11	**8.9**
	2008	2	1				3	6	**4.9**
	Subtotal	**38**	**30**	**13**	**2**		**40**	**123**	
SAC (5-14 years old)	1995	2	1	1			2	6	**1.1**
	1996	3	3	2	1		3	12	**2.1**
	1997	9	9	1	2		9	30	**5.3**
	1998	22	22	5			22	71	**12.5**
	1999	6	5	6			6	23	**4.0**
	2000	4	3	1			5	13	**2.3**
	2001	5	3	3	2		5	18	**3.2**
	2002	36	36	24	1	10	36	143	**25.1**
	2003	18	13	2	2		18	53	**9.3**
	2004	11	9	9			11	40	**7.0**
	2005	26	25	18	1	1	64	135	**23.7**
	2006	2	2	1			2	7	**1.2**
	2007	1	1	1			2	5	**0.9**
	2008	3	3				4	10	**1.8**
	2009	1	1				1	3	**0.5**
	Subtotal	**149**	**136**	**74**	**9**	**11**	**190**	**569**	
1-14 years old	1995	7	5	3	1	1	7	24	**7.3**
	1996	2	2	1	1		2	8	**2.4**
	1997	5	4	1			5	15	**4.5**
	1998	8	8		1		8	25	**7.6**
	1999	2	1	2			2	7	**2.1**
	2000	5	1	2	1		5	14	**4.2**

Age Group	Year	AL	TT	HW	AD	NA	STH	Total	%
	2001	23	23	17	1		23	87	**26.4**
	2002	5	6	5			6	22	**6.7**
	2003	1	1				1	3	**0.9**
	2004	6	5	5			7	23	**7.0**
	2005	8	7	6			17	38	**11.5**
	2006	6	4		4		6	20	**6.1**
	2007	2	3	5		1	6	17	**5.2**
	2008	2	2				3	7	**2.1**
	2009	7	6				7	20	**6.1**
	Subtotal	**89**	**78**	**47**	**9**	**2**	**105**	**330**	
Total		**276**	**244**	**134**	**20**	**13**	**335**	**1022**	

AL: *Ascaris lumbricoides*, TT: *Trichuris trichiura,* HW: *Hookworms*, AD: *Ancylostoma duodenale*, NA: N*ecator americanus*, STH: Soil-transmitted helminths.

Figure 9. Proportion of data published for prevalence of STH by age group and species, LAC 1995-2009



AL: *Ascaris lumbricoides*, TT: *Trichuris trichiura,* HW: *Hookworms*, AD: *Ancylostoma duodenale*, NA: N*ecator americanus*, STH: Soil-transmitted helminths.

151 data were published for intensity of infection for 7 countries (Argentina, Bolivia, Brazil, Colombia, Ecuador, Honduras and Venezuela). Of these data 37.1% showed a light intensity of infection, 34.4% moderate and 28.5% heavy. The bigger number of data published was for Honduras (41.7%), followed by Bolivia and Brazil each one with 15.9% (Table 9).

Table 9. Number of data for intensity of infection of STH by threshold, included in the review, 1995-2009.

Country	Light		Moderate		Heavy		Total
	N	%	N	%	N	%	N
Argentina		0		0	2	4,7	**2**
Bolivia	8	14,3	8	15,4	8	18,6	**24**
Brazil	9	16,1	8	15,4	7	16,3	**24**
Colombia	3	5,4	3	5,8	3	7	**9**
Ecuador	2	3,6	2	3,9	5	11,6	**9**
Honduras	27	48,2	24	46,2	12	27,9	**63**
Venezuela	7	12,5	7	13,5	6	13,9	**20**
Total	**56**	**100**	**52**	**100**	**43**	**100**	**151**

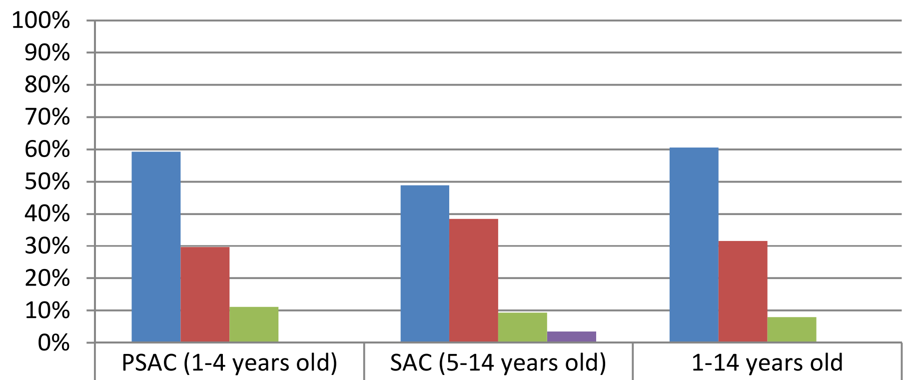
The distribution by age group of the 151 data found for intensity of infection, shows that 27 data were found for PSAC (17.8%), 86 for SAC (56.9%) and 38 for 1-14 years old (25.1%). By species of STH the higher number of data for intensity of infection were found for *Ascaris lumbricoides* (81 data, 53.6%) and for *Trichuris trichiura* (53 data, small a 35.1%), while no data were found for *Necator americanus* (Table 10, Figure 10).

Table 10. Number of data of intensity of infection by species of STH, year and age group, LAC 1995-2009.

Age Group	Year	AL	TT	HW	AD	Total
PSAC (1-4 years old)	1996	1				1
	1998	12	8			20
	2004	3		3		6
	Subtotal	**16**	**8**	**3**		**27**
SAC (5-14 years old)	1996	1				1
	1997	18	17			35
	1998	12	8			20
	1999	3	3	3		9
	2001	1	1	1		3
	2003	4	4		3	11
	2004	3		3		6
	2005			1		1
	Subtotal	**42**	**33**	**8**	**3**	**86**
1-14 years old	1996	1				1
	1998	12	8			20
	2001	2				2
	2003	2	2			4
	2004	3		3		6
	2005	3	2			5
	Subtotal	**23**	**12**	**3**		**38**
Total		**81**	**53**	**14**	**3**	**151**

AL: *Ascaris lumbricoides*, TT: *Trichuris trichiura,* HW: *Hookworms*, AD: *Ancylostoma duodenale*, NA: N*ecator americanus*.

Figure 10. Proportion of data for intensity of infection by age group and species, 1995-2009 LAC

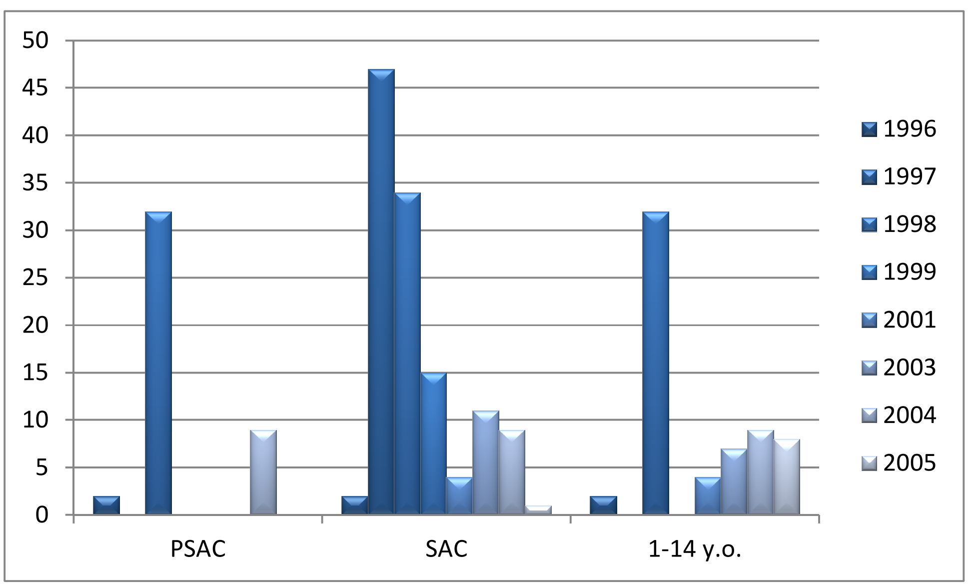


	PSAC (1-4 years old)	SAC (5-14 years old)	1-14 years old
AL	59,3%	48,8%	60,5%
TT	29,6%	38,4%	31,6%
HW	11,1%	9,3%	7,9%
AD	0,0%	3,5%	0,0%

AL: *Ascaris lumbricoides*, TT: *Trichuris trichiura,* HW: *Hookworms*, AD: *Ancylostoma duodenale*.

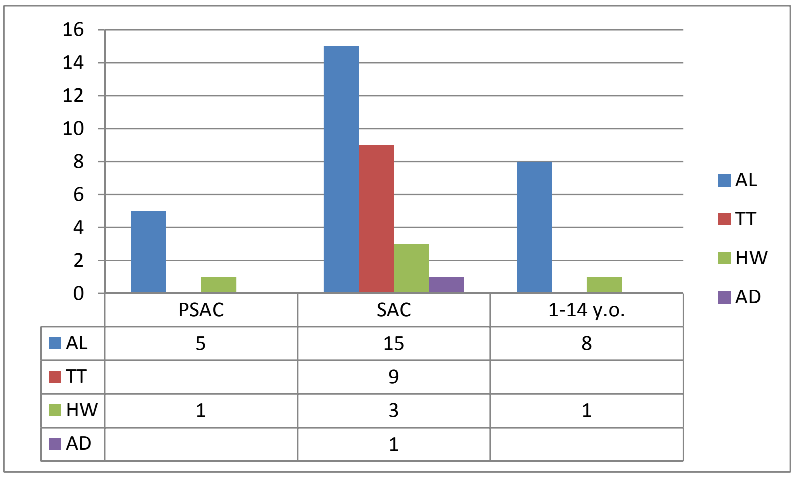
Figure 11 shows the number of data found for intensity of infection by year and age group for the period 1995-2009. Both the lack of information for PSAC population and the lack of information published since 2006 for all age groups for this specific indicator are evident.

Figure 11. Number of data for intensity of infection by year and age group, 1995-2009 LAC



As mentioned, of the 151 data included in this study for intensity of infection, 43 (28.5%) of the data showed heavy intensity; of these, 28 data (65.1%) were for *Ascaris lumbricoides* followed by 9 (20.9%) for *Trichuris trichiura*; the highest number of data for heavy intensity of infection was found for the SAC population (28.5%). Data of heavy intensity for *T. trichiura* and *A. duodenalis* were only found for SAC population (Fig. 12).

Figure 12. Number of data for heavy intensity of infection by age group and species, 1995-2009



AL: *Ascaris lumbricoides*, TT: *Trichuris trichiura,* HW: *Hookworms*, AD: *Ancylostoma duodenale*.

The data of heavy intensity of infection were found for SAC from Bolivia, Brazil, Colombia, Ecuador, Honduras and Venezuela. In the case of heavy intensity of infection in PSAC, data were found for Brazil and Honduras. Data of heavy intensity for children between 1 – 14 years old were found for Argentina, Brazil and Honduras (Table 11).

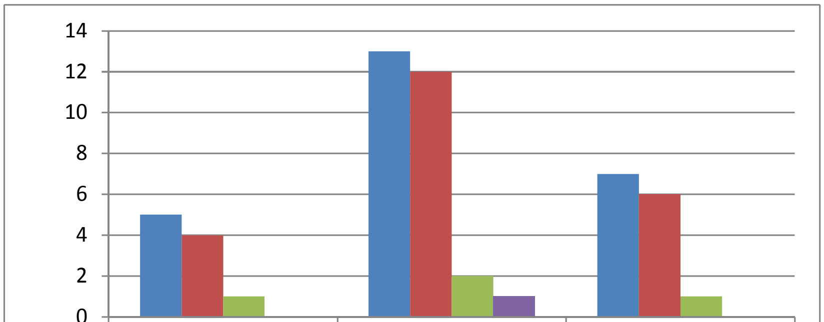
Table 11. Number of data for heavy intensity of infection by country and age group, included in the review, 1995-2009 in LAC.

Country	PSAC	SAC	1-14	Total
Argentina			2	2
Bolivia		8		8
Brazil	2	2	3	7
Colombia		3		3
Ecuador		5		5
Honduras	4	4	4	12
Venezuela		6		6
Total	**6**	**28**	**9**	**43**

52 data (34.4%) of moderate intensity of infection were found amongst the total 151 data found for this indicator; of these data, 25 (48%) were for *A. lumbricoides* and 22 (42.3%) for *T. trichiura*. 53.8% of data for moderate intensity of infection were found for

SAC population, and data for moderate infection for *A. duodenalis* were only found for SAC (Fig. 13).

Figure 13. Number of data for moderate intensity of infection by age group and species, 1995-2009 in LAC

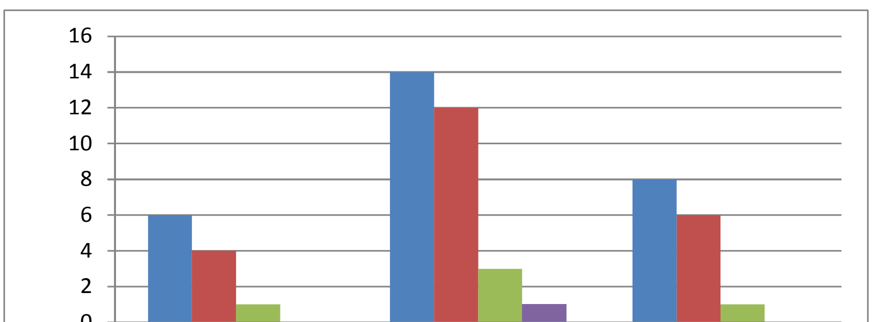


	PSAC	SAC	1-14 y.o.
AL	5	13	7
TT	4	12	6
HW	1	2	1
AD		1	

AL: *Ascaris lumbricoides*, TT: *Trichuris trichiura,* HW: *Hookworms*, AD: *Ancylostoma duodenale*.

56 data (37%) of light intensity of infection were found ; of these data, 28 (50%) were for *A. lumbricoides* and 22 (39.2%) for *T. trichiura*. 53.6% of data for light intensity of infection were found for SAC population, and data for light infection for *A. duodenalis* were only found for SAC (Fig. 14).

Figure 14. Number of data for light intensity of infection by age group and species, 1995-2009 in LAC



	PSAC	SAC	1-14 y.o.
AL	6	14	8
TT	4	12	6
HW	1	3	1
AD		1	

AL: *Ascaris lumbricoides*, TT: *Trichuris trichiura,* HW: *Hookworms*, AD: *Ancylostoma duodenale*.

4.3. Mapping of the general situation of prevalence and intensity of infection of STH in LAC, 2000-2010

In order to present the situation of mapping for prevalence and intensity of infection of STH in LAC for the period 2000-2010, the analysis of the situation by age group and ranges of prevalence are presented by subregions, according to the subregional division of PAHO in the document "Health Situation in the Americas, basic indicators for Latin American and the Caribbean Countries" (Table 12).

Table 12. List of countries by sub-region in LAC, PAHO.

Sub-region	Countries
Mexico	Mexico
Central American Isthmus	Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Panama
Latin Caribbean	Cuba, Dominican Republic, French Guiana, Guadeloupe, Haiti, Martinique, Puerto Rico
Non-Latin Caribbean	Anguila, Antigua & Barbuda, Aruba, Bahamas, Barbados, Cayman Islands, Dominica, Grenada, Guyana, Jamaica, Monserrat, Netherlands Antilles, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname, Trinidad & Tobago, Turks & Caicos Islands, Virgin Islands (UK), Virgin Islands (US)
Andean Area	Bolivia, Colombia, Ecuador, Peru, Venezuela
Brazil	Brazil
Southern cone	Argentina, Chile, Paraguay, Uruguay

Source: PAHO, Health Information and Analysis Project. Health situation in the Americas: Basic indicators, 2010. Washington, D.C., United States of the America, 2010.

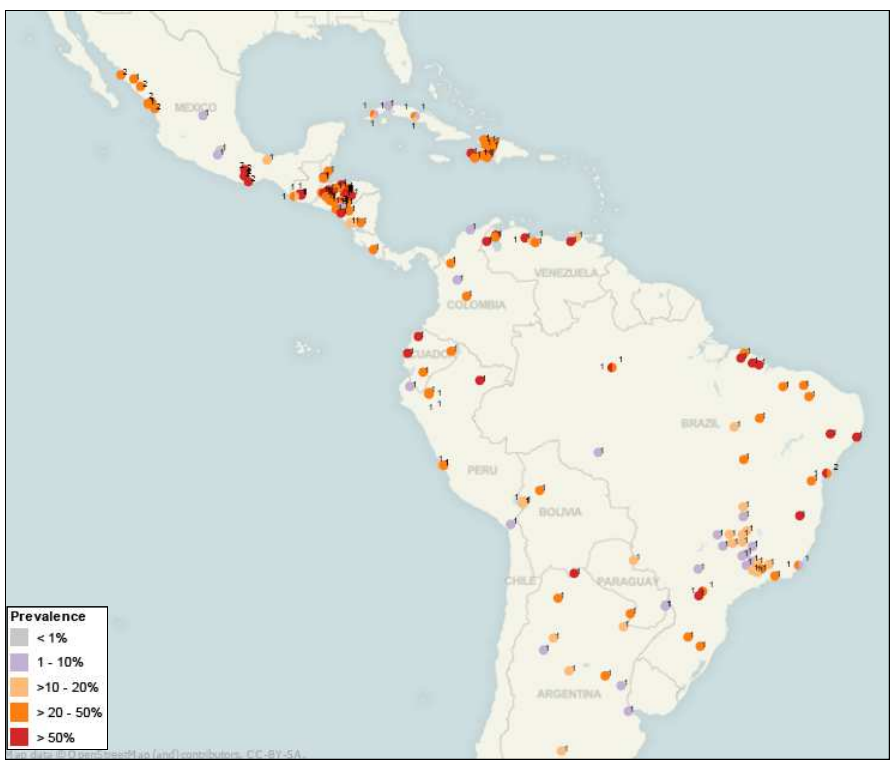
As a general overview of the data, the number of data found for prevalence of STH by age group and by range of prevalence in LAC for the period 2000-2010 is shown in Figure 15: 40 data for prevalence of STH published for PSAC, 190 data for SAC and 105 data for children between 1-14 years old.

In this general overview it is important to indicate that for PSAC, 12 data of 40 in total (30%) showed a prevalence of STH between >20-50%, while 7 (17.5%) showed a prevalence above 50%, meaning that almost half (47.5%) of the data for prevalence of STH for PSAC showed values above 20%.

In the case of SAC 190 data were found in LAC for prevalence of STH; of these, 75 (39.4%) showed prevalence between >20-50%, while 54 (28.4%) showed a prevalence above 50%; therefore, 67.9% of the data for prevalence of STH for SAC showed values over 20%.

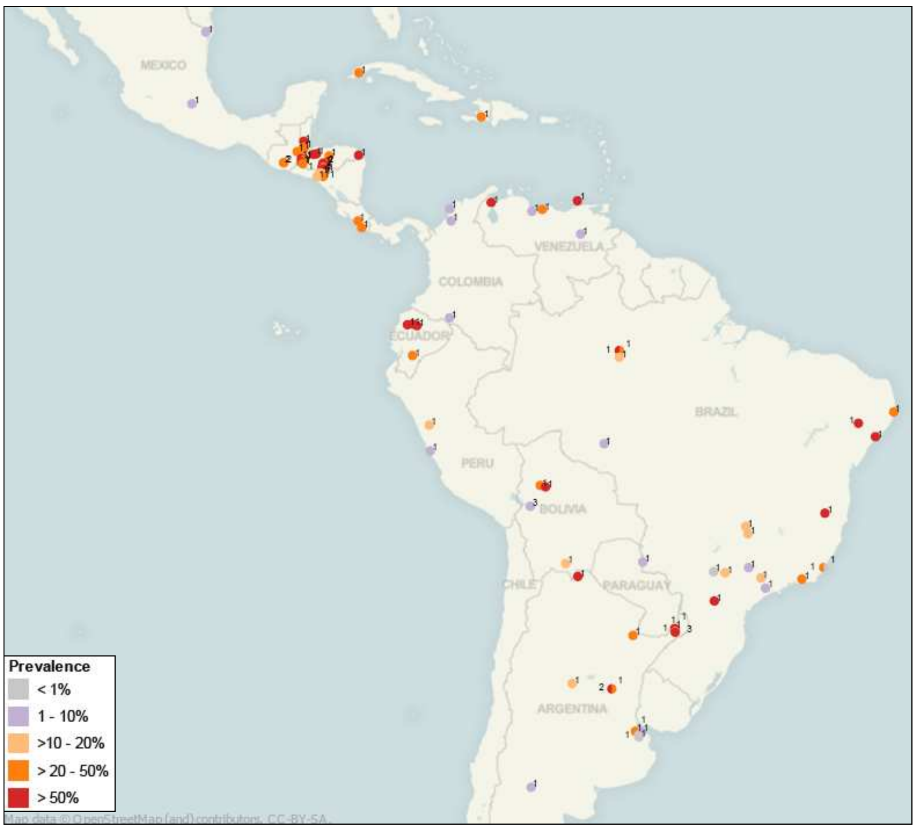
Figure 15. Data published for prevalence of STH for PSAC in LAC 1995-2009

Figure 16. Data published for prevalence of STH for SAC in LAC 1995-2009.



Also the number of data published for prevalence of STH for children between 1 to 14 years old for the period 1995-2009 is important, since these data are useful as a proxy for identifying the prevalence of STH for PSAC and SAC in those cases in which it is difficult to have data disaggregated by age group. In the case of children between 1-14 years old, 105 data were found for prevalence of STH; of these, 30 (28.6%) showed prevalences between >20-50%, while 32 (30.5%) showed a percentage above 50%; which means that 59% of the data for prevalence of STH for this age group showed values over 20% (Fig. 17).

Figure 17. Data published for prevalence of STH for children between 1-14 years old in LAC 1995-2009.



Regarding data for intensity of infection in LAC by age group, a low number of reports (151) was found in this review: 27 data for PSAC, 86 for SAC and 38 for 1-14 years old (Fig. 18 and Fig. 19). In the case of PSAC, 6 data (22.2%) were found for heavy intensity of infection: 83.3% (5 data) of them by *A. lumbricoides* and 16.6% (1 data) by hookworms. For SAC, 28 data (32.6%) were found of heavy intensity of infection: 53.6% of them by *A. lumbricoides*, 32% by *T. trichiura,* 10.7% by hookworms and 3.6% by *Ancylostoma doudenale*. For children between 1-14 years old, 9 data (23.7%) were found for heavy intensity of infection: 88.8% of them by *A. lumbricoides* and 11.1% by hookworms.

Figure 18. Data published for intensity of infection for PSAC population in LAC 1995-2009.

Figure 19. Data published for intensity of infection for SAC population in LAC 1995-2009.

4.3.1. Mapping for prevalence and intensity of infection of STH for Mexico

Pre-School Age Children

Data for prevalence of STH for PSAC were only found in one paper for Colima State, Comala municipality in 2007 which reported 6.9% of prevalence of STH (Fig. 20). In this municipality 5.3% prevalence for *A. lumbricoides* and 6.9% for *T. trichiura* was reported. Data for intensity of infection in this age group were not found.

Figure 20. Data published for prevalence of STH for PSAC for Mexico, 1995-2009.

School Age Children

In Mexico 25 data published for prevalence of STH were found: 13 in 1998, 11 in 2003 and 1 in 2005; 40% (10 data) of the data showed prevalence values above 50% and 44% (11 data) between ≥20 and 50% (Table 13). Data for prevalence of STH above of 50% were for Oaxaca State, showing 53% of prevalence in the following municipalities: Oaxaca de Suarez, Pluma Hidalgo, San Agustín Amatengo and San Agustín de las Juntas (Fig. 21). No data for intensity of infection in this age group were found in Mexico.

Table 13. Data found for prevalence of STH over 20% for SAC population for Mexico, 1995-2009.

State	Municipality	Study place	Percentage of prevalence	Year
Oaxaca	Oaxaca de Juarez	Santa María de Magdalena	53	1998
Oaxaca	Oaxaca de Juarez	Santa María de Magdalena	53	2003
Oaxaca	Oaxaca de Juarez	Las Lomas de San Jacinto	53	1998
Oaxaca	Oaxaca de Juarez	Las Lomas de San Jacinto	53	2003
Oaxaca	Pluma Hidalgo	Pluma hidalgo	53	1998
Oaxaca	Pluma Hidalgo	Pluma hidalgo	53	2003
Oaxaca	San Agustin Amatengo	La Lobera	53	1998
Oaxaca	San Agustin Amatengo	La Lobera	53	2003
Oaxaca	San Agustin de las Juntas	La Era	53	1998

State	Municipality	Study place	Percentage of prevalence	Year
Oaxaca	San Agustin de las Juntas	La Era	53	2003
Sinaloa	Ahome	Las Puentes	33	1998
Sinaloa	Ahome	Las Puentes	33	2003
Sinaloa	Culiacan	Imala	33	1998
Sinaloa	Culiacan	Imala	33	2003
Sinaloa	Escuinapa	Pueblo Nuevo	33	1998
Sinaloa	Escuinapa	Pueblo Nuevo	33	2003
Sinaloa	Mazatlan	El Paraíso	33	1998
Sinaloa	Mazatlan	Doroteo Arango	33	1998
Sinaloa	Mocorito	El Treinta	33	1998
Sinaloa	San Ignacio	El Higueral	33	1998
Sinaloa	San Ignacio	El Higueral	33	2003

Figure 21. Data published for prevalence of STH for SAC for Mexico, 1995-2009.

Children under 14 years old

In Mexico 2 data for prevalence of STH for children between 1-14 years old were found: one for the Mexico City (1998 with 6% prevalence) and one for Tamaulipas State (Valle Hermoso municipality in 1997 with 3.65% of prevalence). For the Mexico City also a prevalence of 6% was reported for both *A. lumbricoides* and *T. trichiura*, while in the municipality of Valle Hermoso prevalences of 3.6% for *A. lumbricoides*, 1.3% for *T. trichiura* and 0.22% for hookworms were reported (Fig. 22).

Figure 22. Data published for prevalence of STH for children between 1-14 years old for Mexico, 1995-2009.

No data for intensity of infection in this age group were found in Mexico.

4.3.2. Mapping for prevalence and intensity of infection of STH for the Central American Isthmus countries

Pre-School Age Children

For PSAC nine data for prevalence of STH for Belize, Costa Rica and Honduras were found for the period 1995-2009. Seven of these data corresponded to Honduras. Only two reported prevalence >50% (Belize in the Toledo State in 2004 and Honduras in the Francisco Morazán State and municipality of San Antonio de Oriente in 1998); four reported prevalence between >20 – 50% (Costa Rica in State Punta Arenas, municipality of Punta Arenas; Honduras in the State Francisco Morazán - municipalities of Maraita and San Antonio de Oriente) (Fig. 23, Table 14).

Regarding prevalence of STH by species only one data was found in Honduras for *A. lumbricoides* with prevalence over 50% (Francisco Morazán State, municipality of San Antonio de Oriente in 1998). No data were found for Panama.

Figure 23. Data published for prevalence of STH for PSAC in countries of Central American Isthmus, 1995-2009.

Table 14. Data found for prevalence of STH over 20% for PSAC population for the Central American Isthmus Countries, 1995-2009.

Country	State	Municipality	Study place	Percentage of prevalence	Year
Belize	Toledo	No Second Adm Level	Columbia Forest reserve (Golden stream, Medina Bank, San Marcos, Tambran, Bladder)	55.0	2004
Honduras	Francisco Morazan	San Antonio de Oriente	El Chagüite	78.0	1998
Honduras	Francisco Morazan	San Antonio de Oriente	El Llano	42.0	1998
Honduras	Francisco Morazan	San Antonio de Oriente	Santa Inés	40.0	1998
Honduras	Francisco Morazan	Maraita	El Chagüite Belén	25.0	1998
Costa Rica	Puntarenas	Puntarenas	Hatillo	21.0	1998

One data for Honduras was found for heavy intensity of infection for *A. lumbricoides* in Francisco Morazán State - San Antonio de Oriente municipality in 1998. Also reports were found for moderate intensity of infection for *A. lumbricoides* and *Trichuris trichiura* in Honduras (Francisco Morazán State - municipalities of Maraita and San Antonio de Oriente in 1998) (Fig. 24, Fig. 25).

Figure 24. Data published for intensity of infection by *Ascaris lumbricoides* for PSAC in countries of Central American Isthmus, 1995-2009.

Figure 25. Data published for intensity of infection by *Trichuris trichiura* for PSAC in countries of Central American Isthmus, 1995-2009.

School Age Children

For SAC 52 data were found for prevalence of STH for Belize (3), Costa Rica (1), Honduras (36), Guatemala (7) and Nicaragua (5); it is important to note no data were found for Panama. For Honduras 17 data showed prevalence of STH above 50%, as well as 5 for Guatemala, 1 for Belize and 1 for Nicaragua; 22 data showed prevalence values >20 – 50% with the highest number in Honduras (16 data) (Table, 15, Fig. 26).

Figure 26. Data published for prevalence of STH for SAC in the Central American Isthmus countries, 1995-2009.

Table 15. Data found for prevalence of STH over 20% for SAC population for the Central American Isthmus Countries, 1995-2009.

Country	State	Municipality	Study place	Percentage of prevalence	Year
Belize	Toledo	No Second Adm Level	Columbia Forest reserve (Golden stream, Medina Bank, San Marcos, Tambran, Bladder)	77.0	2004
Belize	Stann Creek	No Second Adm Level	Stann Creek	46.0	2005
Belize	Toledo	No Second Adm Level	Toledo district	34.4	2005
Costa Rica	Puntarenas	Puntarenas	Hatillo	41.0	1998
Guatemala	Solola	San Antonio Palopo	San Antonio Palopo	63.3	2005
Guatemala	Solola	San Lucas Toliman	San Lucas Tolimán	63.3	2005
Guatemala	Solola	San Pablo La Laguna	San Pablo La Laguna	63.3	2005
Guatemala	Solola	San Pedro La Laguna	San Pedro La Laguna	63.3	2005
Guatemala	Solola	Santa Catarina Palopo	Santa Catarina Palopo	63.3	2005
Guatemala	Quetzaltenango	Quetzaltenango	Schools, 10 communities Valle Palajunoj	33.1	2004
Honduras	Francisco Morazan	San Antonio de Oriente	El Chagüite	93.0	1998
Honduras	Olancho	San Francisco de Becerra	San Francisco de Becerra	85.0	2005
Honduras	Atlantida	La Masica	Colinas	84.9	2005

Country	State	Municipality	Study place	Percentage of prevalence	Year
Honduras	Lempira	Gracias	Gracias	84.6	2005
Honduras	Olancho	Jano	Jano	79.1	2005
Honduras	Copan	Dulce Nombre	Dulce Nombre	76.7	2005
Honduras	Lempira	Lepaera	Lepaera	67.9	2005
Honduras	Santa Barbara	Santa Barbara	Santa Bárbara	67.3	2005
Honduras	Yoro	Yoro	Yoro	63.6	2005
Honduras	Francisco Morazan	Maraita	El Chagüite Belén	63.0	1998
Honduras	Intibuca	Intibuca	Intibuca	59.6	2005
Honduras	Francisco Morazan	Guaimaca	Guaimaca	55.9	2005
Honduras	Olancho	Silca	Silca	55.6	2005
Honduras	Olancho	Guata	Guata	55.3	2005
Honduras	Olancho	Salama	Salama	54.0	2005
Honduras	Copan	Santa Rosa de Copan	Santa Rosa de Copán	53.3	2005
Honduras	Santa Barbara	San Pedro Zacapa	San Pedro de Zacapa	50.9	2005
Honduras	Copan	Santa Rita	Santa Rita	48.2	2005
Honduras	Yoro	El Negrito	El Negrito	48.0	2005
Honduras	Lempira	La Campa	La Campa	46.2	2005
Honduras	Intibuca	Yamaranguila	Yamaranguila	44.4	2005
Honduras	Olancho	Esquipulas del Norte	Esquipula del Norte	38.0	2005
Honduras	Olancho	La Union	La Unión	37.5	2005
Honduras	Olancho	Yocon	Yocón	34.6	2005
Honduras	La Paz	La Paz	La Paz	33.3	2005
Honduras	Francisco Morazan	San Antonio de Oriente	El Llano	32.0	1998
Honduras	Francisco Morazan	Reitoca	Reitoca	31.6	2005
Honduras	Olancho	El Rosario	El Rosario	30.0	2005
Honduras	Francisco Morazan	San Antonio de Oriente	Santa Inés	29.0	1998
Honduras	El Paraiso	El Paraiso	El Paraíso	25.0	2005
Honduras	Olancho	Mangulile	Mangulile	24.0	2005
Honduras	Intibuca	San Marcos de la Sierra	San Marcos de la Sierra	20.8	2005
Honduras	Valle	Amapala	Isla del Tigre	20.4	1996
Nicaragua	Chinandega	Chinandega	Chinandega	84.4	2005
Nicaragua	Esteli	Esteli	Esteli	43.3	2005
Nicaragua	Chontales	Comalapa	Chontales	29.4	2005

Data were also found for prevalence of STH by species. For Guatemala and Honduras data of prevalence by species with values over 50%, especially for *A. lumbricoides* and *T. trichiura* (Table 16) were found.

Table 16. Prevalence of STH by species with prevalence values over 50% for SAC population in data found for the Central American Isthmus Countries, 1995-2009.

Country	State	Municipality	Study place	Percentage of Prevalence	Species	Year
Guatemala	Solola	San Antonio Palopo	San Antonio Palopo	63.25	AL	2005
Guatemala	Solola	San Lucas Toliman	San Lucas Tolimán	63.25	AL	2005
Guatemala	Solola	San Pablo La Laguna	San Pablo La Laguna	63.25	AL	2005
Guatemala	Solola	San Pedro La Laguna	San Pedro La Laguna	63.25	AL	2005
Guatemala	Solola	Santa Catarina Palopo	Santa Catarina Palopo	63.25	AL	2005
Honduras	Francisco Morazan	San Antonio de Oriente	El Chagüite	93	AL	1998
Honduras	Francisco Morazan	San Antonio de Oriente	El Chagüite	85.7	TT	1998
Honduras	Francisco Morazan	Maraita	El Chagüite Belén	63	AL	1998
Honduras	Francisco Morazan	Maraita	El Chagüite Belén	58	TT	1998
Nicaragua	Chinandega	Chinandega	Chinandega	84.4	TT	2005

AL: *Ascaris lumbricoides*, TT: *Trichuris trichiura*.

Only data for heavy intensity of infection by *Ascaris lumbricoides* were found in Honduras for 1998 for San Francisco Morazán State - municipalities of Maraita (one data) and San Antonio de Oriente (three data). Also, only for Honduras data of moderate intensity of infection by *Ascaris lumbricoides* were found in 1998 for the Francisco Morazán State - municipalities of Maraita (two data) and San Antonio de Oriente (six data) (Fig. 27). For Francisco Morazán State - municipalities of Maraita was found one data of moderate intensity of infection by *Trichuris trichiura* and for the municipality of San Antonio de Oriente three data (Fig. 28).

Figure 27. Data published for intensity of infection by *Ascaris lumbricoides* for SAC in countries of Central American Isthmus, 1995-2009.

Figure 28. Data published for intensity of infection by *Trichuris trichiura* for SAC in countries of Central American Isthmus, 1995-2009.

Children under 14 years old

For children 1-14 years old in the Central American Isthmus countries 33 data were found for prevalence of STH for the period 1995-2009: 23 for Honduras, 7 for Guatemala, 2 for Costa Rica and 1 for Belize; it is important to note that no data were found for Panama. In total 12 data showed STH prevalence values above 50% (11 in Honduras and 1 in Belize) and 16 data showed values for STH prevalence between >20 – 50% (7 in Honduras, 7 in Guatemala and 2 in Costa Rica) (Fig. 29, Table 17).

Figure 29. Data published for prevalence of STH for children between 1-14 years old for the Central American Isthmus countries, 1995-2009.

Table 17. Data found for prevalence of STH with values over 20% for children 1-14 years old for the Central American Isthmus Countries, 1995-2009

Country	State	Municipality	Study place	Percentage of prevalence	Year
Belize	Toledo	No Second Adm Level	Columbia Forest reserve (Golden stream, Medina Bank, San Marcos, Tambran, Bladder)	62.9	2004
Costa Rica	Puntarenas	Golfito	Guaymi de Altos de Conte	36.0	2005
Costa Rica	Puntarenas	Puntarenas	Hatillo	26.8	1998
Guatemala	Sacatepequez	Santa Maria de Jesus	La Mano de León (Town)	47.1	2009
Guatemala	Sacatepequez	Santa Maria de Jesus	Santa María de Jesús (Town)	47.1	2009
Guatemala	Izabal	Livingston	El Sol (community)	47.1	2009
Guatemala	Izabal	El Estor	Chichipute (community)	47.1	2009
Guatemala	Izabal	Morales	Río Dulce (community)	47.1	2009
Guatemala	Sacatepequez	Santa Maria de Jesus	La Mano de León (Town)	42.0	2001
Guatemala	Sacatepequez	Santa Maria de Jesus	Santa María de Jesús (Town)	42.0	2001
Honduras	Francisco Morazan	San Antonio de Oriente	El Chagüite	89.2	1998
Honduras	Francisco Morazan	Distrito Central	Tegucigalpa	83.0	2001
Honduras	Copan	Dulce Nombre	Dulce Nombre	81.0	2001
Honduras	Yoro	El Negrito	El Negrito	75.0	2001
Honduras	Cortes	Potrerillos	Potrerillos	69.0	2001
Honduras	Ocotepeque	Fraternidad	Fraternidad	68.0	2001
Honduras	Gracias A Dios	Puerto Lempira	Puerto Lempira	67.0	2001
Honduras	Copan	Santa Rita	Santa Rita	64.0	2001
Honduras	Francisco Morazan	Talanga	Talanga	59.0	2001
Honduras	Francisco Morazan	Maraita	El Chagüite Belén	56.5	1998
Honduras	Francisco Morazan	Guaimaca	Guaimaca	54.0	2001
Honduras	Copan	Santa Rosa de Copan	Santa Rosa de Copán	44.0	2001
Honduras	Choluteca	Choluteca	Choluteca	37.0	2001
Honduras	Ocotepeque	San Marcos	San Marcos Ocotepeque	36.0	2001
Honduras	Francisco Morazan	San Antonio de Oriente	El Llano	35.0	1998
Honduras	Francisco Morazan	Distrito Central	Francisco Morazán	32.0	2001

Country	State	Municipality	Study place	Percentage of prevalence	Year
Honduras	Francisco Morazan	San Antonio de Oriente	Santa Inés	30.8	1998
Honduras	Comayagua	Comayagua	Comayaguela	28.0	2001

Data were also found for prevalence of STH by species. For Guatemala and Honduras data for prevalence by species of STH with values over 50% were found especially for *A. lumbricoides* and *T. trichiura* (Table 18).

Table 18. Data found for prevalence of STH by species with values over 50% for children 1-14 years old for the Central American Isthmus Countries, 1995-2009.

Country	State	Municipality	Study place	Percentage of Prevalence	Species	Year
Honduras	Francisco Morazan	San Antonio de Oriente	El Chagüite	89.2	AL	1998
Honduras	Francisco Morazan	Distrito Central	Tegucigalpa	83	TT	2001
Honduras	Copan	Dulce Nombre	Dulce Nombre	81	TT	2001
Honduras	Yoro	El Negrito	El Negrito	75	TT	2001
Honduras	Francisco Morazan	San Antonio de Oriente	El Chagüite	70.3	TT	1998
Honduras	Cortes	Potrerillos	Potrerillos	69	AL	2001
Honduras	Ocotepeque	Fraternidad	Fraternidad	68	AL	2001
Honduras	Gracias A Dios	Puerto Lempira	Puerto Lempira	67	TT	2001
Honduras	Copan	Santa Rita	Santa Rita	64	TT	2001
Honduras	Yoro	El Negrito	El Negrito	63	AL	2001
Honduras	Yoro	El Negrito	El Negrito	63	HW	2001
Honduras	Francisco Morazan	Talanga	Talanga	59	TT	2001
Honduras	Francisco Morazan	Maraita	El Chagüite Belén	56.5	AL	1998
Honduras	Cortes	Potrerillos	Potrerillos	56	TT	2001
Honduras	Francisco Morazan	Distrito Central	Tegucigalpa	56	AL	2001
Honduras	Francisco Morazan	Guaimaca	Guaimaca	55.9	TT	2001
Honduras	Copan	Dulce Nombre	Dulce Nombre	54	AL	2001
Honduras	Francisco Morazan	Guaimaca	Guaimaca	54	AL	2001
Honduras	Francisco Morazan	Maraita	El Chagüite Belén	52.2	TT	1998

AL: *Ascaris lumbricoides*, HW: *Hookworms*, TT: *Trichuris trichiura*.

For heavy intensity of infection only data were found for Honduras, by *Ascaris lumbricoides,* in 1998 for the San Francisco Morazán State - municipalities of Maraita (one data) and San Antonio de Oriente (three data). Also only for Honduras data of moderate intensity of infection by *Ascaris lumbricoides* were found in 1998 for the Francisco Morazán State - municipalities of Maraita (two data) and San Antonio de Oriente (six data) (Fig. 30). For Honduras data of moderate intensity of infection by *Trichuris trichiura* were found in 1998 for the Francisco Morazán State - municipalities of Maraita (one data) and San Antonio de Oriente (three data) (Fig. 31).

Figure 30. Data published for intensity of infection by *Ascaris lumbricoides* for children between 1-14 years old for the Central American Isthmus countries, 1995-2009.

Figure 31. Data published for intensity of infection by *Trichuris trichiura* for children between 1-14 years old for the Central American Isthmus countries, 1995-2009.

4.3.3. Mapping for prevalence and intensity of infection of STH for the Latin Caribbean countries

Pre-School Age Children

Only published data were found for Cuba in 1998 for Havana City with 0.8% for prevalence of STH (Fig. 32). For the same year and municipality, prevalences of *A. lumbricoides* of 0.2% and of *T. trichiura* of 0.8% were also reported.

Figure 32. Data published for prevalence of STH for PSAC for the Latin Caribbean countries, 1995-2009.

No data of intensity of infection in this age group were found for the Latin Caribbean countries.

School Age Children

For SAC 18 data for prevalence of STH (11 in Haiti and 7 in Cuba) were found. It is important to note that no data were found for Dominican Republic in order to have a complete picture for the island of La Hispaniola. Two data in Haiti showed prevalence values over 50% (one in 1996 for Ouest State, Leogane municipality: 54.7% and one in 2002 for Grand Anse State, Jeremie municipality: 73.7%) (Table 19); for these two municipalities prevalence data were reported for *T. trichiura* and *A. lumbricoides* with values over 50%. 11 data showed values for prevalence of STH between >20-50% (9 for Haiti in 2002 and 2 for Cuba in 2003) (Fig. 33, Table 20).

Figure 33. Data published for prevalence of STH for SAC for the Latin Caribbean countries, 1995-2009.

Table 19. Data found for prevalence of STH over 20% for SAC population for the Latin Caribbean Countries, 1995-2009.

Country	State	Municipality	Study place	Percentage of prevalence	Year
Cuba	Sancti Spiritus	Fomento	Fomento	24.0	2003
Cuba	Pinar del Rio	San Juan y Martinez	San Juan y Martínez (urban area)	21.0	2003
Haiti	Grand Anse	Jeremie	Jeremie	73.7	2002
Haiti	Ouest	Leogane	Leogane	54.7	1996
Haiti	Nord	le Cap-Haitien	Le Cap-Haitien	45.8	2002
Haiti	Nord-Ouest	Port-de-Paix	Port-de-Paix	37.6	2002
Haiti	Artibonite	les Gonaives	Les Gonaives	32.8	2002
Haiti	Sud-Est	Jacmel	Jacmel	28.2	2002
Haiti	Sud	les Cayes	Les Cayes	26.4	2002
Haiti	Nord-Est	Fort-Liberte	Fort-Liberte	25.5	2002
Haiti	Nippes	Miragoane	Miragoane	25.5	2002
Haiti	Ouest	Port-au-Prince	Port-au-Prince	23.9	2002
Haiti	Centre	Hinche	Hinche	20.6	2002

Table 20. Data found for prevalence of STH by species with values over 20% for SAC population for the Latin Caribbean Countries, 1995-2009

Country	State	Municipality	Study place	Percentage of Prevalence	Species	Year
Cuba	Sancti Spiritus	Fomento	Fomento	24.0	AL	2003
Cuba	Pinar del Rio	San Juan y Martinez	San Juan y Martínez (urban area)	21.0	AL	2003
Haiti	Grand Anse	Jeremie	Jeremie	65.3	AL	2002
Haiti	Ouest	Leogane	Leogane	54.7	TT	1996

Country	State	Municipality	Study place	Percentage of Prevalence	Species	Year
Haiti	Nord	le Cap-Haitien	Le Cap-Haitien	37.6	AL	2002
Haiti	Ouest	Leogane	Leogane	29.2	AL	1996
Haiti	Nord-Ouest	Port-de-Paix	Port-de-Paix	28.2	AL	2002
Haiti	Artibonite	les Gonaives	Les Gonaives	25.8	AL	2002
Haiti	Sud-Est	Jacmel	Jacmel	25.5	AL	2002
Haiti	Grand Anse	Jeremie	Jeremie	22.1	TT	2002
Haiti	Nippes	Miragoane	Miragoane	20.4	AL	2002

AL: *Ascaris lumbricoides*, TT: *Trichuris trichiura*.

No data of intensity of infection in this age group in Latin Caribbean countries were found.

Children under 14 years old

For children within 1-14 years old two data were found: one for Haiti in 2001 (Ouest State, Leogane) and one for Cuba in 2007 (Pinar del Rio State, San Juan y Martinez municipality); both of them showed prevalence values between >20-50%; it is important to note that no data were found data for Dominican Republic, thus we have an incomplete picture of the island of La Hispaniola (Fig. 34).

Figure 34. Data published for prevalence of STH for children between 1-14 years old for the Latin Caribbean countries, 1995-2009.

No data for prevalence of STH by species with values over 50% were found; only in Cuba prevalence for *A. lumbricoides* and *T. trichiura* between >20-50% was found in 2007 (Pinar del Rio State, San Juan y Martinez municipality), and in Haiti a prevalence of *T. trichiura* between >20-50% in 2001 (Ouest State, Leogane).

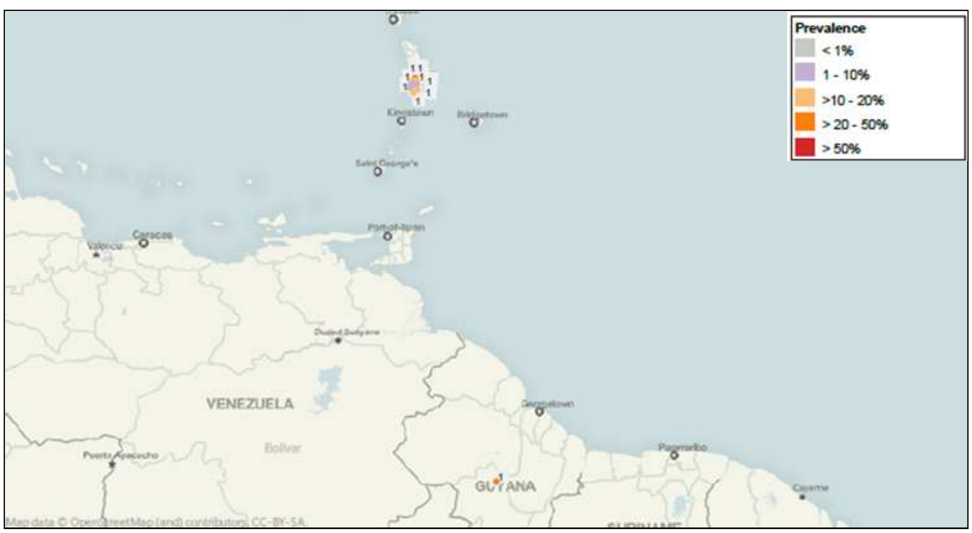
No data for intensity of infection in this age group for the Latin Caribbean countries were found.

4.3.4. Mapping for prevalence and intensity of infection of STH for the Non Latin Caribbean countries

In this group of countries only data were recovered from Guyana and Saint Lucia for children under 14 years old without differentiation between PSAC and SAC. Of 9 data found, 1 was for Guyana in 2002 with 28.2% for prevalence of STH for Region 8 - municipality Ireng/Upper Potaro.

The rest of the data (8) were for Saint Lucia in 2005; in this specific case, data were recovered by Region but not by municipality. For Saint Lucia only Region 1 reported prevalence of STH in children under 14 years old with values between >20-50% (22.5%). For regions 2, 4, 5 and 8 data for prevalence of STH in children under 14 years old with values between >10-20% (11.1%, 12.95%, 10.1% and 18.3%, respectively) were registered, while for regions 3, 6 and 7 data of prevalence of STH in children under 14 years old with values between 1-10% were registered (Fig. 35).

Figure 35. Data published for prevalence of STH for children between 1-14 years old for the Non-Latin Caribbean countries, 1995-2009.



No data were found data for prevalence of STH by species or intensity of infection for the Non-Latin Caribbean countries.

4.3.5. Mapping for prevalence and intensity of infection of STH for the Andean area countries

Pre-School Age Children

For PSAC nine data for prevalence of STH were found: Colombia (4), Ecuador (2), Venezuela (2) and Bolivia (1); none of these data showed prevalence values over 50% and only 1 data for Colombia in 2002 (Cauca State, Guapi municipality) and 1 for Ecuador in 2005 (Chimborazo State, Riobamba municipality) showed values of prevalence between >20-50% (Fig. 36, Table 21). For these two municipalities data of prevalence for *A. lumbricoides* between >20-50% were reported in the same years. It is important to note that no data were found for Peru.

Figure 36. Data published for prevalence of STH for PSAC for the Andean area countries, 1995-2009.

Table 21. Data found for prevalence of STH with values over 20% for PSAC population for the Andean area countries, 1995-2009.

Country	State	Municipality	Study place	Percentage of prevalence	Year
Colombia	Cauca	Guapi	Guapi	26.2	2002
Ecuador	Chimborazo	Riobamba	Chimborazo (20 communities, without names specified)	35.5	2005

No data were found for intensity of infection in this age group for the Andean area countries.

School Age Children

For SAC 32 data were found for prevalence of STH: Peru (9), Venezuela (9), Bolivia (5), Ecuador (5) and Colombia (4). Seven data showed prevalence values above 50%: Venezuela (4), Ecuador (2) and Peru (1); and 12 data showed prevalence values between >20-50%: Peru (5), Colombia (2), Ecuador (2), Venezuela (2) and Bolivia (1) (Fig. 37, Table 22).

Figure 37. Data published for prevalence of STH for SAC for the Andean area countries, 1995-2009.

Table 22. Data found for prevalence of STH with values above 20% for SAC population for the Andean area countries, 1995-2009.

Country	State	Municipality	Study place	Percentage of Prevalence	Year
Bolivia	Beni	General Jose Ballivian	Rurrenabaque (15 communities without names specified)	24.3	2004
Colombia	Cordoba	Tierralta	Tierra Alta (Indigenous reserve Embera Katío)	43.1	2002
Colombia	Cundinamarca	Quipile	La Virgen	36.4	1999
Ecuador	Pichincha	Mejia	Pichincha y Esmeraldas (without locality name)	63.4	2003
Ecuador	Manabi	Portoviejo	Portoviejo	63	2001
Ecuador	Orellana	Orellana	Orellana (Amazon area)	25	2000
Ecuador	Azuay	Cuenca	Santa Ana	21.3	2003
Peru	Loreto	Loreto	Belén	77.9	2004
Peru	Amazonas	Bagua	La Misión	42.7	2002
Peru	Amazonas	Bagua	Nazaret	35.8	2002
Peru	Lima	Lima	Pachacamac (Lima)	35.5	1999

Country	State	Municipality	Study place	Percentage of Prevalence	Year
Peru	Amazonas	Bagua	Mesones Muro	29.4	2002
Peru	Amazonas	Bagua	Chiriaco	27.3	2002
Venezuela	Sucre	Sucre	Sucre (School unity)	82.5	2003
Venezuela	Sucre	Sucre	Yaracuy	58.7	2000
Venezuela	Zulia	Machiques de Perija	Indigenous community (Yukpa toromo)	57.1	2002
Venezuela	Zulia	Maracaibo	Maracaibo (Primary school)	54.2	1997
Venezuela	Carabobo	Carlos Arvelo	Belén Carabobo	41.4	2006
Venezuela	Zulia	San Francisco	San Francisco	26.1	2000

Data for prevalence of STH by species with values over 50% for *A. lumbricoides* were found in Ecuador, Peru and Venezuela and for *T. trichiura* in Peru (Table 23).

Table 23. Data found for prevalence of STH by species with values over 50% for SAC population for the Andean area countries, 1995-2009.

Country	State	Municipality	Study place	Percentage of Prevalence	Species	Year
Ecuador	Manabi	Portoviejo	Portoviejo	63	AL	2001
Peru	Loreto	Loreto	Belén	77.9	TT	2004
Peru	Loreto	Loreto	Belén	60.4	AL	2004
Venezuela	Sucre	Sucre	Sucre (School Unity)	77.8	AL	2003
Venezuela	Zulia	Machiques de Perija	Indigenous community (Yukpa toromo)	57.1	AL	2002

AL: *Ascaris lumbricoides*, TT: *Trichuris trichiura*.

Data of heavy intensity of infection for SAC in some municipalities from Bolivia, Colombia, Ecuador and Venezuela, especially for *A. lumbricoides* and *T. trichiura* (Fig. 38, Fig. 39), and one report of heavy intensity for *A. duodenale* in one municipality in Venezuela (Fig. 40, Table 24); were found, as well as for hookworms in one municipality in Colombia, one in Ecuador (Fig. 41).

Figure 38. Data published for intensity of infection by *Ascaris lumbricoides* for SAC for the Andean area countries, 1995-2009.

Figure 39. Data published for intensity of infection by *Trichuris trichiura* for SAC for the Andean area countries, 1995-2009.

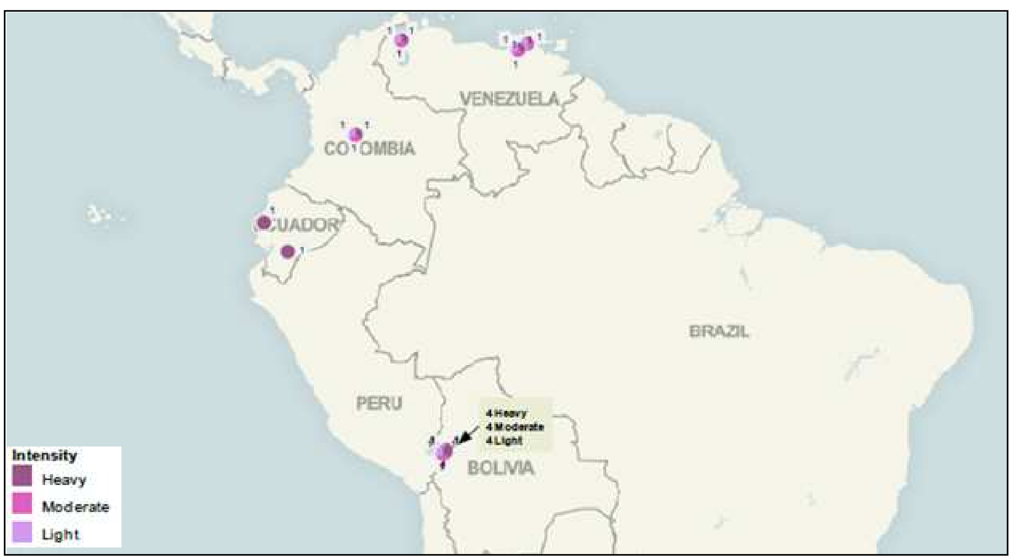


Figure 40. Data published for intensity of infection by *Ancylostoma duodenale* for SAC for the Andean area countries, 1995-2009.

Figure 41. Data published for intensity of infection by hookworms for SAC for the Andean area countries, 1995-2009.

Table 24. Data found for heavy intensity of infection by species for SAC population for the Andean area Countries, 1995-2009.

Country	State	Municipality	Study place	Species	Year
Bolivia	La Paz	Ingavi	Omasuyos	AL	1997
Bolivia	La Paz	Los Andes	Ingavi	AL	1997
Bolivia	La Paz	Murillo	Los Andes	AL	1997
Bolivia	La Paz	Omasuyos	Murillo	AL	1997
Bolivia	La Paz	Ingavi	Omasuyos	TT	1997
Bolivia	La Paz	Los Andes	Ingavi	TT	1997
Bolivia	La Paz	Murillo	Los Andes	TT	1997
Bolivia	La Paz	Omasuyos	Murillo	TT	1997
Colombia	Cundinamarca	Quipile	La Virgen	AL	1999
Colombia	Cundinamarca	Quipile	La Virgen	TT	1999
Colombia	Cundinamarca	Quipile	La Virgen	HW	1999
Ecuador	Azuay	Cuenca	Santa Ana	AL	2003
Ecuador	Azuay	Cuenca	Santa Ana	TT	2003
Ecuador	Manabi	Portoviejo	Portoviejo	AL	2001
Ecuador	Manabi	Portoviejo	Portoviejo	TT	2001
Ecuador	Manabi	Portoviejo	Portoviejo	HW	2001
Venezuela	Sucre	Sucre	Sucre (School Unity)	AL	2003
Venezuela	Sucre	Sucre	Sucre (School Unity)	TT	2003
Venezuela	Sucre	Sucre	Sucre (School Unity)	AD	2003
Venezuela	Sucre	Sucre	Cariaco	AL	1997
Venezuela	Zulia	Maracaibo	Maracaibo (Primary School)	AL	1997
Venezuela	Zulia	Maracaibo	Maracaibo (Primary School)	TT	1997

AD: *Ancylostoma duodenale*, AL: *Ascaris lumbricoides*, HW: *Hookworms*, TT: *Trichuris trichiura.*

Children under 14 years old

For children between 1-14 years old 20 data were found: Bolivia (6), Venezuela (5), Ecuador (4), Colombia (3) and Peru (2). Of these data 6 showed values for prevalence of STH above 50%: Ecuador (3), Venezuela (2) and Bolivia (1). For these three countries data were also found of prevalence of STH between >20-50% (one per country) (Fig. 42, Table 25).

Figure 42. Data published for prevalence of STH for children between 1-14 years old for the Andean area countries, 1995-2009.

Table 25. Data found for prevalence of STH with values above 20% for children 1-14 years old for the Andean area countries, 1995-2009

Country	State	Municipality	Study place	Percentage of Prevalence	Year
Bolivia	Beni	General Jose Ballivian	San Borja	76.1	2004
Bolivia	Beni	General Jose Ballivian	Rurrenabaque (15 communities)	21.3	2004
Ecuador	Pichincha	Ruminahui	Cotogchoa	55.3	1995
Ecuador	Pichincha	Santo Domingo	San Jacinto de Búa	55.3	1995
Ecuador	Pichincha	Pedro Vicente Maldonado	Pichincha (5 hamlets)	51	2000
Ecuador	Azuay	Cuenca	Santa Ana	20.1	2003
Venezuela	Zulia	Mara	Nazareth	70.3	2006
Venezuela	Nueva Esparta	Antolin del Cami	El Cardón de la isla del Coche	70	1997
Venezuela	Miranda	Guaicaipuro	San Daniel	30	1997

Data for prevalence of STH by species with values above 50% for children between 1-14 years old were found in Bolivia, Ecuador and Venezuela, especially for *A. lumbricoides*, *T. trichiura* and hookworms (Table 26).

Table 26. Data found for prevalence of STH by species with values over 50% for children between 1-14 years old for the Andean area countries, 1995-2009

Country	State	Municipality	Study place	Prevalence	Species	Year
Bolivia	Beni	General Jose Ballivian	San Borja	76.1	HW	2004
Ecuador	Pichincha	Ruminahui	Cotogchoa	55.3	AL	1995
Ecuador	Pichincha	Santo Domingo	San Jacinto de Búa	55.3	AL	1995
Venezuela	Nueva Esparta	Antolin del Cami	El Cardón de la isla del Coche	70	TT	1997
Venezuela	Zulia	Mara	Nazareth	50.5	TT	2006

AL: *Ascaris lumbricoides*, HW: *Hookworms*, TT: *Trichuris trichiura.*

4.3.5. Mapping for prevalence and intensity of infection of STH for Brazil

Pre-School Age Children

For PSAC in Brazil 18 published data were found of which 4 showed values for prevalence of STH above 50% (Pernambuco State - Petrolina in 1996: 80.3%; Amazonas State - Santa Isabel do Rio Negro in 2002: 57.7%; Rio Grande Do Sul - Porto Alegre in 2003: 51% and Minas Gerais State - Novo Oriente de Minas in 2004: 59.7%). Five data showed values for prevalence of STH between >20-50% (Fig. 43, Table 27).

Figure 43. Data published for prevalence of STH for PSAC for Brazil, 1995-2009.

Data for prevalence of STH by species, especially for *A. lumbricoides,* with values over 50% were found for four municipalities (Table 28).

Table 27. Data found for prevalence of STH with values above 20% for PSAC population for Brazil, 1995-2009.

State	Municipality	Study place	Percentage of prevalence	Year
Amazonas	Santa Isabel do Rio Negro	Santa Isabel do Rio Negro	57.7	2002
Amazonas	Santa Isabel do Rio Negro	Santa Isabel do Rio Negro	34.3	2005
Minas Gerais	Novo Oriente de Minas	Americaninhas	59.7	2004
Minas Gerais	Patos de Minas	Patos de Minas	50.0	2007

State	Municipality	Study place	Percentage of prevalence	Year
Parana	Candido de Abreu	Candido de Abreu	49.0	2004
Pernambuco	Petrolina	Tacaratu (Itaparica: villages Brejo dos Padres, Saco dos Barros, Espinheiro, Tapera, Serrinha)	80.3	1996
Rio de Janeiro	Campos dos Goytacazes	Parque Santuario	21.5	2004
Rio Grande do Sul	Porto Alegre	Porto Alegre	51.0	2003
Santa Catarina	Lages	Lages	35.0	2002

Table 28. Data found for prevalence of STH by species with values over 50% for PSAC population for Brazil, 1995-2009.

Country	State	Municipality	Study place	Percentage of Prevalence	Species	Year
Brazil	Minas Gerais	Novo Oriente de Minas	Americaninhas	65.5	AL	2004
Brazil	Minas Gerais	Novo Oriente de Minas	Americaninhas	59.7	HW	2004
Brazil	Pernambuco	Petrolina	Tacaratu (Itaparica: villages Brejo dos Padres, Saco dos Barros, Espinheiro, Tapera, Serrinha)	80.3	AL	1996
Brazil	Rio Grande do Sul	Porto Alegre	Porto Alegre	51	AL	2003

AL: *Ascaris lumbricoides*, HW: *Hookworms.*

For Minas Gerais State, Novo Oriente de Minas municipality, a data was found of heavy intensity of infection in PSAC in 2004 for *A. lumbricoides* and hookworms (Fig. 44, Fig. 45).

Figure 44. Data published for intensity of infection by *Ascaris lumbricoides* for PSAC for Brazil, 1995-2009.

Figure 45. Data published for intensity of infection by hookworms for PSAC for Brazil, 1995-2009.

School Age Children

For SAC 50 published data were found for prevalence of STH of which 10 showed values above 50% (Table 29). Also 16 data were found for prevalence of STH with values between >20-50% (Table 30 and Fig. 46).

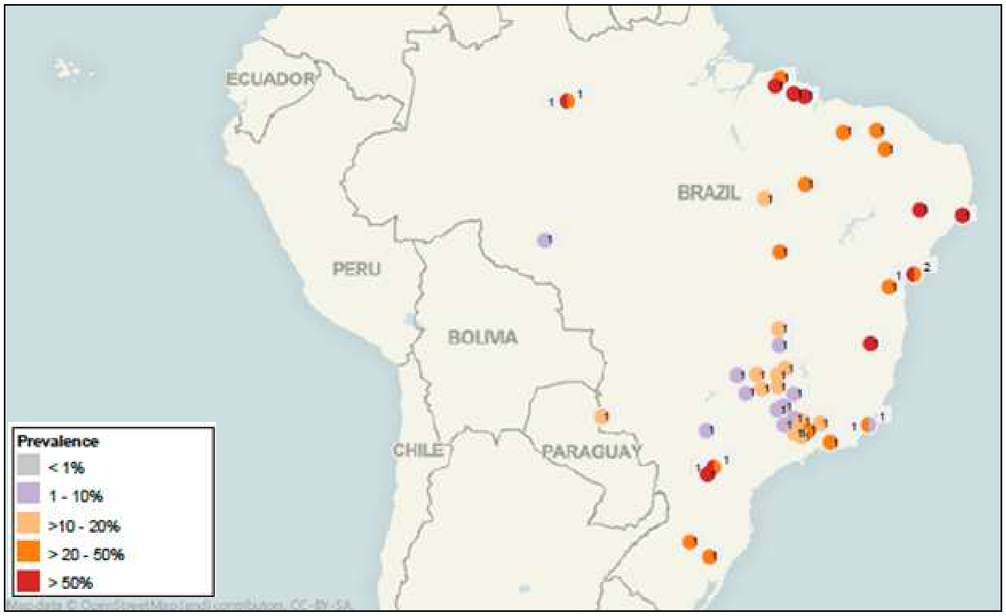
Table 29. Data found for prevalence of STH with values above 50% for SAC population for Brazil, 1995-2009.

State	Municipality	Study site	Percentage of Prevalence	Year
Alagoas	Barra de Santo Antonio	Maracacume	59.1	1999
Amazonas	Santa Isabel do Rio Negro	Santa Helena	65.1	2002
Bahia	Salvador	Santa Isabel do Rio Negro	53.5	1998
Maranhao	Santa Helena	Ortigueira (Indigenous area)	64.7	2005
Maranhao	Maracacume	Candido de Abreu	61.5	2005
Minas Gerais	Novo Oriente de Minas	Americaninhas	76.4	2004
Para	Ourem	Tacaratu (Itaparica: villages Brejo dos Padres, Saco dos Barros, Espinheiro, Tapera, Serrinha)	63.5	2005
Parana	Telemaco Borba	Salvador do Bahia City	93	1998
Parana	Candido de Abreu	Ourem	73.6	2004
Pernambuco	Petrolina	Barra de Santo Antonio	79.3	1996

Table 30. Data found for prevalence of STH with values between >20 - 50% for SAC population for Brazil, 1995-2009.

State	Municipality	Study site	Percentage of Prevalence	Year
Amazonas	Santa Isabel do Rio Negro	Santa Isabel do Rio Negro	48.1	2005
Bahia	Salvador	Salvador do Bahia city	40	2004
Bahia	Salvador	Salvador do Bahia city	38.6	1997
Bahia	Jequie	Jequié	35.8	1997
Ceara	Independencia	Independencia	25.1	2005
Ceara	Mucambo	Mucambo	25.1	2005
Minas Gerais	Sao Lourenco	Sao Lourenco	24.2	2002
Para	Braganca	Braganca	25.1	2005
Parana	Telemaco Borba	Ortigueira (rural area)	22	1998
Piaui	Ribeiro Goncalves	Ribeiro Gonçalves	25.1	2005
Piaui	Sao Jose do Peixe	Sao Jose do Peixe	25.1	2005
Rio de Janeiro	Seropedica	Seropedica	33.9	2001
Rio de Janeiro	Campos dos Goytacazes	Parque Santuario	20.8	2004
Rio Grande do Sul	Passo Fundo	Passo Fundo	42.9	2009
Rio Grande do Sul	Caxias do Sul	Caxias do Sul	25.8	2004
Tocantins	Dianopolis	Dianopolis	25.1	2005

Figure 46. Data published for prevalence of STH for SAC for Brazil, 1995-2009.



Data for prevalence of STH by species with values above 50% were found for *A. lumbricoides*, *T. trichiura* and hookworms in 2004 (Table 31).

Table 31. Data found for prevalence of STH by species with values over 50% for SAC population for Brazil, 1995-2009.

Country	State	Municipality	Study place	Percentage of Prevalence	Species	Year
Brazil	Alagoas	Barra de Santo Antonio	Barra de Santo Antonio	59.1	TT	1999
Brazil	Alagoas	Barra de Santo Antonio	Barra de Santo Antonio	57	AL	1999
Brazil	Alagoas	Barra de Santo Antonio	Barra de Santo Antonio	51.3	HW	1999
Brazil	Amazonas	Santa Isabel do Rio Negro	Santa Isabel do Rio Negro	51.2	AL	2002
Brazil	Maranhao	Santa Helena	Santa Helena	64.7	AL	2005
Brazil	Maranhao	Maracacume	Maracacume	61.5	AL	2005
Brazil	Minas Gerais	Novo Oriente de Minas	Americaninhas	76.4	HW	2004
Brazil	Minas Gerais	Novo Oriente de Minas	Americaninhas	57.8	AL	2004
Brazil	Parana	Telemaco Borba	Ortigueira (indigenous area)	88	AL	1998
Brazil	Parana	Candido de Abreu	Candido de Abreu	73.6	AL	2004
Brazil	Parana	Telemaco Borba	Ortigueira (indigenous area)	52	HW	1998
Brazil	Pernambuco	Petrolina	Tacaratu (Itaparica: villages Brejo dos Padres, Saco dos Barros, Espinheiro, Tapera, Serrinha)	79.3	AL	1996

AL: *Ascaris lumbricoides*, HW: *Hookworms,* TT: *Trichuris trichiura.*

For Minas Gerais State, Novo Oriente de Minas municipality data showing heavy intensity of infection for *A. lumbricoides* and hookworms in 2004 for SAC was found (Fig, 47 and Fig. 48).

Figure 47. Data published for intensity of infection by *Ascaris lumbricoides* for SAC for Brazil, 1995-2009.

Figure 48. Data published for intensity of infection by hookworms for SAC for Brazil, 1995-2009.

Children under 14 years old

For children between 1-14 years old 20 data were found in Brazil, of which 5 showed prevalence of STH values over 50% (Table 32) and 4 showed prevalence of STH between >20-50% (Table 33 and Fig. 49).

Figure 49. Data published for prevalence of STH for children between 1-14 years for Brazil, 1995-2009.

Table 32. Data found for prevalence of STH with values over 50% for children under 14 years old for Brazil, 1995-2009.

State	Municipality	Study site	Percentage of Prevalence	Year
Amazonas	Santa Isabel do Rio Negro	Santa Isabel do Rio Negro	61.8	2002
Minas Gerais	Novo Oriente de Minas	Americaninhas	67.3	2004
Parana	Candido de Abreu	Candido de Abreu	63.4	2004
Pernambuco	Petrolina	Tacaratu (Itaparica: villages Brejo dos Padres, Saco dos Barros, Espinheiro, Tapera, Serrinha)	79.6	1996
Sergipe	Neopolis	Neopolis	85.3	2004

Table 33. Data found for prevalence of STH with values between >20 - 50% for children under 14 years old for Brazil, 1995-2009.

State	Municipality	Study site	Percentage of Prevalence	Year
Amazonas	Santa Isabel do Rio Negro	Santa Isabel do Rio Negro	40.1	2005
Pernambuco	Sao Lourenco da Mata	Matriz da Luz	25.4	1998
Rio de Janeiro	Duque de Caxias	Parque Fluminense	27.5	1997
Rio de Janeiro	Campos dos Goytacazes	Parque Santuario	21.2	2004

Data for prevalence of STH by species with values over 50% for four municipalities, especially for *A. lumbricoides* and hookworms, were found (Table 34).

Table 34. Data found for prevalence of STH by species with values over 50% for children 1-14 years old for Brazil, 1995-2009

Country	State	Municipality	Study place	Percentage of Prevalence	Species	Year
Brazil	Minas Gerais	Novo Oriente de Minas	Americaninhas	67.3	HW	2004
Brazil	Minas Gerais	Novo Oriente de Minas	Americaninhas	62	AL	2004
Brazil	Parana	Candido de Abreu	Candido de Abreu	63.4	AL	2004
Brazil	Pernambuco	Petrolina	Tacaratu (Itaparica: villages Brejo dos Padres, Saco dos Barros, Espinheiro, Tapera, Serrinha)	79.6	AL	1996

AL: *Ascaris lumbricoides*, HW: *Hookworms*.

Data of heavy intensity of infection for *A. lumbricoides* in Amazonas State, Santa Isabel de Rio Negro municipality in 2005, and for *A. lumbricoides* and hookworms in Minas Gerais, Novo Oriente de Minas municipality in 2004, were found (Fig. 50, Fig. 51). One datum of moderate intensity of infection for *Trichuris trichiura* in Amazonas State, Santa Isabel de Rio Negro municipality in 2005 was found (Fig. 52)

Figure 50. Data published for intensity of infection by *Ascaris lumbricoides* for children between 1-14 years old for Brazil, 1995-2009.

Figure 51. Data published for intensity of infection by hookworms for children between 1-14 years old for Brazil, 1995-2009.

Figure 52. Data published for intensity of infection by *Trichuris trichiura* for children between 1-14 years old for Brazil, 1995-2009.

4.3.6. Mapping for prevalence and intensity of infection of STH for the Southern Cone countries

Pre-School Age Children

For PSAC only 2 data were found for Argentina in the Southern Cone countries: Cordoba State (Colon municipality: Unquillo in 2000 with 20.3%) and Salta State (General Jose de San Martin municipality: Tartagal in 2007 with 66.7%) (Fig. 53, Table 35).

Figure 53. Data published for prevalence of STH for PSAC for the Southern Cone countries, 1995-2009.

Table 35. Data found for prevalence of STH with values above 20% for PSAC population for Argentina, 1995-2009.

Country	State	Municipality	Study place	Percentage of prevalence	Year
Argentina	Cordoba	Colon	Unquillo	20.30	2000
Argentina	Salta	General Jose De San Martin	Tartagal	66.70	2007

One datum of prevalence for hookworms above 50% was found in Salta State, General Jose de San Martin municipality, in 2007. In Cordoba State, Colon municipality a prevalence between >20-50% for *A. lumbricoides* was found in 2000.

No data were found for intensity of infection in this age group for the Southern Cone countries.

School Age Children

For SAC, 13 data were found: Argentina (11) and Paraguay (2). Of these data only 1 showed prevalence values of STH over 50% in Argentina in Salta State (General Jose de San Martin municipality: Tartagal in 2007 with 71.4%); and 3 data showed values for prevalence of STH between >20–50% in Argentina in 2005: Formosa State (Municipality Formosa with 31%), Salta State (Municipality Capital with 27%) and Santa Fe State (Municipality La Capital with 22%). Data from Paraguay showed values for prevalence of STH between 1 – 10% (Fig. 54, Table 36).

Figure 54. Data published for prevalence of STH for SAC for the Southern Cone countries, 1995-2009.

Table 36. Data found for prevalence of STH with values above 20% for SAC population for Argentina, 1995-2009.

Country	State	Municipality	Study place	Percentage of prevalence	Year
Argentina	Formosa	Formosa	Formosa	31.0	2005
Argentina	Salta	General Jose De San Martin	Tartagal	71.4	2007
Argentina	Salta	Capital	Salta	27.0	2005
Argentina	Santa Fe	La Capital	Santa Fe	22.0	2005

One datum for prevalence of STH by species above 50% was found in Salta State, General Jose de San Martin municipality (for hookworms in 2007). For this age group no data were found for prevalence of STH by species with values between >20 – 50%.

No data for intensity of infection in this age group were found for the Southern Cone countries.

Children under 14 years old

For children between 1-14 years old, 19 data were found, all of them in Argentina, of which 9 showed prevalence values above 50% (Table 37). Also three data showed values for prevalence of STH between >20-50%: Buenos Aires (La Plata in 1995: 22%), Santa Fe State (La Capital in 1998: 34.4%) and Corrientes State (San Cosme municipality in 2005: 26.5%) (Fig. 55).

Figure 55. Data published for prevalence of STH for children between 1-14 years old for the Southern Cone countries, 1995-2009.

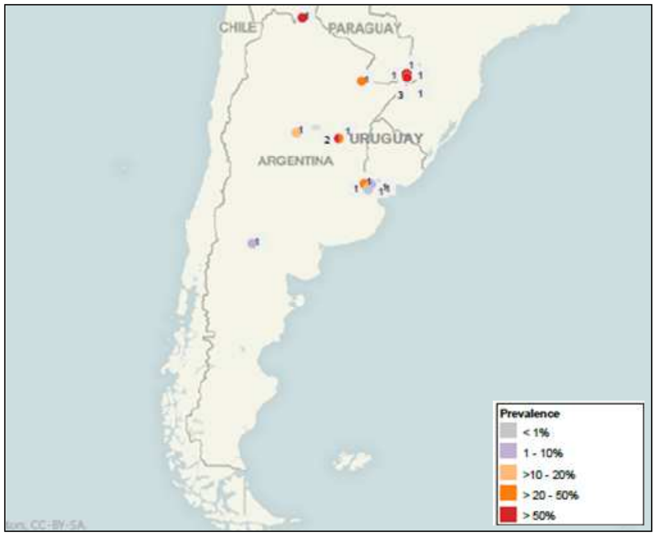


Table 37. Data found for prevalence of STH with values above 20% for children under 14 years old for Argentina, 1995-2009.

Country	State	Municipality	Study place	Percentage of prevalence	Year
Argentina	Buenos Aires	La Plata	La Plata (neighborhood Unión)	22.0	1995
Argentina	Corrientes	San Cosme	Santa Ana Guácaras	26.5	2005
Argentina	Misiones	Cainguas	Takaupí (reserve)	88.90	2006
Argentina	Misiones	Libertador General San Martin	El Pocito	77.8	2007
Argentina	Misiones	Libertador General San Martin	Talcaupi	77.8	2007
Argentina	Misiones	Libertador General San Martin	Ka a cupe	77.8	2007
Argentina	Misiones	Cainguas	Kaaguy Poty (reserve)	73.3	2006
Argentina	Misiones	Cainguas	Yvy Pytá (reserve)	62.3	2006
Argentina	Salta	General Jose De San Martin	Tartagal	69.6	2007
Argentina	Santa Fe	La Capital	Santa Fe barrio abosto	79.5	2001
Argentina	Santa Fe	La Capital	Santa Fe barrio las Lomas	56.0	2001
Argentina	Santa Fe	La Capital	Santa Fe	34.4	1998

Data for prevalence of STH by species with values over 50% for children between 1-14 years old were found especially for *A. duodenalis*, hookworms and *A. lumbricoides* (Table 38).

Table 38. Data found for prevalence of SHT by species with values above 50% for children 1-14 years old for Argentina, 1995-2009.

Country	State	Municipality	Study place	Percentage of Prevalence	Species	Year
Argentina	Misiones	Cainguas	Takaupí (reserve)	88.9	AD	2006
Argentina	Misiones	Libertador General San Martin	El Pocito	77.8	HW	2007
Argentina	Misiones	Libertador General San Martin	Talcaupi	77.8	HW	2007
Argentina	Misiones	Libertador General San Martin	Ka a cupe	77.8	HW	2007
Argentina	Misiones	Cainguas	Kaaguy Poty (reserve)	73.3	AD	2006
Argentina	Misiones	Cainguas	Yvy Pytá (reserve)	62.3	AD	2006
Argentina	Salta	General Jose De San Martin	Tartagal	69.6	HW	2007
Argentina	Santa Fe	La Capital	Santa Fe barrio abosto	79.5	AL	2001
Argentina	Santa Fe	La Capital	Santa Fe barrio las Lomas	56	AL	2001

AD: *Ancylostoma duodenale*, AL: *Ascaris lumbricoides*, HW: *Hookworms*.

Two data of heavy intensity of infection for *A. lumbricoides* in Santa Fe State, La Capital municipality in 2001, were found (Fig. 56).

Figure 56. Data published for intensity of infection by *Ascaris lumbricoides* for children between 1-14 years old for the Southern Cone countries, 1995-2009.

5. Discussion

General panorama of the data for prevalence and intensity of infection of STH in the LAC countries

Mapping for STH prevalence has been identified as an important issue for making evidence-based treatment decisions at local level. To reach the goals defined by WHO at the global level as well by PAHO for the Americas Region, in order to reduce prevalence among SAC in high risk areas to less than 20% prevalence as measured by quantitative egg count, the regular administration of preventive chemotherapy/or mass drug administration (MDA) for at least 75% of SAC at risk, as defined by the countries considering the prevalence has been defined as the primary strategy. If prevalence of soil-transmitted helminths among SAC is ≥ 50%, it is necessary to treat all SAC twice each year. If prevalence of STH among at-risk SAC is ≥ 20% and <50%, it is necessary to treat all SAC once each year.

As a result of this review of data published for the period 2000-2010 regarding the prevalence and intensity of infection of STH for the LAC, data published for 18 countries at the second administrative level (Argentina, Belize, Bolivia, Brazil, Colombia, Costa Rica, Cuba, Ecuador, Guatemala, Guyana, Haiti, Honduras, Mexico, Nicaragua, Paraguay, Peru, Saint Lucia and Venezuela) were found, highlighting the low number of data available on prevalence of STH for PSAC (40 data, 11.9%) as compared to data published for SAC (190, 56.7%) and for children between 1-14 years old (105, 31.3%). This situation is a challenge for the LAC countries because in order to do planning of interventions such as deworming it is necessary to know the prevalence in order to define how many times per year the antiparasitic drugs should be given, and to conduct monitoring and evaluation of progress in drug coverage, as mentioned above.

The low number of data for prevalence and intensity of infection of STH for the PSAC population in LAC needs to be addressed through a better visibility of this age group within the public health programs and the health information systems, in order to attract into interventions integrated into existing platforms such as immunization programs, nutrition programs, the Integrated Management Childhood Illnesses (IMCI) strategy and other initiatives which focus actions in children under 5 years old.

STH infections are widespread globally. As the prevalence and intensity of infection peaks in school age, SAC have traditionally been the priority target group for treatment. Nevertheless, as soon as an infant starts to explore its environment, thus coming into contact with contaminated soil, he/she is at risk of infection according to the levels of transmission in the area. Recent estimates indicate that more than 2 billion people are infected with STHs worldwide, a significant proportion of which are PSAC[13]. The first years of a child's life are marked by intense physical and mental development. In resource-poor settings, this development is compromised by a number of factors, including worm infections that exacerbate already high levels of anemia and wasting malnutrition. Some of the most common health indicators affected by chronic STH infections are iron status, nutrition and growth, vitamin A status, and cognitive development.[14]

An important finding was that 34.9% of the data for prevalence of STH published and selected for this study showed values between >20-50% and 27.8% above 50% of prevalence. These data might indicate that these areas need deworming as a massive intervention (once or twice per year respectively). These data are quite important in order to define the intervention in some areas within countries included in this document, either as a proxy of the baseline data or as a proxy of the evaluation of progress towards the deworming goals in the America's Region.

The most striking epidemiological features of human helminth infections are aggregated distributions in human communities, predisposition of individuals to heavy (or light) infections, rapid reinfection following chemotherapy, and age-intensity profiles that are typically convex (with the exception of hookworms)[15]. The morbidity caused by STH is most commonly associated with infections of heavy intensity. Approximately 300 million people with heavy helminth infections suffer from severe morbidity that results in more than 150,000 deaths annually (Crompton 1999; Montresor and others 2002). Periodic STH deworming has been shown to improve growth, micronutrient status (iron and vitamin A), and motor and language development in PSAC, and makes a strong case for including this age group in control programs where STH infections are prevalent[16].

The low number of data published for intensity of infection of STH in LAC for the period 2000-2010 is highlighted in this study, and especially the lack of data found for this indicator since 2006 at second administrative level, taking into account that this information is important to do the tracking of the diseases and their impact on children's health. 151 data for intensity of infection of STH were found for 7 countries Argentina, Bolivia, Brazil, Colombia, Ecuador, Honduras and Venezuela. Of these data, 28.5% (43 data) were found for heavy intensity of infection (of which 28 were for *Ascaris*

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[13] Albonico M, Allen H, Chitsulo L, Engels D, Gabrielli A-F, et al. (2008) Controlling Soil-Transmitted helminthiasis in Pre-School-Age Children through Preventive Chemotherapy. PLoS Negl Trop Dis 2(3): e126. doi:10.1371/journal.pntd.0000126

[14] Albonico M, Allen H, Chitsulo L, Engels D, Gabrielli A-F, et al. (2008) Controlling Soil-Transmitted helminthiasis in Pre-School-Age Children through Preventive Chemotherapy. PLoS Negl Trop Dis 2(3): e126. doi:10.1371/journal.pntd.0000126

[15] Peter J. Hotez, Donald A. P. Bundy, Kathleen Beegle, et.al. Disease Control Priorities in Developing Countries: Chapter 24, Helminth Infections: Soil-Transmitted Helminth Infections and Schistosomiasis.

[16] Albonico M, Allen H, Chitsulo L, Engels D, Gabrielli A-F, et al. (2008) Controlling Soil-Transmitted helminthiasis in Pre-School-Age Children through Preventive Chemotherapy. PLoS Negl Trop Dis 2(3): e126. doi:10.1371/journal.pntd.0000126

lumbricoides) and 34.4% (52 data) for moderate intensity of infection. The data for heavy intensity of infection were found mainly for SAC, due to the higher number of data found for this age group. Once again it is necessary to mention the need to stimulate surveys and analysis of data for PSAC in order to understand the epidemiologic profiles of the prevalence and intensity of infection of STH in this cohort and to do the necessary planning of the deworming interventions based on evidence.

The data found for children between 1-14 years old for prevalence of STH (105 data, 31.3%) could be used as a proxy value for prevalence of STH at second administrative level (if there were no available data disaggregated by PSAC and SAC). However it could be difficult to plan the deworming activities, due to the difference between children who are enrolled in the education system (5-14 years old) vs. children under 5 years who are not. Hence, different strategies are required to reach different groups of population with deworming activities.

Understanding where the population at-risk is located, including their socio-economic and environmental conditions, is fundamental for appropriate allocation of resources and to develop cost-effective control interventions. In particular, it allows for reliable estimation of the overall drug needs of programs and for efficient geographical targeting of control efforts. The precise global distribution of STH infection and how many people are infected and at risk of morbidity, however, remains poorly defined. This in turn, limits how national governments and international organizations define and target resources to combat the disease burden due to STH infection[17].

Panorama of the data for prevalence and intensity of infection of STH for sub regions and countries in LAC

Mapping of data for prevalence and intensity of infection of STH in LAC for 2000-2010 by sub-region and countries provided information regarding gaps on mapping, and also important information regarding areas that need deworming activities for PSAC and SAC. However, these data may not be showing the full reality, as there may be data or studies not yet published in journals and the Ministries of Health may have unpublished data. The results of this study show some countries with absence of information for prevalence and intensity of STH infections, as well as others with no updated or recent data published. Differences in the observed prevalence of STH infection within municipalities were also illustrated. The main findings by countries and sub regions according to the categorization made for this study are highlighted below.

[17] Brooker, S, Clements, A, Bundy, D. Global epidemiology, ecology and control of soil-transmitted helminth infections. *Adv Parasitol*. 2006 ; 62: 221–261.

Mexico

In the case of data published for Mexico an important gap of information regarding to prevalence of STH for SAC was found, and no data were found for intensity of infection at the second administrative level. Of 28 data for prevalence of STH found for Mexico, the more updated prevalence data was found in 2007 (1 data), followed by 11 found in 2003 and 1 in 2005. This situation shows the need to develop actions in order to know the current epidemiological situation of the prevalence and intensity of infections of STH in Mexico.

It is important to indicate that data for a municipality in Oaxaca State showed prevalence above 50%, which should be useful as a proxy to evaluate in that area the impact of the yearly campaigns of deworming made by the national child health program.

Mexico is under the priority countries for PAHO (Group 1) in order to focus actions for control and elimination of NIDs and it is estimated that there are 1,550,667 of PSAC and 4,002,645 of SAC at risk of suffering infections by STH (Population at risk is the population without access to improved sanitation). Mexico informed of a total of 4,616,686 of PSAC and 14,410,489 of SAC dewormed in 2009[18].

Central American isthmus countries

In general, a gap of data published for prevalence of STH for the countries was identified within this sub-region, specifically for PSAC at second administrative level (9 data found) compared with data for SAC (52 data) and for children between 1-14 years old (33 data). The highest number of data published for prevalence of STH for SAC was for Honduras (36 data), while for Guatemala, Nicaragua, Costa Rica and Belize less than 10 data published for each country were found. The lack of information published for Panama is highlighted.

Also the number of data for prevalence of STH found in this sub-region with values over 50% (17 for Honduras, 5 for Guatemala and 1 for Nicaragua) was important. This data might be useful either as a baseline data or as a proxy for monitoring and evaluation of deworming interventions at the second administrative level; this could be the case in Nicaragua where year by year deworming activities have been developed throughout the immunizations program.

[18] Ault SK, Saboyá MI, Nicholls RS, Requejo RH. Control and Elimination of Five Neglected Diseases in Latin America and the Caribbean, 2010 – 2015. Analysis of Progress, Priorities and Lines of Action for Lymphatic filariasis, Schistosomiasis, Onchocerciasis, Trachoma and Soil-transmitted helminthiases. Pan American Health Organization: Washington D.C., 2010.

Data for heavy intensity of infection were found only for Honduras for *Ascaris lumbricoides* and disaggregated by PSAC and SAC. For other countries no published data were found of heavy intensity of infection, which indicates the need to focus actions to know the epidemiological situation for this indicator in countries of the Central American isthmus.

It is important to highlight that in the case of Belize, Costa Rica, Honduras and Nicaragua the most recent data for prevalence of STH were found for 2005, while for Guatemala data for 2009 were found. This situation shows the need to develop actions in order to know the current epidemiological situation of the prevalence and intensity of infections of STH in the Central American isthmus countries.

Of the Central American Isthmus countries, Guatemala is within the Group 1 of priority countries for PAHO for the control and elimination of NIDs; Belize, El Salvador, Honduras and Panama are within Group 2, Nicaragua within Group 3 and Costa Rica within Group 4. In the table 39 the number of PSAC and SAC at risk of STH infections and the number of children reported as dewormed by country in 2009 are showed[19].

Table 39. Number of PSAC and SAC at risk of STH infections and number of children reported as dewormed by the Central American isthmus countries, 2009.

Country	Population at risk 2009 (population without access to improved sanitation*)		Number of children dewormed in 2009**	
	PSAC	SAC	PSAC	SAC
Belize	28.944	71.642	19,085	57,949
Costa Rica	12,043	32,481	-	-
El Salvador	28.572	82.904	-	1,223,000
Guatemala	1,702,790	3,733,185	-	2,450,648
Honduras	260.233	621.158	-	1,336,334
Nicaragua	279.339	695.632	125,000	2,020,757
Panama	19.328	46.640	96,074	364,076

*Pan American Health Organization, Health Information and Analysis Project. Health Situation in the Americas: Basic indicators 2009. Washington, DC., United States of America, 2009.
** Pan American Health Organization. Regional Program for Neglected and Parasitic Diseases. Databases of deworming activities in LAC, 2005-2009.

Latin Caribbean countries

There is an important gap of data published for prevalence of STH for PSAC in the Latin Caribbean countries at second administrative level; no data were found for Dominican

[19] Ault SK, Saboyá MI, Nicholls RS, Requejo RH. Control and Elimination of Five Neglected Diseases in Latin America and the Caribbean, 2010 – 2015. Analysis of Progress, Priorities and Lines of Action for Lymphatic filariasis, Schistosomiasis, Onchocerciasis, Trachoma and Soil-transmitted helminthiases. Pan American Health Organization: Washington D.C., 2010.

Republic, Haiti, Puerto Rico, French Guiana, Guadeloupe and Martinique. In the case of Cuba only one datum was found in 1998 (0.8% prevalence of STH).

Regarding data for prevalence of STH for SAC, no reports published for Dominican Republic, Puerto Rico, French Guiana, Guadeloupe and Martinique were found. For Cuba and Haiti there are data published. However, the Cuban data are from 2004 and those of Haiti from 2002. This situation shows the need to develop actions in order to know the current epidemiological situation of the prevalence and intensity of infections of STH in the Latin Caribbean countries.

An important gap was identified regarding data for intensity of infection of STH because no published data were found at all.

Actions should focus on the Hispaniola Island (Haiti and Dominican Republic) in order to characterize the epidemiological situation of prevalence and intensity of infection of STH, such as a baseline survey for Dominican Republic as well as monitoring and evaluation of deworming activities that are made yearly in Haiti by different organizations and programs, including the national program for the elimination of lymphatic filariasis which includes treatment with albendazole. In the specific case of Haiti, it is necessary evaluate the situation following the earthquake in January 2010 and the cholera outbreak since the second half of 2010.

Of the Latin Caribbean countries Dominican Republic and Haiti are within the priority countries (Group 1) for PAHO in order to focus actions for control and elimination of neglected infectious diseases. Cuba, French Guiana, Guadeloupe, Martinique and Puerto Rico are within Group 4, whose main feature is to have low number of children at risk of STH infections due to a better national coverage of access to improved sanitation. Dominican Republic has an estimated 182,497 PSAC and 438,176 SAC at risk of STH infections. For 2009 1,601,414 SAC were reported dewormed but there were no deworming data reported for PSAC. Haiti has an estimated 809,827 PSAC and 1,932,493 SAC at risk of STH infections. In 2009 40,564 PSAC and 2,655,053 SAC were reported as dewormed[20].

Non Latin Caribbean countries

In this group of countries only data were recovered at second administrative level for prevalence of STH from Guyana and Saint Lucia for children under 14 years old without differentiation by PSAC and SAC. For other countries no published data were found data: Anguila, Antigua & Barbuda, Aruba, Bahamas, Barbados, Cayman Islands,

[20] Ault SK, Saboyá MI, Nicholls RS, Requejo RH. Control and Elimination of Five Neglected Diseases in Latin America and the Caribbean, 2010 – 2015. Analysis of Progress, Priorities and Lines of Action for Lymphatic filariasis, Schistosomiasis, Onchocerciasis, Trachoma and Soil-transmitted helminthiases. Pan American Health Organization: Washington D.C., 2010.

Dominica, Grenada, Jamaica, Monserrat, Netherlands Antilles, Saint Kitts and Nevis, Saint Vincent and the Grenadines, Suriname, Trinidad & Tobago, Turks & Caicos Islands, Virgin Islands (UK), Virgin Islands (US). However, it is important to note that Suriname developed a national survey in 2010 to know the prevalence and intensity of infection of STH and schistosomiasis, in which the overall prevalence of STH infections was 2.1%; these data still are without publication (February 2011).

Neither Guyana nor Saint Lucia showed values for prevalence of STH over 50%; only in the case of Guyana one datum was found for 2002 of prevalence above 20% (28.2%), and one datum for Saint Lucia with 22.5% of prevalence in 2005; the rest of the data found showed values under 20%.

There is an important gap regarding data for intensity of infection of STH for the countries in this sub-region, because no published data were found. As mentioned, the most recent data published for Guyana were in 2002 and for Saint Lucia in 2005. This situation shows the need to develop actions in order to know the current epidemiological situation of the prevalence and intensity of infections of STH in the Non Latin Caribbean countries, especially for local areas with populations at risk of STH infections, taking into account that most of these countries have a good national coverage of access to improved sanitation.

Of these countries Guyana, Saint Lucia and Suriname are within Group 1 of the priority countries for PAHO for the control and elimination of neglected infectious diseases. The rest of the countries are within Group 4, due to their low number of PSAC and SAC estimated to be at risk of suffering STH infections. The number of children at risk of STH infections are shown in Table 40; none of the three countries informed about the number of children dewormed in 2009; however, Guyana through the national program of elimination of lymphatic filariasis, is providing albendazole together with Diethylcarbamazine (DEC) since 2010. Hence, an evaluation of the impact of this intervention is needed [21].

Table 40. Number of PSAC and SAC at risk of STH infections and number of children reported as dewormed by the Non Latin Caribbean countries, 2009.

Country	Population at risk 2009 (population without access to improved sanitation*)		Number of children dewormed in 2009**	
	PSAC	SAC	PSAC	SAC
Guyana	10,249	30,352	-	-
Saint Lucia	11,688	30,305	-	-

[21] Ault SK, Saboyá MI, Nicholls RS, Requejo RH. Control and Elimination of Five Neglected Diseases in Latin America and the Caribbean, 2010 – 2015. Analysis of Progress, Priorities and Lines of Action for Lymphatic filariasis, Schistosomiasis, Onchocerciasis, Trachoma and Soil-transmitted helminthiases. Pan American Health Organization: Washington D.C., 2010.

Country	Population at risk 2009 (population without access to improved sanitation*)		Number of children dewormed in 2009**	
	PSAC	SAC	PSAC	SAC
Suriname	7,082	18,341	-	-

*Pan American Health Organization, Health Information and Analysis Project. Health Situation in the Americas: Basic indicators 2009. Washington, DC., United States of America, 2009.
** Pan American Health Organization. Regional Program for Neglected and Parasitic Diseases. Databases of deworming activities in LAC, 2005-2009.

Andean area countries

As in other sub-regions and countries, for the Andean area countries (Bolivia, Colombia, Ecuador, Peru and Venezuela) a gap was identified for data regarding prevalence of STH for PSAC (only 9 data found, compared with 32 data found for SAC and 20 for children between 1-14 years old). The lack of information published for Peru, specifically for prevalence of STH in PSAC, is highlighted. None of the data for prevalence of STH in PSAC showed prevalence over 50%.

For these five countries data were found for prevalence of STH for SAC, of which 22% showed values of prevalence over 50%, mainly in Venezuela (4 data), Ecuador (2) and Peru (1), while 37.5% of the data showed prevalence between >20-50% mainly for Peru (5 data), Colombia (2), Ecuador (2), Venezuela (2) and Bolivia (1). This information is useful either as a baseline of prevalence for those local areas or as a proxy for monitoring and evaluation of the interventions in progress at local level.

An important number of data for intensity of infection of STH was found for the countries in the Andean area, more than for other sub-regions included in this study; however, the most recent data were from 2003. For SAC data published for heavy intensity of infection by species were found in Bolivia (8 data in 1997), Colombia (3 in 1995), Ecuador (5 in 2001) and Venezuela (3 in 1997 and 3 in 2003).

The data found for children between 1-14 years old might be used as a proxy of prevalence by PSAC and SAC in local areas without data disaggregated by age group.

The most recent data published for prevalence of STH were found for Bolivia, Colombia and Venezuela (2008); for Peru data published in 2007 were found and for Ecuador in 2005. This situation shows the need to develop actions in order to know the current epidemiological situation of the prevalence and intensity of infections of STH in the Andean area countries.
Bolivia, Ecuador and Peru are within the priority countries for PAHO for the control and elimination of NIDs (Group 1), while Colombia and Venezuela are within Group 2. The number of children at risk of STH infections, and the number of children dewormed in 2009 by country is showed in the Table 41. Venezuela did not report deworming activities in 2009.

Table 41. Number of PSAC and SAC at risk of STH infections and number of children reported as dewormed by the Andean Area countries, 2009.

Country	Population at risk 2009 (population without access to improved sanitation*)		Number of children dewormed in 2009**	
	PSAC	SAC	PSAC	SAC
Colombia	788,174	1,939,432	-	1,500,000
Bolivia	566,787	1,328,671	-	57,269
Ecuador	177,234	456,169	-	5,380,283
Peru	663,530	1,645,053	3,632	2,502,440
Venezuela	2,332,960	5,597,078	-	-

*Pan American Health Organization, Health Information and Analysis Project. Health Situation in the Americas: Basic indicators 2009. Washington, DC., United States of America, 2009.
** Pan American Health Organization. Regional Program for Neglected and Parasitic Diseases. Databases of deworming activities in LAC, 2005-2009.

Brazil

For Brazil a gap of data for prevalence of STH for PSAC (18 data found) was also found compared with data for SAC (50 data). In the case of PSAC, four data showed values of prevalence of STH over 50%; for SAC 20% of data (10) were found with prevalence over 50% (mainly in municipalities of 8 states), and 32% (16) with prevalence between >20-50% (mainly in municipalities of 12 states).

Regarding data for intensity of infection of STH only one datum of heavy infection was found in PSAC and SAC in 2004 for *A. lumbricoides* and hookworms in a municipality of Minas Gerais state.

Data of prevalence and intensity of infection of STH for children between 1-14 years old in Brazil might be used as a proxy of STH prevalence in local areas without data disaggregated by age group.

It is highlighted that Brazil was the only country where data for prevalence of STH were found for each one of the years included in this study. However, as was noted within the mapping section, the studies have been concentrated in certain areas of the country.

Brazil is within the priority countries for PAHO for control and elimination of neglected infectious diseases (Group 1), and it is estimated that it has 2,948,254 PSAC and 7,953,689 SAC at risk of STH infections. In 2009 176,179 SAC were reported as dewormed[22].

[22] Ault SK, Saboyá MI, Nicholls RS, Requejo RH. Control and Elimination of Five Neglected Diseases in Latin America and the Caribbean, 2010 – 2015. Analysis of Progress, Priorities and Lines of Action for Lymphatic filariasis, Schistosomiasis, Onchocerciasis, Trachoma and Soil-transmitted helminthiases. Pan American Health Organization: Washington D.C., 2010.

Southern Cone countries

For these countries (Argentina, Chile, Paraguay and Uruguay) a gap was identified on data published for prevalence of STH for PSAC (2 data) compared with data published for SAC (19 data). The lack of information published for prevalence of STH for PSAC and SAC for Chile and Uruguay is highlighted; in the case of Paraguay no data published for PSAC were found. In contrast, data were found for children between 1-14 years old of Argentina (19 data) of which 47% showed prevalence over 50% (9 data). Argentina might use these data as a proxy for monitoring and evaluation in specific local areas.

For Argentina one datum for prevalence of STH over 50% for PSAC and SAC (Municipality in Salta State) was found. The most recent data for prevalence of STH published in Argentina were from 2007 and for Paraguay from 2001. This situation shows the need to develop actions in order to know the current epidemiological situation of the prevalence and intensity of STH infections in the Southern Cone countries.

The lack of information published for intensity of infection of STH for these four countries is highlighted.

Argentina and Paraguay are within Group 3 of the priority countries for control and elimination of NIDs for PAHO because they both have municipalities in the Chaco Area (The Gran Chaco is a sparsely populated, hot and semi-arid lowland region of the Río de la Plata basin, divided among eastern Bolivia, Paraguay, northern Argentina and a portion of the Brazilian states of Mato Grosso and Mato Grosso do Sul, where it is connected with the Pantanal region). It is estimated that Argentina has 241,719 PSAC and 606,642 SAC, and Paraguay 176,837 PSAC and 425,667 SAC at risk of STH infections. Uruguay and Chile are in Group 4 of the prioritization, and although this group of countries in general show a high percentage of coverage of access to improved sanitation, in the case of Chile there is an important number of PSAC and SAC at risk of suffer of STH infections (59,191 and 156,485 respectively), while Uruguay has 3,967 and 10,339 respectively. No one of these countries reported children dewormed in 2009[23].

After reviewing the data found for prevalence and intensity of infection of STH in LAC, Tables 42 and 43 shows a summary of the main findings and also allows us to view the gaps in the information needed to make fully informed decisions in LAC countries.

[23] Ault SK, Saboyá MI, Nicholls RS, Requejo RH. Control and Elimination of Five Neglected Diseases in Latin America and the Caribbean, 2010 – 2015. Analysis of Progress, Priorities and Lines of Action for Lymphatic filariasis, Schistosomiasis, Onchocerciasis, Trachoma and Soil-transmitted helminthiases. Pan American Health Organization: Washington D.C., 2010.

Table 42. Number of data for prevalence and intensity of infection included by country and by age group, 1995-2009.

Country	***Data published for prevalence of STH***						***Data published for intensity of infection***					
	PSAC		**SAC**		**1-14**		**PSAC**		**SAC**		**1-14**	
	# of data	**Year of most recent data**	**# of data**	**Year of most recent data**	**# of data**	**Year of most recent data**	**# of data**	**Year of most recent data**	**# of data**	**Year of most recent data**	**# of data**	**Year of most recent data**
Argentina	2	2007	11	2007	19	2007	-	-	-	-	2	2001
Belize	1	2004	3	2005	1	2004	-	-	-	-	-	-
Bolivia	1	2004	5	2004	6	2008	-	-	24	1997	-	-
Brazil	18	2008	50	2009	20	2009	6	2004	7	2005	11	2005
Chile	-	-	-	-	-	-	-	-	-	-	-	-
Colombia	4	2008	4	2008	3	2000	-	-	9	1999	-	-
Costa Rica	1	1998	1	1998	2	2005	-	-	-	-	-	-
Cuba	1	1998	7	2004	1	2007	-	-	-	-	-	-
Dominica	-	-	-	-	-	-	-	-	-	-	-	-
Dominican Republic	-	-	-	-	-	-	-	-	-	-	-	-
Ecuador	2	2005	5	2003	4	2003	-	-	6	2003	4	2003
El Salvador	-	-	-	-	-	-	-	-	-	-	-	-
French Guiana	-	-	-	-	-	-	-	-	-	-	-	-
Guadeloupe	-	-	-	-	-	-	-	-	-	-	-	-
Guatemala	-	-	7	2007	7	2009	-	-	-	-	-	-
Guyana	-	-		-	1	2002	-	-	-	-	-	-
Haiti	-	-	11	2002	1	2001	-	-	-	-	-	-
Honduras	7	1999	36	2005	23	2001	21	1998	21	1998	21	1998
Jamaica	-	-	-	-	-	-	-	-	-	-	-	-
Martinique	-	-	-	-	-	-	-	-	-	-	-	-
Mexico	1	2007	25	2005	2	1998	-	-	-	-	-	-
Nicaragua	-	-	5	2005	-	-	-	-	-	-	-	-
Panama	-	-	-	-	-	-	-	-	-	-	-	-
Paraguay	-	-	2	2001	-	-	-	-	-	-	-	-
Peru	-	-	9	2005	2	2007	-	-	-	-	-	-
Puerto Rico	-	-	-	-	-	-	-	-	-	-	-	-
Saint Lucia	-	-	-	-	8	2005	-	-	-	-	-	-
Suriname*	-	-	7	2010	-	-	-	-	7	2010	-	-
Trinidad & Tobago	-	-	-	-	-	-	-	-	-	-	-	-
Uruguay	-	-	-	-	-	-	-	-	-	-	-	-
Venezuela	2	2008	9	2008	5	2008	-	-	20	2003	-	-

*Suriname developed a national survey during 2010 for STH, however the data are without publication by February 2011.

For other Non-Latin Caribbean countries was not found data: Anguila, Antigua & Barbuda, Aruba, Bahamas, Barbados, Cayman Islands, Grenada, Monserrat, Netherlands Antilles, Saint Kitts and Nevis, Saint Vincent and the Grenadines, Turks & Caicos Islands, Virgin Islands (UK), Virgin Islands (US)

Table 43. Threshold of percentage of STH prevalence and species of STH related with heavy intensity of infection found by country and by age group, 1995-2009.

Country	*Threshold of Percentage of STH prevalence*						*Heavy intensity of infection*		
	PSAC		**SAC**		**1-14**		**PSAC**	**SAC**	**1-14**
	Min.	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Species**	**Species**	**Species**
Argentina	20.3	66.7	6.0	71.4	0	88.9	-	-	AL
Belize	55.0		34.4	77.0	66.2		-	AL, TT	-
Bolivia	16.1		11.6	24.3	2.0	76.1	-	-	-
Brazil	0	80.3	1.2	9.3	0.7	85.3	AL, HW	AL, HW	AL, HW
Chile	-	-	-	-	-	-	-	-	-
Colombia	0.9	26.2	5.17	43.1	2.0	9.9	-	AL, TT, HW	-
Costa Rica	21.0		41.0		26.8	36.0	-	-	-
Cuba	0.8		1.8	24	40.5		-	-	-
Dominica	-	-	-	-	-	-	-	-	-
Dominican Republic	-	-	-	-	-	-	-	-	-
Ecuador	19.6	35.5	3.7	63.4	20.1	55.3	-	AL, TT, HW	
El Salvador	-	-	-	-	-	-	-	-	-
French Guiana	-	-	-	-	-	-	-	-	-
Guadeloupe	-	-	-	-	-	-	-	-	-
Guatemala	-	-	10.2	63.3	42.0	47.0	-	-	-
Guyana	-	-	-	-	28.2		-	-	-
Haiti	-	-	20.6	73.7	29.3		-	-	-
Honduras	7.4	78.0	6.6	93.0	11.7	89.2	AL	AL	AL
Jamaica	-	-	-	-	-	-	-	-	-
Martinique	-	-	-	-	-	-	-	-	-
Mexico	6.9		0.8	53.0	3.7	6.0	-	-	-
Nicaragua	-	-	10.9	84.4	-	-	-	-	-
Panama	-	-	-	-	-	-	-	-	-
Paraguay	-	-	5.1		-	-	-	-	-
Peru	-	-	1.6	77.9	6.8	18.4	-	-	-
Puerto Rico	-	-	-	-	-	-	-	-	-
Saint Lucia	-	-	-	-	8.5	22.5	-	-	-
Suriname*	-	-	2.1		-	-	-	-	-
Trinidad & Tobago	-	-	-	-	-	-	-	-	-
Uruguay	-	-	-	-	-	-	-	-	-
Venezuela	1.96	11.0	5.07	82.5	2.86	70.3	-	AL, TT, AD	-

AD: *Ancylostoma duodenale*, AL: *Ascaris lumbricoides*, HW: *Hookworms*, TT: *Trichuris trichiura*

*Suriname developed a national survey during 2010 for STH, however the data are without publication by February 2011.

For other Non-Latin Caribbean countries was not found data: Anguila, Antigua & Barbuda, Aruba, Bahamas, Barbados, Cayman Islands, Grenada, Monserrat, Netherlands Antilles, Saint Kitts and Nevis, Saint Vincent and the Grenadines, Turks & Caicos Islands, Virgin Islands (UK), Virgin Islands (US)

6. Conclusions

Although it was possible to find data at second administrative level for prevalence of soil-transmitted helminths (335 data) and for intensity of infection (151 data) between 2000 and 2010 for 18 countries, there is an important lack of information to make fully-informed decisions for deworming in PSAC and SAC in LAC. Also an important reduction of data published on STH prevalence since 2006 was observed. This results in a weakness in information to make evidence-based decisions at national and subnational levels for improving child health, especially to reduce the burden of intestinal parasitic worms. This situation could be due to the lack of interest in this issue for health authorities, research groups and other groups of interest in LAC that have greater interest in other public health issues. It also could be caused by a reduction in data published in journals, or absence of publication of some studies done at the local level.

It is necessary and urgent to update mapping for prevalence and intensity of infection of STH in order to make better evidence-based decisions regarding deworming activities. The data available for PSAC are insufficient to know the current situation of STH prevalence and intensity of infection, and although more data for SAC population were found, these data are only from some countries or from some second administrative levels and in some cases are not updated.

For this purpose, new tools developed to estimate the occurrence of NIDs in areas without data from surveys might be useful. The geographical information systems (GIS) framework allows ready comparison between disease patterns and environmental data, while remote sensing (RS) technologies can use high-resolution satellite data to provide estimates of such variables as temperature, vegetation (as a proxy for various environmental factors), and humidity. The relationships between observed infection patterns and environmental factors can be investigated using both traditional and spatially explicit statistical approaches, allowing the spatial distributions of prevalence of infection to be predicted in unsurveyed areas. Such analyses are increasingly adopting a Bayesian approach to statistical inference that provides a robust method for measuring uncertainty in prediction[24]. Of course, to use these new tools to predict the prevalence of STH requires that health workers are trained on using it, acquiring the software and equipment and having access to the databases with variables required to do the predictions. These new tools have the advantage of allowing do estimations at any moment and at any place and are being used by researchers and interest groups as support to the current parasitological surveys promoted at national and subnational levels. The capacity to do surveys in LAC countries needs to be strengthened at the same

[24] Brooker S, Hotez PJ, Bundy DAP (2010) The Global Atlas of Helminth Infection: Mapping the Way Forward in Neglected Tropical Disease Control. PLoS Negl Trop Dis 4(7): e779. doi:10.1371/journal.pntd.0000779

time as these new tools are promoted as an innovation strategy that may reduce costs and time.

It is also necessary to push the operational research agenda with governments and groups of interest in order to develop STH mapping activities. The mapping is necessary in order to know where the populations at risk are, which age groups are at risk of STH infection, the municipalities, the slums in urban areas in which the authorities need to focus their work (if these data are available), and also for monitoring and evaluation purposes throughout time in order to know the impact of interventions, not only deworming, but also nutrition, education, and environmental interventions and integrated actions to reduce child morbidity and mortality and to improve child development.

To develop mapping activities at local level, it is necessary to have resources (human and financial), and also an integrated approach to increase the efficient use of those resources, especially when it is not possible to allocate more. Mapping activities as well as deworming could be integrated within other public health programs toward improving child health: expanded programs of immunization - EPI, integrated management of childhood illnesses – IMCI, nutrition programs, healthy schools, among others; and within other NIDs programs, especially in places with overlapping of STH with some these diseases (lymphatic filariasis, onchocerciasis, trachoma, schistosomiasis, etc.). Some studies of integrated mapping for NIDs, including STH, have been documented and developed in countries from other regions (i.e. Africa and Asia) with promised results in order to reduce costs, time and financial resources; these could help to the LAC in order to adapt it according with the own epidemiological situation by country.

Without enough, accurate and specific data about STH prevalence and intensity of infection by age group (PSAC and SAC) in LAC it will be difficult to identify with right confidence the main gaps and places to focus integrated actions, including deworming, to reach the regional and global goals of deworming our children at risk.

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