Child Health, Development, and Helminthic Infection in Andean Nations: Building the Case for Government-Sponsored Deworming

By

Tiffany Pack

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Advisor: Hollie Pavlica, PhD

Second Reader: Donna Henry, MPH

Date
ABSTRACT

It is estimated that, globally, at least 2 billion people (Savioli 2004) are infected with soil-transmitted helminths (STHs) - whipworms, roundworms and hookworms. STH infections have, until recently, been marginalized in terms of international attention and resources. In the last decade, focus has begun to shift toward recognition of STH infections as neglected tropical diseases and serious long term health threats, and rightly so, as STH infections are responsible for a myriad of negative health effects such as chronic anemia, nutrient malabsorption and reduced cognitive function. In 2001, the World Health Assembly passed a resolution to treat STH infections in high-risk groups with a goal of treating over 75% of school-age children at risk by 2010. High risk groups are typically found within developing where poverty and its associated challenges of limited access to improved sanitation, clean drinking-water and health care endure. Among those infected with STHs, about one third are estimated to be children with the highest rates of infection typically in school age children between the ages of 5 and 15 years (UN-ECOSOC 2010). Helminth infections adversely impact these children in terms of cognitive development, school attendance and educational performance. STHs have also been connected to anemia or malabsorption of Vitamin A and iron (WHO PPC 2010), deficiencies associated with increased measles and diarrheal morbidity and general fatigue in children (WebMD 2010) and with blindness and fatigue in adults (CDC 2010).

Andean nations (defined as Bolivia, Colombia, Ecuador, Peru and Venezuela) are particularly affected as, using national poverty standards, they are five of the six poorest countries in South America (World Bank WDI 2008). Given economic impediments, disparate progress has been made in the last decade in the areas of child nutrition, education and improved water and sanitation. However, for rural communities which are typically associated with the
highest prevalences of soil-transmitted helminths, lack of access to safe water, improved sanitation and health care persist. Children within these communities are particularly affected. Until systemic improvements to foundational public health challenges can be achieved, child health and development and in turn the long term national health and productivity will be threatened. Therefore, until these challenges can be addressed, Andean region governments must take necessary steps to protect their nations’ children from these diseases in the short term. A straightforward, researched method of protection is school-based parasite prevention. These programs have important implications not only for immediate, individual child health and development, but also for the long term health, productivity of their nations.
**Introduction**

It is estimated that, globally, at least 2 billion people (Savioli 2004) are infected with soil-transmitted helminths (STHs), plainly stated, whipworms, roundworms and hookworms. While world resources, funding and attention have rightfully been focused on three serious public health issues (tuberculosis, HIV/AIDS and Malaria), STH infections have, until recently, been marginalized in terms of attention and resources. The fact that many infected people are clinically sub-symptomatic makes the total scope of the burden of disease hard to quantify and exacerbates the problem of raising these infections to critical global attention (ParaSite 2010). Further complicating matters, in societies where STHs are endemic, parasites are often so widespread that they are not recognized as a medical problem. In the last decade, focus has begun to shift toward recognition of STH infections as neglected tropical diseases and serious long term health threats, and rightly so, as STH infections are responsible for a myriad of negative health effects such as chronic anemia, nutrient malabsorption and reduced cognitive function. In 2001, the World Health Assembly passed a resolution to treat STH infections in high-risk groups with a goal of treating over 75% of school-age children at risk by 2010. As later reported in the 2004 Joint Statement by the World Health Organization (WHO) and the United Nations Children’s Fund (UNICEF), the burden of disease believed to be correlated with STHs is increasingly recognized as a significant public health issue, with the greatest impact on developing countries, where poverty and its associated challenges of limited access to improved sanitation, clean drinking-water and health care endure. Among those infected with STHs, about one third are estimated to be children with the highest rates of infection typically in children between the ages of 5 and 15 years (UN-ECOSOC 2010).
Helminth infections adversely impact school age children (children between the ages of 5 to 15 years), even those with asymptomatic infections, in terms of cognitive (language and memory) development, school attendance and educational performance. They have also been connected to anemia or malabsorption of Vitamin A and iron (WHO PPC 2010). These deficiencies are associated with increased measles and diarrheal morbidity and general fatigue in children (WebMD 2010) and with blindness and fatigue in adults (CDC 2010).

In the western hemisphere, Andean nations (defined as Bolivia, Colombia, Ecuador, Peru and Venezuela) are particularly affected as, using national poverty standards, they are five of the six poorest countries in South America (World Bank 2008). In fact, in its 2006 report on poverty, the World Bank noted that in the fifteen years leading up to 2006, while poverty fell slightly in Central America and declined in the Southern Cone area, it actually increased in the Andean Community (from 25 to 31 percent) (Perry, 2006). Given economic impediments, disparate progress has been made in the last decade in the areas of child nutrition, education and improved water and sanitation. However, for rural communities which are typically associated with the highest prevalences of soil-transmitted helminths, the complex public health issues of access to safe water, improved sanitation and health care persist. Children within these communities are particularly affected. Until systemic improvements to foundational public health challenges can be achieved, child health and development and in turn the long term national health and productivity will be threatened. Therefore, until these challenges can be addressed, Andean region governments must take necessary steps to protect their nations’ children from these diseases in the short term. A straightforward, researched method of protection is school-based parasite prevention. These programs have important implications not
only for immediate, individual child health and development, but also for the long term health, productivity of their nations.

**Problem Scope**

*Global Prevalence*

Soil-transmitted helminths are broadly dispersed throughout the tropics and subtropics and STH distribution in a country correlates closely with climate and soil characteristics (Savioli 2004). Equally important to STH distribution is poverty along with inadequate water supplies and sanitation. Throughout the developing world, the four most common soil-transmitted helminths are roundworm (*Ascaris lumbricoides*), whipworm (*Trichuris trichiura*), and the anthropophilic hookworms (*Necator americanus* and *Ancylostoma duodenale*) (Hotez 2006). Within Latin America as a whole, an estimated 19% of people have trichuriasis (100 million cases), 16% ascariasis (84 million cases), and 10% are positive for hookworm infection (50 million) (Tanner 2009).

Extrapolating the fact that children comprise about one third of those infected with helminths worldwide and that within the population of children, those of school age tend to be the hardest hit by intestinal parasite infection (Hotez 2008), we know that a significant portion of these estimated cases are within school age populations.

*Helminth Infection Transmission and Contributors*

Soil-transmitted helminth infections are transmitted via feces as parasites leave the human host as eggs or larvae in feces. After excretion, worms incubate and develop in soil and are spread to other human hosts via one of two routes: ingestion or skin penetration. Ascaris and trichuris are transmitted via ingestion when feces contaminated soil, water, food or hands come into contact with the mouth and the pathogen is transmitted. These ingestion-transmitted
infections can be both water-washed and food-borne (WHO 2010). Hookworms, on the other hand, infect the host via skin penetration when the host comes into direct contact with contaminated soil. Figure 1 provides a visual overview of the routes of STH disease transmission.

Based on these defined routes, critical elements to prevent the spread of disease are: 1) access to improved water sources; 2) hygiene - personal, domestic and community; and 3) access to improved sanitation.

**Figure 1. F Diagram of Disease Transmission.**

Lack of access to safe drinking water remains a reality of everyday life throughout the developing world. The World Health Organization considers improved drinking water sources to be those sources provided through technologies which are proven to be more likely to provide safe water (such as household connections, public standpipes, boreholes, protected dug wells, protected springs, and rainwater collections) than unimproved technologies (WHOSIS 2010). In
2002, 1.1 billion people still lacked access to improved water sources, representing approximately 17% of the global population (WHO WSH 2010).

Hygiene plays an equally important role in the transmission of diseases, including helminth infection. In terms of hygiene, the WHO defines three areas of educational opportunities related to the causes of disease and proliferation of parasitic disease. These are: 1) personal hygiene; 2) domestic hygiene; and 3) community hygiene (WHO WSH Chapter 8).

Personal hygiene includes, most importantly, hand hygiene and washing hands at critical points such as after defecation, after handling child feces and before and after handling food. In terms of hookworm prevention, it also includes education on the risks associated with going barefooted and the importance of wearing shoes. Domestic hygiene includes regular laundering which is important for the prevention of hygiene-related diseases such as scabies, ringworm, trachoma, conjunctivitis and to remove potential fecal contamination from clothing and bedding.

Community hygiene encompasses areas such as water source protection, proper disposal of solid waste and excreta, wastewater drainage, controlling animal rearing and market hygiene.

With consideration given to all related factors - water, hygiene and sanitation - it is lack of access to improved sanitation which has the most profound effect on the proliferation of human helminth infection. It is all but impossible for a country to guarantee its citizens clean water without widespread improvements in sanitation. The Joint Monitoring Programme (JMP) of the WHO and UNICEF defines improved sanitation as facilities that ensure hygienic separation of human excreta from human contact. These include: flush or pour-flush toilets/latrines to piped sewer systems, septic tanks or pit latrines; ventilated improved pit latrines, pit latrines with slabs; and composting toilet (JMP 2008).
Globally, the JMP reports that, while significant improvements have been made in providing access to clean drinking water, sanitation lags behind the United Nations (UN)-specified Millennium Development Goal (MDG) target of reducing by half the proportion of people without access to basic sanitation by 2015 (JMP 2008). In 2002, when this goal was set, 2.6 billion people, or 42% of the world’s population, lacked access to improved sanitation (WHO WSH 2010). In 2009, it was estimated that in order to meet the sanitation MDG target by 2015, an additional 370,000 people per day every day until 2015 must gain access to improved sanitation (WHO WSH 2010).

Global Burden of Helminth Disease

Even with the global deficit in the aforementioned improvements to contributing factors, it is still uncommon for human hosts to die from STHs. While this is a blessing given their soil-transmitted helminth prevalence, it confounds measuring the impact of these diseases via traditional gauges such as mortality figures. For this reason, measurement of helminth-associated disease burden via disability-adjusted life years (DALYs) provides a much more realistic picture. DALYs are defined by the WHO as a time-based measure that combines years of life lost due to premature mortality and years of life lost due to time lived in states of less than full health (WHO GBD 2010). Man-Suen Chan (1997) estimated the global DALYs associated with soil-transmitted helminths as shown in Table 1. Based on his calculations of DALYs lost, the combination of all STHs represents a DALY factor higher than that for malaria which, due to its correlatable mortality rate, has received much more international attention (Chan 1997).
Table 1. DALYs associated with Helminth Infection

<table>
<thead>
<tr>
<th>Helminth</th>
<th>DALYs lost in millions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ascaris</td>
<td>10.5</td>
</tr>
<tr>
<td>Trichuris</td>
<td>6.4</td>
</tr>
<tr>
<td>Hookworms</td>
<td>22.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>39.0</strong></td>
</tr>
</tbody>
</table>


**Child Health and STHs**

As previously discussed, factors impacting population health most often have an intensified impact on child health. Esrey et al illustrated this point in their 1991 analysis which linked improvements in water and sanitation to reductions in parasitic infections and finally to dramatic improvements in child survival (Esrey 1991). Worldwide, the combination of poor hygiene and lack of access to sanitation are factors in about 88% of deaths of children under age 5 from diarrheal diseases (UN Water 2010). Not only do helminth infections overtly contribute to diarrheal cases, but they are also more subtly linked to malnutrition and growth stunting (Crompton 1993). While there are multiple predictors for stunting, helminth infections, like Ascaris, have been linked in a number of studies to micronutrient depletion and nutrient malabsorption (Casapia 2006). Further, Trichuris infection is associated not only with chronic dysentery, but also with iron deficiency, anemia and diminished growth rates (Stephenson 2000). And, hookworm infections are recognized as the leading cause of pathologic blood loss in tropical and subtropical countries, escalating anemia cases by causing blood loss through mechanical damage to mucosa. (Larocque 2005).

Associated with parasitic infection’s link to physical child development is its more recently recognized link to cognitive development. While there are numerous environmental issues which can contribute to diminished cognitive development, Jardim-Botelho’s (2008) work
and the work of others like Berkman (2002) and Ezeamama (2005) are building on a growing body of evidence linking chronic parasitic infection and diminished cognitive development.

The notable association between poor physical and mental health outcomes and soil-transmitted helminth burden suggests that infections may affect school enrollment, attendance, and grade attainment (Hotez 2006). Fast-forwarding to the adulthoods of children with chronic helminth infection, these factors may portend long-term negative impacts in the link between helminth infection and economic health.

What Can be Done? STH Prevention and Treatment

Having discussed the magnitude of parasitic infection, its causes and effects on society’s most vulnerable, it is time to turn to what can be done to prevent these infections and their spread as well as how to treat to existing infections. Let’s begin with a discussion of prevention methods, their benefits, costs and short and long term requirements for their achievement. See Figure 2 for a review of routes of STH disease transmission with an illustration of barrier points added.

Access to Improved Sanitation

As previously discussed, the linchpin in containing and preventing the spread of soil-transmitted helminth infection is access to and utilization of improved sanitation methods. The UN Millennium Development Goal (MDG) target related to sanitation is to reduce by half the proportion of the 2.6 billion people without access to basic sanitation by 2015. Recall that the WHO/UNICEF Joint Monitoring Program defines improved sanitation as facilities that ensure hygienic separation of human excreta from human contact, including: flush or pour-flush toilets/latrines to piped sewer systems, septic tanks or pit latrines; ventilated improved pit
latrines, pit latrines with slabs; and composting toilets (JMP 2008). According to the World Health Organization’s Water Sanitation and Health data, improved sanitation alone can reduce diarrhea morbidity by 32% (WHO WSH 2010). The barrier to achieving this level of reduction is its significant cost. It is estimated that halving the number of people globally without sustainable access to improved sanitation by 2015 would cost US$ 9.52 billion per year over and above current investments (WHO WSH 2010).

**Figure 2. F Diagram of Disease Transmission and Control**

![Disease Transmission and Control Diagram](image)

*Adapted from Wagner & Lanoix Model 1958*

**Access to Safe Drinking Water**

Access to safe drinking water, as noted, is also a key component to reducing the spread of parasitic disease. By definition, improved water supply involves better access and protected water sources (e.g. stand post, borehole, protected spring or well, or collected rain water). It also implies a significantly increased probability that the water is safe and more accessible and that
some measures are taken to protect the water source from contamination (WHO WSH 2010). With the inclusion of severe outcomes in the estimation, it is predicted that improved water supply can reduce diarrhea morbidity worldwide by between 6% and 25% (WHO WSH 2010). Bringing improved water to the developing world, though, is incredibly complex- politically, socially and economically. There is heated debate throughout the world regarding the efficacy and fitness of World Bank policies on this topic and its current promotion of water privatization as the best means to improve access to improved water. The Bank’s position is that poor governments are often too corrupt and poorly equipped to run public water systems efficiently. Thus, allowing foreign corporations to take over these systems provides immediate investment and skilled management to system management and planning (Schultz 2005). Detractors to this theory point to Bolivia, in particular, where a privatization project at the end of the 20th century led to an almost immediate 200% increase in the cost of water (far more than most impoverished residents could afford) and to riots, martial law and an eventual ousting of the private company in question (Schultz 2005). Improved water is also financially challenging to achieve given that it is estimated to require an investment of approximately US$1.78 billion per year to reach the MDG of halving the proportion of people globally without sustainable access to improved water supply every year until 2015 (WHO WSH 2010).

Improved Hygiene and Hygiene Education Programs

The potential impact of improved hygiene through practices like proper hand washing is also significant. Consistent improvement in hand washing and safe food handling is estimated to reduce childhood diarrhea by 35% and safe disposal of child feces is estimated to lead to a reduction of nearly 40% (IRC WASH 2010). The challenges associated with successful delivery of programs to promote hygiene are both tangible factors like access to clean water and soap and
human capital requirements and the less tangible factors like the difficulties inherent in creating sustained human behavioral change. Hygiene promotion programs have, in any case, in their favor relatively low cost of delivery. For example, UNICEF estimates that within the parameters of School Sanitation and Hygiene Education (SSHE), the provision of hygiene education to 600 million school aged children would carry an overall price tag of $1.2 billion (WELL 2010).

Improvement efforts related to all three areas – water, sanitation and hygiene - have been statistically linked to potential for reduction in human parasitic infection. In estimating the impact which improvements in all three areas might have on human helminth infection, the WHO’s assessment is that improvements in access to sanitation; access to safe water sources and hygiene practices together can reduce morbidity from ascariasis by 29% and hookworm by 4% (WHO WSH 2010).

*Soil-transmitted Helminth Available Treatment and Targeted Programs*

Deworming or anthelmintic drug treatment focuses on decreasing the parasite burden in a human host and, thus, associated morbidity. While people of all ages rapidly reacquire infection following treatment, evidence from several studies and one in particular from Tanzania in 1997 show that repeated periodic deworming in high-risk groups can hold helminth infection to levels below those associated with morbidity and that they will often result in rapid health and development improvements in children (Albonica, 1995). Chemotherapy-based anti-helminth programs are reliant on reducing the effective reproductive ratio [the average number of female offspring produced throughout the lifetime of a mature female parasite, which themselves achieve reproductive maturity (Biology Online 2010)] for a period of time which is long enough for the parasite population itself to be driven from the community being treated (Hotez 2006).
The most common anthelminthic medications are Mebendazole and Albendazole. Each is widely available, has been proven safe to use in children and is relatively inexpensive. In 2001, when the World Health Assembly endorsed use of these drugs as part of integrated control programs, the Partners for Parasite Control (PPC) was formed. The PPC is made up of governments of Member States with a commitment to reduce poverty in low-income countries; UNICEF, WHO, World Food Program (WFP), Office of the United Nations High Commissioner for Refugees (UNHCR), World Bank, nongovernmental organizations (NGOs), universities, philanthropic foundations and pharmaceutical companies. The PPC’s goal is to promote control of worm-induced diseases, specifically schistosomiasis and soil-transmitted helminthiasis. The group defines deworming as “the delivery of safety-tested, single dose, oral anthelminthic drugs for the reduction of both the subtle and the overt morbidity that accompanies worm infections” (WHO PPC 2004). The Partnership’s focus is to promote the extension of deworming programs deep into the populations of low-income, endemic countries. The PPC’s most important functions are to serve as a platform for sharing the latest technical and scientific information and practical information on control programs; a centralized point where partners can collaborate to use their respective skills to “piggy-back” deworming onto existing campaigns and programs; a resource for necessary tools and training (field, lab and health education materials); a monitor of endemic country progress toward the 2010 goal; a local, national and global action generator; and as international advocate for worm control (WHO PPC 2004).

Schools are a natural choice as a channel for delivery of deworming programs. Formalized governmental and non-governmental educational structures exist in most endemic countries. Food and other established nutritional programs like Vitamin A supplementation are already regularly delivered via these channels. And, as previously identified, school age children
are the highest risk population sector for soil-transmitted helminth infection. One of the most promising aspects of school-based programs is their cost which ranges from as low as US$ .27 for a single drug treatment to US$3.50 per child per year for a fully-delivered school-based parasite prevention program (GiveWell 2010). Even so, given available structure and support, as of 2006 only 64 of the 130 countries considered to be endemic reported data to the WHO on treatment of school aged children; within these 64 countries, the average level of coverage for school age children was only 22% of those at risk; and only 9 of these countries had reached the target of 75% coverage of school aged children.

![Map of Andean Nations](http://www.iom.int/jahia/Jahia/activities/americas/andean-countries)

**Andean Nations – Helminth Prevalence, Contributing Factors and Progress**

**Prevalence and Child Health**

Narrowing the focus to Andean countries, Bolivia, Colombia, Ecuador, Peru and Venezuela are particularly affected by soil-transmitted helminth infection as they are each soil-transmitted helminth endemic nations and they are each five of the six poorest countries in South America (WHO WDI 2008). The status of human helminth infection in the region is particularly serious and more bleak than for Latin America as a whole. Recall from earlier discussion that the estimated average prevalence of Ascaris, for example, in Latin American is 16%. In comparison, Ascaris rates specific to the Andean nations of Ecuador and Venezuela are as high
as 38% and 29% respectively. Table 2 provides STH prevalence data for the Andean region overall.

Table 2. Andean Prevalence: Soil-Transmitted Parasites

<table>
<thead>
<tr>
<th>Country</th>
<th>Population</th>
<th>Estimated Prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Ascaris</td>
</tr>
<tr>
<td>Bolivia</td>
<td>9 million</td>
<td>15%</td>
</tr>
<tr>
<td>Colombia</td>
<td>45 million</td>
<td>14%</td>
</tr>
<tr>
<td>Ecuador</td>
<td>13 million</td>
<td>38.3%</td>
</tr>
<tr>
<td>Peru</td>
<td>29 million</td>
<td>26.1%</td>
</tr>
<tr>
<td>Venezuela</td>
<td>25 million</td>
<td>29%</td>
</tr>
</tbody>
</table>


In Andean countries, as in the rest of the developing world, school age children (children between the ages of 5 and 15 years) comprise the population sector which is most highly impacted by soil-transmitted helminth disease. In Ecuador, the only Andean country where parasitic infection has received significant national attention throughout its last two political administrations, within its 3.3 million school age children, estimated average prevalence of ascaris, trichuris and hookworms are 39.5%, 18.2% and 2.5% respectively (Schools and Health 2010).

**Contributing Factors**

Similar to the situation through the developing world, helminth infection prevalence in Andean countries is closely associated with deficits in access to clean water and improved sanitation. And, while progress has been made over the last decade, none of these nations has a public water supply that can be consistently guaranteed as safe to consume without boiling. Lack of access to improved water sources has been a political lightning rod throughout the region. The most widely discussed examples of this phenomenon are in Bolivia where two attempts to privatize water based on World Bank protocol, one in Cochabamba in 2000 and one in El Alto in
2006, failed. In Ecuador, the first president to win a second term since the 1970s, Rafael Correa, campaigned heavily on a platform which named access to water as a major issue and human right. He ratified a new constitution in 2008 which included water as a right for all. Notable advancements have been made in the last decade regarding access to improved sources of drinking water, but the data around improved water sources and specifically what this description encompasses can be somewhat misleading. Recall that improved water supply is defined in terms of better access and protected water sources and implies a significantly increased probability that the water is safe and more accessible and that some measures are taken to protect the water source from contamination (WHO WSH 2010). Improved water supply therefore does not necessarily imply disinfected water. Based on drinking water access data reported in Table 3 below, the region shows improvement. In conjunction with these estimates, however, it is worth noting that throughout Latin America as recently as 2001, only about 41% of those with household water connections received disinfected water and approximately 60% of water supply systems were intermittently operational (putting recipients at risk for contracting diarrheal and other waterborne diseases) (PAHO 2002).

### Table 3. Andean Region Access to Improved Drinking Water

<table>
<thead>
<tr>
<th>Country</th>
<th>Percentage of Population with Access to Improved Drinking Water</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rural</td>
</tr>
<tr>
<td>Bolivia</td>
<td>62%</td>
</tr>
<tr>
<td>Colombia</td>
<td>73%</td>
</tr>
<tr>
<td>Ecuador</td>
<td>81%</td>
</tr>
<tr>
<td>Peru</td>
<td>56%</td>
</tr>
<tr>
<td>Venezuela *</td>
<td>66%</td>
</tr>
</tbody>
</table>

* Venezuelan data are from 2001 and 2004

Sources: WHOSIS & Wapedia Water Supply & Sanitation

While access to potable water is a serious challenge to the prevention of soil-transmitted helminth infection, one of the factors which makes it most difficult to guarantee safe water is a
country’s ability to provide secure sanitation. Multiple studies have cited rural populations as particularly at risk due to water and sanitation inequalities. This applies especially to rural populations in each of the Andean countries where access to improved sanitation in rural areas reported as recently as 2006 remains very low. Table 4 provides data regarding access to improved sanitation in Andean countries. Even in countries where access to improved sanitation seems to be progressing toward desired Millenium Development Goals, these statistics, as they relate to STH prevalence, are deceptive. Ascaris and Trichuris are transmitted via ingestion and can infect the human host via water-washing. Only a very small percentage of the wastewater discarded by the populations of each of the Andean nations is treated. See Table 5. Helminths can survive in wastewater. In fact, at 20 – 30 degrees Celsius (68 – 86 degrees Fahrenheit), excreted Ascaris eggs can survive in sewage and freshwater for many months (Wescott 1997). Without significantly improved wastewater treatment coverage, natural water sources and irrigated crops will continue to be contaminated sources proliferating human helminth infections.

Table 4. Access to Improved Sanitation

<table>
<thead>
<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Bolivia</td>
<td>22%</td>
<td>54%</td>
<td>43%</td>
<td></td>
</tr>
<tr>
<td>Colombia</td>
<td>58%</td>
<td>85%</td>
<td>78%</td>
<td></td>
</tr>
<tr>
<td>Ecuador</td>
<td>72%</td>
<td>94%</td>
<td>84%</td>
<td></td>
</tr>
<tr>
<td>Peru</td>
<td>36%</td>
<td>85%</td>
<td>72%</td>
<td></td>
</tr>
<tr>
<td>Venezuela</td>
<td>48%</td>
<td>71%</td>
<td>Unknown</td>
<td></td>
</tr>
</tbody>
</table>


Table 5. Andean Country Coverage - Wastewater Treatment

<table>
<thead>
<tr>
<th>Country</th>
<th>Year Reported</th>
<th>Estimated Percentage of Wastewater Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bolivia</td>
<td>2004</td>
<td>22%</td>
</tr>
<tr>
<td>Colombia</td>
<td>2006</td>
<td>25%</td>
</tr>
<tr>
<td>Ecuador</td>
<td>2004</td>
<td>8%</td>
</tr>
<tr>
<td>Peru</td>
<td>2004</td>
<td>22%</td>
</tr>
<tr>
<td>Venezuela</td>
<td>2003</td>
<td>14%</td>
</tr>
</tbody>
</table>

Source: Wapedia Water Supply and Sanitation
Recent Initiatives Directly or Indirectly Addressing Helminth Prevention

In each of the Andean countries, there is a current focus on improving water and sanitation and, in several newly revised constitutions (those of Ecuador, Peru and Bolivia, for example) water has been recognized as a basic human right. These efforts are at the same time being challenged and will continue to be challenged by water shortages attributable to climate change. A study commissioned by the Andean Community of Nations in 2008 predicts that, due to melting glaciers and greater desertification of the Andean mountains, by 2025, about 70 million people across the region will have extreme difficulty accessing clean water sources (Portilla 2008).

Bolivia, after two failed attempts to privatize water, has adopted a new national water law, Water for Life, which legally recognizes “usos y costumbres” (traditional communal practices) and which includes independent water system protections, public consultations on rates, and a commitment to prioritizing social needs (Baer 2006). In conjunction with the traditional communal practices approach to water, Community Led Total Sanitation (CLTS) was also brought to Bolivia by UNICEF Bolivia. CLTS is an innovative approach to eliminate open defecation; communities are facilitated to conduct their own appraisal and analysis of open defecation as a problem and take their own action to eradicate it (IDS 2010). Despite these innovative efforts, crumbling infrastructure, a diminishing water table and the current economy’s negative impact on international investment leave Bolivia’s public systems in a perilous situation (Baer 2006). 

In Colombia, the administration of popular president, Alvaro Uribe, has laid out four related program initiatives and is actively working on these in the race to meet Millenium Development Goals for sanitation. The initiatives are: 1) Saneamiento para Asentamientos
(SPA), which has the objective of improving conditions for people living in extreme poverty in urban areas; 2) Saneamiento de Vertimientos Municipales which addresses increased wastewater treatment; 3) Agua Transparente, an initiative which aims to implement methodologies to discourage corrupt contractual practices in drinking water and sanitation improvement projects; and 4) Lavado de Manos, an extensive national ad campaign delivered via all media sources to promote hand washing for the prevention of diarrhea (MinAmbiente 2010).

While progress has been made in Ecuador, the country is faced with challenges left by years of mismanagement and corruption in the water and sanitation services sector. According to a 2004 assessment by the Water Secretariat, as part of its research toward improvement of sanitation access, 13% of Ecuadorian systems are sustainable, at least 49% have mild to severe impairment and 38% have collapsed altogether. In spite of these challenges, in 2001 the Rural and Small Town Water Supply and Sanitation Project (PRAGUAS I) set up a bold incentive framework for water and sanitation service investment for municipalities. The central government grants loans to municipalities which delegate water and sanitation service contracts to more autonomous, accountable public, private or cooperative service providers (World Bank 2006). This project phase provided new water supply systems for 252,000 people and on-site sanitation for 127,000 people, approximately 5% and 3% of Ecuador’s total rural population of 4.7 million (Port of Entry 2006). PRAGUAS II, funded by the World Bank in 2006, is targeted to increase coverage and effective use of sustainable water and sanitation services in Ecuador for poorer populations in rural communities and small towns. This project should, at completion, impact another 490,000 rural Ecuadorians (Port of Entry 2006).

In Peru, water management is a central flash point for conflict within the country. In 2009 up to the end of February, forty-eight percent of the 218 social conflicts registered by the
Ombudsman of Peru revolved around socio-environmental problems, many linked to the "water management" (Rosales 2009). Within this context, Agua Para Todos (Water for All), a sweeping plan laid out by President Alan Garcia in 2006, states that Millennium Development Goals for access to improved water sources and sanitation and for water for virtually everyone in Peru by 2015 can be achieved. The government's draft National Sanitation Plan considers that investments of US$4,789 million would be needed in the period of 2005-2015 (US$497 million/year) in order to achieve the goal (PAHO 2006). Within the rural sector of Agua Para Todos (PRONASAR), while there are reports that up to 1911 projects have been completed under this program since 2006, the Peruvian government website reports that, as of December 31, 2009, 492 projects have been started and 333 of these have been completed benefitting 272,406 people (PRONASAR 2010). The program has been widely criticized for its overcommitment and lack of detail. As recently as July 2009, analysts discussing the wastewater treatment aspect of the plan alone stated that reaching Garcia’s goal of 100% wastewater coverage by 2015 would be a huge challenge for Peru to achieve even by 2020 (Medalla 2009).

Venezuelan water and sanitation services are provided by the national water company HIDROVEN, five state water companies, the Corporación Venezolana de Guayana (CVG) and several municipalities and community-based organizations (Wapedia 2010). HIDROVEN developed a six year plan for the period 2002-2007, which was part of the economic development plan for the nation. The plan had the objectives of: 1) extending the coverage and quality improvements and continuity of water services and basic sanitation with 99% water coverage and 45% reduction in nonrevenue water (or water which is produced and lost before it reaches the customer) and 2) extending the coverage of collection, treatment and disposal of sewage with 99% sewage collection coverage and treatment of 30% of the wastewater.
Investments under the Plan for 2002 and 2003 and, consequently, the objectives guidelines were not met. Nevertheless, HIDROVEN continues to view this document as the best approximation for its vision (CAF 2004). The plan estimates that a total of US$ 4.77 billion will be required between 2003-2015 for the sector, which implies an average annual investment of approximately US$ 500 million, or about four times historic investment levels (CAF 2004).

Throughout the Andean region, estimated investments required to meet water and sanitation goals are considerable. Table 6 shows the estimated requirement outlined in 2000 by each of the five nations in order to reach sanitation-related Millenium Development Goals. These noted requirements along with systemic, climate and global economic challenges make it nearly impossible for these countries to achieve their respective goals and address soil-transmitted helminth infection and prevalence via these channels any time in the near future.

<table>
<thead>
<tr>
<th>Country</th>
<th>Country-Specific MDG: Additional People to be Covered</th>
<th>Estimated Total Investment Required to Achieve Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bolivia</td>
<td>2,663,000</td>
<td>US$ 262 Million</td>
</tr>
<tr>
<td>Colombia</td>
<td>12,500,000</td>
<td>US$ 1.3 Billion</td>
</tr>
<tr>
<td>Ecuador</td>
<td>3,500,000</td>
<td>US$ 359 Million</td>
</tr>
<tr>
<td>Peru</td>
<td>6,500,000</td>
<td>US$ 665 Million</td>
</tr>
<tr>
<td>Venezuela</td>
<td>9,400,000</td>
<td>US$ 964 Million</td>
</tr>
</tbody>
</table>


Turning now to other potential initiatives targeted to controlling soil-transmitted helminths, none of the Andean governments, with the exception of Ecuador, has fully embraced the World Health Organization’s recommended and supported school based parasite control programs. See Table 7 for each country’s self-reported data on treatment of school age children. Thanks to the administration of Jamil Mahuad in 2000 and subsequent administrations, Ecuador has already surpassed the Millenium Development Goal of 75% helminth prevention coverage for school age children. Bolivia has more recently emphasized antihelminthic treatment
Table 7. Percentage of School Age Children Being Treated for Parasites

<table>
<thead>
<tr>
<th>Country</th>
<th>Year Reported</th>
<th>Estimated number of school-age children being treated</th>
<th>Estimated Percentage of school-age children being treated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bolivia</td>
<td>2008</td>
<td>1,000,000</td>
<td>43.18 %</td>
</tr>
<tr>
<td>Colombia</td>
<td>2008</td>
<td>423,205</td>
<td>4.80 %</td>
</tr>
<tr>
<td>Ecuador</td>
<td>2006</td>
<td>2,415,000</td>
<td>85.00 %</td>
</tr>
<tr>
<td>Peru</td>
<td>2006</td>
<td>1,729,412</td>
<td>29.00 %</td>
</tr>
<tr>
<td>Venezuela</td>
<td>2008</td>
<td>25,250</td>
<td>.45 %</td>
</tr>
</tbody>
</table>


as part of its Escuelas Saludables initiative and regionally based programs are underway.

Colombia focuses on addressing parasite control primarily through the health system. Neither Peru nor Venezuela report any centralized effort toward helminth control in school age children, though there appears to be significant non-governmental organizational focus, via UNICEF, to this end in Peru.

Conclusion – Why are school-based programs an obvious choice?

Bolivia, Colombia, Ecuador, Peru and Venezuela are each making progress toward improved conditions for their respective populations. Given the challenge before each to make rapid advances in sanitation and drinking water service, immediate reduction of STH infection via these improvements is unlikely. Projected costs juxtaposed to global economic status and complexities of sector improvements juxtaposed to the need for sector expertise are serious barriers to progress. In order to simultaneously develop and elevate the health of their populations, Andean nation administrations must support and promote a more immediate solution. For a myriad of reasons, the most obvious and direct resolution is implementation of school-based antihelminthic programs.
First, to restate, among those infected with STHs, about one third are estimated to be children with the highest rates of infection in school age children (UN-ECOSOC 2010). STH infected-children are adversely affected in terms of cognitive development, school attendance and educational performance. Additionally, the heavier the intensity of infection, the greater the risk of school absenteeism to the point that some infected children attend school only half as much as their uninfected peers (World Bank 2010).

Second, as noted in earlier discussion, soil-transmitted helminth infections have also been connected to anemia associated with the malabsorption of Vitamin A and iron (WHO PPC 2010). These deficiencies can be correlated to increased measles and diarrheal morbidity and general fatigue in children (WebMD 2010). STH infection’s negative impact on education coupled with helminth infection’s connection to Vitamin A and iron-deficiency anemia and wasting foretell of a future of health-compromised adults and populations with diminished educational attainment (Guyatt 2000).

Third, regular treatment of school-age children helps to offset the worst effects of infection, even when no improvement is made in safe water supply or sanitation (Savioli 2002). By reducing helminth infection transmission within the community, school-based deworming programs substantially improve health in untreated children as well those treated. In fact, it is estimated that treating only school age children can reduce the total burden of disease due to intestinal worm infections by up to 70% in a given community as a whole (World Bank 2010).

Potential ramifications of helminth infection and the benefits of school-based helminth prevention programs have significant implications for long-term productivity and, ultimately, the level and speed of development progress in affected nations. In the long run, increased education is aligned with improved labor productivity, including farmer productivity and efficiency.
Additionally, health influences the GDP of a country as healthy workers are more productive than their similar unhealthy counterparts. Studies like those of Thomas and Strauss (1997) establish a relationship between height, BMI, per capita protein intake, per capita calorie intake and productivity and income levels with the conclusion that each of these health influencing factors net a substantial return in the labor market. Also, antihelminthic programs help to boost developmental factors which in turn reduce the spread of parasitic disease. In other words, in the short run, deworming programs avert helminth infections while, in the long run, the combination of programs and improved infrastructure and associated developmental gains continually improves the opportunity for infections to be averted by reducing transmission altogether (Hotez 2006).

Fourth, in addition to their implied positive impacts on prevention of infection, health and productivity, school-based programs are evidenced to be very effective. Korea’s early approach to parasite prevention provides an excellent example of such evidence. Korea began mass antihelminth program for school-age children in 1970. In 1971, the country’s overall intestinal helminth egg positive rate was: *Ascaris*, 58.2%; *Trichuris*, 65.4%; and hookworms; 10.7%. By 2004, the egg positive rate had been reduced to: Ascaris, 0.03%; *Trichuris*, 0.02%; and hookworms, 0% (Hong 2006). The Korean example also intimates that the social driving force to establish a national control system for organizing repeated mass chemotherapy, combined with environmental and sanitation improvement, is critical to achieving STH control in developing communities (Hong 2006). In other words, to be successful and enduring, these programs need to be supported and promoted at the national level.

Fifth, school-based programs, in addition to their effectiveness at achieving dramatic reductions in STH prevalence, are safe and easy-to-implement. The need for mass treatment of
schoolchildren can be determined using low cost surveys to ascertain whether or not a school is in an area of significant infection risk. Because antihelminthic drugs are very safe to use, even in children, there is no need for individual examination (World Bank 2010). Once need is established, teachers can be taught to deliver the drugs safely with only a few hours training (World Bank 2010).

Sixth, school-based programs are also very cost-effective. Operational research in Ghana and Tanzania has demonstrated that for the first five years of intervention, the average yearly cost of delivered treatment is typically less than US$0.50, including training of teachers and the procurement and distribution of drugs to students (World Bank 2010). Using these figures, in a country like Bolivia, for example, with an estimated 1,407,019 school age children in 2008 (Schools and Health 2010), total cost for school-base parasite prevention would be approximately US$ 703,510 annually - an estimate which is substantially lower than the costs of providing improved sanitation in Bolivia for example, which based on data from Table 6, is estimated to require $17,466,666 annually for achievement of 2015 MDG goals.

Beyond the World Health Assembly’s 2001 resolution to treat STH infections in high-risk groups with the goal to treat over 75% of school-age children at risk by 2010 and the formation of Partners for Parasite Prevention, specific focus has more recently been applied to Latin America. In late 2008, the Global Network for Neglected Tropical Diseases (NTDs) in conjunction with the Interamerican Development Bank, the Pan American Health Organization, and the World Health Organization instituted a program to ensure that medicines for NTDs, including anthelminthic drugs, are available to at-risk populations living in the region (Global Network 2008). Thus, a global health infrastructure to combat STH infection with regional ties to South American nations is in place. Supporting the widely held perspective that combating STH
infection is a public health “best buy”, combined with co-investments from the Global Network for Neglected Tropical Diseases and its partners, school-based deworming is an incredibly moderate but very cost-effective program for improving education, accelerating development and reducing poverty (Hotez 2009).

Finally, let us not forget that, apart from personal health, national development and the availability of external support, also exists politics and the struggle for governing administrations to stay in power. In at least two Andean countries, Bolivia and Ecuador, indigenous peoples have brought down successive administrations in protest over access to basic human requirements, like water. Peter Hotez (2009), in his editorial “A Constitutional Amendment for Deworming” goes so far as to suggest that in Ecuador, Bolivia and Venezuela, where socialistic constitutions have either just been ratified or are being drafted, that constitutional amendments be added for deworming. He goes on to suggest that new constitutions supporting deworming, coupled with financial assistance and resources from the global community, could serve as catalysts for expansion of control programs within the entire region (Hotez 2009). Regardless of this potential international influence, supporting programs which so directly impact the health of a nation’s children, including indigenous children, can only serve to build political capital and better ensure the longevity and viability of current regional administrations.
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GiveWell: Combination deworming (mass drug administration targeting both schistosomiasis and soil-transmitted helminths) Retrieved from: http://www.givewell.net/international/technical/programs/deworming January 30, 2010


