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Malaria in selected non-Amazonian countries of Latin America

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ABSTRACT

Approximately 170 million inhabitants of the American continent live at risk of malaria transmission. Although the continent's contribution to the global malaria burden is small, at least 1–1.2 million malaria cases are reported annually. Sixty percent of the malaria cases occur in Brazil and the other 40% are distributed in 20 other countries of Central and South America. *Plasmodium vivax* is the predominant species (74.2%) followed by *P. falciparum* (25.7%) and *P. malariae* (0.1%), and no less than 10 *Anopheles* species have been identified as primary or secondary malaria vectors. Rapid deforestation and agricultural practices are directly related to increases in Anopheles species diversity and abundance, as well as in the number of malaria cases. Additionally, climate changes profoundly affect malaria transmission and are responsible for malaria epidemics in some regions of South America. Parasite drug resistance is increasing, but due to bio-geographic barriers there is extraordinary genetic differentiation of parasites with limited dispersion. Although the clinical spectrum ranges from uncomplicated to severe malaria cases, due to the generally low to middle transmission intensity, features such as severe anemia, cerebral malaria and other complications appear to be less frequent than in other endemic regions and asymptomatic infections are a common feature. Although the National Malaria Control Programs (NMCP) of different countries differ in their control activities these are all directed to reduce morbidity and mortality by using strategies like health promotion, vector control and impregnate bed nets among others. Recently, international initiatives such as the Malaria Control Program in Andean-country Border Regions (PAMAFRO) (implemented by the Andean Organism for Health (ORAS) and sponsored by The Global Fund to Fight AIDS, Tuberculosis and Malaria (GFATM)) and The Amazon Network for the Surveillance of Antimalarial Drug Resistance (RAVREDA) (sponsored by the Pan American Health Organization/World Health Organization (PAHO/WHO) and several other partners), have made great investments for malaria control in the region. We describe here the current status of malaria in a non-Amazonian region comprising several countries of South and Central America participating in the Centro Latino Americano de Investigación en Malaria (CLAIM), an International Center of Excellence for Malaria Research (ICEMR) sponsored by the National Institutes of Health (NIH) National Institute of Allergy and Infectious Diseases (NIAID).

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1. Current malaria problem in non-Amazonian regions of Latin America

1.1. Changing epidemiology of Plasmodium falciparum and Plasmodium vivax

1.1.1. General picture in the American continent

According to recent estimates, approximately 170 million people live at risk of *P. vivax* and *P. falciparum* transmission in 21 countries of Latin America (LA) and the Caribbean (Fig. 1) (Guerra et al., 2008, 2010). Approximately 60% of the malaria cases in the Americas are reported from Brazil, with an incidence almost exclusively restricted to the Amazon Region, whereas the other 40% of the cases are reported from Colombia (14.2%), Peru (8.8%), Venezuela (5.4%), Bolivia (1.9%) and Ecuador (1.1%), as well as from the Caribbean, mainly Haiti (2.8%), and some Central American countries, Guatemala (3.8%), Panama (0.4%) and Honduras (1.5%). A limited number of cases (0.3%) are also reported from Mexico (PAHO and WHO, 2007a). The contribution of LA to the global malaria burden is small, with an estimated <1% (~3 million cases) of the total world malaria cases occurring in LA in 2007 (Hay et al., 2010).

About 90% of these malaria cases originate in the Amazon basin shared by Bolivia, Brazil, Colombia, Ecuador, French Guiana, Guyana, Peru, Suriname and Venezuela (PAHO, 2006) whereas the other 10% is contributed by non-Amazon regions, mainly the Andean region (2%) and Central America (4.1%) (Fig. 1).

In terms of malaria species, 74.2% of infections are caused by *P. vivax* and 25.7% by *P. falciparum*, with an estimated mortality of 1%. Less than 0.1% of the cases reported are caused by *P. malariae* in scattered foci in different countries (Sina, 2002; WHO, 2009). Additionally, in some areas of the Amazon forest, parasites containing gene sequences corresponding to the simian parasite *P. simiovale* have been described (de Arruda et al., 1998; Kremsner et al., 1992; Qari et al., 1993; Rosenberg et al., 1989). Fig. 2 shows the evolution of malaria in the Americas in terms of parasite species predominance.

Despite the great regional efforts to control malaria and the evident success of the Global Malaria Eradication Program (GMEP) in eliminating malaria or significantly reducing its transmission in numerous areas of the continent by the1960s (Gusmao, 1999), malaria transmission has maintained an increasing trend in recent decades, with periodical epidemic peaks in some areas likely associated with the climatic changes introduced by the warm phase of El Niño Southern Oscillation (ENSO) (Mantilla et al., 2009). However, there has been a significant decrease in incidence in the last five years (PAHO and WHO, 2008a).

In an effort to better understanding of the epidemiology of malaria in non Amazonian settings, four countries of the region: Colombia, Guatemala, Panama and Peru have been initially selected to conduct a study in the context of the project Centro Latinoamericano de Investigación en Malaria (CLAIM), to assess the diversity of parasite populations related to the epidemiology, vectors and clinical findings of malaria. The aim is to establish a scientific framework that supports the development of new intervention strategies for malaria elimination in these Latin American countries.

1.1.2. Malaria transmission in non-Amazonian regions

Malaria in non-Amazonian regions of LA is found mainly along the coastal regions and lowland Andean valleys as well as in meso-America, from Mexico to Panama (PAHO and WHO, 2008a). We describe here the current status of malaria in four countries of South and Central America participating in the CLAIM.

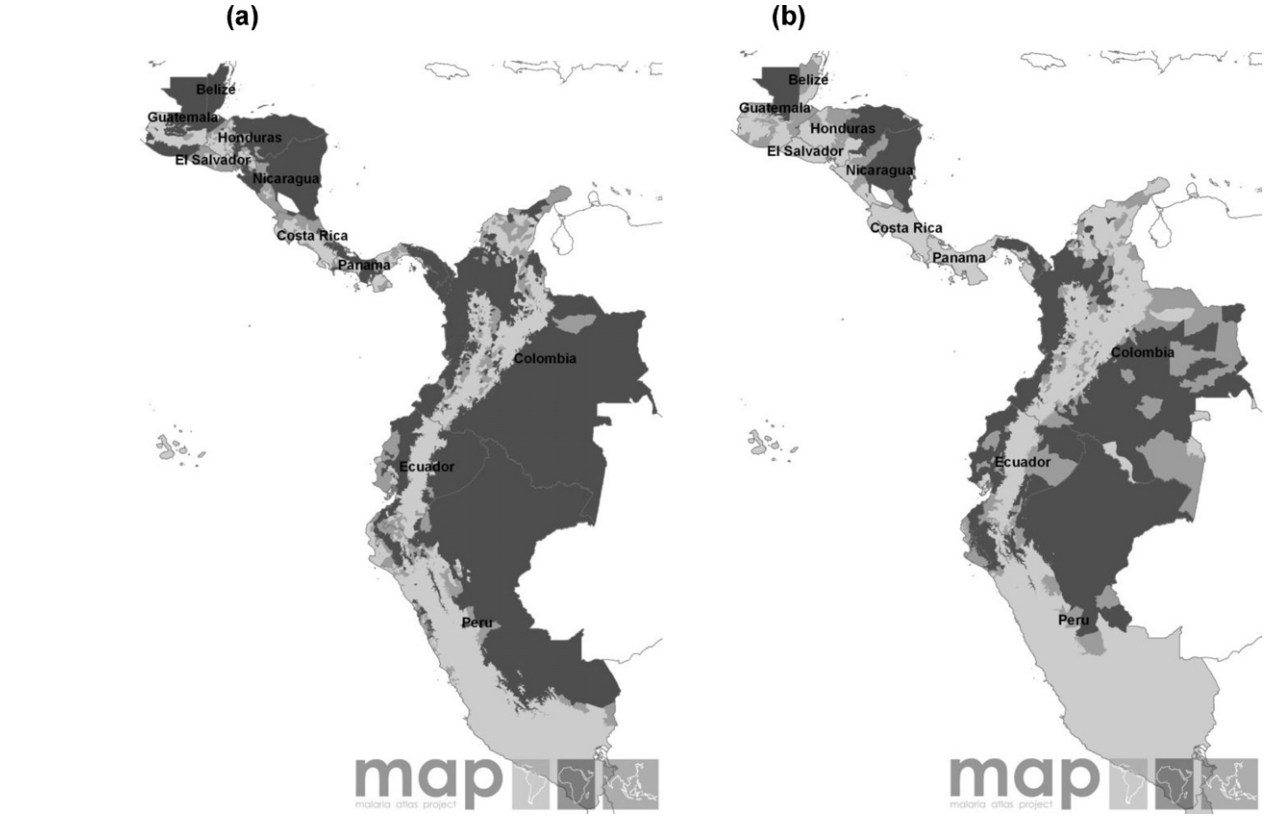

Fig. 1. Distribution of *Plasmodium vivax* (a) and *P. falciparum* malaria (b) in the study areas of CLAIM and neighboring countries. Risk is stratified according to API into stable transmission (dark grey areas; API ≥ 0.1 per 1000 per annum), unstable transmission (medium grey areas; API < 0.1 per 1,000 per annum) and malaria free (light grey areas; API = 0) (Guerra et al., 2008, 2010).