The Neglected Tropical Diseases in Latin America and the Caribbean: Burden of Disease and Approaches for Elimination and Control

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Contents

Abstract Neglected tropical diseases (NTDs) have afflicted humankind since time immemorial, and their impact has impacted, and continues to do so, leading to disabling, deforming, stigmatizing diseases. This group of diseases decreases the freedoms and capabilities of individuals leading to economic poverty and underdevelopment. In Latin America and the Caribbean, the toll associated with many neglected tropical diseases is similar, if not higher, than that of HIV/AIDS and tuberculosis in this region. Fortunately, through the use of stepped-up advocacy, partnerships, resource mobilization, capacity enhancement, and careful allocation of resources, a number of NTDs can be controlled and potentially eliminated in Latin America and the Caribbean.

Keywords Neglected tropical diseases (NTDs) • Latin America • Caribbean • Chagas disease • Leprosy • Schistosomiasis • Soil-transmitted helminthes • Leptospirosis • Bartonellosis • Trichuriasis • Lymphatic filariasis • Hookworm • Cysticercosis • Leishmaniasis • Onchocerciasis • Yellow fever

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1 Overview of the Neglected Tropical Diseases in Latin America and the Caribbean

Map is not the territory. This phrase coined by the Polish–American scientist and philosopher Alfred Korzybski may be interpreted from different perspectives. If we choose to focus on infectious pathogens, assessing geopolitical divisions may only cloud our perception of the ecological reach and biological determination of microbes, and it may also impair our appreciation of the biosphere (Lapo and Vladimir 2001). The Neglected Tropical Diseases (NTDs) illustrate the importance of Korzybski's dictum by impacting more than one billion people across the globe, and by placing at least 2 billion at risk (Ault 2007, 2008; Gyapong et al. 2010; Hotez et al. 2008a; Holveck et al. 2007). This geographic dilemma is exemplified in borders such as that of northern Mexico and the southern United States where populations sharing the same terrain and similar culture and history are also at risk of the same NTDs (Hotez et al. 2012). Similarly, there is a blurring of arbitrarily chosen borders in maps as demonstrated by the distribution of some NTDs in the Western Hemisphere corresponding with the legacy of the slave trade by Europeans (Lammie et al. 2007; Ault and Roses Periago 2011). In addition, due to international migration of populations latently infected with *Trypanosoma cruzi*, the cause of Chagas disease, from endemic areas in Latin America migrating to nonendemic areas (i.e., Europe), illustrates the potential globalization of previously geographically restricted NTDs.

Indeed, across most territories and regardless of the cartography chosen, impoverished people embedded in social failures may suffer from one or more NTDs. This group of infectious diseases is defined by the occurrence of chronic parasitic, bacterial, or other diseases that promote poverty because of their impact on child growth and cognitive development, pregnancy, and people's economic capabilities (productivity as an adult, low literacy, people being too sick to work, and parents taking time off work to care for sick children—frequently all this leading to premature death) (Table 1) (Ault 2007). As a result, the disease burden due to the major NTDs has been estimated to be 57 million disability-adjusted life years (DALYs) lost per year (Gyapong et al. 2010; Hotez et al. 2008a; Holveck et al. 2007; Ault 2008).

In Latin American and Caribbean region (LAC), many people currently live in poverty (more than 100 million people live on less than US$2 per day) (World Bank 2005). Most of the poor in this region live as subsistence farmers in rural areas and urban slums placing this large number of individuals at risk of infection and the disease consequences of NTDs (Hotez et al. 2012). Furthermore, the burden of disease resulting from the NTDs in LAC may exceed that of HIV/AIDS (Ault 2007). Health inequities are directly responsible for placing individuals at risk of NTDs: unsafe water, poor sanitation, refuse disposal, lack of access to health services, low literacy levels, and inadequate nutrition among other social determinants (Franco-Paredes et al. 2007a, b; Conteh et al. 2010; Montenegro and Stephens 2006). Concomitantly, NTDs represent important, yet often unrecognized, reasons of why the poorest people in the Americas cannot escape poverty (Hotez

Table 1 Ranking of neglected tropical diseases in Latin America and the Caribbean by prevalence and distribution

Disease	Population currently infected in LAC	Population at risk in LAC	Major vulnerable populations or geographic areas	No. LAC countries infected	Percentage of LAC population infected (% poor people infected)	Percent global disease burden in LAC
Trichuriasis	100 million	523 million	Poor Rural & Urban Slums	27	17.8 % (46.9 %)	16.6 %
Ascariasis	84 million	514 million	Poor rural & Urban slums	27	15.0 % (39.4 %)	10.4 %
Hookworm	50 million	346 million	Poor rural	26	8.9 % (23.5 %)	8.7 %
Chagas disease	8–9 million	25–90 million	Poor rural & Urban slums	13	1.6 % (4.1 %)	99.8 %
Schistosomiasis	1.8 million	36 million	Poor rural	4 with >1000 cases	0.3 % (0.8 %)	0.9 %
Blinding Trachoma	1.1 million	ND	Poor rural	3	0.2 % (0.5 %)	1.3 %
Lymphatic Filariasis	720,000	8.9 million	Urban slums & Poor rural	7	0.1 % (0.3 %)	0.6 %
Dengue fever	552,141 reported in 2006	ND	Urban slums	23	0.1 % (0.2 %)	ND
Cysticercosis	400,000	75 million	Poor rural	15	<0.1 % (0.2 %)	ND
Cutaneous (CL) and Visceral (VL) Leishmaniasis	62,000 CL 5,000 VL	ND	Urban slums & Poor rural	18	ND	ND
Leprosy	47,612 new cases	ND	Poor rural & Urban slums	22	<0.1 % (<0.1 %)	11.4 %

(continued)

Table 1 (continued)

Disease	Population currently infected in LAC	Population at risk in LAC	Major vulnerable populations or geographic areas	No. LAC countries infected	Percentage of LAC population infected (% poor people infected)	Percent global disease burden in LAC
Onchocerciasis	64 new cases in 2004	515,675	Poor rural	6	<0.1 % (<0.1 %)	0.3 %
Jungle yellow fever	86 new cases in 2004	ND	Jungle & Urban slums	4	<0.1 % (<0.1 %)	<0.1 %

From: Hotez et al. (2008a)

et al. 2008a; Lammie et al. 2007). LAC accounts for 8.8 % or 1.5–5 million DALYs of the global disease burden due to NTDs (Hotez et al. 2008a).

The NTDs in the Americas are concentrated not only within pockets of intense poverty but also among selected vulnerable populations, especially among indigenous populations (Hotez et al. 2008a). In some areas, women and children may be considered neglected populations due to their limited access to health and social support services (Franco-Paredes et al. 2007a, b). There is also mounting evidence that populations in conflict areas are disproportionately impacted by NTDs. Other vulnerable groups impacted by poverty and heavily affected by communicable and noncommunicable diseases include periurban communities (e.g., slum and shantytown dwellers) and the rural poor (e.g., migratory workers in agriculture, miners, and fishers) (Hotez et al. 2008a; Franco-Paredes et al. 2007a).

In Guatemala and southern states in Mexico, indigenous populations suffer from some of the highest rates of soil-transmitted helminth infections in the Americas, as well as high rates of onchocerciasis and Chagas disease (Hotez et al. 2008a; Conteh et al. 2010; Montenegro and Stephens 2006; Beltrame et al. 2002). Similarly, the indigenous people of Bolivia and Peru experience high rates of fasciolasis, cysticercosis, and plague; those in Colombia are at elevated risk for leishmaniasis, Chagas disease, and yellow fever; and in Brazil, high levels of soil-transmitted helminth infections and subsequent growth stunting occur among indigenous populations (Hotez et al. 2008a; Montenegro and Stephens 2006; Beltrame et al. 2002). In Guatemala and Mexico, the indigenous populations who live in coffee plantations are most at risk for onchocerciasis, whereas in Ecuador and Colombia the disease affects those living on the banks of river shores, primarily people of African and indigenous descent (Montenegro and Stephens 2006; Beltrame et al. 2002). In addition to LAC's indigenous populations, poor communities of African descent, such as those found in parts of the Caribbean, Central America, and Brazil, suffer from high prevalence rates of NTDs, especially hookworm infection, lymphatic filariasis, onchocerciasis, and schistosomiasis (Beltrame et al. 2002; Sauerbrey 2008; Hotez et al. 2008b; Maciel et al. 2008). Besides the major NTDs summarized in Table 1, there are other infectious diseases that are prevalent in LAC but that precise estimates are not available (Table 2).

The epidemiology of some NTDs, such as Chagas disease, is shifting partly due to urbanization, migration patterns of the rural poor, and an increase in urban poverty (Hotez et al. 2008a; World Bank 2005). Demographic trends suggest that the urbanization of poverty will continue: if poverty rates remain unchanged, by 2015 two-thirds of the poor in LAC will be living in cities (World Bank 2005), which may impact transmission patterns of some NTDs including Chagas and leishmaniasis due to urban migration. Many urban slums are built on unsecured land, often located in areas prone to natural disasters, such as flooding and landslides, or in close proximity to environmental hazards, such as landfills (Maciel et al. 2008), all of which can create environments that make the urban poor more susceptible to NTDs. In LAC, leptospirosis is an important cause of morbidity, especially in urban slums (Hotez et al. 2008a). In Brazil alone, more than 10,000 cases of severe leptospirosis cluster in the slum settlements, which lack adequate sewage systems and refuse collection services (Maciel et al. 2008). In South

Table 2 Major NTDs in Latin America and the Caribbean where there is no reliable data on disease burden and estimates

Helminth infections	Protozoan infections	Bacterial infections	Fungal infections and Ectoparasitic infections	Viral infections
Echinococcosis	Amebiasis	Bartonellosis	Mycetomas	Hemorrhagic Fevers
Cysticercosis	Giardiasis	Buruli ulcer	Paracoccidioidomycosis	Rabies
Fascioliasis		Leptospirosis	Myiasis	
Strongyloidiasis		Plague	Scabies	
Toxocariasis		Treponematoses (nonvenereal)	Tungiasis	

From: Hotez et al. (2008a)

America, visceral leishmaniasis is increasingly a periurban disease (Hotez et al. 2008a; World Bank 2005). In these settings, lack of sanitation with abundant rodents and large numbers of stray dogs and sporadic garbage collection provide sandflies-breeding sites and increase the risk for leishmaniasis (Alvar et al. 2006).

NTDs disproportionately result in negative health outcomes for girls and women (Hotez et al. 2008a; Alvar et al. 2006; Hotez 2009; Friedman et al. 2007). In Latin America, hookworm infection is a major contributor to anemia and iron loss in pregnancy (Hotez et al. 2008b). There is also some evidence that schistosomiasis in pregnancy causes: increased maternal morbidity and low birth weight (Hotez et al. 2008a; Beltrame et al. 2002). It has also been noted that congenital infections with some NTD pathogens can commonly occur (Montenegro and Stephens 2006). Congenital toxoplasmosis and malaria are the best-known examples, but now there is also evidence that congenital Chagas disease occurs with higher frequency among pregnant mothers infected with *T. cruzi* (Franco-Paredes et al. 2007a, b).

Although poverty has contributed to the proliferation of NTDs, evidence is mounting for associations between increased prevalence of diseases, conflict, and systematic human rights violations (Franco-Paredes et al. 2007a, b; Alvar et al. 2006). The emergence of cutaneous leishmaniasis in Colombia is linked to several decades of armed and guerilla internal conflict fueled by cocaine production and trafficking (Beyrer et al. 2007). In Colombia, more than 25 % of leishmaniasis cases reported in 2004 affected military personnel patrolling conflict areas, representing a three-time increase from the 2003 rate (Beyrer et al. 2007). For civilians living in conflict areas in Colombia, the size and pattern of disease incidence are unknown (Beyrer et al. 2007). In addition, the cycle of poverty, disease, inequality, and underdevelopment has at times led to social disruption and civil strife, as was the case in Chiapas, Mexico in 1994 with the Zapatista movement (Franco-Paredes et al. 2007a), which saw a concurrent reemergence of the Chagas disease (Ault 2008). Conflicts can break down community-health infrastructures, restrict access to health care, limit surveillance, prevention, treatment, and vector control, hamper outbreak investigations due to safety concerns, and reduce donor interest in research (Beyrer et al. 2007). Moreover, the conditions created by war and conflict further perpetuate the neglect of NTDs and marginalization of poor and internally displaced persons with these diseases.

2 Control and Elimination of NTDs in Latin America and the Caribbean

A major aspiration of public health interventions is that of attaining global health equity (Dowdle and Cochi 2011; Hopkins 2013). Given the fact that infectious diseases continue to cause a high burden of disease in many settings, disease-eradication efforts offer the opportunity to foster global health equity. Smallpox eradication framed this concept as a monumental global achievement with lasting societal benefits. As attractive as it may be, and after smallpox, the eradication of other infectious pathogens has proven difficult to accomplish (White and Franco-Paredes 2015; Tarantola and Foster 2011; Lockwood et al. 2014).

The principles of disease eradication rely on four factors: biologic feasibility, adequate public health infrastructure, funding, and sustained political and societal will (Dowdle and Cochi 2011). Global decisions on disease eradication require consideration of prioritization and costs in order to achieve the most appropriate, cost-beneficial, and equitable outcome of disease control (Hopkins 2013). Based on these premises, today, we have tools to effectively target the NTDs group including safe and inexpensive antihelminthics, rapid test kits for confirming the infection of several parasites, and community-based and integrated approaches to control these maladies. Therefore, it has become an ethical imperative to work toward the control and elimination of NTDs (Ault 2008; Ault and Roses Periago 2011). Furthermore, the World Health Organization (WHO) has identified some NTDs for elimination with three main targets for Latin America by the year 2015: Rabies, onchocerciasis, and Chagas disease transmission through transfusion of blood products. By the year 2020, WHO's elimination targets include leprosy, Chagas in most Latin American countries, lymphatic filariasis, and the endemic treponematoses (Ault and Roses Periago 2011).

LAC countries have had important success in eliminating infectious diseases in the region including smallpox, poliomyelitis, and measles (Ault 2007; Ault and Roses Periago 2011). In 2009, the Directing Council of the Pan-American Health Organization (PAHO) put forward a mandate in the form of a resolution (CD49-R19) to support countries in LAC to achieve elimination or substantially reducing the burden of disease associated with 12 NTDs. PAHO and the LAC countries have demonstrated that a number of NTDs can be eliminated in the region through the use of existing tools, political commitment, stepped-up advocacy, development of private–public partnerships, and resource mobilization (Ault and Roses Periago 2011). Onchocerciasis transmission has been eliminated in 8 of 13 foci among the six endemic countries in the region by the end of 2010. Additionally, a significant reduction in the burden of disease of Chagas disease has been achieved by a reduction in domestic vector transmission of (*Rhodnius prolixus* and *Triatoma infestans*) through the use of systematic indoor spraying concomitantly with a decline in blood transfusion associated infection.

In summary, there has been important achievement in controlling some NTDs in LAC including onchocerciasis and lymphatic filariasis in children and adults,,

malaria in Haiti and Dominican Republic, trachoma in school-age children, schistosomiasis in St Lucia and Suriname. With regard to Chagas disease, continuing interventions to maintain and expand programs using domestic vectoral transmission and transfusional Chagas efforts for elimination are under way (Ault and Roses Periago 2011). For some other disease whose burden can be drastically reduced with available tools, including schistosomiasis and soil-transmitted helminthiasis, ongoing efforts in LAC include mass drug administration to reduce intensity of infection or by preventive chemotherapy to prevent new infections (Salam et al. 2014). The use of spatial analysis and risk maps targeting of soil-transmitted helminthiasis maybe particularly useful but there is a lack of prevalence estimates of infection in many countries of LAC (Chammartin et al. 2013). Despite these limitations, current evidence suggests that effective community-based strategies exist and deliver a range of preventive and therapeutic interventions to decrease the burden of disease caused by helminthic NTDs.

Despite these achievements, health equity goes beyond providing health care. Preventing, treating, and rehabiliting those suffering an NTD may foster social equity in LAC. By decreasing health inequities linked with NTDs, our ultimate goal is to promote people's freedom and capabilities and to return a sense of dignity and self-realization into their lives (Franco-Paredes and Santos-Preciado 2011). Many gaps remain in reducing inequities and inequalities in health in LAC. Pursuing community participation and intersectoral partnerships is crucial to maintain gain and make interventions to control NTDs sustainable in the region. Furthermore, there is an urgent need for pursuing horizontal cooperation among countries that share problems or borders and to execute joint actions and develop intercountry plans. Finally, control and elimination of NTDS require multiple parallel interventions including mass drug administration of antiparasitic or antibacterial drugs, improvements in sanitation, and other integrated programs. However, the development of preventive or therapeutic vaccines to control major NTDs may play a crucial synergistic role in decreasing their burden of disease. In this context, the development of hookworm vaccine is in the pipeline, and there are existing partnerships for the development of vaccines against leishmaniasis and Chagas disease.

In collaboration with Springer–Verlag, the core objective of this collection of volumes is to generate a regional and unique approach to address the impact of the major neglected tropical diseases. In this regard, this volume brings attention to the substantial burden of diseases associated with NTDs in Latin America and the Caribbean. In addition, each chapter provides a discussion of potential approaches to their control and elimination. Some topics such as control or elimination strategies of echinococcosis, leptospirosis, endemic treponematosis, and soil-transmitted helminthes will be discussed in detail in other volumes of this collection. A selected group of hands-on international experts contributed to this volume. These topics are written by local experts with ample field experience and clinical expertise to discuss their perspectives in controlling and eliminating some of the major NTDs in LAC.

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