REPORT ON THE SITUATION OF MALARIA IN THE AMERICAS

2014

Pan American Health Organization

World Health Organization
REGIONAL OFFICE FOR THE Americas

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Contents

Abbreviations

ABER	Annual Blood Examination Rate
ACT	Artemisinin-based Combination Therapy
ADM1	First-level administrative division (i.e. state, province, department, etc.)
ADM2	Second-level administrative division (i.e. district, municipality, canton, etc.)
ADM3	Third-level administrative division (i.e. commune)
AIM	Action and Investment to Defeat Malaria
AMI	Amazon Malaria Initiative
API	Annual Parasite Index
CDC	Centers for Disease Control and Prevention
CHA/VT	Communicable Diseases and Health Analysis Departmentt
CHAI	Clinton Health Access Initiative
EMMIE	Elimination of Malaria in Mesoamerica and the Island of Hispaniola
Gates Foundation	Bill & Melinda Gates Foundation
G6PD	Glucose-6-phosphate-dehydrogenase
Global Fund	The Global Fund to Fight AIDS, Tuberculosis and Malaria
GTS	Global Technical Strategy for Malaria 2016-2030
HRP-2	Histidine-Rich Protein II
IDSP	Integrated Disease Surveillance Program
IRSv	Indoor Residual Spraying
ITN	Insecticide-Treated Net
LLIN	Long-Lasting Insecticide Treated Net
MDA	Mass Drug Administration
MDG	Millennium Development Goal
MDG 6C	Millennium Development Goal Target 6C
ORAS	Andean Organization for Health (acronym in Spanish)
PAHO	Pan American Health Organization
PAMAFRO	Project for Malaria Control in Andean Border Areas (acronym in Spanish)
PCR	Polymerase Chain Reaction
RACCN	North Caribbean Coast Autonomous Region (acronym in Spanish)
RACCS	South Caribbean Coast Autonomous Region (acronym in Spanish)
RAVREDA	Amazon Network for the Surveillance of Antimalarial Drug Resistance (acronym in Spanish)
RBM	Roll Back Malaria

RDT	Rapid Diagnostic Test
SENEPA	National Service for Eradication of Malaria (acronym in Spanish)
SNEM	National Service for Control of Arthropod Vector-borne Diseases (acronym in Spanish)
SPR	Slide Positivity Rate
T3	Test-Treat-Track
UN	United Nations
USAID	United States Agency for International Development
USP	United States Pharmacopeia
WHA	World Health Assembly
WHO	World Health Organization
WOCBA	Women of Child-Bearing Age

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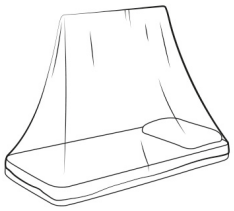
2014 Key Facts of the Americas

21 countries are endemic for malaria

389,390 cases

87 deaths

92.5% of all cases occurred in the Amazon sub-region



Approximately **790,000** insecticide-treated nets were distributed, protecting an estimated **6.4** million people

69% of all cases in the Americas were *Plasmodium vivax* infections,

24% were *Plasmodium falciparum*

108 million people are at risk for malaria in the Americas, **5.7** million of these are at high risk*

60% of all cases occurred in men

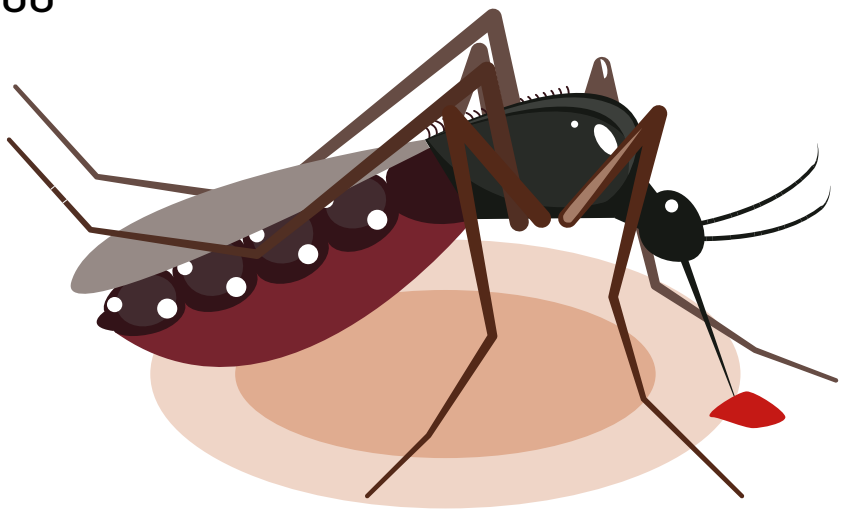
US$**20** million of funding for malaria in the countries of the Americas came from external sources

6.7 million were tested by microscopic examination

*High risk areas are those with an annual parasite index of 10 or more cases per 1,000 inhabitants.

2000-2014 Key Facts of the Americas

67%
decline in cases
since 2000



79%
decline in deaths
since 2000

6.5 million cases and
3,500 deaths averted based on rates from 2000

14 endemic countries have reduced malaria incidence by more than **75%**, achieving Target 6C of the MDGs 'to have halted and begun to reverse the incidence of malaria'

2 countries with **0** local cases of malaria in 2014

FOREWORD

In 1954, the countries in the Americas made the trail-blazing decision to adopt malaria eradication as a program with the Pan American Sanitary Bureau as the coordinating unit. It was a year later when the Global Program for Malaria Eradication was created and became the coordinating unit for malaria in the world. Throughout its more than a century-long effort in reducing malaria transmission, the disease has remained at the forefront of Pan American Health Organization (PAHO) member states' concerns. In September 2016, health ministers from across the Region of the Americas adopted a new plan for malaria elimination over the next four years, urging countries to intensify the fight against the disease.

The current state of malaria in the Americas has changed dramatically from the mid-fifties. The disease has been eliminated in many countries but was quick to have resurgence or increase in territories which failed to recognize the fragility of their achievements, where the improvements on social determinants remained a challenge and which continued to have receptivity for malaria. Due to reinforced global and regional malaria, commitments since the year 2000, the number of cases due to malaria has more than halved while the progress made in preventing deaths has been even more phenomenal. For the first time in over three decades, we are now able to imagine a world without malaria, with 18 countries of the Americas expressing official commitment to malaria elimination. One country is currently in the process of becoming certified for malaria elimination and at least four more are expected to follow within the next several years.

Despite these advances, some countries continue to face significant public health challenges. In particular, some health systems still need strengthening to accurately assess the current situation. Another area of critical concern is the potential emergence of resistance to anti-malarial medicines used in the Guiana Shield. Populations living in situations of vulnerability such as indigenous groups live in precarious conditions and are at a higher risk of having malaria. Information about the risk of malaria among pregnant women also remains inadequate in many countries of the Americas and is a key priority for PAHO.

Funding for malaria efforts in the Americas comes mostly from domestic sources, which demonstrate strong country ownership of programs. Nevertheless, the Global Fund to Fight AIDS, Tuberculosis and Malaria (Global Fund) and the United States Agency for International Development (USAID) have also continued to be among the most important sources of external support for countries with malaria in the Americas. However, as malaria has declined, funding has again dwindled, which potentially jeopardizes continued progress towards elimination.

The aim of this document is to provide an overview of the current malaria situation. PAHO's Regional Malaria Program of the Neglected, Tropical and Vector Borne Diseases Unit of the Communicable Diseases and Health Analysis Department (CHA/VT) has produced this report with officially-reported information provided by the Member states between 2000 and 2014. The report includes a general overview of the current malaria situation at the regional, sub-regional, and country levels for those that are endemic to malaria. It documents the achievements since 2000 as well as the challenges that remain.

We hope that the results presented may not only inform on the malaria situation, but inspire positive action towards achieving malaria elimination. As we move towards achieving the Sustainable Development Goals, 18 countries have declared malaria elimination as a goal either partially or throughout the entire country; others aim to further reduce malaria by 90%. The World Health Organization's Global Technical Strategy 2016-2030 has called for efforts towards the acceleration of malaria elimination and PAHO's Plan of Action for Malaria Elimination 2016-2020 in the Americas will further this goal.

The Region of the Americas has come a long way in its efforts to curb the burden of malaria since 2000 and this could not be achieved without the persistent efforts of countries along with contributions made by various entities and organizations. To achieve elimination, however, even more resources will be needed as the present-day challenges are some of the most complex and socially sensitive.

PAHO looks forward to an enduring partnership of the member states and various stakeholders in addressing the key challenges and critical gaps which have been documented in this report, towards achieving the ultimate and shared goal of a malaria free world.

Dr. Marcos Espinal

Director, Department of Communicable Diseases and Health Analysis

SECTION I: REGION OF THE AMERICAS

In the decade of 1990–2000 (a decade prior to our analysis time period), malaria began to decrease in some countries with a few peaking during this time (1). Some epidemics were exacerbated by funding challenges and the El Niño Southern Oscillation effect.

In the Americas, the number of malaria cases declined by 67% between 2000 and 2014 and malaria-related deaths have declined by 79% (Figure 1). There are currently 21 malaria-endemic countries and territories (hereafter referred to as countries) in the Americas: Argentina, Belize, Bolivia, Brazil, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, French Guiana, Guatemala, Guyana, Haiti, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Suriname, and Venezuela. A goal of 75% reduction of malaria morbidity was set at the 58th World Health Assembly (WHA) using an assumed baseline year of 2000 (2) as outlined by Goal 6 of the Millennium Development Goals (MDG) (3). This goal, established in 2005, has been achieved in 14 of the 21 endemic countries. At the end of 2014, all malaria-endemic countries in the Americas have reduced malaria morbidity compared to 2000 except for Haiti and Venezuela (Figure 2). There are currently 13 countries in the Americas in the control phase. Belize, Dominican Republic, Ecuador, El Salvador, and Mexico are in the pre-elimination phase, while Argentina, Costa Rica, and Paraguay are in the elimination phase. In 2014, Argentina officially requested certification of malaria-free status from the World Health Organization (WHO). Despite these achievements, there are still an estimated 108 million people at risk for malaria, of which at least 5.7 million were classified as being at high risk[1] (Table 1).

Figure 1. Number of cases and deaths due to malaria in the Region of the Americas, 2000–2014

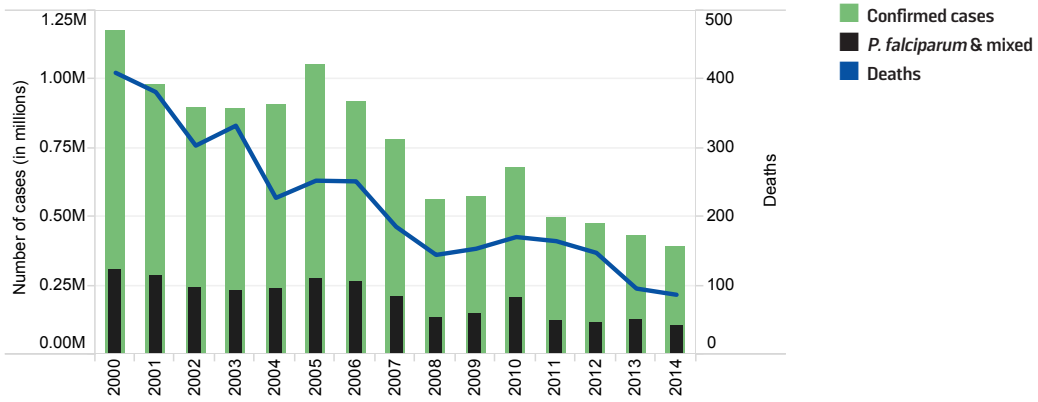
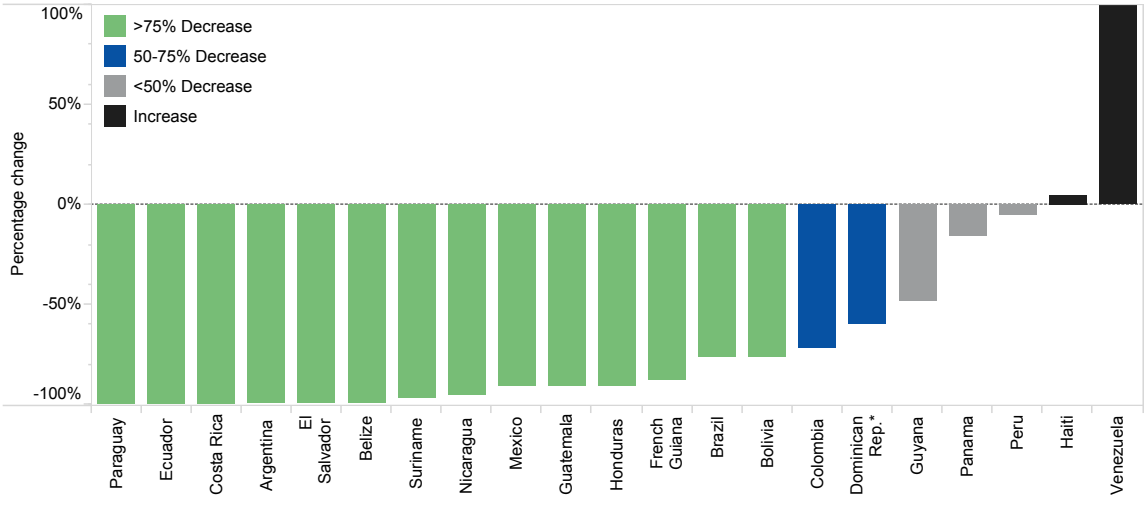


Figure 2. Change in malaria cases by country in the Region of the Americas, 2000–2014



*Dominican Republic

[1] High risk areas are those with an annual parasite index of 10 or more cases per 1,000 inhabitants.

Table 1. Malaria in countries in the control phase in the Region of the Americas, 2000, 2012-2014

Country	Year	Total population at risk	Blood samples examined	Confirmed cases	*P. falciparum* & mixed infections	Annual Parasite Index (x1000)
Bolivia	2000	3,569,495	143,990	31,469	2,536	8.82
	2012	5,212,078	121,944	7,415	348	1.42
	2013	0	133,260	7,342	994	...
	2014	0	124,900	7,401	341	...
Brazil	2000	31,597,300	2,562,576	613,241	131,616	19.41
	2012	44,212,156	2,325,775	242,758	35,379	5.49
	2013	41,992,553	1,873,518	178,546	31,482	4.25
	2014	35,965,912	1,658,976	143,145	23,409	3.98
Colombia	2000	18,835,155	478,820	144,432	51,730	7.67
	2012	9,603,584	346,599	60,179	15,721	6.27
	2013	9,691,401	284,332	51,722	18,174	5.34
	2014	10,596,997	325,713	40,768	20,504	3.85
Dominican Rep.*	2000	6,568,000	427,297	1,233	1,226	0.19
	2012	6,787,117	415,808	952	950	0.14
	2013	6,577,495	431,683	579	576	0.09
	2014	0	362,304	496	491	...
French Guiana	2000	167,000	48,162	3,708	3,051	22.20
	2012	199,040	13,638	900	264	4.52
	2013	199,199	22,327	877	307	4.40
	2014	125,004	14,651	448	148	3.58
Guatemala	2000	2,912,000	246,642	53,311	1,474	18.31
	2012	6,057,530	186,645	5,346	68	0.88
	2013	6,541,912	153,731	6,214	152	0.95
	2014	9,565,826	264,269	4,931	92	0.52
Guyana	2000	615,000	209,197	24,018	12,324	39.05
	2012	698,795	196,622	31,601	20,293	45.22
	2013	0	205,903	31,479	17,425	...
	2014	747,884	142,843	12,353	5,139	16.52
Haiti	2000	...	21,190	16,897	16,897	...
	2012	10,312,000	167,726	27,866	25,423	2.70
	2013	10,388,424	172,624	20,957	20,378	2.02
	2014	10,466,500	134,766	17,696	17,696	1.69
Honduras	2000	6,080,000	175,577	35,125	1,446	5.78
	2012	5,478,118	155,165	6,439	583	1.18
	2013	5,270,455	144,436	5,428	1,159	1.03
	2014	5,598,244	151,420	3,380	567	0.60
Nicaragua	2000	4,980,000	509,443	23,878	1,369	4.79
	2012	3,198,774	536,278	1,235	236	0.39
	2013	0	517,141	1,194	220	...
	2014	0	605,357	1,163	163	...
Panama	2000	2,756,554	149,702	1,036	45	0.38
	2012	2,402,289	107,711	844	1	0.35
	2013	3,724,171	93,624	705	6	0.19
	2014	183,428	80,701	874	8	4.76
Peru	2000	14,724,000	1,483,816	68,321	20,618	4.64
	2012	4,499,236	758,723	31,436	3,501	6.99
	2013	4,499,236	863,790	43,139	6,843	9.59
	2014	11,778,357	864,413	64,676	6,988	5.49
Suriname	2000	62,177	63,377	11,361	10,648	211.20
	2012	80,000	17,464	569	126	7.11
	2013	80,000	13,693	729	343	9.11
	2014	23,000	17,608	401	165	17.43
Venezuela	2000	8,747,000	261,866	29,736	5,491	3.40
	2012	5,689,293	410,663	52,803	13,302	9.28
	2013	5,939,612	476,764	78,643	27,659	13.24
	2014	5,916,153	522,617	90,708	27,843	15.33

''...'' Indicates unavailable data
*Dominican Republic

There was a decrease in the number of confirmed cases reported since 2000, from 1,181,095 cases to 389,390 cases in 2014. Brazil (36.8%), Venezuela (23.3%), and Peru (16.6%) together accounted for 76.7% of malaria cases in the Americas in 2014 (Figure 3). Deaths related to malaria also declined from 410 in 2000 to 87 deaths in 2014 (Figure 1), with Brazil accounting for 41% of these deaths. However, reporting discrepancies exist for mortality data, especially those from earlier years during the 2000–2014 period. Pan American Health Organization's (PAHO) Regional Health Observatory is a data repository that monitors priority health topics including mortality. There are notable discrepancies between malaria deaths from this repository and data reported by countries for this report, which are analyzed in later chapters. Eleven countries reported no deaths related to malaria in 2014. It is estimated that 6.5 million cases and 3,500 deaths were averted during 2001–2014 assuming the rates from 2000 remained constant. For this report the endemic countries have been divided into four sub-regions: Amazon, Hispaniola, Mesoamerica, and the Southern Cone. In 2014, the Amazon sub-region accounted for 92.5% of all cases in the Americas, followed by Hispaniola (4.7%), Mesoamerica (2.8%), and the Southern Cone (<0.1%). Further analysis on sub-regions is detailed in later chapters.

The annual parasite index (API) is used to further measure epidemiological risk of malaria across countries. Figure 3 shows the API of reported cases per 1000 people at risk per year for the endemic countries. For 2014, Guyana, Suriname, and Venezuela had an API of more than 15 cases/1000 people at risk. However, it should be noted that a large migratory population of illegal miners in these countries is not included in the total population at risk of malaria, leading to artificially high APIs. Furthermore, when analyzing number of cases and APIs at the smallest administrative unit reported[2], areas of focalized transmission can be identified. For example, the Sifontes municipality in the province of Bolivar, Venezuela, has had the largest amount of cases each year for 2012–2014 as well as a consistently high API. In 2014, Sifontes's API was 849 cases/1000 people. In Peru, the province of Loreto has a high endemicity, with the municipalities of Tigre, Pastaza, and Andoas reporting both high APIs and number of cases (Figures 4 and 5). Similarly, the municipalities of Mancio Lima and Rodrigo Alves located in the province of Acre, Brazil, have also reported high numbers of cases and high APIs.

Table 2. Malaria in countries in the elimination and pre-elimination phase in the Region of the Americas, 2012–2014

Country	Year	Confirmed cases	Cases Investigated	Imported	Autochthonous *P. falciparum*	Imported – *P. falciparum*	Imported – *P. vivax*	Active Foci
Argentina	2012	4	4	4	0	0	4	0
	2013	4	4	4	0	0	4	0
	2014	4	4	4	0	0	4	0
Belize	2012	37	1	1	0	1	0	...
	2013	26	26	4	0	0	4	4
	2014	19	19	0	0	0	0	8
Costa Rica	2012	8	8	1	0	0	1	1
	2013	6	6	4	0	1	3	0
	2014	6	6	5	0	3	2	0
Ecuador	2012	558	204	14	68	12	2	14
	2013	378	100	10	160	1	9	3
	2014	241	...	...	...	...	...	...
El Salvador	2012	21	21	7	0	3	4	10
	2013	7	7	1	0	0	1	2
	2014	8	8	2	0	0	2	2
Mexico	2012	842	842	9	0	9	0	71
	2013	499	499	4	0	4	0	61
	2014	664	664	8	0	6	2	56
Paraguay	2012	15	15	15	0	11	4	0
	2013	11	11	11	0	7	3	0
	2014	8	8	8	0	7	1	0

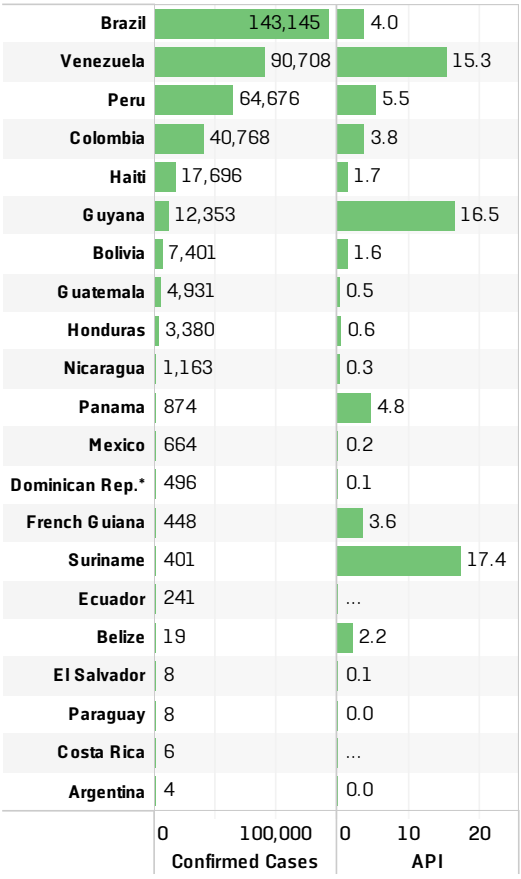
'...'' Indicates unavailable data.

[2] Most countries reported at the ADM2 level, except for Bolivia, Peru, and Haiti reporting at ADM3 level. Guyana, Suriname, and Peru reported ADM1 level data. Foci information was provided for Argentina, Belize, Costa Rica, El Salvador, and Paraguay. Ecuador did not report 2014 data.

Cases increased in Bolivia, Mexico, Panama, Peru, and Venezuela in 2014 when compared to 2013 (Table 1). In Peru, cases have increased each year since 2011 and reached a 49.9% increase in 2014 compared to the previous year. If this trend continues, Peru could report more cases in 2015 than those reported in 2000 (Figure 2). Venezuela had a 15.3% increase in cases between 2013 and 2014. Cases have increased due to worsening economic conditions, increased mining activities, and decreased vector-control interventions. Overall, Venezuela reported more cases in 2014 than in any year in the previous 50 years. In other countries, only a small increase in malaria was seen (<200 cases total). In Mexico, this increase has been related to the change in human migratory routes onwards to USA from Central and South America.

Plasmodium vivax is the main species in the Americas, causing 69% of malaria cases in 2014 (Figure 8). Cases in Haiti and the Dominican Republic are almost exclusively caused by *P. falciparum* (Figure 9). On the other hand, Argentina, Belize, El Salvador, Mexico, and Panama report exclusively *P. vivax* cases while Guatemala reports <1% of cases due to *P. falciparum*. Some countries have seemingly high proportions of certain species due to the small amount of cases such as Paraguay and Costa Rica where the majority of their *P. falciparum* cases were imported. Colombia had an increase of *P. falciparum* cases in 2014, which caused half of all malaria cases in that country; this is a 34% increase from 2013. *Plasmodium malariae* is also prevalent in the Americas, though accounts for less than 0.1% of all cases. Most cases are reported from the Amazon sub-region, particularly from Brazil, Colombia, French Guiana, Guyana, Peru, Suriname, and Venezuela. Costa Rica has also reported autochthonous *P. malariae* cases in the last few years. Species information was unavailable for 4% of all confirmed cases in 2014 largely from Brazil and Peru.

Figure 3. Number of cases and Annual Parasite Index (API) by country, 2014



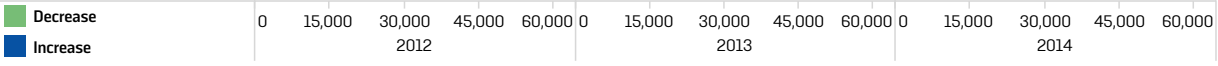
"..." indicates unavailable data.
*Dominican Republic

Throughout the Americas, men are more at risk for malaria than women (Figure 7). This trend has been consistent throughout the years and malaria mostly affects males between the ages of 15-24 years. Females are most affected during the ages of 5-14; however, the amount of cases in this age group is still less than their male counterparts. Approximately 60% of all cases occurred in men in 2014. Adjusting for age, Guyana had an incidence of 2,324 cases per 100,000 men in 2014, which is 2.9-fold higher than that in women. Venezuela also reported a 2.5-fold higher incidence in men compared to women in 2014. In the Americas, malaria is associated with occupational activities occurring outdoors such as mining and agricultural work, which predominately employs young males, a condition prevalent in both the aforementioned countries. However, an estimated 9% of all cases in 2014 occurred in children under 5 years of age, suggesting that malaria transmission occurs within households. Haiti, Peru, and Panama had particularly high incidence of malaria in children <5 years. IRS and ITN use in these countries can protect young children as a method of vector control for malaria within households.

Malaria risk is dependent on interactions with epidemiologic factors- host, vector, parasite, and environment. The Americas, as the rest of the world, has a diverse set of challenges involving interactions between these factors. The most important challenges currently being faced in the Americas have evolved from those of the past and are related to social determinants, occupation, geography, and various other issues. Social determinants mostly stemming from race, ethnicity, and cultural distinctions are a major issue in key malaria-endemic areas of the Americas such as Panama, Nicaragua, Honduras, Colombia, Guyana, and throughout the Amazon. Many of these distinct groups of people are impoverished, lack access to healthcare, and face cultural barriers inhibiting proper treatment. Another current challenge is malaria's association with occupation, particularly in mining, logging, and agriculture. Miners in all countries making up the Guiana Shield are at risk of malaria with limited intervention or control methods available to them. Finally, additional problems such as Haiti's weak surveillance system and the surge of cases in Venezuela due to a challenging political situation add to the prevailing malaria concerns in the Americas.

Figure 4. Municipalities with the highest number of malaria cases in the Region of the Americas, 2012-2014

Municipality	Country	2012	2013	2014
Sifontes	Venezuela	31,396	46,610	52,509
Cruzeiro do Sul	Brazil	16,055	20,043	17,210
San Juan Bautista	Peru	...	7,414	10,616
Manaus	Brazil	9,768	7,295	7,443
Labrea	Brazil	4,068	4,651	7,412
Andoas	Peru	...	1,029	6,842
Porto Velho	Brazil	15,570	9,134	6,639
Mancio Lima	Brazil	5,205	7,281	6,207
Atures	Venezuela	2,269	4,377	5,897
Cedeno	Venezuela	3,604	5,057	5,289
Eirunepe	Brazil	9,269	8,483	5,288
Gran Sabana	Venezuela	2,985	5,195	5,224
Tigre	Peru	...	2,511	5,194
Raul Leoni	Venezuela	1,363	2,844	5,130
Quibdo	Colombia	1,703	4,232	5,008
Rodrigues Alves	Brazil	3,701	3,524	4,774
Sao Gabriel*	Brazil	4,049	5,524	4,533
Itaituba	Brazil	14,179	9,004	3,940
Barcelos	Brazil	2,432	2,423	3,863
Pastaza	Peru	...	2,821	3,677



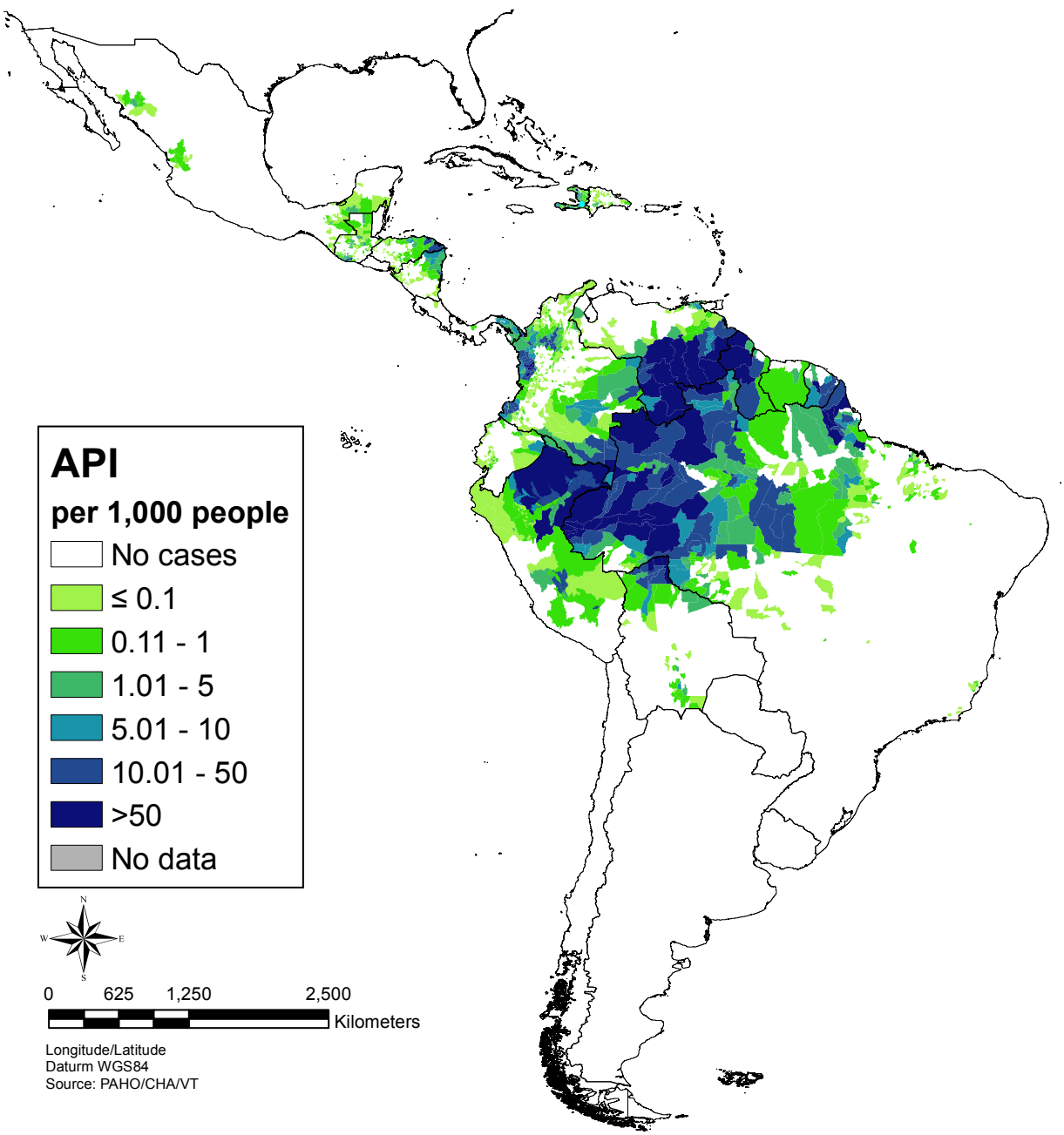
*Sao Gabriel da Cachoeira

Figure 5. Municipalities with the highest API in the Region of the Americas, 2012-2014

Municipality	Country	2012	2013	2014
Alto Nanay	Peru	636.4	560.7	850.8
Sifontes	Venezuela	731.1	777.2	848.7
Tigre	Peru	...	303.1	621.6
Pastaza	Peru	...	437.3	573.5
Andoas	Peru	...	87.4	566.8
Soplin	Peru	660.8	269.4	430.9
Mancio Lima	Brazil	327.6	422.7	341.9
Trompeteros	Peru	...	122.8	264.8
Rodrigues Alves	Brazil	242.5	190.6	263.6
Novita	Colombia	49.4	84.2	237.5
Alto Tapiche	Peru	98.4	...	209.3
Manapiare	Venezuela	33.9	95.6	198.0
Napo	Peru	42.0	52.8	197.0
Yaquerana	Peru	208.9	215.2	196.0
Cruzeiro do Sul	Brazil	201.1	230.4	195.2
Urarinas	Peru	...	26.5	194.5
Serra do Navio	Brazil	111.6	75.6	185.8
Tado	Colombia	83.6	97.2	184.3
Yavari	Peru	...	150.7	174.5
Putumayo	Peru	12.5	9.1	174.4

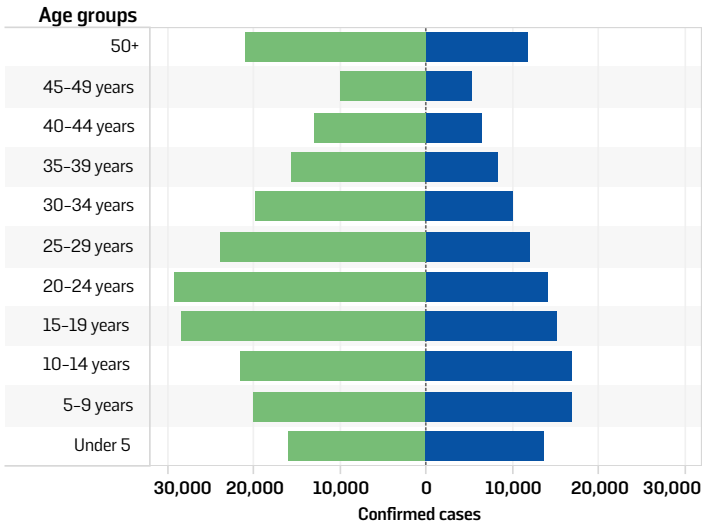
"..." indicates unavailable data.

Figure 6. Malaria by Annual Parasite Index (API) in the Region of the Americas, 2014



*Bolivia and Haiti reported API at the ADM3 level. Guyana and Suriname reported API at the ADM1 level. All other countries reported at the ADM2 level, except Ecuador who did not report 2014 data and instead ADM2 level data from 2013 is shown. Peru reported ADM3 data for Amazonas, Ayacucho, Cusco, Junin, Loreto, and San Martin while reporting ADM1 data for the rest of the provinces.

Figure 7. Malaria cases by age and sex in the Region of the Americas, 2014



*Ecuador, French Guiana, and Haiti did not provide gender and age data for 2014 cases. Cases not reported within the presented age groups were excluded as they could not be categorized into the dimensions of the graph. Cases of unknown gender (46) were also excluded.

Figure 8. Number of cases by species, 2000–2014

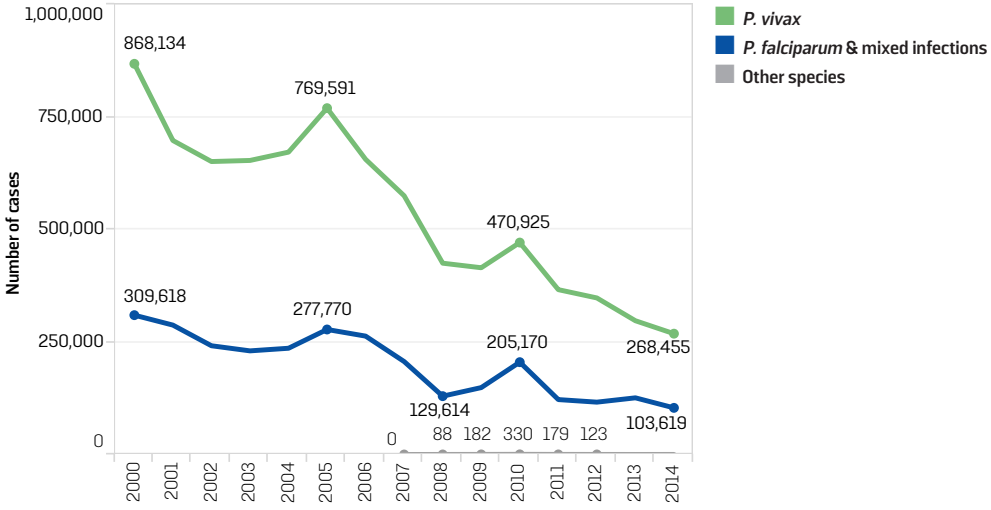
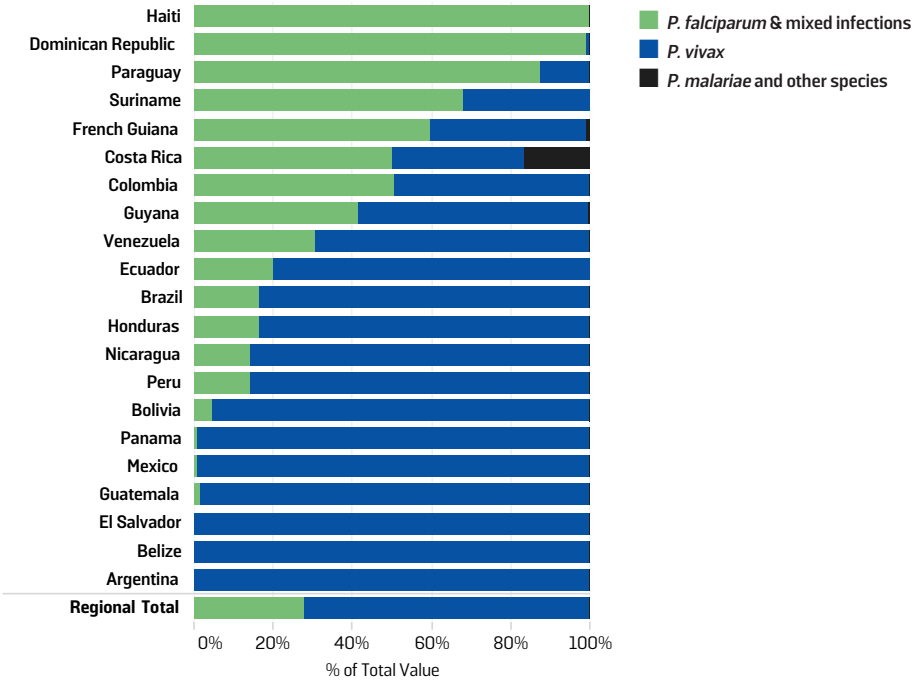


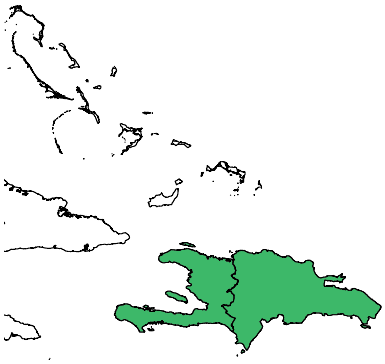
Figure 9. Proportion of malaria cases by species, 2014



SUB-REGIONS

Amazon

Bolivia
Brazil
Colombia
Ecuador
French Guiana
Guyana
Peru
Suriname
Venezuela



Hispaniola

Dominican Republic
Haiti

Mesoamerica

Belize
Costa Rica
El Salvador
Guatemala
Honduras
Mexico
Nicaragua
Panama

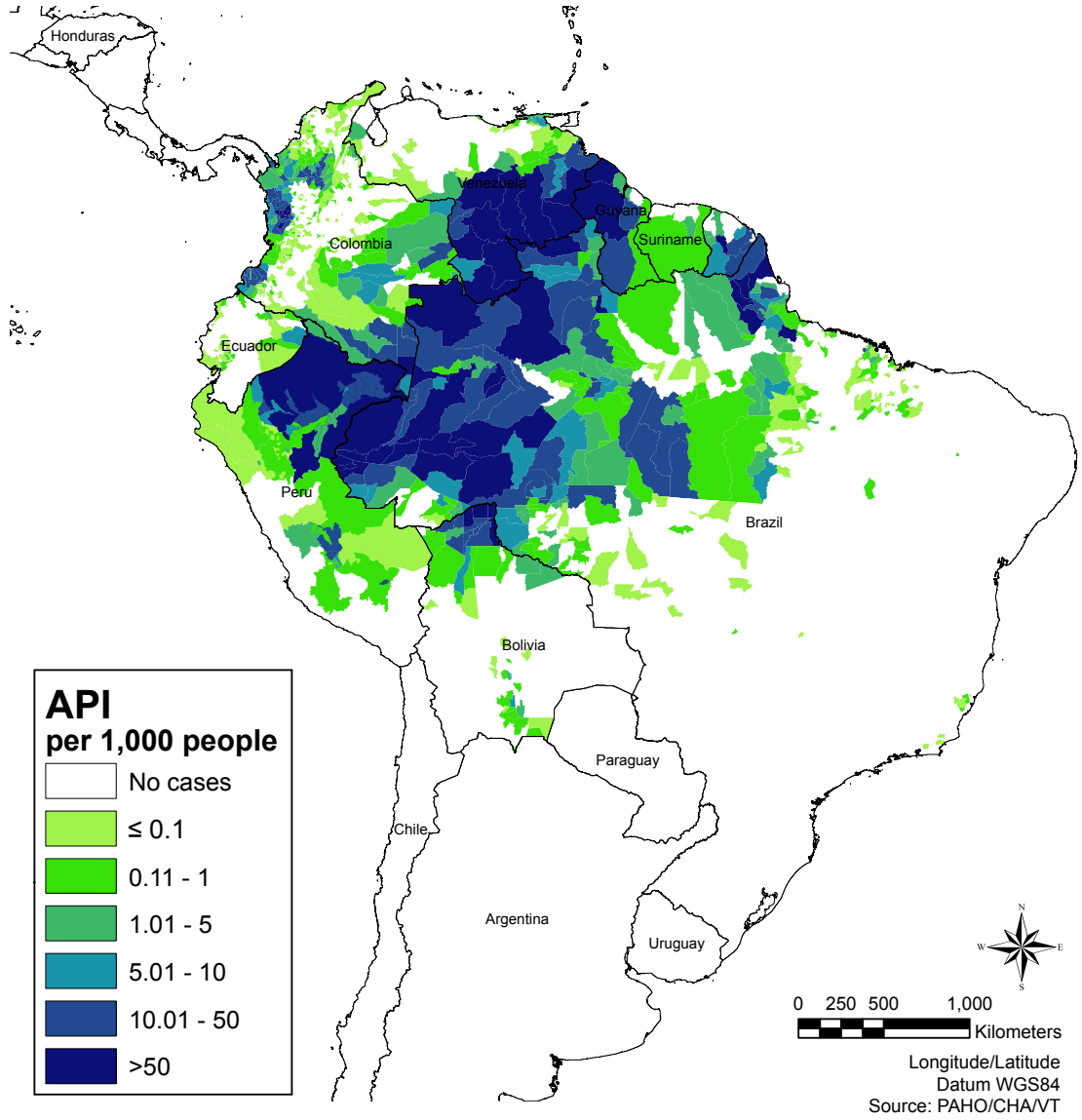
Southern Cone

Argentina
Paraguay

Non-Endemic

Anguila
Antigua and Barbuda
Aruba
Bahamas
Barbados
Bermuda
Bonaire
British Virgin Islands
Canada
Cayman Islands
Chile
Cuba
Curacao
Dominica
Grenada
Guadeloupe
Jamaica
Martinique
Montserrat
Puerto Rico
Saba
Saint Barthelemy
Saint Kitts and Nevis
Saint Lucia
Saint Martin
Saint Vincent and the Grenadines
Sint Eustatius
Sint Maarten
Trinidad and Tobago
Turks and Caicos
Uruguay
United States of America
United States Virgin Islands

Figure 1. Malaria by Annual Parasite Index (API) in the Amazon sub-region, 2014



*Bolivia and Haiti reported API at the ADM3 level. Guyana and Suriname reported API at the ADM1 level. All other countries reported at the ADM2 level, except Ecuador who did not report 2014 data and instead ADM2 level data from 2013 is shown. Peru reported ADM3 data for Amazonas, Ayacucho, Cusco, Junin, Loreto, and San Martin while reporting ADM1 data for the rest of the provinces.

SECTION II: SUB-REGIONS

AMAZON

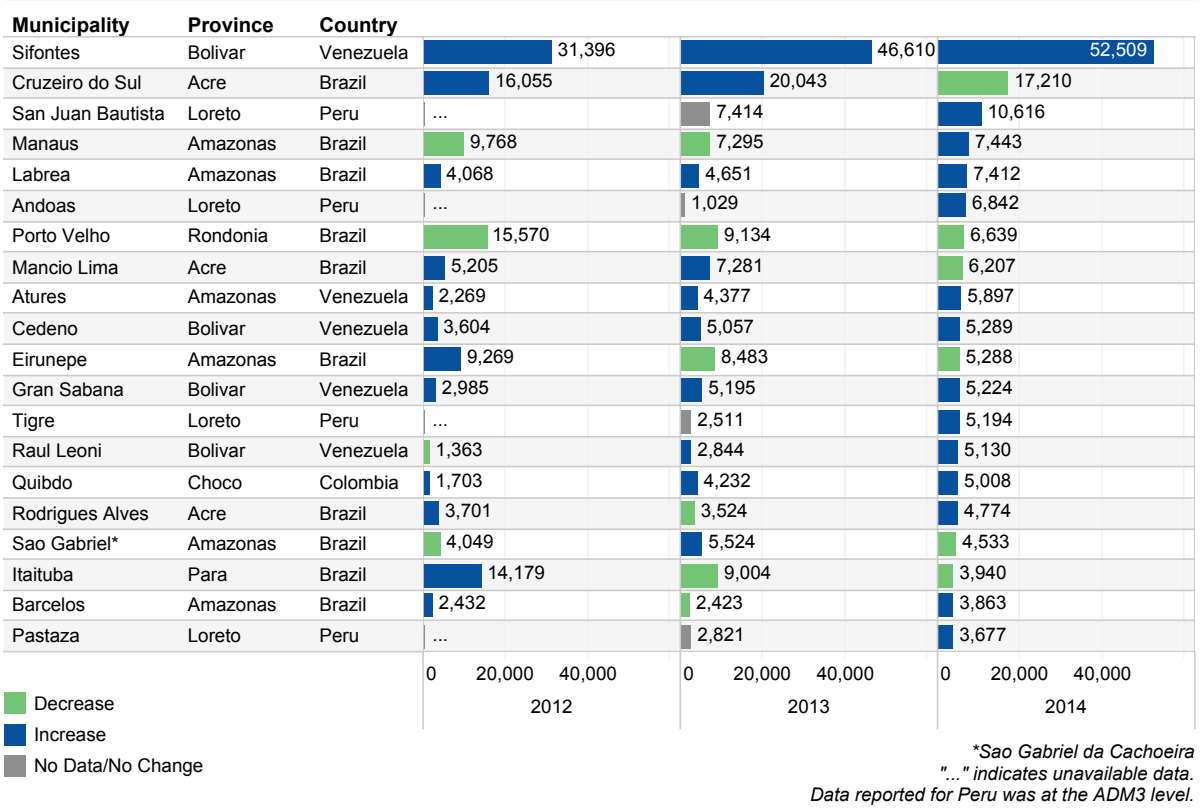
The Amazon sub-region has the highest burden of malaria in the Americas. Spanning over 5.5 million square kilometers, the Amazon rainforest encompasses 9 countries including Bolivia, Brazil, Colombia, Ecuador, French Guiana, Guyana, Peru, Suriname, and Venezuela (Figure 1). Combined, these countries reported 92.5% of all cases in the Americas. The municipalities with the highest malaria burden in this sub-region are all from the Amazon rainforest except for some in Colombia and Ecuador (Figure 2).

Colombia reports many cases from the Choco province, which shares a border with Panama. Another highly endemic area in Colombia is the municipality of Tumaco in Nariño province near the Ecuadorian border. For 2014, only partial data was available for Ecuador including number of confirmed cases, species information, and number of slides examined. Though sub-national data for 2014 was not reported, the province of Esmeraldas in Ecuador, located along the Colombian border was the most endemic area in 2013 and reported the most cases (141) in the country for that year. While the majority of cases in Colombia and Ecuador are reported from the Pacific coast area, these countries also report cases from the Amazon rainforest. In stark contrast, the rest of the countries in the Amazon sub-region reports almost no cases along their coastal areas.

The Amazon rainforest is sparsely populated, which is an advantage for the fight against malaria. However, for those who live and work in the rainforest, malaria is a very serious threat for which treatment is not easily accessible. Small-scale gold mining draws many people, particularly Brazilians known as *garimpeiros*, to the Guiana Shield (an area rich in minerals). Due to the interest in mining, there is a lot of cross-border movement in this area. Some countries such as French Guiana have very strict laws prohibiting foreigners to work within their borders, which influences access to healthcare for those involved in illegal mining.

The illegal population faces complex challenges in accessing healthcare for many other reasons, too. One of these is their remote location and lack of transportation to even the nearest health centers, making accessing treatment difficult. Another challenge is the fear of

Figure 2. Municipalities (ADM2) with the highest number of malaria cases in the Amazon sub-region, 2012-2014



**Sao Gabriel da Cachoeira*
"..." indicates unavailable data.
Data reported for Peru was at the ADM3 level.

identification of illegal status at health facilities and possible deportation. Another issue is the language barrier faced by many patients in the Guiana Shield. There are various cultures in this area including a Dutch-speaking population in Suriname, French population in French Guiana, English population in Guyana, Portuguese-speaking *garimpeiros* from Brazil, Spanish-speaking population in Venezuela and Colombia, as well as various indigenous tribes and ethnicities with their own proper languages. The inability for health personnel and patients to communicate leads to improper treatment and possibly life-threatening consequences.

Suriname has had success in reducing the number of malaria cases as a result of two consecutive projects supported by the Global Fund. Currently, the country's biggest malaria challenge is managing the importation of malaria cases from French Guiana. Suriname's ministry of health has provided treatment to miners through trained individuals working in mining areas; however, Suriname cannot eliminate malaria alone and trans-border cooperation is pivotal in order to achieve real progress. While Suriname benefitted from resources provided by the Global Fund to carry out their projects, Guyana is the only other country in the Guiana Shield currently eligible to receive funding from this source.

Due to the probable non-adherence to and self-treatment with antimalarials in the Guiana Shield, the risk of developing artemisinin resistance is high. Studies conducted within the framework of the AMI/RAVREDA project have not found decreased sensitivity to artemisinin in Suriname and Guyana. French Guiana and Brazil have similar ongoing studies.

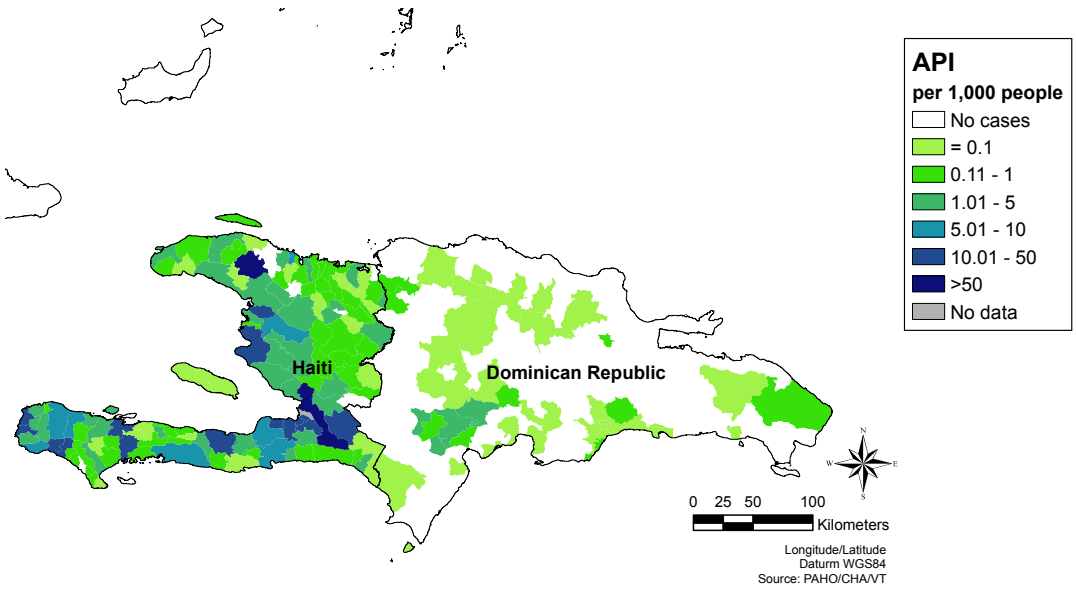
Outside the Guiana Shield, other highly endemic areas of the Amazon sub-region are in Peru and Bolivia. Approximately 43.8% of all cases in Bolivia were reported from Guayaramerin, a municipality along the Brazilian border and where many people work in the Amazon rainforest to harvest *castaña* (chestnut). Access to healthcare in this border area has been particularly challenging due to movement of people across borders. In Peru, there has been an increase in malaria cases in the province of Loreto, the largest and most sparsely-populated province in the country, a majority of which is covered by the Amazon rainforest. People living in conditions amenable for malaria transmission along with inadequate coverage with preventive interventions in the last few years after the end of a Global Fund financed project (PAMAFRO) have been the reasons for continued transmission in this province.

HISPANIOLA

Except for a few sporadic outbreaks in the past, malaria has been mostly eliminated in the Caribbean. However, the island of Hispaniola is still endemic (Figures 3 and 4). Infections are almost exclusively caused by *P. falciparum*. Although surveillance in Haiti is inadequate, data from the Dominican Republic, which has adequate malaria surveillance, indicates no local transmission of *P. vivax*. In 2014, there were 5 imported *P. vivax* cases in the Dominican Republic (all from Venezuela). Less than 0.01% of all cases were caused by this species in 2000-2014.

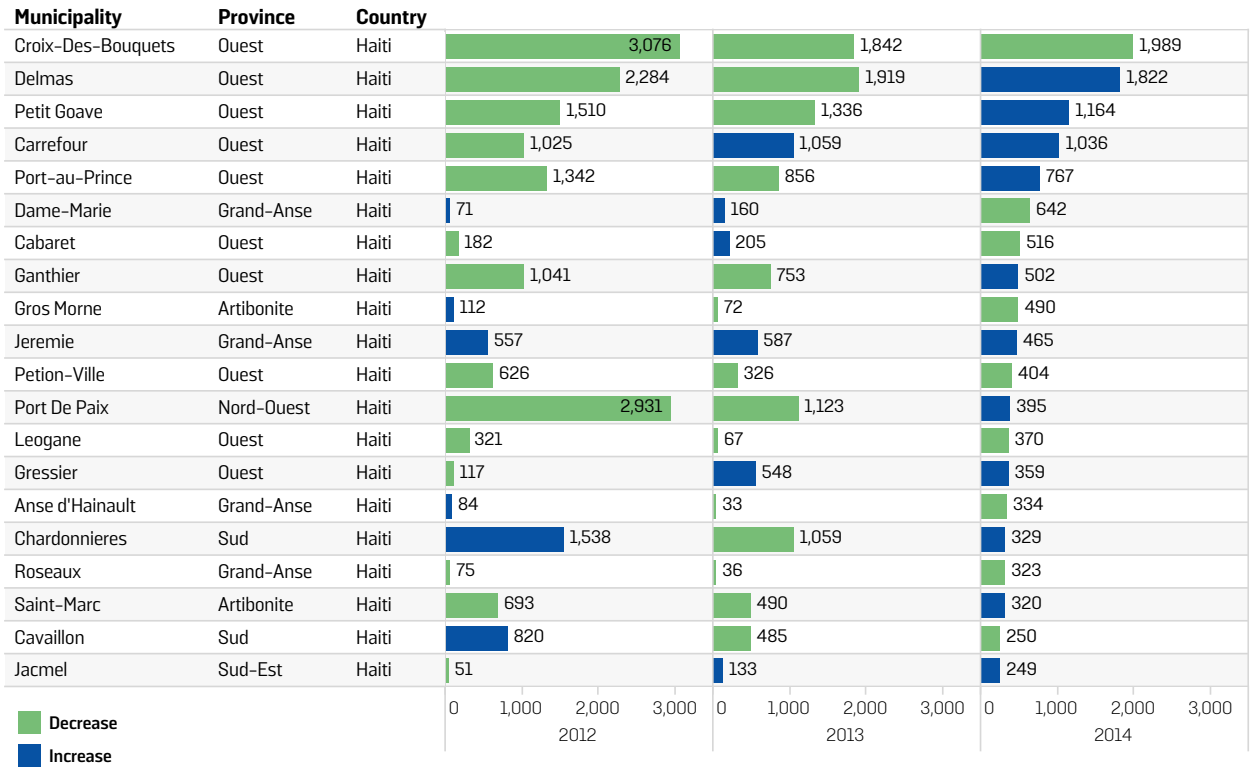
Haiti suffered a devastating earthquake in January of 2010, and a combination of the subsequent chaotic

Figure 3. Malaria by Annual Parasite Index (API) at the municipality level in the Hispaniola sub-region, 2014



*Haiti reported API at the ADM3 level, Dominican Republic reported API at the ADM2 level.

Figure 4. Municipalities with the highest number of malaria cases in the Hispaniola sub-region, 2012-2014



environment and lack of infrastructure influenced malaria transmission, among the country's other problems. Duplication of data for those tested for malaria multiple times and by multiple organizations after the earthquake is a probable cause for the increase in malaria by 69.9% from 2009 to 2010 in Haiti. In the Dominican Republic, malaria increased largely in areas along major migratory routes and in the capital after the earthquake (33.8% increase from 2009 to 2010). Owing to inadequate quality of surveillance, it is not possible to ascertain true malaria trends in Haiti. On the other hand, the Dominican Republic will likely achieve a 50-75% decline by 2015.

However, in recent years surveillance in Haiti has improved and information is more reliable. A prime reason for this has been the increase in testing of all suspected malaria cases with the introduction of RDTs, although it has led to replacement of microscopy in many areas rather than complementing the existing diagnostic network. In border areas, especially in the northeast, malaria seems to have declined significantly. In Monte Cristi province of Dominican Republic, malaria has decreased by 99% since 2010 and only 1 confirmed case was reported in 2014 from the whole province. One of the adjacent municipalities in Haiti, Ferrier in Nord-est province, reported that of 280 people tested with RDTs, 0 were confirmed positive in 2014. Fort Liberte, in the west of Ferrier, reported 2 positive cases (772 tested with 263 by RDTs). Due to the increase in urbanization in the north of the country after the 2010 earthquake, breeding places for *An. albimanus* have decreased while those for the *Aedes* and *Culex* species have increased (4). These data suggest that the northern area of Haiti has very low transmission. Data from 2015 is still required before conclusions about malaria trends can be drawn. On the other hand, the southern province of Grand Anse in Haiti is highly endemic and preliminary reports in 2015 indicated that the area had an outbreak of malaria.

Both Haiti and the Dominican Republic use chloroquine and primaquine as the first line treatment for *P. falciparum* and *P. vivax*. Primaquine is used as radical treatment and is administered in a 45-mg single dose for *P. falciparum* and as a 14-day regimen of 15 mg for *P. vivax*. Resistance studies conducted in Hispaniola in the past have demonstrated susceptibility of the parasite to chloroquine treatment (5).

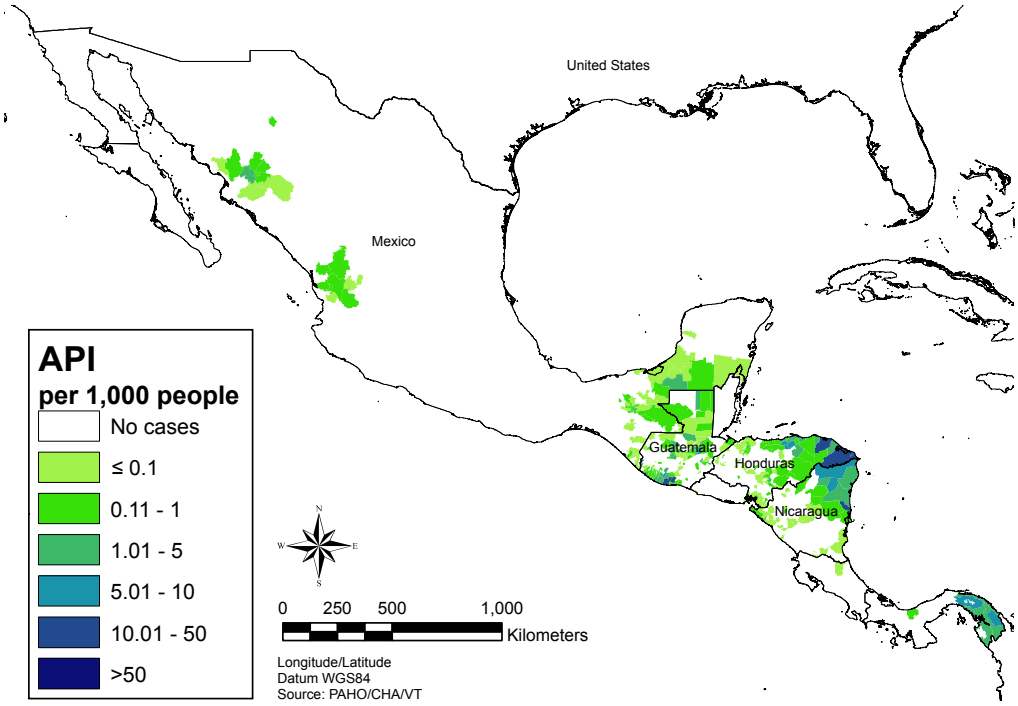
Each country uses vector control by promoting ITN usage; on the other hand, IRS is presently only used in the Dominican Republic. Both countries have also increased their use of RDTs to diagnose cases and

enhanced surveillance. The Dominican Republic has specifically targeted problem areas and populations to monitor using their surveillance system.

The Dominican Republic reports many imported cases from Haiti, especially along the border and in migrating populations. The countries recognize that cooperation between the two governments will be pivotal in decreasing incidence and have included plans to align elimination efforts in their respective strategic plans. Initiatives such as EMMIE and the Malaria Zero project focus on elimination of malaria on the whole island. Malaria Zero is funded by the Bill and Melinda Gates Foundation (Gates Foundation) and aims to eliminate malaria by 2020.

Inadequate funding has been a major problem in Hispaniola, but more so for Haiti. Most of the funding for malaria control in Haiti has come from external donors such as the Global Fund, USAID, PAHO/WHO, CDC, BMGF, CHAI, etc. In contrast, most funding for malaria in the Dominican Republic comes from the government with support also provided by the Global Fund.

Figure 5. Malaria by Annual Parasite Index (API) in the Mesoamerica sub-region, 2014



MESOAMERICA

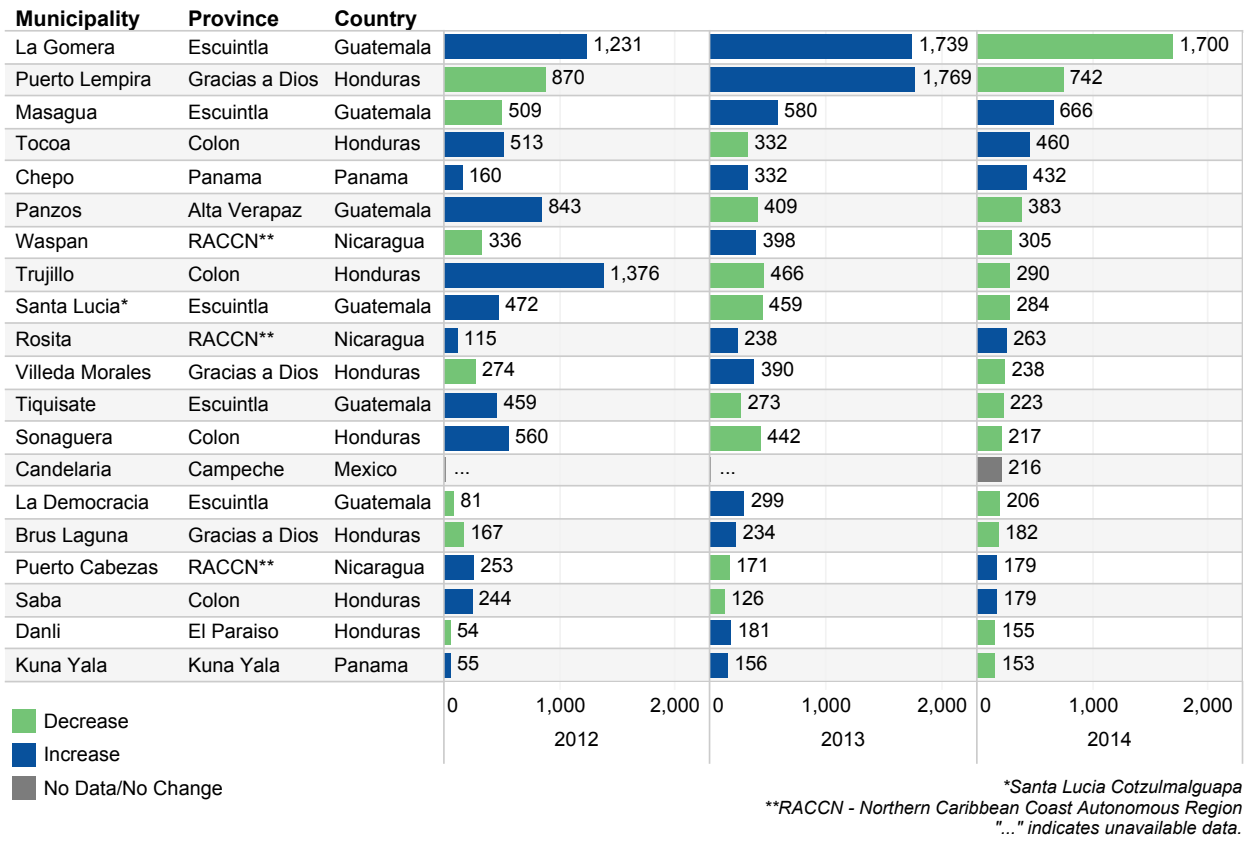
The countries of Mesoamerica have had a significant decrease in malaria cases. Since 2000, there has been a 91.2% reduction in malaria cases in the entire sub-region. Of the 8 countries that form the Mesoamerican sub-region, Mexico, Guatemala, Belize, El Salvador, Honduras, Nicaragua, Costa Rica, and Panama, the last is the only country that has not achieved WHA target for the MDG 6C of 75% reduction of cases compared to 2000 (Figure 5).

Costa Rica is currently in the elimination phase, while Belize, El Salvador, and Mexico are all in the pre-elimination phase. Costa Rica, Belize, and El Salvador all reported less than 20 autochthonous malaria cases in 2014.

Malaria transmission is concentrated in the province of Escuintla in Guatemala, the shared Moskitia area of Honduras and Nicaragua, and Chepo municipality and the Guna Yala *comarca* in Panama (Figure 6). Escuintla is characterized as an impoverished province with a mobile population arriving from the highlands and northeast areas of the country to work in the sugarcane plantations. The municipalities of particular concern in this province are La Gomera and Masagua.

In Honduras and Nicaragua, many ethnic groups live in the Moskitia area, a tropical rainforest that flanks both countries. Malaria has been a challenge in this area due to difficulties in accessing healthcare as well as poverty. Though the majority of cases in the Moskitia are caused by *P. vivax*, this area reports the most cases caused by *P. falciparum* in Mesoamerica. Combined, the provinces of Gracias a Dios in Honduras and Northern Caribbean Coast Autonomous Region (RACCN) in Nicaragua reported 64.4% of *P. falciparum* cases in the sub-region. In Panama, the administrative regions (or *comarcas*) of Madungandi (near the municipality of Chepo) and Guna Yala have substantial indigenous and ethnic populations. In these *comarcas,* there is limited access to healthcare, along with cultural and language barriers affecting a patient's ability to be adequately treated.

Figure 6. Municipalities (ADM2) with the highest number of malaria cases in the Mesoamerica sub-region, 2012-2014



**Santa Lucia Cotzulmalguapa*
***RACCN - Northern Caribbean Coast Autonomous Region*
"..." indicates unavailable data.

The majority of the cases in Mesoamerica are caused by *P. vivax*; in 2014, this species caused 92.4% of cases in the sub-region. The remaining 7.6% of cases were caused by *P. falciparum* and mixed infections mostly in the provinces of Gracias a Dios and Colon in Honduras and RACCN in Nicaragua. First line treatment for both *P. falciparum* and *P. vivax* in the entire sub-region is chloroquine and primaquine except for Panama who, like Colombia, uses the combination drug artemether-lumefantrine to treat *P. falciparum* cases. In Guatemala, a 15-mg dose of primaquine for 3 days is used to treat *P. falciparum*. Studies and molecular surveillance show that the parasite continues to be sensitive to chloroquine in the sub-region. Treatment for *P. vivax* in the sub-region is a 3-day dose of chloroquine and a 14-day dose of primaquine except in Nicaragua, Panama, and Costa Rica where 0.5 mg/kg per day is given for 7 days. Different treatment policies across countries, especially along the Honduras and Nicaragua border, lead to incomplete adherence and treatment.

In the sub-region, ethnic and mobile populations are especially at higher risk of having malaria. Central American countries are a major transit area for mobile populations from all over the world towards the north to Mexico, U.S., and Canada. Mobile populations are susceptible to malaria due to the nature of their migratory lifestyle. Health clinics set up in sites along migratory routes in Mexico and aimed at such migratory populations have tried to improve healthcare access.

SOUTHERN CONE

Argentina and Paraguay are the only remaining malaria-endemic countries in the Southern Cone. Both countries, however, are currently in the elimination phase and have reported a small number of cases in the past few years. In 2014, Argentina reported 4 cases and Paraguay reported 8, all of which were imported cases. No autochthonous cases have been reported in the past three years in Argentina; the country has applied for certification of malaria-free status to the WHO in 2014. Paraguay has not reported any autochthonous cases since 2012 and is expected to request certification by the WHO soon.

While no autochthonous cases have been reported, the major issue has been the importation of cases from neighboring countries. Argentina has reported many imported cases from Bolivia and Brazil, particularly in the provinces of Salta and Misiones. Salta attributes the malaria problem to impoverished Bolivians crossing into Argentina for work. In Misiones, malaria problems stem from ecological conditions, poverty, and proximity to malaria-endemic areas of Brazil. In Paraguay, people returning from Africa have been an important source of imported cases other than Brazil.

Argentina's intervention plan includes high-quality surveillance and vector control to prevent malaria transmission especially in border areas. In the past, Argentina has even assisted in indoor residual spraying of Bolivian homes in adjoining border areas as a binational effort to reduce transmission across borders.

In Paraguay, the National Service for Eradication of Malaria (SENEPA is its acronym in Spanish) has been a long-standing malaria service created in the 1950s by the government. In 2008, SENEPA began implementing the national malaria plan that focused on epidemiological surveillance, free testing and treatment for malaria patients, and vector control. The goals of the malaria plan were achieved quickly and a plan dedicated to elimination was created with the goal to eliminate the disease by 2015. The plan includes objectives for reporting all cases, treating all patients, quality-assured diagnosis, linking Geographical Information Systems (GIS) to surveillance information, and community capacitation for prevention and treatment.

Progress has thus far come a long way for both Argentina and Paraguay; efforts in the latter were recognized as the "Malaria Champion of the Americas" for the year 2012. Their continued efforts are a remarkable model for other countries in the Region which will find themselves in a similar position in the next few years.

NON ENDEMIC COUNTRIES

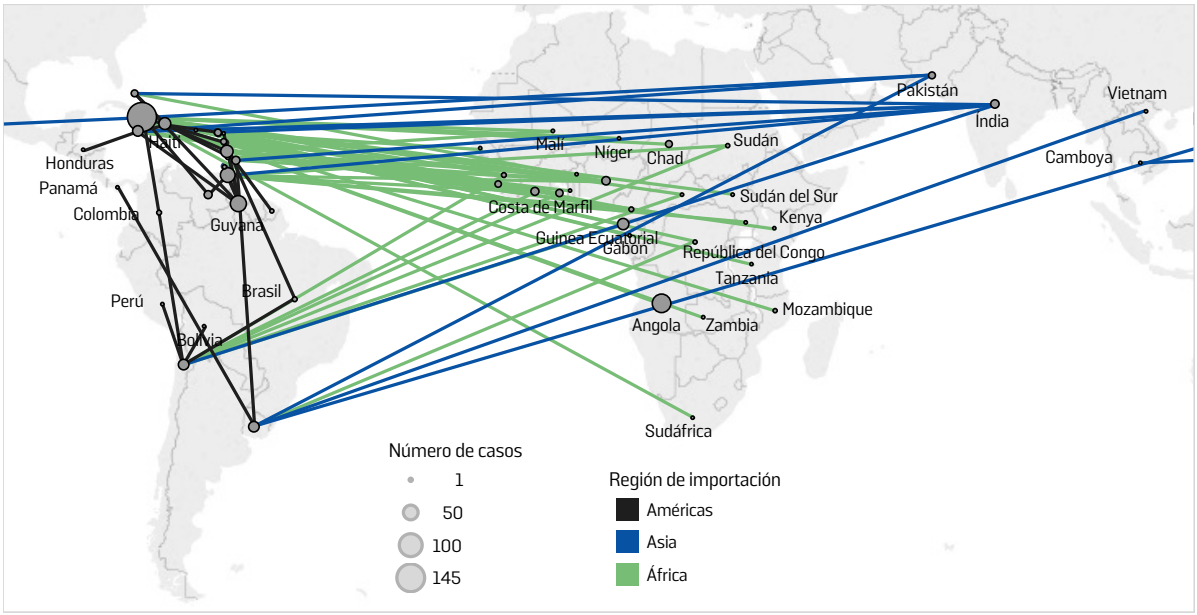
There are 30 member states and territories in the Region of the Americas that are considered non-endemic for

Table 1. Malaria cases in non-endemic countries in the Region of the Americas, 2010-2014

Country	2010	2011	2012	2013	2014
United States of America	1,691	1,925	1,687	1,742	1,727
Canada	514	517	477	488	447
Cuba	...	28	32	48	37
Trinidad & Tobago	23	10	19	13	12
Martinique	7	13	2	9	5
Barbados	2	10	9	5	2
Uruguay	...	2	7	13	2
Guadeloupe	8	1	2	2	1
Saint Lucia	...	1	2	1	1
British Virgin Islands	0	...	...	0	0
Grenada	0	0	1	2	0
Anguilla	...	0	0	0	...
Antigua & Barbuda	1	1	0	0	...
Aruba	...	...	...	...	...
Bahamas	1	6	2	2	...
Bermuda	...	...	...	...	...
Bonaire	...	...	...	...	...
Cayman Islands	1	1	3	...	...
Chile	3	5	10	6	...
Curaçao	...	...	...	...	...
Dominica	1	1	0	...	...
Jamaica	12	9	5	6	...
Monteserrat	0	0	0	0	...
Puerto Rico	5	2	1	1	...
Saba	...	...	...	...	...
Saint Barthelemy	...	...	1	...	...
Saint Kitts & Nevis	1	1	0	0	...
Saint Martin	1	7	1	...	...
Saint Vincent*	2	0	0	...	...
Sint Eustatius	...	...	...	...	...
Sint Maarten	...	...	...	...	...
Turks & Caicos Islands	...	...	...	...	...
US Virgin Islands	0	0	0	0	...
Grand Total	2,273	2,540	2,261	2,338	2,234

*Saint Vincent & the Grenadines
"..." indicates unavailable data.

Figure 7. Malaria cases imported in the Region of the Americas, 2011 - 2014



malaria. In 2014, nine of these countries reported a total of 1,932 malaria cases most of which were reported from the United States of America (USA) (Table 1). Canada reported about 20% of the cases imported in the Americas between 2010 and 2014. Though 8 countries have officially been certified as malaria-free and another 9 have been listed on the supplementary list (indicating countries where malaria never existed or disappeared without specific measures), thousands of cases continue to be imported from endemic countries every year (6).

Malaria is imported from all endemic countries of the world, though the majority of cases come from those who have traveled from African countries (Figure 7). Non-endemic countries who submitted information about origin of case during 2011-2014 (excluding the USA), reported a total of 1,326 cases, with 58.7% coming from Africa, 31.1% from the Americas, 7.9% from Asia, and 2.2% had an unidentified origin (Table 2). During 2011-2014, cases imported to non-endemic countries in the Americas mostly originated from Angola (19.2% of total reported), followed by Guyana (14.3%); Haiti (7.6%) and Venezuela (3.49%) were other important endemic countries from the Americas from which cases were imported. Consequently, the majority of cases in this period were due to *P. falciparum* infections in all countries except for Trinidad and Tobago and Grenada where *P. vivax* infection importation predominated. It is noteworthy to mention that species could not be identified in some cases reported from Chile (n=7), Saint Lucia (n=2), Martinique (n=1), and Barbados (n=1). It is of utmost importance that non-endemic countries maintain their diagnostic capacities as part of surveillance to prevent reestablishment of transmission. Among non-endemic countries, malaria surveillance in Cuba is fairly robust as evidenced by the information reported.

Of the non-endemic countries in the Caribbean sub-region, Cuba reported the most imported cases each year throughout 2011-2014. Many of the cases were imported by traveling medical personnel as well as military returning from United Nations (UN) peace-keeping deployments. This is also the case in Uruguay. Furthermore, this is also evident in age and gender information of imported cases; of all the cases for which age and gender information was available (805) during 2011-2014, a majority were in men (70.7%) and those in the 15-49 year age group (men: 56.7%, women: 20.6%).

During 2006-2009, Jamaica had an outbreak of malaria, which resulted in a peak of 43 cases during epidemiological week 50 of 2006 (7). The outbreak began due to an influx of imported malaria cases believed to have been introduced by Haitian refugees in the years prior. Jamaica reported 15 autochthonous cases in 2009, but has not reported any thereafter. The Bahamas also had an outbreak in 2006, identifying 19 cases within a 2-month period (8). The Bahamas was eventually listed on the supplementary list in 2012. Jamaica, on the other hand, was certified as malaria-free in 1966 and is an example of a successful outbreak intervention and emergency response during reintroduction of malaria.

The malaria challenges in non-endemic countries are based on travel and the potential to be unprepared for outbreaks. Many of the non-endemic countries are islands, which implies that it is easier to screen for malaria in immigrants when compared to those countries where immigration can happen via land, the latter being harder to check. With the ever-increasing mobility of humans by air, sea, and land, non-endemic countries will always be at risk of malaria importation. Non-endemic countries all have the *Anopheles* vector; it is therefore imperative to have functioning surveillance and emergency response systems to prevent reestablishment of malaria transmission by intervening in a timely manner.

Table 2. Imported cases in non-endemic countries of the Americas by country / Region of origin, 2011 - 2014

	Country /Territory																	
Country/Region from which malaria was imported	**Antigua & Barbuda**	**Bahamas**	**Barbados**	**Canada**	**Chile**	**Cuba**	**Grenada**	**Guadeloupe**	**Jamaica**	**Martinique**	**Puerto Rico**	**Saint Barthelemy**	**Saint Lucia**	**Saint Martin**	**Trinidad & Tobago**	**U.S.A.***	**Uruguay**	**Total**
Argentina																1		1
Bahamas																1		1
Belize																3		3
Bolivia					1											1		2
Brazil					3			1								16		20
Colombia					3	1										7		11
Costa Rica																3		3
Dominican Republic																14		14
Ecuador																2		2
El Salvador																3		3
French Guiana								1		3						1		5
Guatemala				1												18		19
Guyana	1	1	5				2		5	4			3		22	89	1	133
Haiti		1	1	1		3		2	5	6	0	0		6		134		159
Honduras									1							42		43
Jamaica																3		3
Mexico																4		4
Nicaragua																4		4
Panama																3	1	4
Peru				1	2											36		39
Suriname																1		1
Trinidad & Tobago															1			1
Venezuela						9									2	2		13
Caribbean, unsp.																2		2
Central America, unsp.																7		7
South America, unsp.																2		2
Total	1	2	6	3	9	13	2	4	11	14	0	0	3	6	25	399	2	500
Africa		6	8	126	18	249	2	4	12	24	2	2	2		18	9,998	24	10,495
Asia		6	4	8	2	14			4					4	6	1,782	10	1,840
Oceania	0			2												58		60
Unknown	0	2	2	752	4				2	6						1,396		2,164
Total	0	14	14	888	24	263	2	4	18	30	2	2	2	4	24	13,234	34	14,559

*United States of America

SECTION III: CROSS-CUTTING ISSUES

Policies, Strategies, Goals and Targets for Malaria

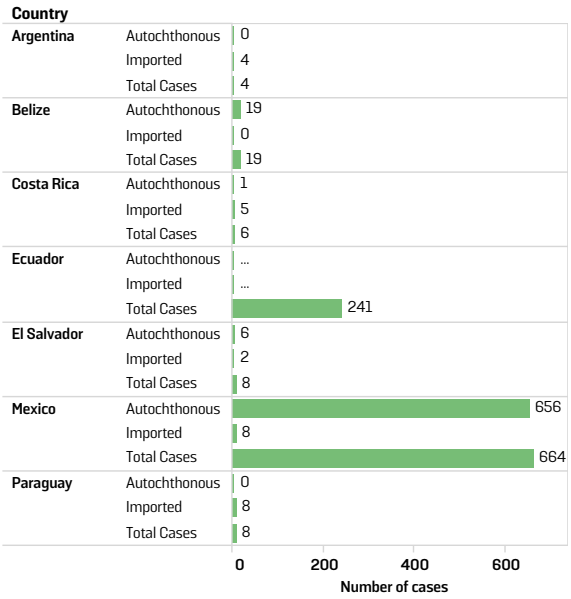
Many of the global goals and targets set for malaria since 2000 have influenced the targets for the Region. Table 1 summarizes some of the major global declarations concerning malaria during 2000–2015.

Table 1. Global plans regarding malaria control and elimination, 2000–2015

- United Nations Millennium Declaration
- World Health Assembly WHA58.2
- Global Malaria Action Plan for a malaria-free world (updated goals for 2011 and beyond)

The United Nations Millennium Declaration made malaria a priority in 2000 by establishing it as one of the 8 goals. Target 6C is "Have halted by 2015 and begun to reverse the incidence of malaria and other major diseases." Following the MDGs, further targets for MDG 6C were created during the 58th WHA in 2005. Resolution WHA58.2 called for a 75% reduction of morbidity and mortality due to malaria by 2015. In 2011, Resolution CD 51.R9 was passed at the 51st Session for the Directing Council which led to the 'Strategy and Plan for Malaria' for the 2011–2015, period which aligned with MDG and Roll Back Malaria (RBM) targets (9).

Figure 1. Number of cases by origin of infection in countries approaching elimination, 2014



*Ecuador did not report origin of infections for 2014.

Currently, 14 of the 21 endemic countries in the Americas have committed to malaria elimination in their national strategic plans and enlisted initiatives. At the 68th WHA, the WHO adopted its new malaria strategy: the Global Technical Strategy for Malaria 2016–2030 (GTS)(10). The new strategy focuses on acceleration of elimination with a target of certifying 35 new countries as malaria-free by 2030. The Action and Investment to Defeat Malaria (AIM)(11) is a tool that can enable stakeholders to gain support for malaria initiatives and further complements the GTS. PAHO/WHO has updated the Regional Strategy and Plan of Action that expands the GTS and tailors goals specifically for the Americas for the 2016–2020 period. The combination of the aforementioned documents will serve in guiding elimination efforts in the Americas.

Policies differ based on a country's program phase (control or elimination) and focus on the areas of diagnosis, treatment, vector control, and surveillance. For those countries in the pre-elimination and elimination phases of malaria, it is important to have in place a program for assurance of diagnostic quality of microscopy of laboratories. Currently, all 8 countries in the Americas (Argentina, Belize, Costa Rica, Dominican Republic, Ecuador, El Salvador, Mexico, and Paraguay) that are in the pre-elimination and elimination phases do so. Furthermore, national reference laboratories should be internationally certified; 4 countries in the pre-elimination and elimination phases were reported certified in 2014 including Argentina, Costa Rica, El Salvador, and Mexico. In treatment policies, strict supervision of treatment with primaquine is currently implemented by 11 of the 19 endemic countries in the Americas where *P. vivax* is endemic. Routine admission of patients with uncomplicated *P. falciparum* malaria in hospitals is a recommended policy for pre-elimination and elimination phases and was put in place in all but Belize, Dominican Republic, and Ecuador. Monitoring of therapeutic efficacy is currently being undertaken in 12 countries in Americas while another five do not have enough cases in a year to carry out *in-vivo* drug efficacy trials. In vector control, the use of larval control is currently a policy in 13 countries of the Americas, most of which are in the Mesoamerican sub-region. All countries except Suriname recommend use of IRS while bed nets are distributed for free in all countries except

Argentina and Paraguay, both of which have not reported autochthonous cases in the past two years. Monitoring of insecticide resistance in malaria vectors was reported as a policy in all but three countries in the Americas; however, implementation is still lacking in some of these. Malaria is a notifiable disease in public sector all countries in the pre-elimination and elimination phase in the Americas and four of these require that the private sector also notify cases. Additionally, as a policy, all confirmed cases of these countries are to be investigated.

Elimination

As of 2014, three countries were in the malaria elimination phase: Argentina, Costa Rica, and Paraguay. Additionally, Belize, Dominican Republic, Ecuador, El Salvador, and Mexico were in the pre-elimination phase. The classification criteria for program phase encompasses epidemiological factors, case management policies, and surveillance(12). Specifically, in Argentina and Paraguay all cases were imported (Figure 1). In Costa Rica, all cases except 1 recrudescence case were imported and in El Salvador 2 of 8 cases were imported. This indicates that transmission in these countries is very low or has been interrupted.

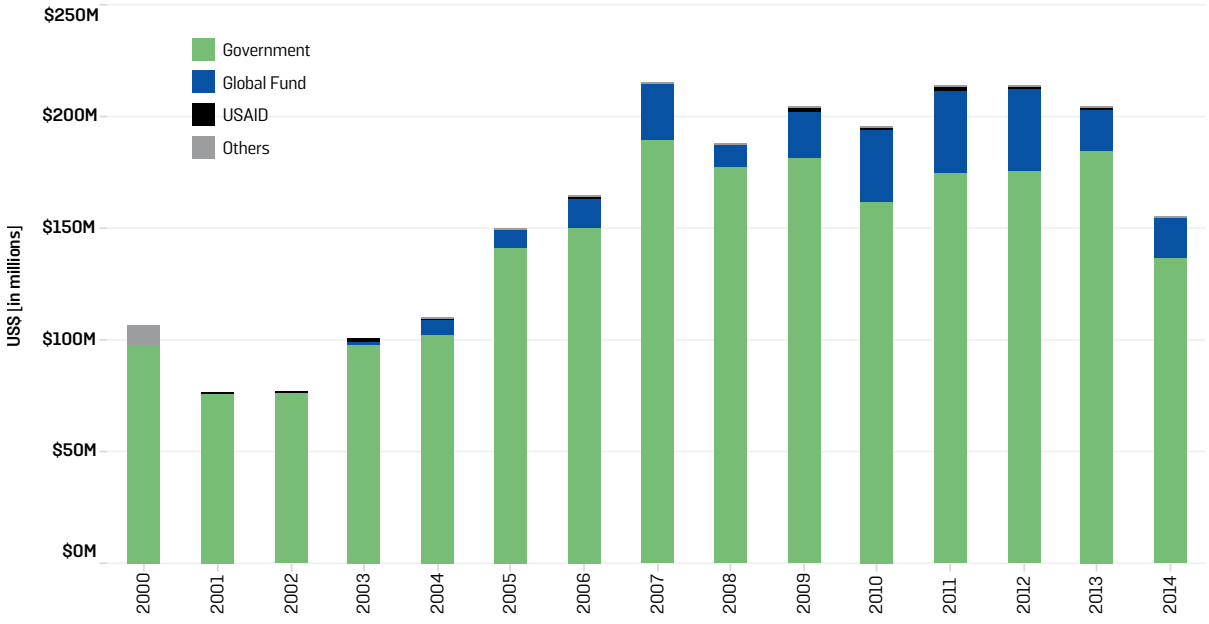
Eighteen of the 21 countries in the Americas have committed to eliminate malaria in the whole country or a part thereof. A number of malaria projects in the Americas focus on malaria elimination. The Malaria Elimination in Mesoamerica and the Hispaniola Island (EMMIE) Initiative is funded by the Global Fund and provides support for Belize, Costa Rica, Dominican Republic, El Salvador, Guatemala, Haiti, Honduras, Nicaragua, and Panama, while Mexico also supports the initiative. Malaria Zero is a project funded by the Gates Foundation and aims to eliminate malaria on the Island of Hispaniola. Another project, the Mesoamerican Initiative on Malaria in Vulnerable Populations supported by the Mexican Agency for International Cooperation and Development also aims for malaria elimination in some countries.

These initiatives, along with the availability of domestic resources, financial support from key partners, and technical collaboration from international agencies, provide an important platform for realizing malaria elimination goals.

Funding for Malaria

The majority of funding for malaria in the Americas comes from governmental sources. At least US$20 million came from external funding sources in 2014; the Global Fund alone provided US$17.6 million and has supported the Americas since 2003 (Figure 2). Fifteen out the 21 endemic countries received funding from the Global Fund in 2014 either through individual grants or as part of multi-country initiatives. Of those countries that were eligible to receive funding from the Global Fund, all except El Salvador and Paraguay received grants; however, these two countries are in the

Figure 2. Funding for malaria in the Region of the Americas, 2000-2014



process of applying for Global Fund grants. Additionally, the Global Fund supports projects involving multiple countries in the Americas such as PAMAFRO and the EMMIE initiative. PAMAFRO, implemented from 2005 to 2010 by the Andean Organization for Health (ORAS), focused on prevention of malaria in the border areas of Colombia, Ecuador, Peru, and Venezuela. The EMMIE initiative utilizes a cash-on-delivery mechanism and aims to accelerate efforts towards malaria elimination by 2020. Overall, support from the Global Fund has increased steadily since the establishment of the organization in 2002. Though funding decreased by half from US$36 million in 2011-2012 to US$18 million in 2013-2014, the Global Fund still contributes greatly to the malaria budget. The USAID-financed Amazon Malaria Initiative (AMI) has supported the Americas since 2002. The initiative, implemented by PAHO, distributed nearly US$1 million in 2014 to 11 countries. Though funding is often little compared to the entire country's malaria budget, funds are applied towards antimalarial sensitivity surveillance, improving the quality of diagnosis and treatment, improving quality of pharmaceuticals and supply chain management, strengthening vector surveillance and management, improving epidemiologic surveillance, and facilitating south-south cooperation.

Countries that did not report having received any external funding were Argentina, French Guiana, Mexico, and Venezuela. Excluding Venezuela, all countries have decreased their cases substantially since 2000. Malaria funding in Venezuela is of particular concern because the amount of cases has reached record-high levels, but the amount of reported governmental funding will not be able to support the resources desperately needed for control and intervention. The country is currently ineligible to receive funds from the Global Fund, nor receives funding from USAID. There is no external funding for Venezuela, but support is an apparent need.

Other external sources of funding in the Americas are the Gates Foundation (Malaria Zero project), the Clinton Health Access Initiative (CHAI), and other non-governmental organizations. Private companies also provide funds, often times voluntarily through social responsibility programs. Estimates on private sector funding are not available for this report.

Overall, total domestic funding in countries of the Americas decreased between 2013 and 2014 by 26% despite having increased in 2011 and 2012. Colombia had a US$11.6 million decrease in 2014 compared to the previous year, while Panama had a US$3.8 million increase the same year. Ecuador, French Guiana, and Peru did not report information on the amount of domestic funding for malaria in 2014, although resources were provided. As countries begin to gradually enter the elimination phase, adequate funding will have to be maintained to achieve these goals as well as prevent reestablishment of malaria transmission. At present, funding information is only collected at the national level and may not include funds for malaria at subnational levels, funds related to patient care and or salaries of medical personnel in hospitals and health centers. Countries may also not include funding from other governmental sources such as military or social security hospitals in their reports. Other in-kind contributions may also not be reported by countries as donations may be difficult to translate into monetary values. All these issues add to the underreporting of resources for malaria, especially domestically.

Diagnosis and Treatment

Malaria microscopy is the gold standard for diagnosis of *Plasmodium* infections and is the most widely used diagnostic tool in the Americas. During 2014, 6.7 million blood slides examinations were done, lower than in previous years due to the overall reduction of cases. The use of RDTs has increased in the Americas over the last few years and in 2014 reached its highest amount reported. A total of 354,119 RDTs were examined during 2014 from nine countries. In most of these countries, RDTs are performed by community health workers in rural areas where people have limited access to health facilities. Haiti, however, uses RDTs nationwide, having been introduced in 2012. Evidence suggests RDTs have replaced rather than complemented microscopy in Haiti.

In 2014, about a quarter of the total reported cases in the Americas were caused by *P. falciparum* and mixed infections. Compared to data from 2000, *P. falciparum* decreased by 66.5%. Most *P. falciparum* cases are reported from the Amazon sub-region and account for 82% of cases reported in the entire Americas in 2014. As artemisinin-based combination therapies (ACTs) were introduced in the Amazon sub-region, an initial decrease could be seen in the number of *P. falciparum* cases (Figure 3), indicating the beneficial effects of introduction of ACTs.

PAHO recommends that 80% of cases, treatment should begin in less than 72 hours from the onset of symptoms (13). There is a paucity of data on this subject, though countries in the Americas have begun to report this information in the past few years. Honduras has shown a decrease in the percentage of cases receiving timely treatment due to changes from presumptive treatment to treatment of only confirmed cases, thus having a negative trend (Figure 4). Bolivia's increase in the percentage of cases receiving timely treatment may be an error of data collection since the country now reports that almost all cases are starting treatment in less than 24 hours of onset of symptoms.

Figure 3. Number of *P. falciparum* and mixed cases and those treated with ACTs in the Amazon sub-region, 2000-2014

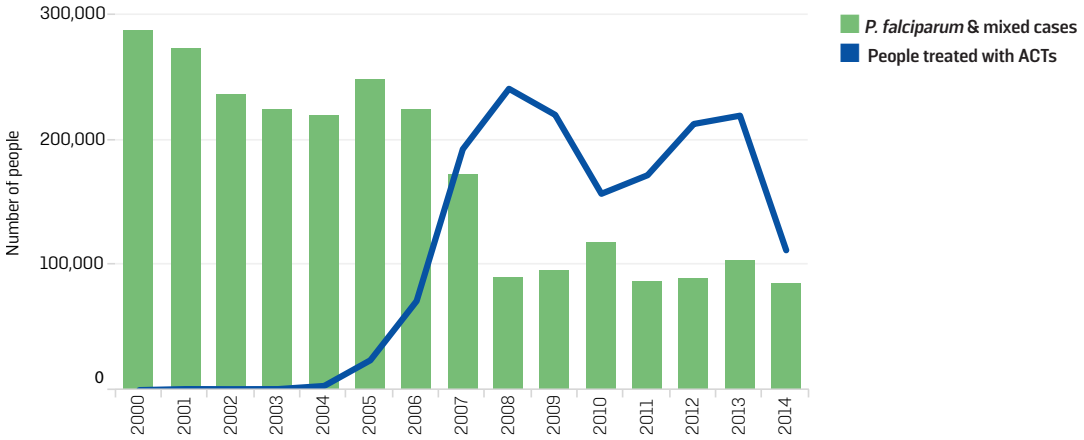


Table 2. Microscopy and RDT use in the Region of the Americas, 2000-2014

Year	Blood smears examined	RDTs Examined
2000	9,793,737	...
2001	9,205,342	0
2002	9,025,164	0
2003	8,414,602	0
2004	8,365,723	5,000
2005	12,660,369	8,500
2006	9,270,303	30,063
2007	9,390,226	57,078
2008	8,193,079	46,253
2009	8,124,331	121,048
2010	8,455,652	66,843
2011	7,612,545	105,482
2012	7,442,929	220,529
2013	6,977,551	175,765
2014	6,707,921	354,119

"..." Indicates unavailable data.

Figure 4. Time between first symptom and initiation of treatment in countries of the Americas, 2012-2014

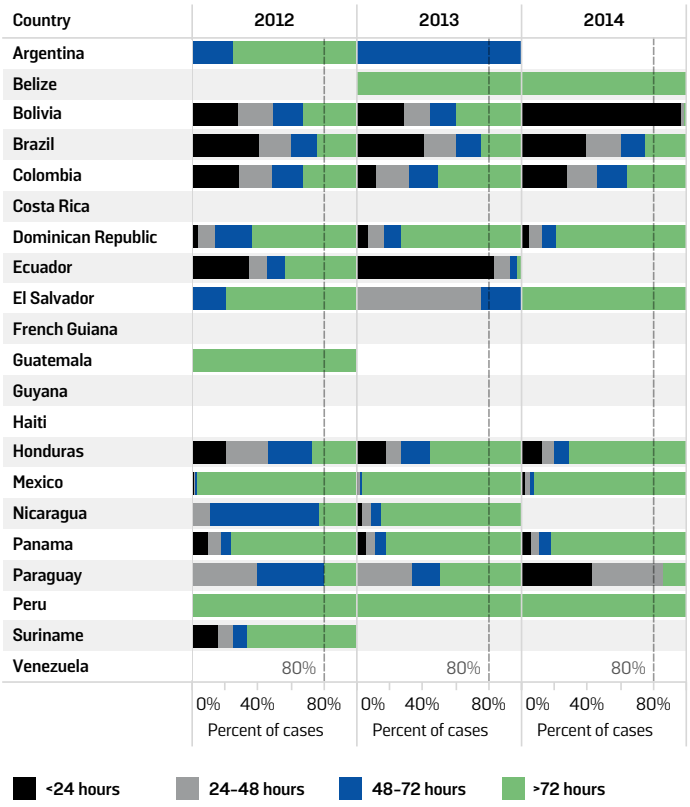


Table 3. First line of treatment for malaria by species type in the Region of the Americas

Country	*P. falciparum*	*P. vivax*
Argentina	AS+MQ; AL	CQ+PQ(7)
Belize	CQ+PQ(1d)	CQ+PQ(14)
Bolivia	AS+MQ+PQ	CQ+PQ(7)
Brazil	AL+PQ; AS+MQ+PQ	CQ+PQ(7); CQ+PQ(14)
Colombia	AL	CQ+PQ(14)
Costa Rica	CQ+PQ(1d)	CQ+PQ(7); CQ+PQ(14)
Dom. Rep.*	CQ+PQ(1d)	CQ+PQ(14)
Ecuador	AL+PQ	CQ+PQ(7)
El Salvador	CQ+PQ(1d)	CQ+PQ(14)
French Guiana	AL; AQ+PG	CQ+PQ
Guatemala	CQ+PQ(3d)	CQ+PQ(14)
Guyana	AL+PQ(1d)	CQ+PQ(14)
Haiti	CQ+PQ(1d)	CQ+PQ(14)
Honduras	CQ+PQ(1d)	CQ+PQ(14)
Mexico	CQ+PQ	CQ+PQ
Nicaragua	CQ+PQ(1d)	CQ+PQ(7)
Panama	AL+PQ	CQ+PQ(7); CQ+PQ(14)
Paraguay	AL+PQ	CQ+PQ(14)
Peru	AS+MQ+PQ(1d)	CQ+PQ(7)
Suriname	AL+PQ(1d)	CQ+PQ(14)
Venezuela	AS+MQ+PQ(1d)	CQ+PQ(14)

CQ- Chloroquine PQ- Primaquine MQ- Mefloquine
AS- Artesunate AL- Artemether & Lumefantrine
PG- Proguanil AQ- Atovaquone
For *P. falciparum* - (3d): 15 mg of Primaquine per day for 3 days (adults)
(1d): 45 mg of Primaquine in 1 dose on 1st day (adults)
For *P. vivax*- (14d): 15 mg of Primaquine per day for 14 days (adults)
(7d): 30 mg of Primaquine per day for 7 days (adults)
** Artemisinin-based combination therapy (ACT) is used for imported cases of *P. falciparum* in countries using CQ as first-line treatment for this species.
*Dom. Rep. - Dominican Republic

Brazil and Colombia are approaching the 80% recommendation. The Dominican Republic has had an increase in the percent of cases starting treatment in more than 72 hours because of their continuous concern with immigrants avoiding treatment so as not to expose their illegal status. Panama has had a high percentage of cases receiving treatment in more than 72 hours because many cases occur in areas with limited access to healthcare and among populations with strong cultural barriers. Paraguay has the reported ability to manage malaria cases rapidly. Their advantage over other countries in the Americas is that they have had only a few imported cases. Once a case is detected, healthcare personnel are expected to inform SENEPA, who then provides malaria services including treatment. Active malaria surveillance entails systematic collection of blood samples for people with or without symptoms by going out into the communities. As countries approach elimination, more emphasis is laid on active surveillance wherein the time period between onset of symptoms and treatment is decreased, as thus the probability of transmission from an infected person to others decreases. This could lead to an increase in the proportion of cases detected through active surveillance specifically and in general the total number of cases reported by the country. Panama reported that 81% of cases were detected through active surveillance in 2014. This country together with Argentina, Paraguay, and Dominican Republic reported that over 70% of all microscopic examinations were done on blood smears collected through active surveillance. This proportion stands at around 50% in Belize, Bolivia and Brazil, indicating the underlying effort of the country. Few countries, including Ecuador, French Guiana, Guatemala, Haiti, Mexico, and Peru, have not reported data on active surveillance.

Antimalarial Resistance

Currently, there are 12 endemic countries in the Americas that use ACT drugs for the treatment of uncomplicated *P. falciparum*. These include endemic countries of South America and Panama. There are a few countries that use ACTs to treat *P. falciparum* but did not report on the number of people treated in 2014 including Ecuador, French Guiana, Guyana, and Peru, though the latter has provided this information consistently in the past. The rest of the countries in the Mesoamerican and Hispaniola sub-regions treat all malaria infections with chloroquine, which continues to be efficacious based on routine surveillance information. Currently, molecular surveillance of chloroquine resistance is conducted in Honduras(14) and Nicaragua and will be extended to other countries of Mesoamerica.

Drug resistance can develop due to inadequate treatment resulting from non-compliance of medication dosages. Throughout the Americas there have been areas known to be a problem. In the Guiana Shield,

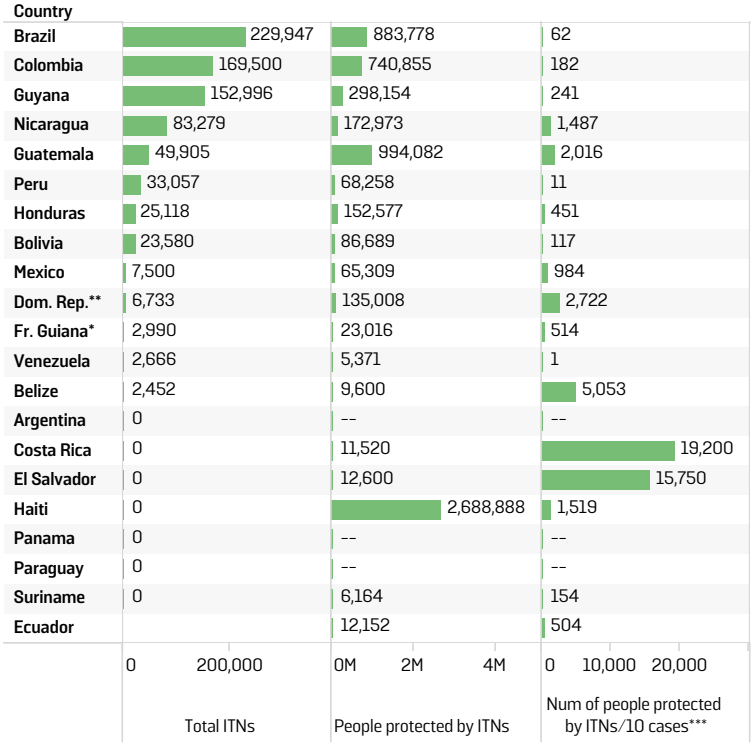
some miners often consume enough medicine to feel better and then proceed to sell the rest before completing the recommended dosage. The quality of antimalarials available in the private sector is also circumspect. Although artemisinin monotherapy is banned, it is available illegally in the interiors of countries in the Guiana Shield.

Along the border of Honduras and Nicaragua, treatment policies differ, causing problems of adherence leading to inadequate dosage. Throughout the Americas, primaquine is used to clear hypnozoites in the liver for *P. vivax* infections and is usually given in a 7-day dose of 0.5 mg/kg or 14-day dose of 0.25 mg/kg. While drug resistance has not been reported along the Honduras and Nicaraguan border, a difference in policies may contribute to apathetic attitudes towards drug adherence. Primaquine also causes adverse effects in those with glucose-6-phosphate dehydrogenase (G6PD) deficiencies. Though primaquine is used extensively throughout the Americas to treat malaria, G6PD testing is not routinely conducted. The prevalence of G6PD is low in the Americas and, although primaquine is being used, it has historically not been associated with the reported adverse events.

In 2012, Suriname detected possible signs of decreased sensitivity to artemisinin-based treatment. Therefore, several institutions were prompted to take action and studies were conducted in order to see if decreased sensitivity had emerged not just in Suriname, but the rest of the Guiana Shield. In-vivo studies were conducted in Suriname and Guyana. Another study is planned to determine resistance along the border between French Guiana and Brazil. The AMI/RAVREDA project provides technical assistance for these studies. Preliminary data from these studies show that there is no decreased sensitivity to artemisinin; nonetheless, risk factors continue to exist and require urgent attention on the part of all governments of the Guiana Shield area and partnering institutions.

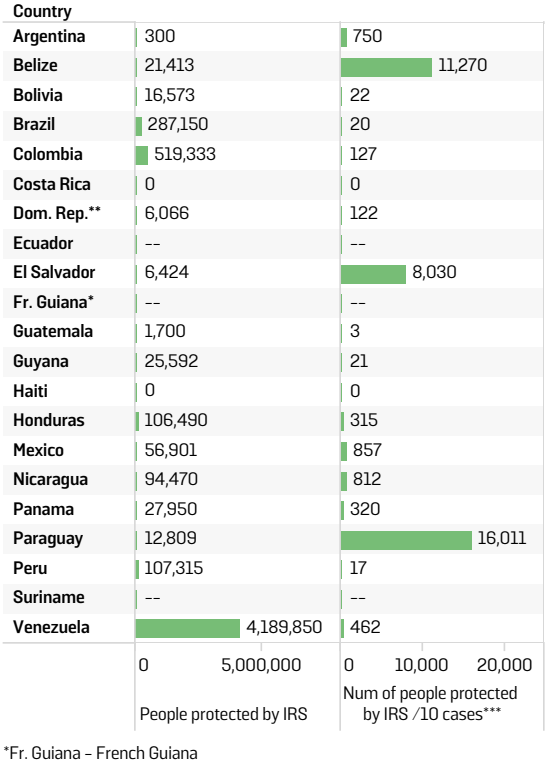
PAHO/WHO additionally provides assistance to maintain stocks of antimalarials. Countries are requested to provide quarterly stock information, which has decreased stock-outs, improved planning, and fostered south-south collaboration by exchange of medicines between countries. PAHO also keeps a regional stock of medicine for quick mobilization of antimalarial medicines in the event of emergencies or severe cases.

Figure 5. ITN coverage in the Region of the Americas, 2014



*Fr. Guiana – French Guiana
**Dom. Rep. – Dominican Republic
***Number of people protected by ITNs per 10 malaria cases in 2014.
''--''indicates unavailable data.

Figure 6. IRS coverage in the Region of the Americas, 2014



*Fr. Guiana – French Guiana
**Dom. Rep. – Dominican Republic
***Number of people protected by IRS per 10 malaria cases in 2014
''--''indicates unavailable data.

Vector Control

ITNs

In the Americas, ITNs and IRS are the primary vector control methods. All endemic countries in the Americas have policies to distribute ITNs free of charge except for Argentina and Paraguay. Though the majority of endemic countries have policies in place for ITN distribution, only 13 countries reported ITN distribution in 2014, amounting to about 790,000 total nets distributed. Brazil, Colombia, and Guyana distributed the most ITNs (Figure 5). All reported ITNs distributed in 2014 were long-lasting insecticide treated nets (LLINs). An estimated 6.4 million people were protected by ITNs in 2014, including those receiving protection from ITNs distributed in previous years. This estimate represents 5.9% of the total population at risk for malaria in the Americas. This includes protection from LLINs that have an average efficacy of 3 years. Haiti, for example distributed almost 3 million bed nets in 2012, which, if used properly, would continue to protect an estimated 2.7 million people in 2014. More than 4.5 million nets were distributed throughout the Americas in 2012, the highest number ever recorded. Even when excluding Haiti, 2012 was still the year when most bed nets were distributed. The number of people protected by ITNs per 10 cases was the highest for Costa Rica and other countries in the elimination phase that distribute them, though for countries still in the control phase, Dominican Republic, Guatemala, Haiti, and Nicaragua protect many people.

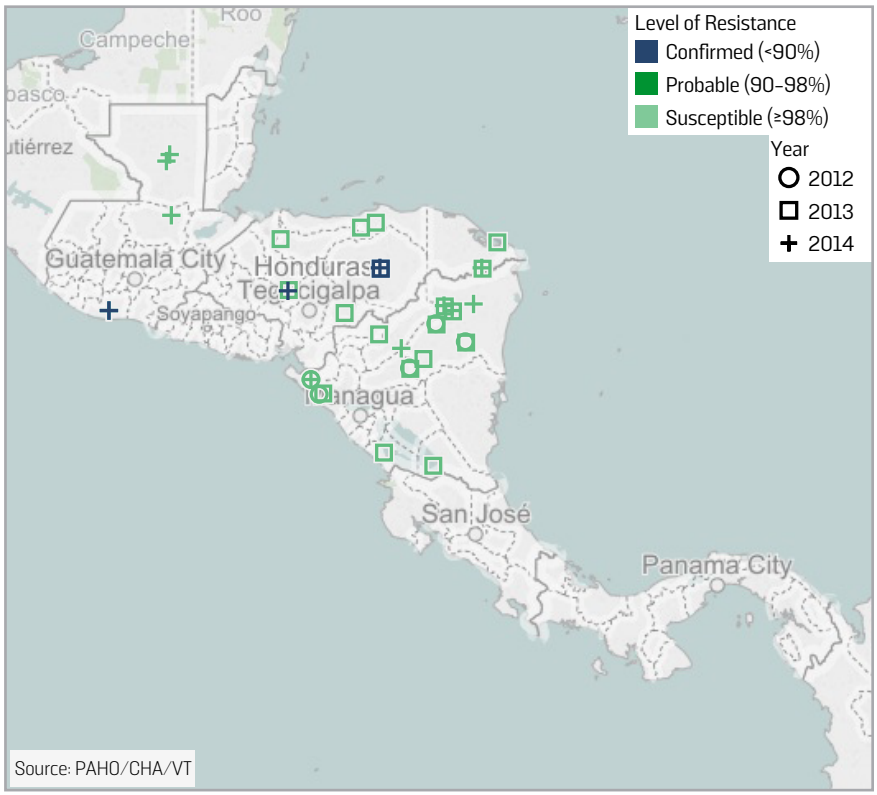
IRS

All endemic countries use IRS except Haiti and Suriname. The use of DDT is not authorized as an official policy in any of the countries in the Americas. In 2014, 16 countries reported using IRS, protecting an estimated 5.5 million people in the Region, or 5.1% of the total population at risk for malaria in the Americas. Analysis of the number of people protected by IRS per 10 cases shows that Paraguay protects the most people followed by Belize and El Salvador (Figure 6). Among those countries in the control phase, Nicaragua, Venezuela, Honduras, and Panama protected over 300 people with IRS per 10 cases.

Insecticide Resistance

As many as 11 countries have reported information on insecticide surveillance for *Anopheles* mosquitoes during 2012–2014 (Figures 7–9). Routine surveillance

Figure 7. Insecticide sensitivity studies for pyrethroids in *Anopheles* in the Mesoamerica sub-region, 2012–2014



of insecticide resistance is not conducted in Argentina, Belize, Costa Rica, El Salvador, Guyana, and Paraguay. French Guiana and Venezuela have not submitted this information and it is unclear if routine surveillance is conducted. Almost all countries that submitted data show resistance to pyrethroids in some areas except for Belize, Haiti, and Suriname.

In Haiti, the vector remains sensitive to pyrethroids tested. However, the Dominican Republic has reported resistance to alpha-cypermethrin and deltamethrin along the border with Haiti in the northwestern provinces of Montecristi and Dajabon. The vector continues to be sensitive to pyrethroids in all other areas of the country except Azua.

In Mesoamerica, resistance has been detected in malaria-endemic areas like Chepo in Panama, Escuintla in Guatemala, and Comayagua and Olancho in Honduras. Although resistance to deltamethrin has been reported in Nicaragua, the country uses fenitrothion to which the vectors continue to be susceptible. Many other areas of these countries have reported that the principal malaria vector is sensitive to pyrethroids.

While confirmed resistance to deltamethrin has been reported in Choco (*An. darlingi*) and other provinces on the Pacific coast (*An. albimanus*) of Colombia, *An. albimanus* largely continues to be susceptible in Antioquia and on the Atlantic coast of the country. Resistance of *An. darlingi* to pyrethroids has been reported in other high transmission areas of South America like Loreto in Peru, Guayaramerin in Bolivia, and Acre in Brazil. Information about insecticide resistance monitoring has been deficient in the past few years from most Amazon countries.

Priority Groups

There are various subsets of people who are at higher risk of malaria or developing severe malaria. Some of these

Figure 8. Insecticide sensitivity studies for pyrethroids in *Anopheles* in the Amazon sub-region, 2012-2014

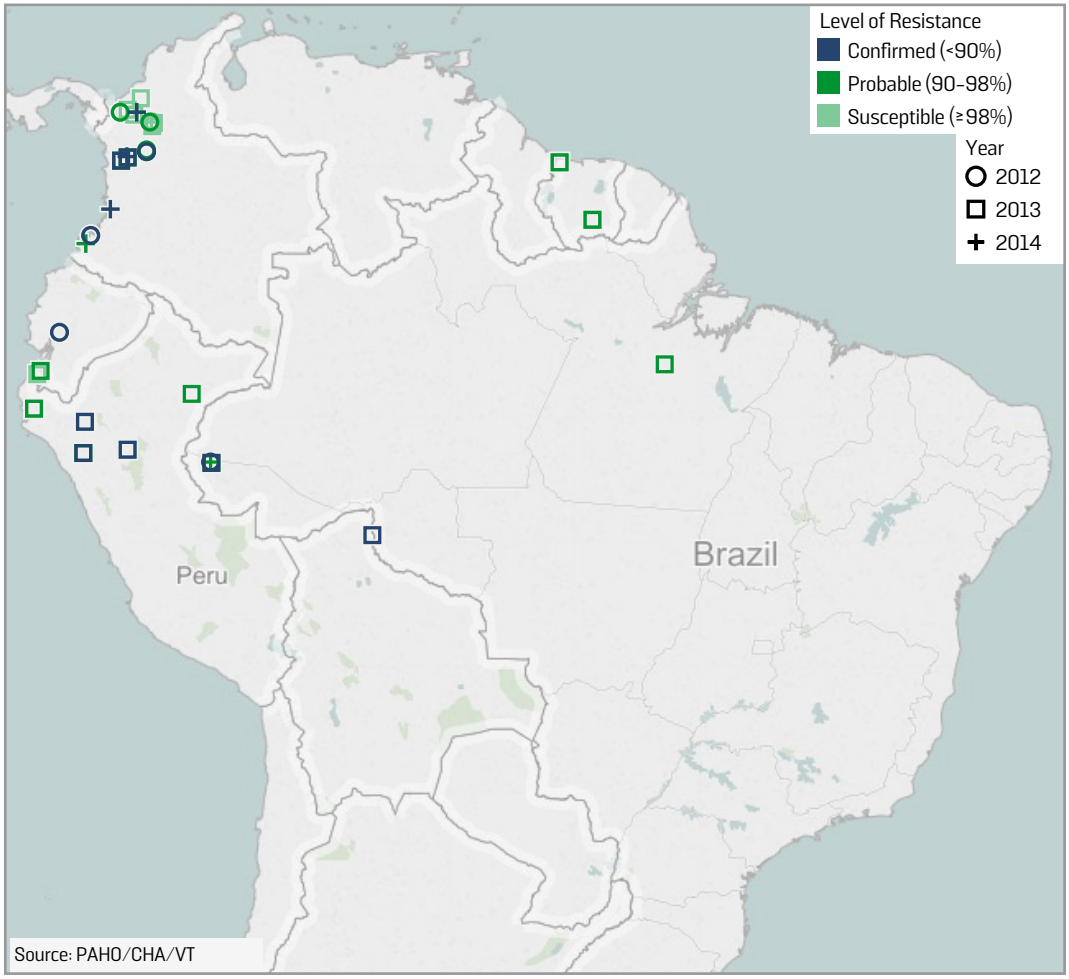


Figure 9. Insecticide sensitivity studies for pyrethroids in *Anopheles* in the Hispaniola sub-region, 2012-2014

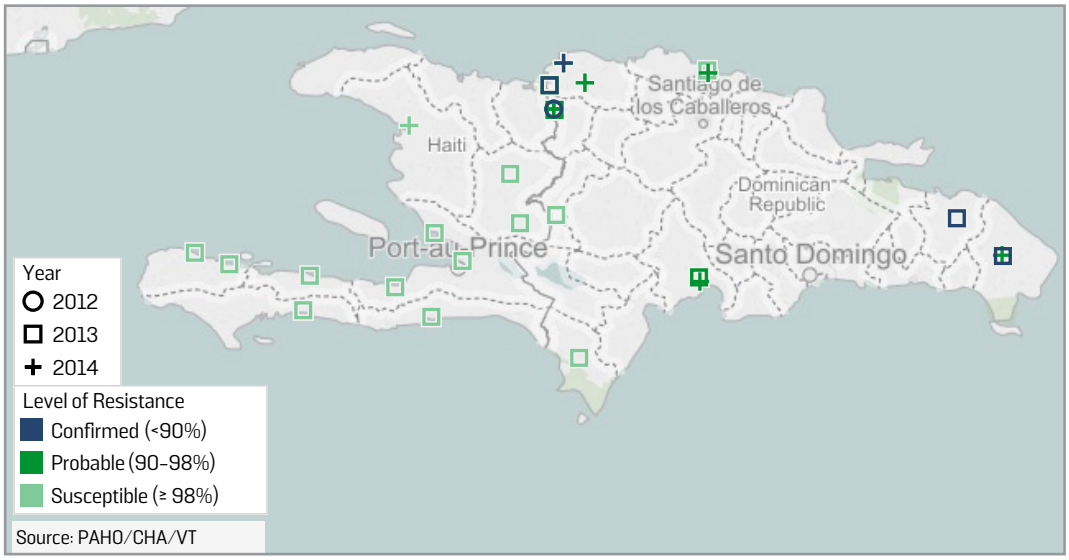


Figure 10. Malaria in priority groups in the Region of the Americas

populations have been identified as children less than 5 years of age, pregnant women, and migrant populations among others. In the Americas, priority groups vary by country. Notable trends in the Americas can be observed in indigenous populations, people living in border areas, and mobile populations. Malaria is also an occupational risk for miners, loggers, and plantation workers.

Generally, these priority groups tend to have higher rates of poverty, live in rural areas, lack access to diagnosis and treatment, lack access to preventive methods, possess cultural barriers, and experience marginalization.

Indigenous peoples and ethnic groups are vulnerable to malaria in many Latin American countries including Miskitos in Honduras and Nicaragua, Guna Yala in Panama, Embera-Wounaans in Colombia and Panama, and Yanomamis in Venezuela just to name a few. The Economic Commission for Latin America and the Caribbean estimated an indigenous population of 45 million in Latin America in 2010(15). One of the reasons for higher rates of malaria among the ethnic groups and the indigenous population is that the areas they inhabit are associated with higher vector exposure such as the forests in the Amazons or the marshes of the Moskitia area.

Unfortunately, health information is not always collected about these populations leading to poor understanding about the risk. Cases for ethnic/indigenous populations were only reported by 8 of the 21 endemic countries in the Americas in 2014. Without adequate data, it is difficult to track disease trends and implement proper interventions as well as make a sound case for policy changes. PAHO resolution CD47.R18(16) was approved in 2006 and addressed the health needs of the indigenous peoples of the Americas calling for equity in each country. Access to prompt and quality diagnosis and treatment of malaria for this population is plagued by cultural and language barriers. Indirect costs like that for transportation further decrease accessibility; areas where these populations live are usually rural and far away from the nearest health center. Many ethnic groups and indigenous peoples also use traditional medicine adding to the complexity of the issue. WHO estimated that 80% of the indigenous population in the world uses traditional medicine as a means of primary care (17). It is therefore important to overcome these barriers and factor acceptability of Western versus traditional medicine when treating these populations.

In 2014, five countries in the Americas reported a number of cases in those living in border areas including Venezuela, Brazil, Dominican Republic, Panama, and Bolivia (Figure 10). As malaria decreases, transmission is ever more limited to border areas that are hard to access. Venezuela reported 90.3% of all confirmed cases to be among those living near the border. Both Bolivia and Brazil reported about half of their cases to be in this population and around 40% in Panama and Suriname (2012-2013 data). However, the definition and the method by which the population of those living in border areas is measured are not standard and thus the information is not comparable across countries. Other countries such as Honduras and Nicaragua, who do not specifically report the number of border cases, have a higher endemicity along their borders. Tracking cases along the border is a difficult task especially in the Guiana Shield where some miners lead discrete lifestyles due to the illegal nature of their work. In the past Mexico has also reported many cases from the border areas.

Occupational associations with high malaria transmission are of particular concern for several countries in the Americas. Some countries have reported cases in the mining, logging, and agricultural plantation workers. Throughout the Americas, miners represented 13% of all cases in 2014; however, underreporting is highly probable as many live discreet lifestyles and may try to avoid health facilities. Suriname and Brazil have reported cases in miners consistently over the past few years showing a general decline. Venezuela has reported cases in miners for the past 3 years, demonstrating an increase in cases which mirrors the trend in overall cases for the country. Colombia was the only other country to report on miners, recording more than a 1000 cases. The health information system in Guyana does not collect information on occupation and as such no cases in miners were reported by the country.

Before 2014, Brazil was the only country to report on cases in plantation workers (except for minimal cases in Belize and Paraguay). In 2014, almost 4,000 cases in plantation workers were reported (excluding Brazil) with an estimated half of those from Venezuela. Loggers are another occupational group of concern for Brazil and malaria has declined in them every year since 2009. No other country has reported information on this occupational group. Identifying possible associations with occupation can provide avenues for intervention. Afro-Colombians and Haitians are other priority groups accounting for more than 35% of all cases in Colombia and Dominican Republic respectively between 2012 and 2014.

Malaria in Pregnancy

Incidence for malaria in pregnancy varies throughout the Americas, though the countries of the Guiana Shield report the highest rates. Brazil reported the highest number of malaria infections in pregnant women in 2014 (2,300) or 2% of total cases reported in that country. Bolivia and Suriname also reported that approximately 2% of the total cases occurred among pregnant women. Data regarding pregnancy cases are not routinely reported by French Guiana or Mexico, while Ecuador did not submit data for 2014.

Data were pooled for multiple years as only a small number of malaria in pregnancy cases were reported in some countries and/or data were missing for the most recent year (Table 4). While the incidence of malaria in pregnant women was significantly higher than that in non-pregnant women in child-bearing age in Brazil and Guyana, that was not the case in Suriname and Venezuela (Figure 10). Malaria is highly correlated with gold mining in these countries. Women at risk in the mining areas include cooks, sexual workers, and other working women; they are less likely to be pregnant, resulting in lower incidence rates of malaria in pregnancy in some of these countries. In Guyana and Brazil, areas other than mining camps are also endemic wherein pregnant women are more likely to have malaria. The relative risk was significantly higher in pregnant women in Bolivia but significantly lower in Colombia, Ecuador, and Peru. As Ecuador moves towards elimination, malaria is now restricted to some pockets of the country and malaria in pregnant women is less of a concern. On the other hand, lower risk in Colombia and Peru is mostly indicative of a weak surveillance system with regards to pregnancy status in malaria patients. In Colombia, the reported numbers vary widely, almost halving from one year to the other, although no such significant deviation in case numbers are seen overall, indicating irregular reporting. A recent hospital based study estimated the prevalence to be around 9% of all pregnant women (18).

Surveillance systems in Haiti are weak, yet the relative risk in pregnant women was significantly higher during 2011-2012. This concurs with the highest of incidence rates in children under 5 years old in that country, probably indicating that malaria transmission is happening largely indoors. On the other hand, the relative risk is significantly lower in the Dominican Republic; migrants from neighboring Haiti are at high risk of malaria and are mostly men in the economically productive age group (15-49 years old).

In Honduras specifically, the number of pregnant women with malaria increased during 2010-2013, while the total number of cases decreased. This indicates an improvement in quality of surveillance during that period. It is noteworthy to mention that neighboring Nicaragua, which has a similar epidemiology as Honduras, reported a non-significant lower risk in pregnant women. This was also the case in Panama, indicating no increased risk of malaria in pregnant females. On the other hand, the surveillance system in Guatemala is deficient in coverage and unable to collect information about women who are pregnant and have malaria; since 2010 only 4 malaria cases have been reported, although unpublished data from studies show the prevalence by PCR to be around 12% in pregnant women. In other Central American countries like El Salvador, Belize, and Costa Rica, the number of malaria cases are too low for malaria in pregnancy to be of significant concern.

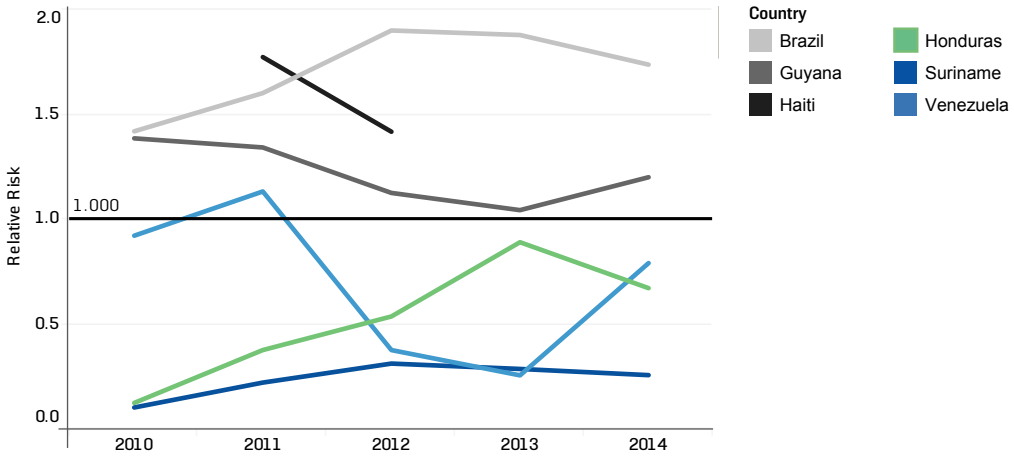
To better target this population, malaria programs in the Americas should ensure that there is adequate communication with prenatal care programs so that every pregnant woman exposed in endemic areas uses protective measures like bed nets and is given malaria tests at each visit during pregnancy and after delivery. Some countries like Guatemala, Honduras, and Nicaragua have policies stipulating that every pregnant woman living in an endemic area should be tested for malaria during prenatal visits; however, implementation of this policy remains irregular.

Table 4. Malaria in pregnancy by country in the Region of the Americas

Country	Most recent year					Over a period of years	
	Year	Malaria Cases in Pregnancy	Malaria in Pregnancy Rate†	WOCBA Incidence±	Relative Risk	Period	Relative Risk
Bolivia	2014	143	70,60	54,67	1.29*	2010-2014	1.12*
Brazil	2014	2303	93,07	53,45	1.74*	2010-2014	1.67*
Colombia	2014	318	51,71	70,56	0.73*	2010-2014	0.76*
Dominican Republic	2014	3	1,71	4,84	0.35	2012-2014	0.41*
Ecuador	2013	10	3,77	1,87	2.02	2010-2013	0.60*
Guatemala	2014	1	0,29	42,23	0.01	2012, 2014	0.01
Guyana	2014	151	1320,97	1097,65	1.20*	2010-2014	1.21*
Haiti	2012	621	292,21	205,66	1.42	2011, 2012, 2014	2.15*
Honduras	2014	46	33,73	50,09	0.67*	2010-2014	0.76*
Nicaragua	2014	17	17,03	16,51	1.03	2011-2014	0.87
Panama	2014	5	8,30	14,28	0.58	2010-2014	1.04
Peru	2014	469	94,03	115,17	0.82*	2011-2014	0.84*
Suriname	2014	8	101,41	127,86	0.79	2010-2014	0.80
Venezuela	2014	333	68,85	267,12	0.26*	2010-2014	0.24*

† (per 100,000 pregnant women)
* indicates relative risk significance at a 95% confidence interval
± Women of child-bearing age (WOCBA) incidence per 100,000 women aged 15-45

Figure 11. Relative risk of malaria in pregnancy by country, 2010–2014



SECTION IV: COUNTRIES

ARGENTINA

Argentina has achieved 100% reduction in malaria since 2000 and only reports imported cases (Figures 1-3). The country is currently in the elimination phase. It has surpassed the WHA58.2 target for MDG6C, and in 2014 only 4 cases had been reported. Also, there was only one malaria-related death during 2000-2014.

Since 2011, Argentina has implemented a two-pronged strategy based on classification of endemic area into two strata. Stratum 1 comprises of a low endemicity area where elimination measures are being implemented and stratum 2 comprises of transmission-free areas monitored by surveillance. Stratum one includes the departments (ADM2) of Oran and General San Martin (of Salta province) and stratum 2 includes the departments of El Carmen, Santa Barbara, Palpala, San Pedro, Ledesma, and Doctor Manuel Belgrano (of Jujuy province).

There have been no autochthonous cases reported since 2011 (Figure 2 and Table 1). During 2000-2014, cases have only been reported from 5 provinces: Chaco, Jujuy, Salta, Tucuman, and Misiones. All other provinces in Argentina have interrupted transmission of the disease. Of the reported cases during 2012-2014, all imported cases were identified as *P. vivax* infections.

Figure 1. Malaria in Argentina by foci, 2014

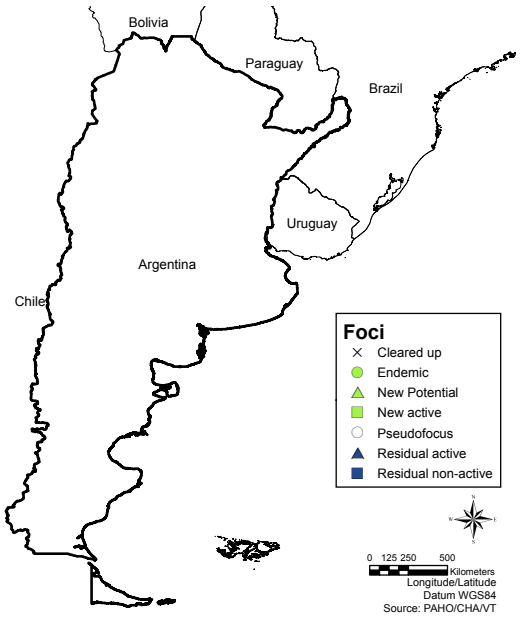


Figure 2. Autochthonous and imported cases in Argentina, 2000-2014

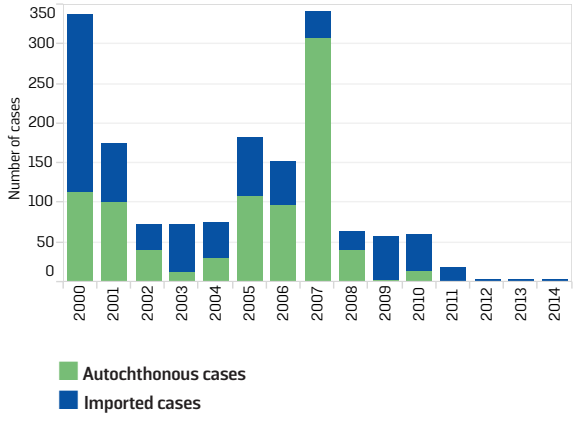


Figure 3. Number of cases and deaths due to malaria in Argentina, 2000-2014

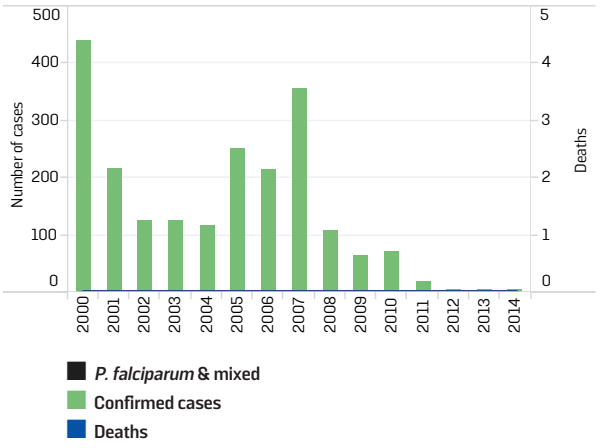
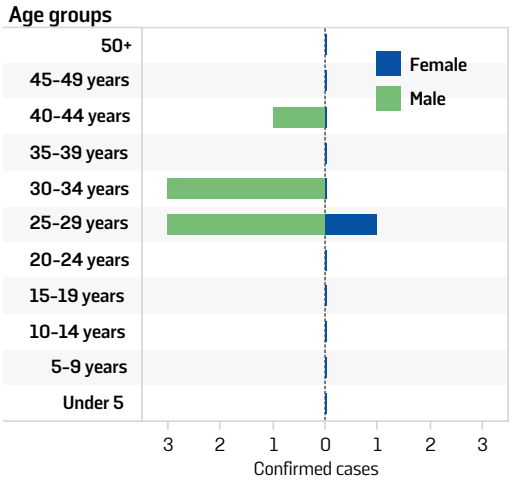


Table 1. Elimination profile of Argentina, 2010-2014

	2010	2011	2012	2013	2014
Total Cases	72	18	4	4	4
Cases Investigated	72	18	4	4	4
Autochthonous Cases	14	0	0	0	0
Autochthonous-P.f.	0	0	0	0	0
Autochthonous-P.v.	14	0	0	0	0
Imported Cases	46	18	4	4	4
Imported-P.f.	0	0	0	0	0
Imported-P.v.	46	18	4	4	4
Active Foci	...	...	0	0	0

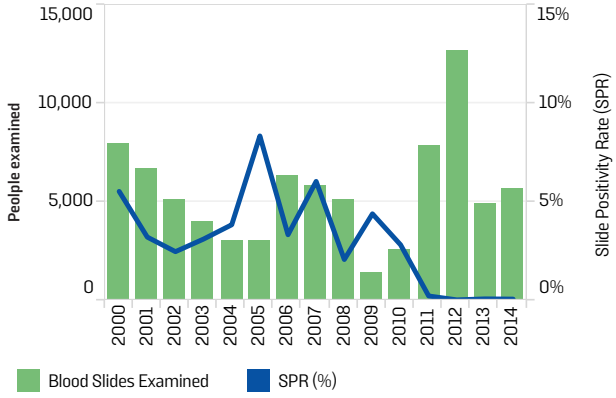
P.f.: *Plasmodium falciparum*
P.v.: *Plasmodium vivax*
"..." indicates unavailable data.

Figure 4. Malaria cases by age and sex in Argentina, 2012-2013



*Data based on age and sex was unavailable for 2014.

Figure 5. Blood slides examined and SPR in Argentina, 2000-2014



Age and sex information was not available for reported cases in 2014. In 2012-2013, more men than women were reported sick with malaria (Figure 4). The most affected groups were younger males between 25-29 years and 30-34 years old, belonging to the economically productive years of life.

Diagnosis and Treatment

Argentina does not use RDTs to diagnose malaria (Figure 5). *Plasmodium falciparum* is treated with artesunate-mefloquine or artemether-lumefantrine combination drugs, while chloroquine and primaquine (0.5 mg/kg for 7 days) are used for *P. vivax* infections.

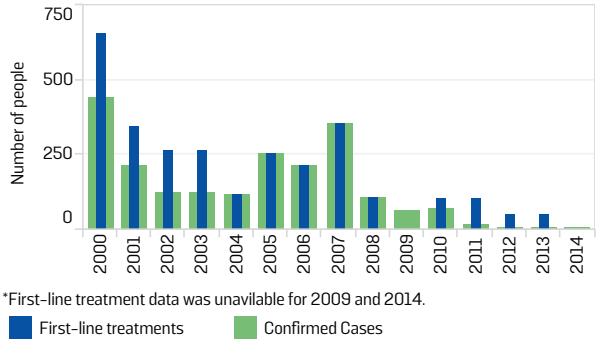
Data for timeliness of treatment were not available for 2014, but time to treatment improved in 2013 compared to 2012 (Figure 7). While these figures are based on a small number of cases, shortened diagnosis and treatment time is an important factor

for countries striving to eliminate malaria and preventing re-introduction.

Vector Control

Historically, IRS use has been an important factor in achieving malaria elimination in Argentina. They have even used a trans-border approach, implementing a binational project spraying houses in bordering Bolivian towns. As of 2014, IRS usage has decreased substantially and currently protects about 300 people (Figure 8). This is due to the fact that low transmission areas (stratum 1) have graduated into areas with no detectable transmission (stratum 2) and thus no longer need IRS. Argentina does not use ITNs as a means of vector control.

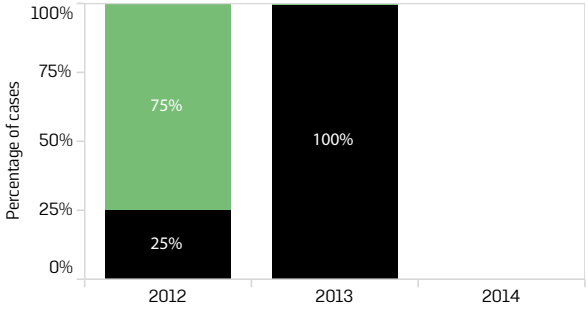
Figure 6. Number of malaria cases and those treated with first-line treatment in Argentina, 2000-2014



*First-line treatment data was unavilable for 2009 and 2014.

First-line treatments Confirmed Cases

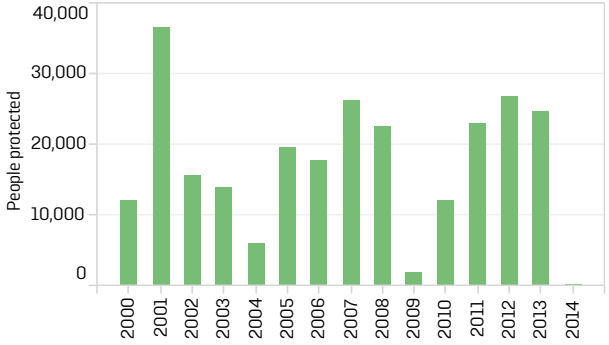
Figure 7. Time between first symptom and initiation of treatment in Argentina, 2012-2014



*Data is unavailable for 2014.

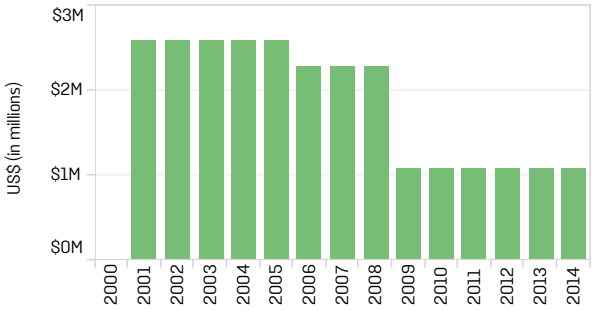
>72 hours 48-72 hours 24-48 hours <24 hours

Figure 8. People protected by IRS and by ITNs in Argentina, 2000-2014



People protected by IRS People protected by ITNs

Figure 9. Funding for malaria in Argentina, 2000-2014



*Funding information for 2000 is unavailble.

Government Global Fund USAID Others

Funding

The government has consistently provided around US$1.08 million for malaria since 2009. The budget has been on a steady decline since 2001 (Figure 9). The government has exclusively funded malaria prevention since 2000.

BELIZE

Belize has achieved almost 99% reduction in malaria since 2000, surpassing the WHA58.2 goal of 75% reduction of malaria by 2015 compared to the year 2000 and achieving the MDG6 goal of having halted by 2015 and reversing the incidence of malaria and other major diseases. Belize is currently in the pre-elimination phase and reported 19 cases in 2014, a decrease of 26.9% from the previous year (Figures 1-2). Only two malaria-related deaths have been reported during the period of 2000-2014.

Almost all transmission is limited to *P. vivax* infections presently, although there was an outbreak of *P. falciparum* in 2005. All malaria cases were investigated in 2014 and were found to be due to local transmission, except one which was a relapse case. Malaria continues to be concentrated in the southern district (ADM1) of Stann Creek where 12 cases were reported in 2014 in three foci – Trio, Santa Rosa, and Riversdale (Sagitun Farms) (Figure 1). In this area, malaria transmission risk is related to working in banana plantations and agricultural farms. Since 2009, malaria has now been limited to only 2 of the 8 localities that had malaria in that district.

Overall, malaria was reported from only 5 localities in 2014 compared to 50 in 2009. Malaria transmission was re-established in the northern districts of Corozal and Orange Walk in 2014, wherein 6 cases were reported from two foci – San Narciso and Nuevo San Juan. These districts border Mexico and movement of laborers and visitors to and from adjacent areas of that country which have ongoing transmission (Othon P. Blanco – Quintanaroo) are factors that increase the vulnerability in these districts.

Imported cases have been reported in previous years, mostly from Guatemala and Honduras. In 2014, more women were found to have had malaria infections, accounting for 57.9% of cases, though in the past men have been more affected (60.9% of cases in 2013, and 67.6% of cases in 2012) (Figure 3).

Analyzing information from 2000-2014, children between the ages of 5-9 years old were the most affected age group. However, in recent years (2013-2014) those in the 15-19 year old age group have had the highest incidence, highlighting that malaria is largely related to occupation in the remaining foci with transmission.

Figure 1. Malaria in Belize by foci, 2014

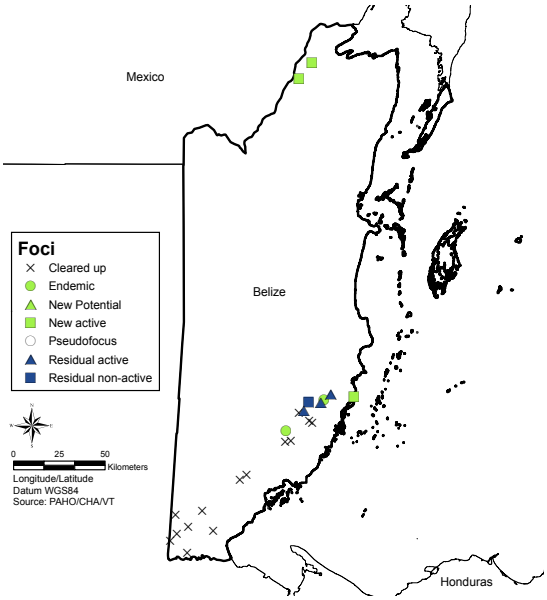


Figure 2. Number of cases and deaths due to malaria in Belize, 2000-2014

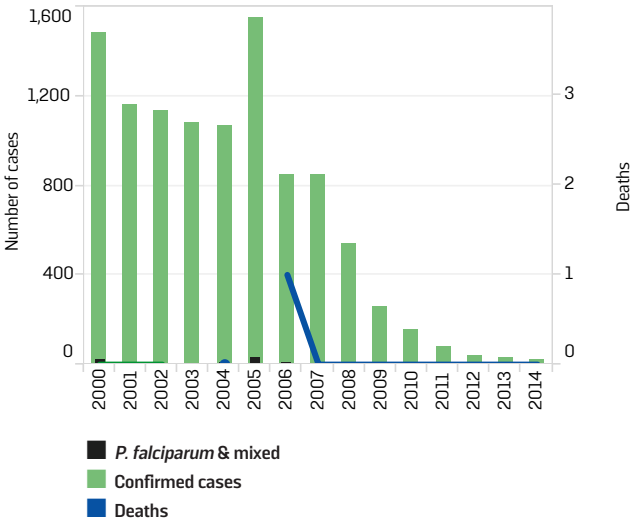
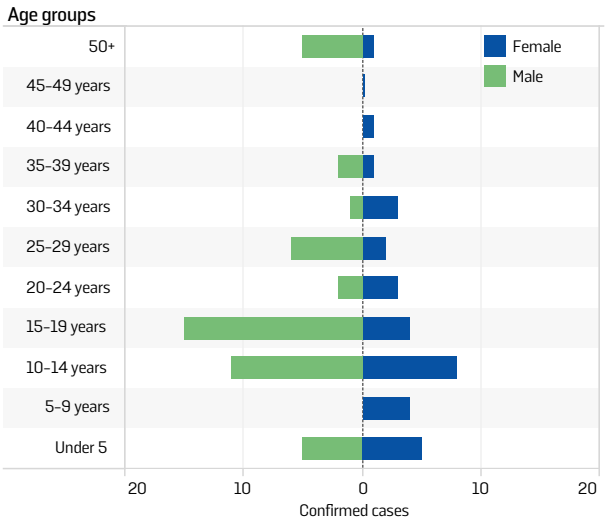


Table 1. Elimination profile of Belize, 2011–2014

	2011	2012	2013	2014
Total Cases	79	37	26	19
Cases Investigated	1	1	26	19
Autochthonous Cases	78	36	22	19
Autochthonous–P.f.	0	0	0	0
Autochthonous–P.v.	78	36	22	0
Imported Cases	1	1	4	0
Imported– P.f.	1	1	0	0
Imported– P.v.	0	0	4	0

*P. f.–*Plasmodium falciparum* *P. v.–*Plasmodium vivax*

Figure 3. Malaria cases by age and sex in Belize, 2012–2014



Diagnosis and Treatment

Belize does not use RDTs to diagnose malaria. The number of blood slides being examined has remained largely stable over the years (Figure 5). However, in 2014 almost half (48%) of the slides examined and 16% of confirmed cases were detected through active surveillance. Both these proportions have been increasing in the past 3 years, indicating an increase in the quality of surveillance as the country advances towards elimination.

Both *P. falciparum* and *P. vivax* infections are treated with chloroquine and primaquine as a first-line treatment. Access to diagnosis and treatment for all patients was not timely in 2013 and 2014 as all patients were given treatment more than 72 hours after onset of symptoms. Recollection of blood slides taken by voluntary collaborators and community health workers is done every 7 days and a 1-day presumptive treatment with chloroquine is given to all suspected cases at that level owing to the delay in diagnostic results. Presumptive

Figure 4. Blood slides examined and SPR in Belize, 2000–2014

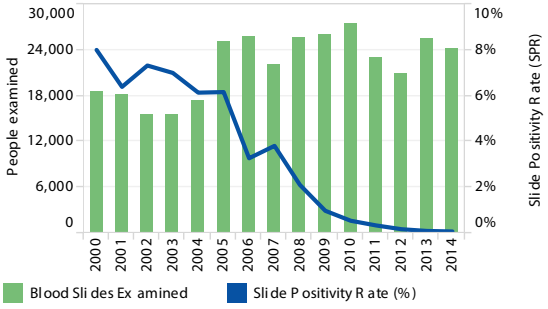
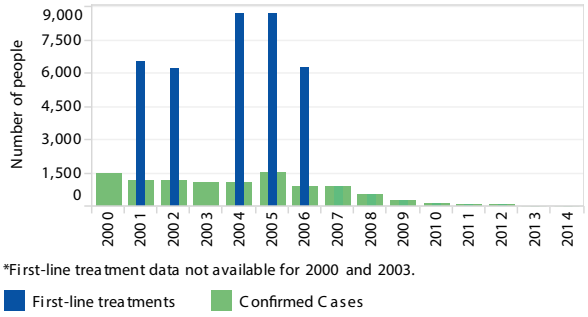


Figure 5. Number of malaria cases and those treated with first-line treatment in Belize, 2000–2014



treatment should be stopped and efforts made to decrease the time period between taking a slide and its diagnosis using RDTs if warranted.

Vector Control

Over the years, IRS usage has decreased and currently protects about 21,000 people; a 78.8% decrease from 10 years ago (Figure 6). This is primarily due to the decrease in malaria and the number of foci with active transmission during the period from almost 50 in 2009 to only 5 in 2014. Insecticide-treated nets are used concurrently with IRS for vector control, especially given to plantation workers. An estimated 9,600 people were protected by nets in 2014. Insecticide susceptibility surveillance has not been routinely conducted. The last study conducted in 2007 by Uniformed Services University of the Health Sciences found possible resistance to permethrin and confirmed resistance to organophosphates and organochlorines in *Anopheles albimanus* in the north of the country (19). *An. albimanus* is the main malaria vector in the country while *An. darlingi* predominates during the transition between the wet and dry season in the southern districts (20).

Funding

The government has provided most of the funding for malaria contributing about US$270,000 in 2014 (Figure 7). Funding has continued to increase since 2007. Additional support has been provided annually by USAID through the AMI/RAVREDA project since 2010. In 2014, the Global Fund also provided start-up funds via the EMMIE project. Although not specifically accounted for, a European Union project focused on integrated vector control also benefited malaria prevention in the past few years.

Figure 6. Time between first symptom and initiation of treatment in Belize, 2012-2014

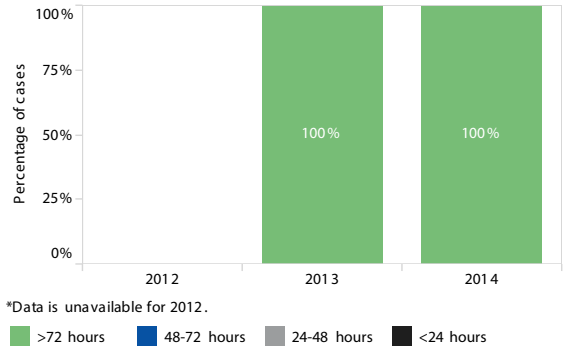


Figure 7. People protected by IRS and by ITNs in Belize, 2000-2014

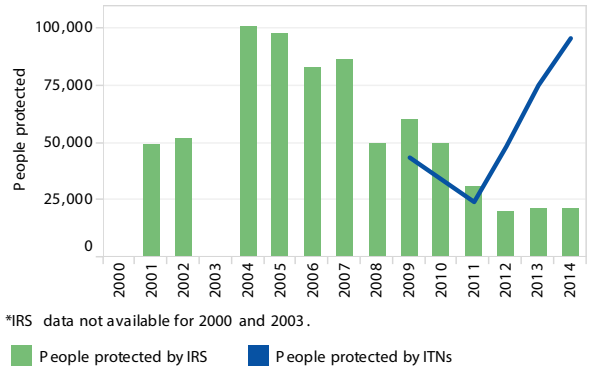
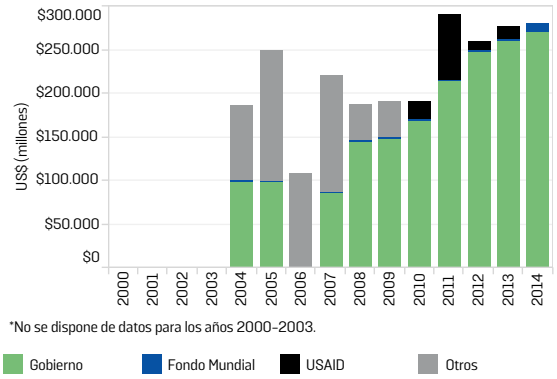


Figure 8. Funding for malaria in Belize, 2000-2014

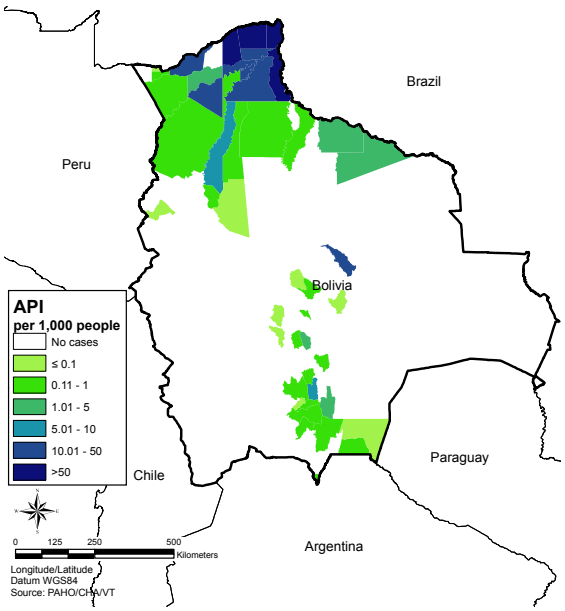


BOLIVIA, PLURINATIONAL STATE OF

Bolivia achieved the WHA 58.2 target for MDG 6C in 2011 and has maintained it since. In 2014, it had decreased morbidity by 76.5% since 2000. Deaths have also decreased and only one was reported in 2014 for the first time in 10 years.

The Amazon area in the northern part of the country has the highest incidence, particularly in the departments of Pando and Beni where 96.2% of all confirmed cases were reported in 2014 (Figures 1–3). Many of the people living in the municipalities (ADM3) of Guayaramerin and Riberalta in Beni make a living by harvesting chestnuts in the nearby Amazon forest across the border. During harvest season, the population in this area increases due to an influx of workers. In Guayaramerin, the Las

Figure 1. Malaria by Annual Parasite Index (API) at municipality level (ADM3), Bolivia 2014



Arenas stream has been identified as a breeding spot for malaria vectors and is most likely causing malaria cases in surrounding areas where people who reside close to the stream live in precarious housing (21). Approximately 95.4% of all cases in the country were due to *P. vivax,* while the rest were due to *P. falciparum* and mixed infections. *Plasmodium falciparum* cases have decreased by 66.1% since 2013. Most cases of *P. falciparum* in Bolivia have been reported in the Guayaramerin municipality. A total of 9.4% of cases in the municipality were due to *P. falciparum* infections. Most municipalities in the country almost exclusively have *P. vivax* transmission. There were about 8.7% of municipalities in the entire country that reported more than 10 malaria cases, 9.3% reported 1–10 cases, and the remainder reported no cases. There were no reported cases from the departments of Potosi and Oruro.

Figure 2. Number of cases and deaths due to malaria in Bolivia, 2000–2014

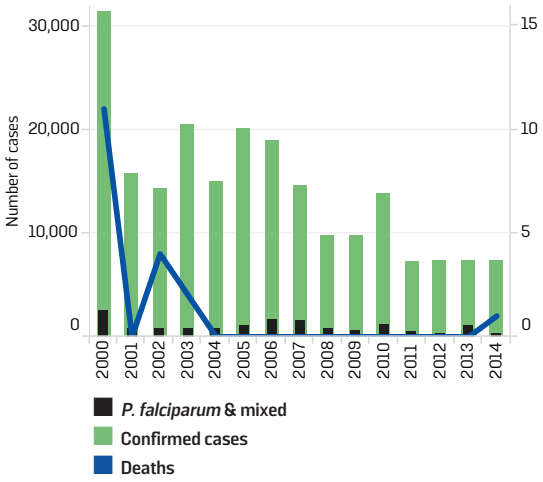


Figure 3. Municipalities with the highest number of malaria cases in Bolivia, 2012–2014

Municipality	Department	2012	2013	2014
Guayaramerin	Beni	3,857	3,897	3,240
Riberalta	Beni	1,074	1,547	2,137
Nueva Esperanza	Pando	155	215	308
Santos Mercado	Pando	24	353	300
El Sena	Pando		340	272
Villa Nueva	Pando	39	117	141
Ingavi	Pando	54	74	108
Cobija	Pando	82	124	54
Bella Flor	Pando	52	85	46
Ixiamas	La Paz	1	187	1

Decrease
Increase

0 2,000 4,000

The most common vectors in the country are *An. darlingi*, mostly affecting the Amazon area in the north, and *An. pseudopunctipennis*, affecting the southern area near Argentina.

Men are more affected by malaria than women, making up 61.9% of cases and having an incidence of 85 cases per 100,000 men compared to 51 cases per 100,000 women (Figure 4). Young men between the ages of 15-19 are the most affected age group (Figure 5). The malaria in pregnancy rate was 71 cases per 100,000 pregnant women, which was found to be 1.3-folds higher than non-pregnant women of child-bearing age.

Priority Groups

An estimated 35,000 chestnut harvesters known as *zafreros* are the most at-risk population in Bolivia. *Zafreros* migrate to harvest areas with their families and live in precarious conditions that are only accessible by river or poor and often impassible roads. Indigenous peoples also inhabit the Amazon forest area and are affected by malaria. Health services are almost non-existent in these areas.

Diagnosis and Treatment

Microscopy is predominately used to diagnose malaria cases, though RDTs have been used in the past particularly in rural areas. RDT usage was not reported for 2014 (Figure 6). An efficacy study conducted in 2011 found 6.5% of 96 patients with *P. vivax* infections to be resistant to chloroquine (22).

A 7-day course of chloroquine and primaquine is the first-line treatment for *P. vivax* infections, while artesunate and mefloquine combination therapy is used as the first-line treatment for *P. falciparum* (Figure 7).

Figure 4. Malaria cases by age and sex in Bolivia, 2014

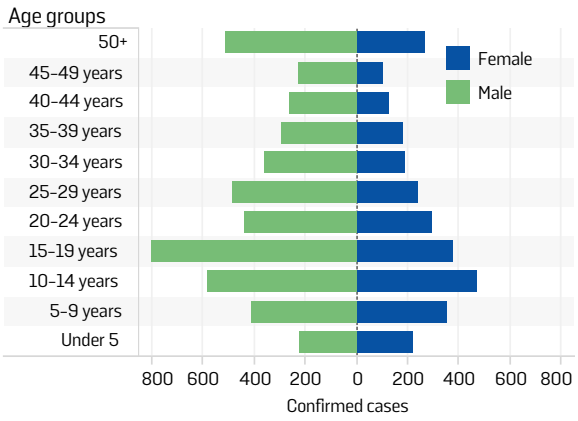


Figure 5. Malaria incidence by age and sex in Bolivia, 2014

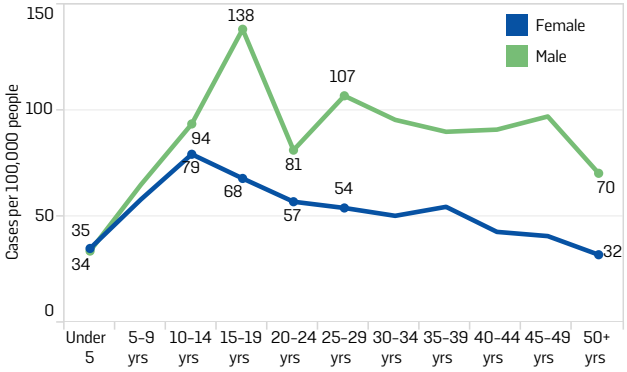


Figure 6. Blood slides examined, RDTs examined, and SPR in Bolivia, 2000-2014

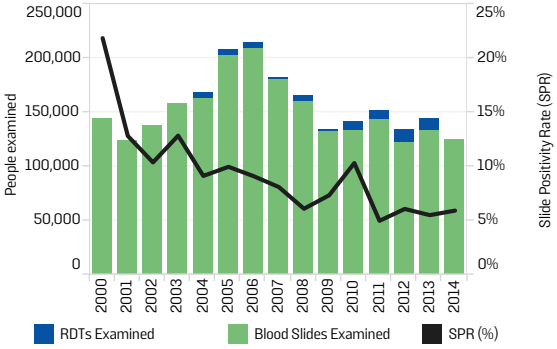


Figure 7. Number of malaria cases and those treated with first-line treatment in Bolivia, 2000-2014

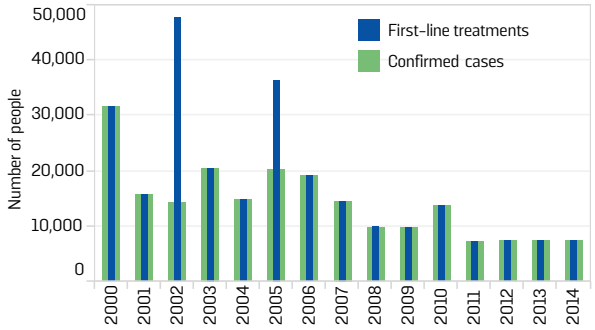


Figure 8. Time between first symptom and initiation of treatment in Bolivia, 2010–2014

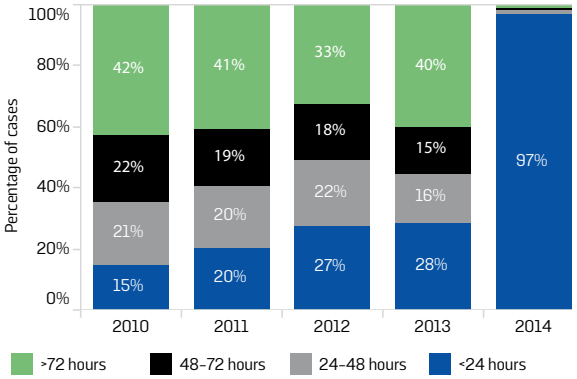
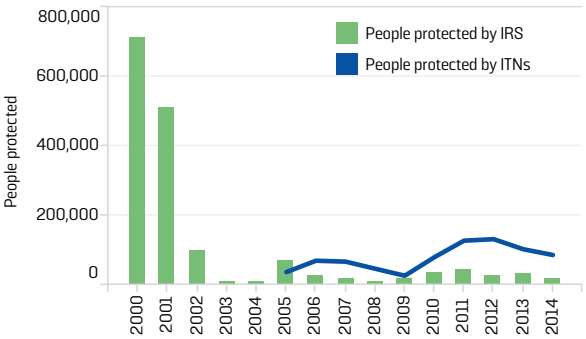


Figure 9. People protected by IRS and by ITNs in Bolivia, 2000–2014



The reported time from the appearance of first symptom to treatment improved significantly in 2014 (Figure 8). However, data for further years will be required to determine if this is an actual improvement in access to diagnosis and treatment.

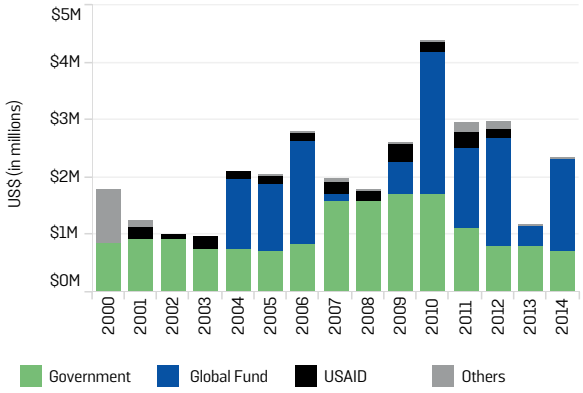
Vector Control

The use of IRS has decreased considerably compared to 2000, and in 2014 protected about 16,500 people (Figure 9). Confirmed resistance to pyrethroids was detected in Guayaramerin in 2013. Vector control via ITNs protected an estimated 87,000 people in 2014 where there is a focus to distribute nets in targeted Amazonian communities as well as to pregnant women living in high-risk areas during prenatal visits.

Funding

The government has consistently provided funding for malaria throughout the years. The Global Fund has also provided support for malaria control and contributed US$1.6 million last year (Figure 10). Funds from USAID were available in Bolivia until 2012.

Figure 10. Funding for malaria in Bolivia, 2000–2014

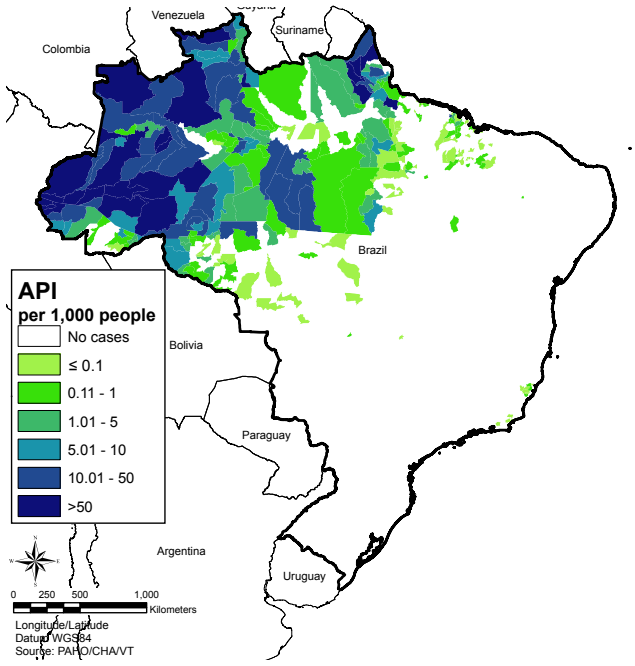


BRAZIL

Brazil has had a significant decrease in malaria morbidity and mortality since 2000. As of 2014, the country officially met the WHA 58.2 target of reducing the malaria burden by 75%. There were 143,145 confirmed cases of malaria in 2014, a 76.7% decrease from cases reported in 2000 (Figures 1-2). The number of cases decreased each year during 2011-2014, with an average of 19% decrease for these years. There were also 36 malaria deaths reported for 2014, an 85% decrease from deaths reported in 2000.

Malaria is highly prevalent in the Amazon forest area located in the northwestern part of the country (Figure 1). Incidence of malaria in the Amazon basin accounts for 99.8% of cases in the country, but only 13% of the country's population lives in this area. Cases from the top 15 municipalities account for 57.3% of all cases in the country (Figure 3). Cruzeiro do Sul in Acre state had the highest number of cases in 2013 and 2014, though there was a 14% decrease in cases between those years.

Figure 1. Malaria by Annual Parasite Index (API) at municipality level (ADM2), Brazil 2014



Municipalities in the state of Para have had a dramatic reduction in incidence in recent years following an outbreak in 2009. Factors that may have contributed to the outbreak were limited access to treatment, non-adherence to treatment by patients, noncompliance of national treatment guidelines, lack of prevention measures, and increased surveillance (23).

The Ministry of Health focused malaria efforts on 5 municipalities (Anajas, Oeiras, Cameta, Curralinho, Jacareacanga, and Itaituba) in Para state, all of which have decreased malaria incidence. Anajas and Oeiras municipalities in particular have had a decline of more than 90% from 2012.

Figure 2. Number of cases and deaths due to malaria in Brazil, 2000-2014

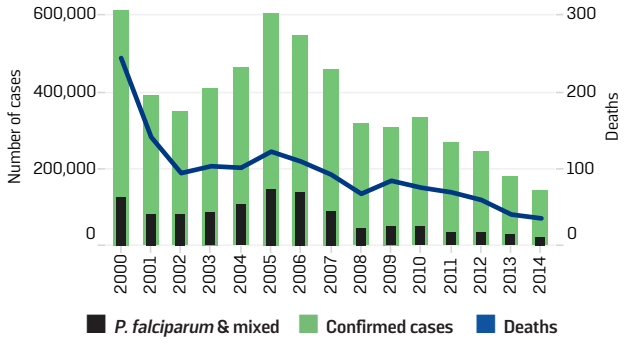
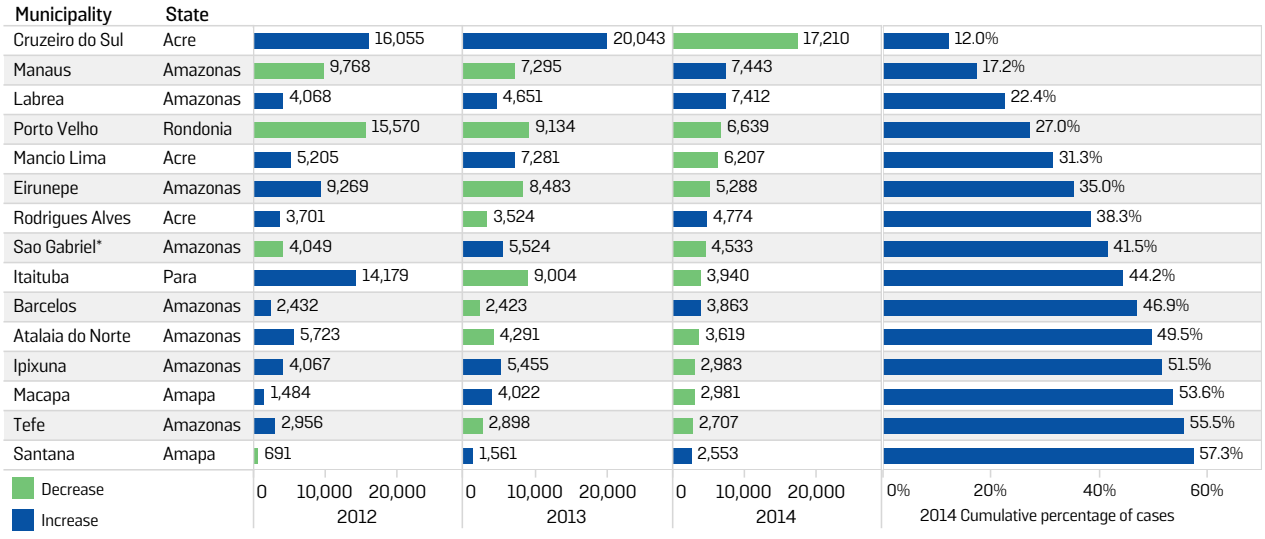


Figure 3. Municipalities with the highest number of malaria cases in Brazil, 2012-2014



*Sao Gabriel da Cachoeira

Plasmodium vivax caused 82.9% of all cases in 2014, while *P. falciparum* and mixed cases caused 16.3% of cases. The primary vector in the Amazon area is *An. darlingi*.

Men have been more affected by malaria than women, in 2014 accounting for 60.4% of confirmed cases (Figure 4). In 2014, incidence of malaria in pregnant women was 93 cases per 100,000 pregnant women per year, which was 1.75-fold higher than non-pregnant women of child-bearing age. Throughout all ages, malaria incidence was higher in men than in women (Figure 5). In both sexes, children aged 5-9 years had the highest incidence among all groups. When coupled with higher rates of incidence in pregnant women, this suggests transmission occurrence in households.

Figure 4. Malaria cases by age and sex in Brazil, 2014

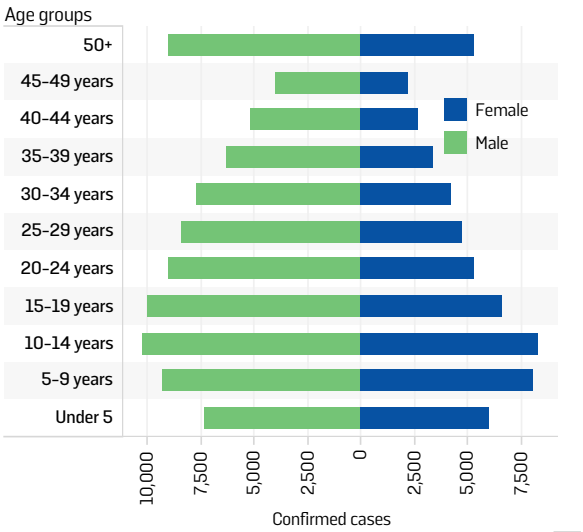
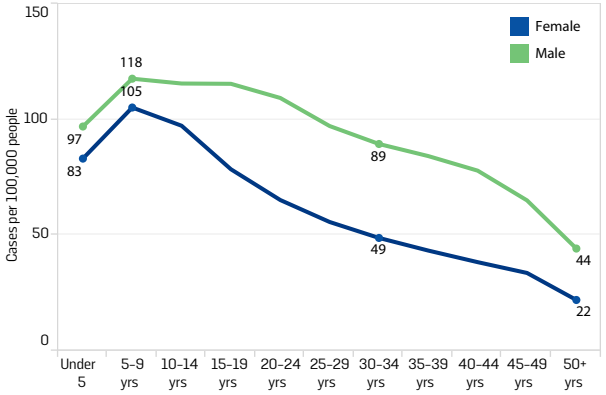
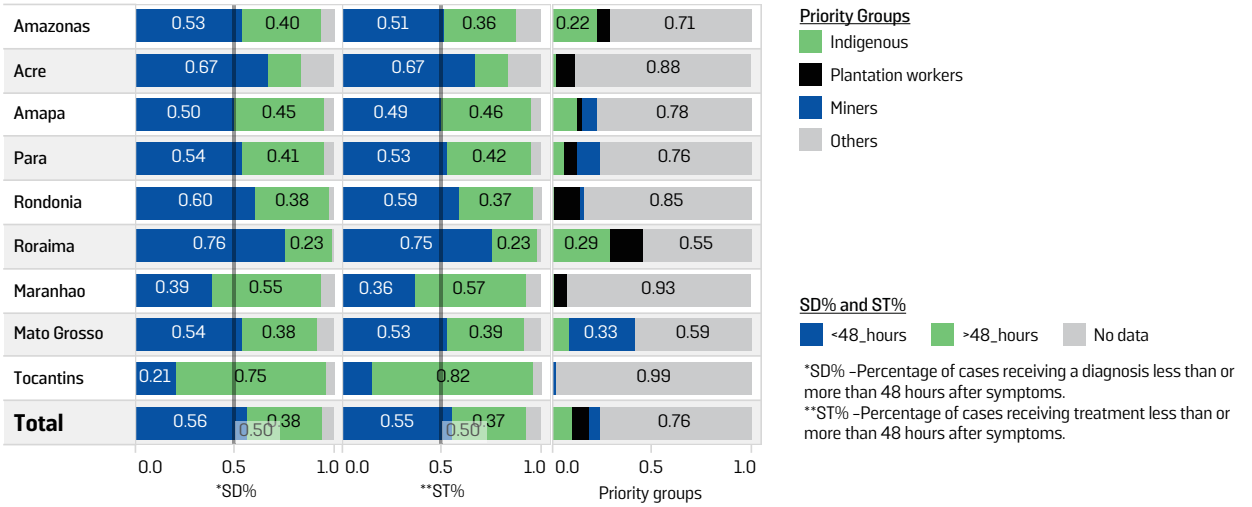


Figure 5. Malaria incidence by age and sex in Brazil, 2014



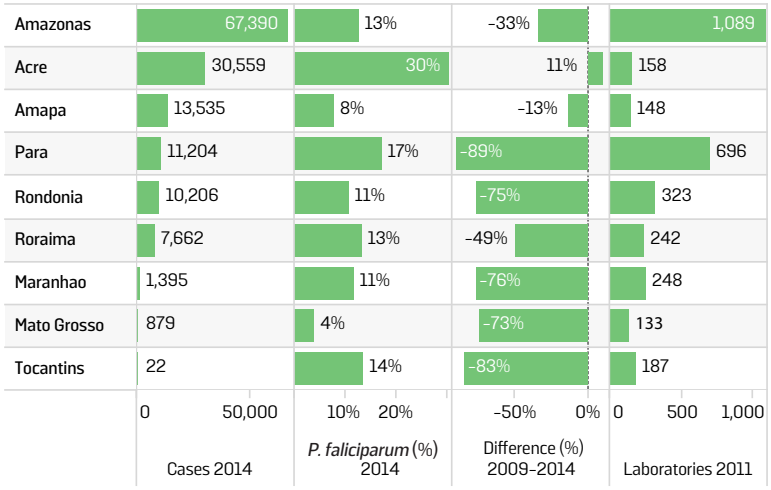
Gold mining has historically been associated with malaria incidence affecting miners; however, other occupational associations have also been established especially among those working in timber extraction and fish farming (Figure 6). In 2014, mining cases decreased by 47% and loggers decreased by 19% from 2013. The arrival of workers into the Amazon area has contributed to deforestation as rural areas urbanize to support this new population. Initially, deforestation was accompanied by higher malaria incidence that flourished in chaotic environments, but urbanization eventually led to the stabilization of physical environments, thereby decreasing vector proliferation (24).

Figure 6. Comparative analysis of malaria situation in states of the Amazon basin, 2011



*SD% -Percentage of cases receiving a diagnosis less than or more than 48 hours after symptoms.
**ST% -Percentage of cases receiving treatment less than or more than 48 hours after symptoms.

Figure 7. Comparative analysis of malaria situation in states of the Amazon basin



Figures 6 and 7 compare the malaria situation states of that are a part of the Amazon basin based on data obtained from a report (25). Para has had the largest decrease since 2009, while Acre has had an 11% increase of cases. In 2011, Amazonas state had the most laboratories; however, in 2014 this state had the highest number of cases. Despite having a high number of laboratories, the state only diagnosed about half of their patients in less than 48 hours since the start of symptoms in 2011. In that same year, the time in which the patient received treatment after diagnosis was not prompt. Around 36% of patients received treatment after more than 48 hours following diagnosis.

The priority groups of concern are indigenous peoples, who account for 15.1% of all cases in 2014, and plantation workers, who account for 23.7%. During 2011, in the Amazon basin indigenous populations were primarily affected in the states of Amazonas (22%) and Roraima (29%) (Figure 6). In Mato Grosso, miners were the most affected group comprising 33% of all cases in the state during 2011.

Diagnosis and Treatment

Microscopy is the main method of diagnosing malaria. In 2014, the SPR was 8.57%, but it has been on a steady decline since 2010 (Figure 8). The decline in both API and SPR further confirms the decreasing morbidity trends in Brazil.

First-line treatment for *P. vivax* is chloroquine and primaquine, while artemether-lumefantrine combination

Figure 8. Blood slides examined, RDTs examined, and SPR in Brazil, 2000-2014

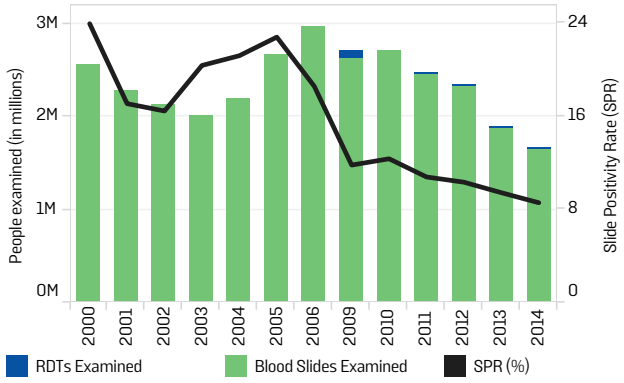
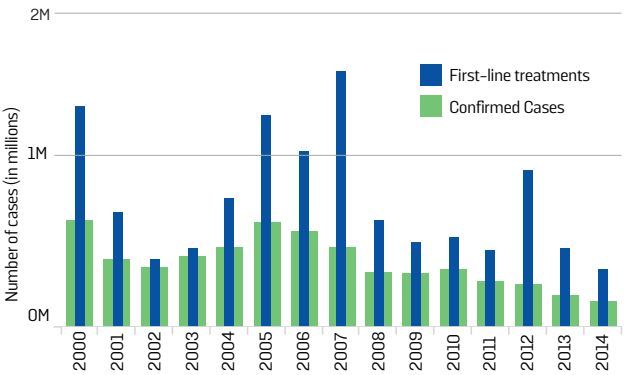


Figure 9. Number of malaria cases and those treated with first-line treatment in Brazil, 2000-2014



and artesunate–mefloquine are used for *P. falciparum* infections. A 2014 study found first-line treatment failure of 5.2% in *P. vivax* cases and an association with high initial mean parasitemia (26). Brazil reports more first-line treatment provided to people than actual confirmed cases; this is probably because estimates of first-line treatments could be based on actual number of tablets used in a year, which is higher than actual tablets used owing to losses due to the expiration of medicines and decay of quality among other reasons (Figure 9).

Vector Control

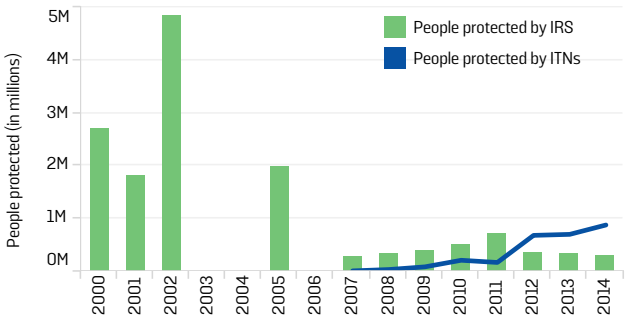
Brazil has recently reinforced efforts on distributing ITNs as a method of vector control. Almost 884,000 people were protected by ITNs in 2014, which has been the highest estimate for Brazil thus far (Figure 10). The number of people protected has increased in the past 3 years, while IRS usage has decreased. At nearly 290,000 people in 2014, the number of people protected by IRS was the lowest recorded since 2007.

Finances

Funding for malaria has mostly come from the government and is managed in a decentralized manner. In 2014, Brazil spent a little more than US$72 million (Figure 11). The USAID has provided support to Brazil, particularly the Amazon area, via the AMI/RAVREDA initiative since its inception in 2002. The Global Fund to Fight AIDS, Tuberculosis and Malaria has also contributed to malaria control efforts and in 2009 provided a grant to make bed net usage a national policy. After 2011, Brazil decided to sustain the project with domestic funds.

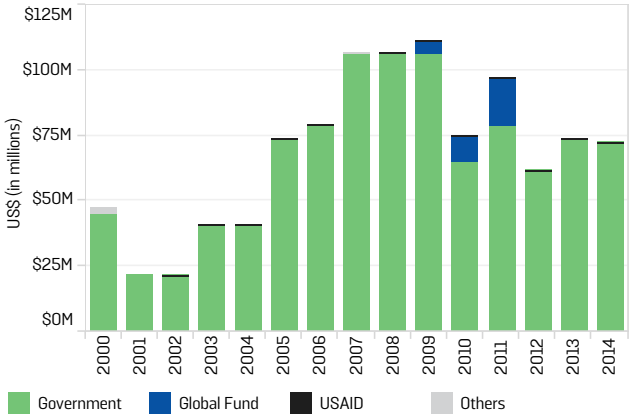
The private sector is also obligated to contribute to malaria funding if their enterprise is located in the Amazon area and their operations are found to have an impact on malaria transmission. Companies must develop social responsibility programs for malaria prevention and control that follow that of the municipalities in which they are located.

Figure 10. People protected by IRS and by ITNs in Brazil, 2000–2014



*IRS information unavailable for 2003, 2004, and 2006.

Figure 11. Funding for malaria in Brazil, 2000–2014



COLOMBIA

Colombia has decreased malaria cases in the past few years and is on track to meet the WHA 58.2 target for MDG 6C by 2015. In 2014, cases have decreased by 71.8% since the beginning of the millennium (Figures 1 and 2). Colombia reported 17 malaria-related deaths in 2014 (only Brazil reported a higher amount), though they have decreased by 86.3% since 2000.

The department of Choco along the Panama border had the highest number of cases in 2014, having increased by 39.4% since 2013 (Figure 3). Quibdo, in the department of Choco, had the highest reported number of cases of all municipalities at 5,008. Antioquia department previously had the highest amount of cases, but malaria has decreased by 55.4% since 2013.

Figure 1. Malaria by Annual Parasite Index (API) at municipality level (ADM2), Colombia 2014

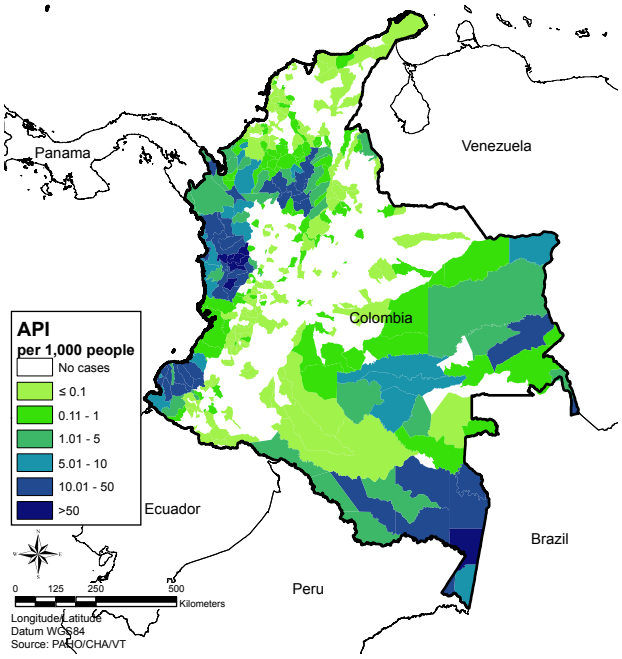
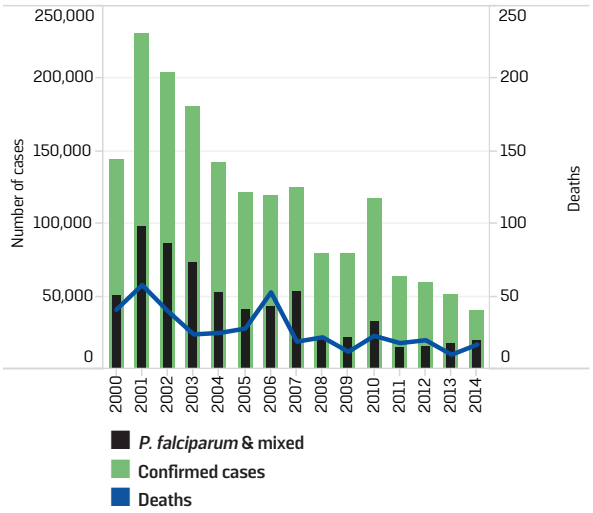


Figure 2. Number of cases and deaths due to malaria in Colombia, 2000-2014



There are various malaria vector species in Colombia including *Anopheles darlingi*, *An. pseudopunctipennis*, *An. albimanus*, *An. nunestovari*, *An. neivai*, and *An. punctimacula*. *Plasmodium falciparum* infections accounted for about half of all cases in 2014, an increase from the previous year (34%). In the past, the majority of cases have been due to *P. vivax*, but in 2014 Choco had an outbreak of *P. falciparum* malaria.

Figure 3. Municipalities with the highest number of malaria cases in Colombia, 2012-2014

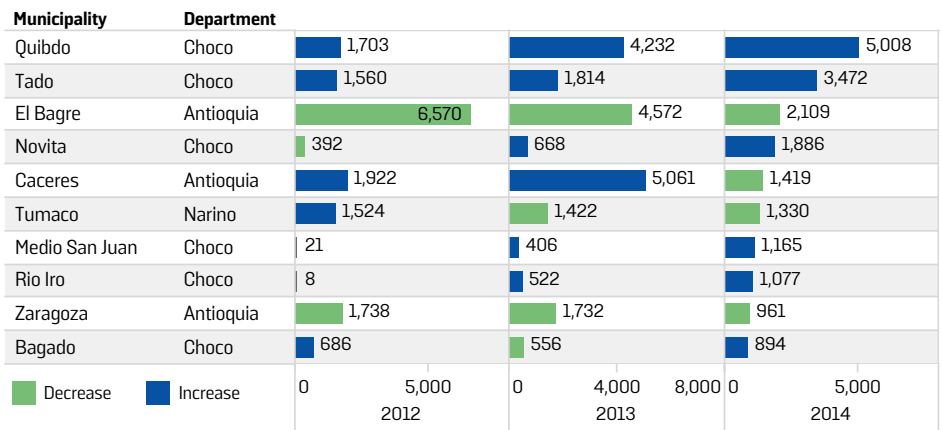
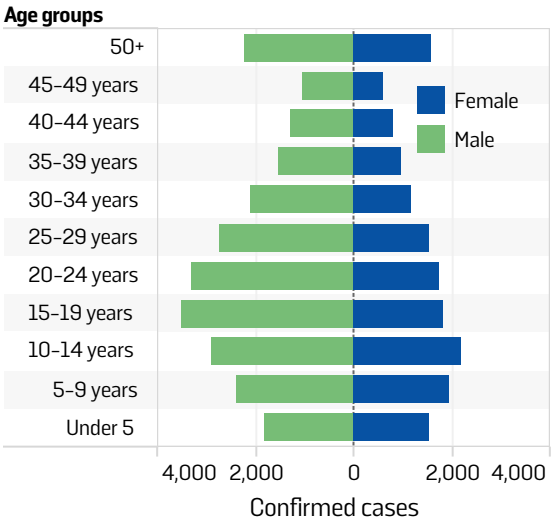


Figure 4. Malaria cases by age and sex in Colombia, 2014



Men are more at risk for malaria than women and accounted for 61% of cases in 2014 (Figure 4). The age-standardized incidence that year was 102 cases per 100,000 men and 65 cases per 100,000 women. Throughout all age groups, the incidence of malaria was higher in men than in women, peaking for those men in the 15-19 year age group (Figure 5). In women, the incidence was highest for those aged 10-14 years old.

Diagnosis and Treatment

Although both microscopy and RDTs are presently used for malaria diagnosis, the former is the principal method (Figure 6). RDTs were introduced in 2007 and their use has varied from year to year. The SPR in 2014 was 10.1, decreasing from over 30 at the start of the millennium. Colombia uses cholorquine and primaquine (0.25 mg/kg for 14 days) as a first-line treatment for *P. vivax*, while artemether-lumefantrine combination is used to treat *P. falciparum* cases.

In 2014, access to treatment improved compared to the previous year when almost half of malaria patients received treatment in more than 72 hours following the onset of symptoms (Figure 8). Currently, only 36% of all malaria patients have to wait more than 72 hours before receiving treatment, an especially important factor during *P. falciparum* outbreaks. However, data have varied significantly from one year to the other, which raises doubt over the quality of information available for ascertaining trends in access to diagnosis and treatment.

Figure 5. Malaria incidence by age and sex in Colombia, 2014

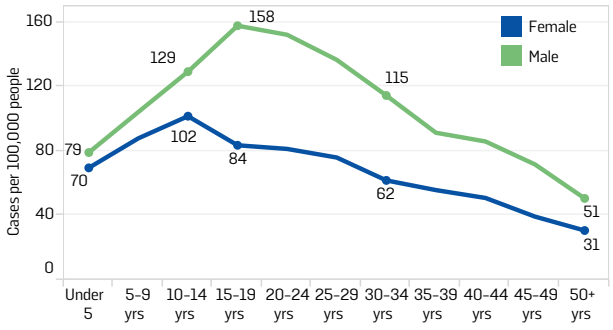


Figure 6. Blood slides examined, RDTs examined, and SPR in Colombia, 2000-2014

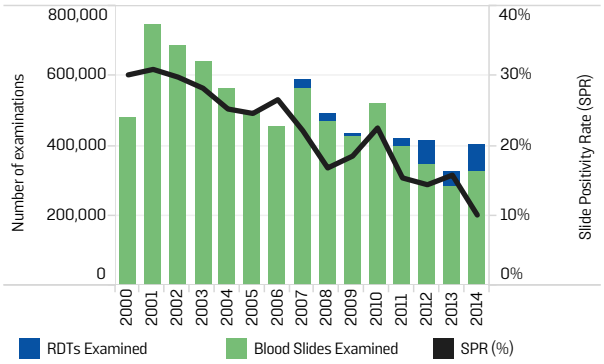
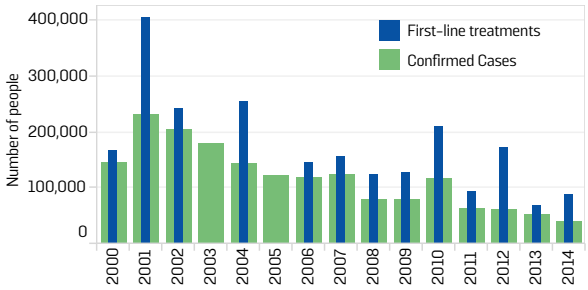
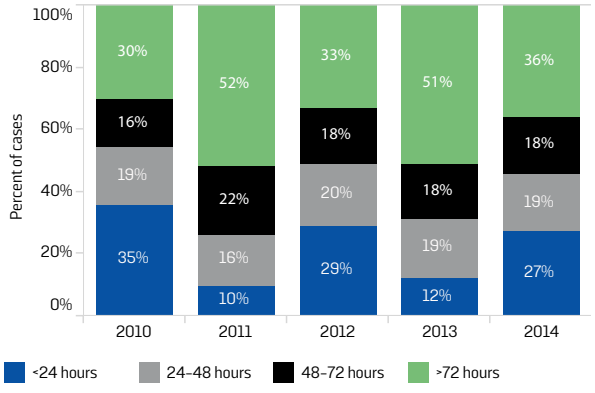


Figure 7. Number of malaria cases and those treated with first-line treatments in Colombia, 2000-2014



*First-line treatment data unavailable for 2003 and 2005.

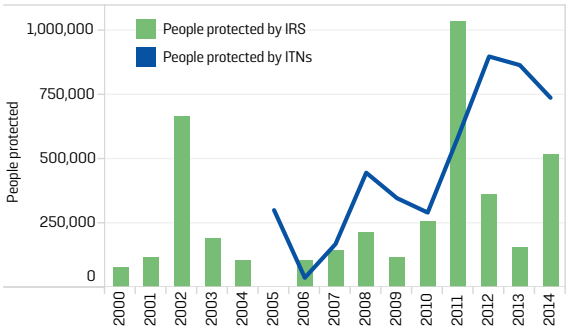
Figure 8. Time between first symptom and initiation of treatment in Colombia, 2010-2014



Vector Control

ITNs have been distributed in Colombia, most notably in 2005, 2008, and 2012. An estimated 750,000 people are estimated to be protected by ITNs (Figure 9). Use of IRS increased in 2014 compared to the year before, protecting around 520,000 people. Tests performed in 2013 and 2014 found confirmed resistance in *An. darlingi* vectors to organochloride and pyrethroid insecticides in the department of Choco, the department with the highest incidence of malaria in the country.

Figure 9. People protected by IRS and by ITNs in Colombia, 2000-2014

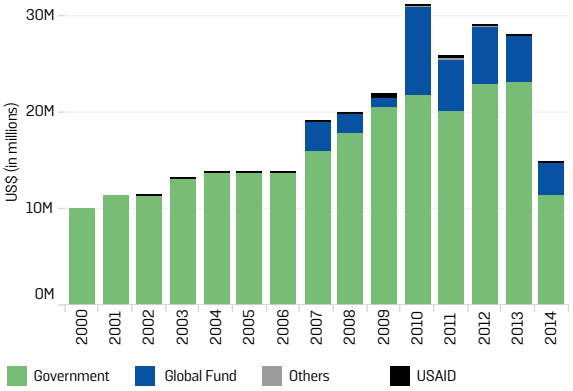


*IRS data is not available for 2005.

Funding

Although various external sources have contributed to malaria funding, the majority of funds are provided by the government. However, these funds were reportedly decreased to half in 2014 compared to 2013 (Figure 10). The Global Fund has provided financial support, although the last grant ended in 2014 and the country is no longer eligible to receive funds. The USAID has provided resources since 2002 via the AMI/RAVREDA project. Other external funds have come from PAHO/WHO in the past. The recent decrease in funding may put at risk the progress made as cases tend to increase when resources decrease, especially so in Choco and other malaria endemic areas where the Global Fund grant was supporting malaria-related activities up until 2014.

Figure 10. Funding for malaria in Colombia for 2000-2014



COSTA RICA

Costa Rica has met the WHA 58.2 target for MDG 6C and reported only 6 malaria cases in 2014, a 99.7% decrease since 2000 (Figures 1 and 2). The country is currently in the elimination phase and has reported less than 10 cases since 2012. There have been no deaths reported since 2009.

Cases are dispersed throughout the country and all cases except one were imported in 2014 (Table 1 and Figure 3). Three *P. falciparum* cases were imported from Africa and two *P. vivax* cases were imported from Nicaragua. One case of recrudescence of *P. malariae* was also reported. The provinces of Huetar Atlantica and Huetar Norte have transformed since 2000 due to agricultural developments, particularly in banana and citrus farms. The transformation has led to an increased risk of malaria due to vector habitat changes and an increase in human migration to work in these areas. Most cantons of Costa Rica have not reported local transmission in the last 3 or more years (stratum 1) (Figure 4). The last autochthonous case of malaria was reported in the canton of Puntarenas in 2013. This is the only malaria endemic area of the country in recent years. Strangely, a few autochthonous cases of *P. malariae* have been reported during 2012-2014, although records indicate no transmission since 1962.

Anopheles albimanus and *An. pseudopunctipennis* are the primary malaria vectors.

Figure 1. Malaria in Costa Rica by foci, 2014

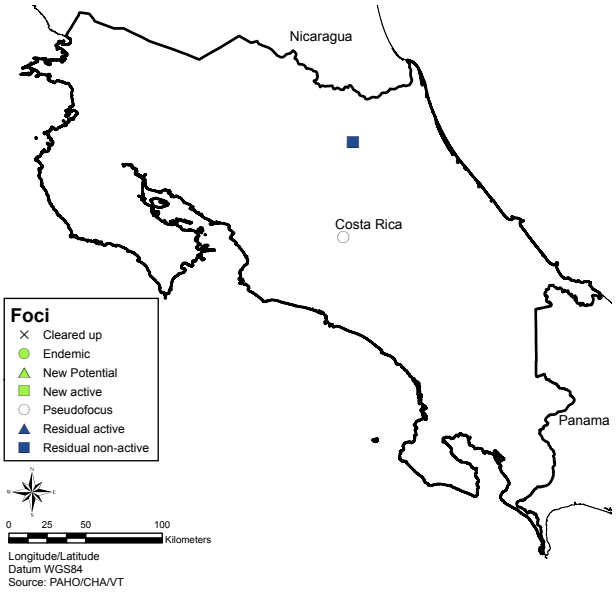


Figure 2. Number of cases and deaths due to malaria in Costa Rica, 2000-2014

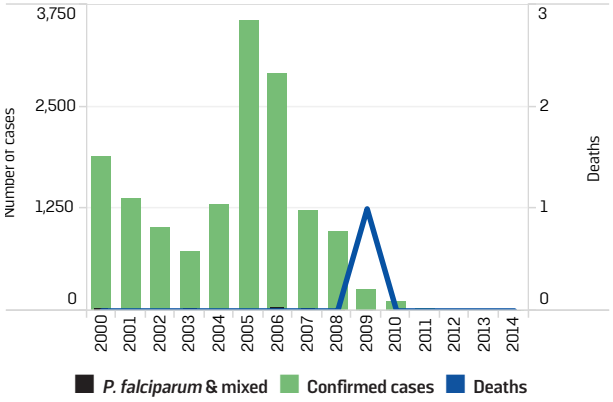


Table 1. Cantons with malaria in Costa Rica, 2012-2014

Canton	Province	2012		2013		2014	
		Total cases	Imported cases	Total cases	Imported cases	Total cases	Imported cases
Desamparados	San Jose	0	0	0	0	1	1
Guacimo	Limon	0	0	0	0	1	1
Nandayure	Guanacaste	0	0	0	0	1	1
Sarapiqui	Heredia	0	0	0	0	1	0
Siquirres	Limon	0	0	0	0	1	1
San Carlos	Alajuela	1	0	1	0	1	1
Puntarenas	Puntarenas	3	0	2	1	0	0
La Cruz	Guanacaste	0	0	1	1	0	0
Upala	Alajuela	0	0	1	1	0	0
Carrillo	Guanacaste	1	1	0	0	0	0
Golfito	Puntarenas	1	0	0	0	0	0
San Jose	San Jose	1	0	0	0	0	0
Talamanca	Limon	1	0	0	0	0	0

Figure 3. Autochthonous and imported cases in Costa Rica, 2010-2014

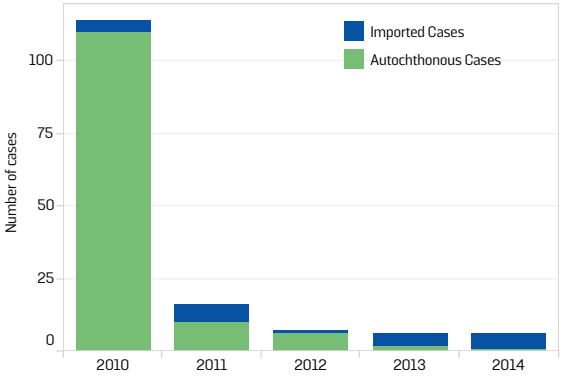
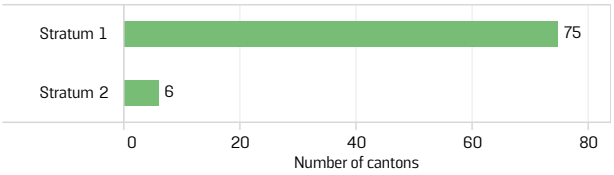


Figure 4. Number of cantons by strata in Costa Rica, 2012-2014



*Stratum 1: No autochthonous malaria case in 2012-2014;
Stratum 2: <1 case per 1000 inhabitants in 2012-2014;
Stratum 3: >1 case per 1000 inhabitants in ≥1 year

Diagnosis and Treatment

Fewer blood slides have been examined due to the decrease in cases over the years, amounting to about 4,500 slides in 2014 (Figure 6). The country has recently been in the process of transitioning microscopic staining techniques from modified Romanowsky to Giemsa. Chloroquine and primaquine are used as first-line treatment for both *P. falciparum* and *P. vivax* infections.

Despite the small amount of cases in the past 3 years, access to diagnosis and treatment is estimated to be relatively quick, owing to the unique model of health system in Costa Rica (Figure 8). Apart from the hospitals and clinics, basic teams for comprehensive healthcare provide last-mile connectivity, increasing access to healthcare through periodic home visits. Cases of *P. falciparum* imported from countries with documented chloroquine resistance are treated with ACT.

Figure 5. Malaria cases by age and sex in Costa Rica, 2012-2014

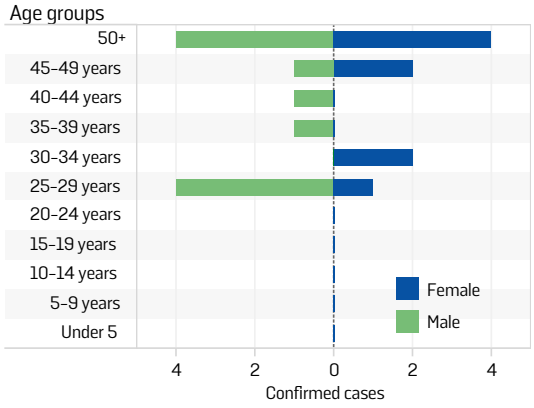


Figure 6. Blood slides examined and SPR in Costa Rica, 2000-2014

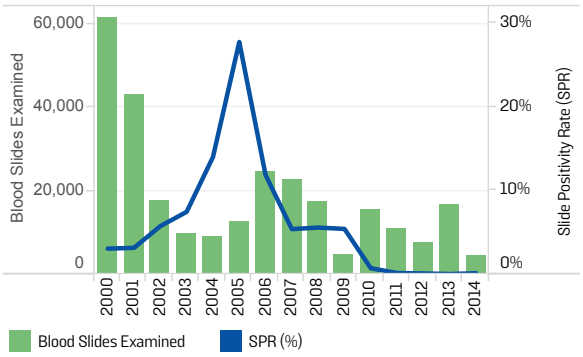


Figure 7. Number of malaria cases and those treated with first-line treatment in Costa Rica, 2000-2014

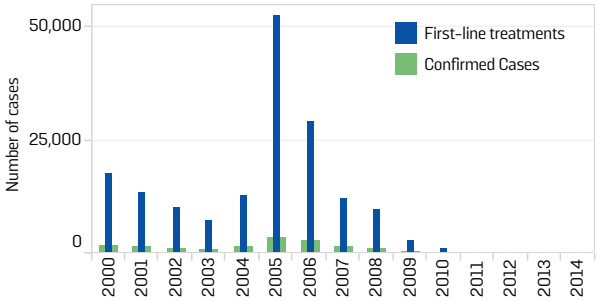


Figure 8. Time from first symptom to treatment in Costa Rica, 2010-2014

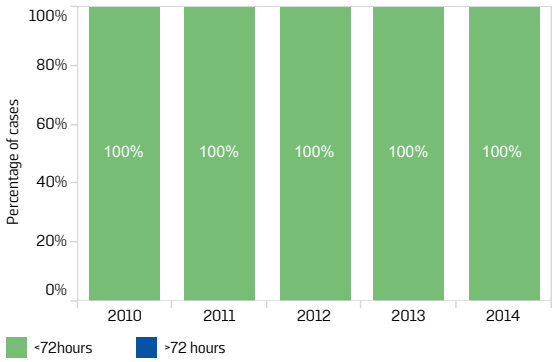
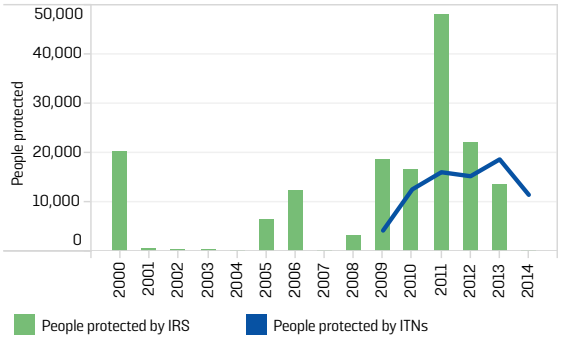


Figure 9. People protected by IRS and by ITNs in Costa Rica, 2000-2014



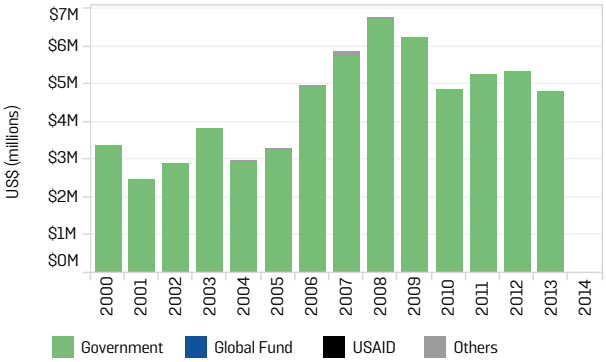
Vector Control

The last distribution of ITNs occurred in 2013 and currently protect an estimated 11,500 people (Figure 9). Vector control by IRS was not reported in 2014, but has decreased since 2011 as a result of the decline in malaria cases.

Funding

For decades, the government has provided millions of dollars in funding for malaria prevention and elimination (Figure 10). While governmental funding was not reported in 2014, no less than US$2.5 million have been spent every year since 2000. Although US$200,000 were available from the Global Fund as startup funding through the multi-country EMMIE project, around US$20,000 were reported to have been used for malaria at the end of 2014.

Figure 10. Funding for malaria in Costa Rica, 2000-2014



*Data unavailable for 2014.

DOMINICAN REPUBLIC

The Dominican Republic has reduced malaria by 59.8% since the year 2000. Though the WHA 58.2 target for MDG 6C may not be reached by 2015, the country has achieved a notable decrease in morbidity (Figures 1 and 2). In 2014, the Dominican Republic was classified as being in the pre-elimination phase. In 2010, the country had a surge of cases after the earthquake struck neighboring Haiti. Since then, morbidity has decreased by 80%.

Figure 2. Number of cases and deaths due to malaria in Dominican Republic, 2000-2014

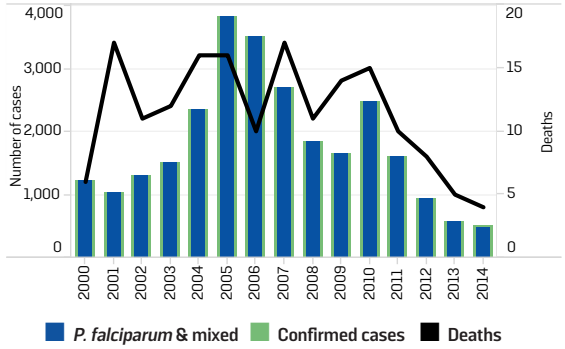
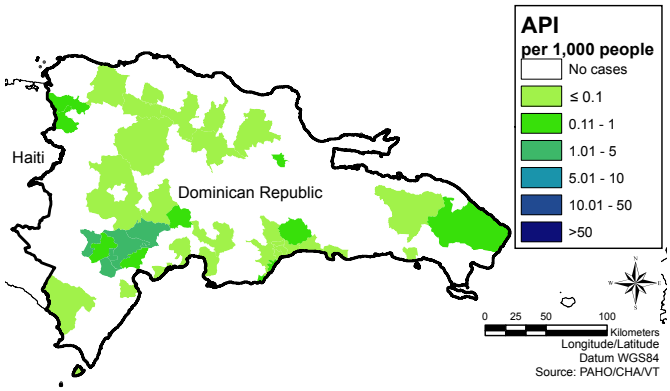


Figure 1. Malaria by Annual Parasite Index (API) at municipality level (ADM2), Dominican Republic 2014



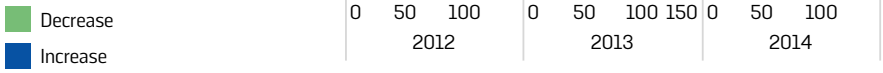
Dajabon is known for its binational market attracting many Haitians and Dominicans alike, leading to movement of people across the border. Approximately 2000 Haitians are allowed to enter the country twice weekly to buy and sell goods since 2005 when the market was established. Malaria is attributed to this immigration in Dajabon, but cases have decreased in the past year (17 cases compared to 1000 in 2007) due to focused interventions, improvements in surveillance, and partner support.

The provinces of Santo Domingo had an outbreak in 2014, reporting 161 more cases from 2013 particularly in the municipalities of Santo Domingo North and Santo Domingo East (Figure 3). In the northwestern part of the country, the municipality of Dajabon has decreased its cases considerably in the past decade.

The country investigates all cases and found that 37 cases were imported in 2014. During 2012-2014, there was 70 municipalities designated as stratum 2 and 71 as stratum 1 (Figure 4). However, there were 14 municipalities with more than 1 case per 1,000 inhabitants in 1 or more years (stratum 3).

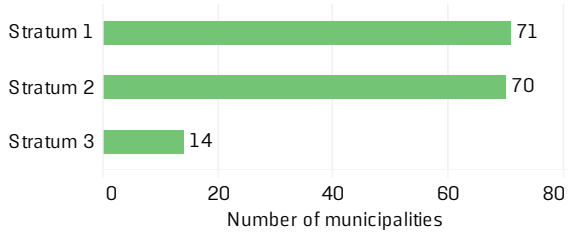
Figure 3. Municipalities with the highest number of malaria cases in Dominican Republic, 2012-2014

Municipality	Province	2012	2013	2014
Santo Domingo Norte	Santo Domingo	5	10	110
Santo Domingo Este	Santo Domingo	13	20	75
Tamayo	Baoruco	13	10	45
Neiba	Baoruco	17	23	43
Las Yayas de Viajama	Azua	6	0	33
Higuey	La Altagracia	7	30	28
Cristobal	Independencia	1	8	22
Santo Domingo*	Distrito Nacional	4	3	18
Dajabon	Dajabon	99	51	17
San Gregorio**	San Cristobal	0	0	12



*Santo Domingo de Guzman
**San Gregorio de Nigua

Figure 4. Number of municipalities (ADM2) by strata in Dominican Republic, 2012-2014.

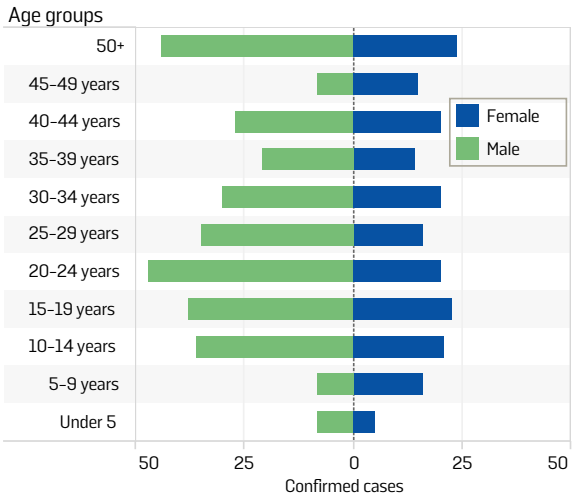


*Stratum 1: No autochthonous malaria case in 2012-2014;
Stratum 2: <1 case per 1000 inhabitants in 2012-2014;
Stratum 3: >1 case per 1000 inhabitants in ≥1 year.

Anopheles albimanus is the principal malaria vector present on the Island in both the Dominican Republic and Haiti. All malaria cases are caused by *P. falciparum*, though the country reported 5 *P. vivax* cases in 2014, all imported from Venezuela. Haiti, on the other hand, exclusively reported *P. falciparum* cases.

Men in general tend to be more at risk of malaria in the Dominican Republic and accounted for 60.9% of all cases in 2014 (Figure 5). The incidence in men was 5.8 cases per 100,000 men in 2014, while women had an incidence of 3.7 cases per 100,000 women. Men between the ages of 20-24 had the highest incidence in 2014 (Figure 6).

Figure 5. Malaria cases by age and sex in Dominican Republic, 2014



Diagnosis and Treatment

Rapid diagnostic tests to detect malaria have been introduced in the past 5 years; however, microscopy has been the primary method used to diagnose malaria (Figure 7). Around 80% of suspected cases were tested through active case detection and 43% of all confirmed cases in the country were confirmed through active surveillance.

Chloroquine and primaquine is the first-line treatment for both *P. falciparum* and *P. vivax* infections. Studies on Hispaniola Island have shown that *P. falciparum* continues to remain sensitive to chloroquine. Haiti follows the same treatment regimen.

Time from onset of symptoms to treatment has gradually worsened since 2012. Currently about 79% of patients receive treatment after more than 72 hours after onset of symptoms (Figure 9). Many cases are reported in Haitians, some of whom do not go to a health center when they are sick owing to their illegal immigration status in the country.

Figure 6. Malaria incidence by age and sex in Dominican Republic, 2014

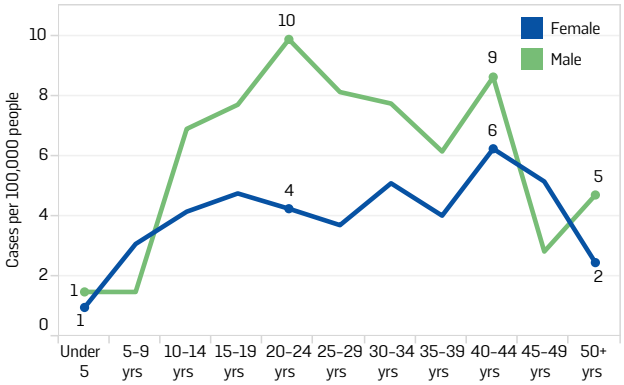


Figure 7. Blood slides examined, RDTs examined, and SPR in Dominican Republic, 2000-2014

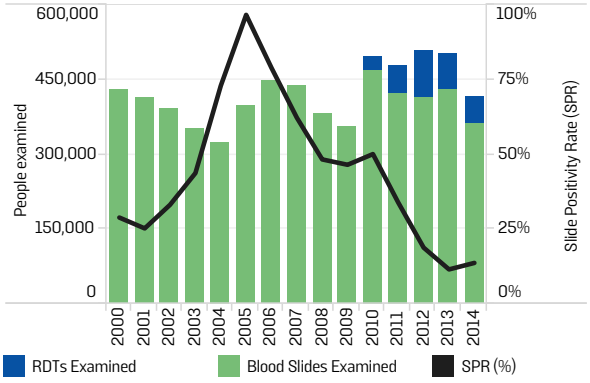
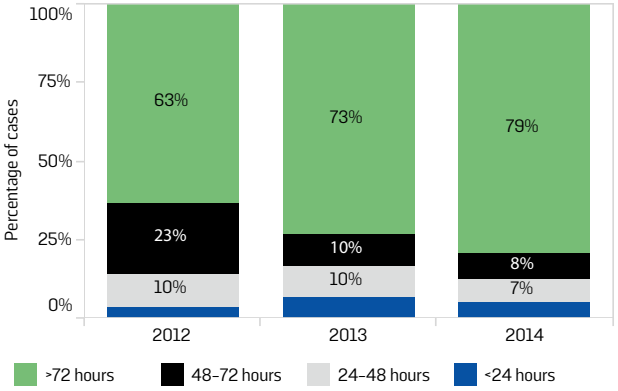


Figure 9. Time between first symptom and initiation of treatment in Dominican Republic, 2012 - 2014



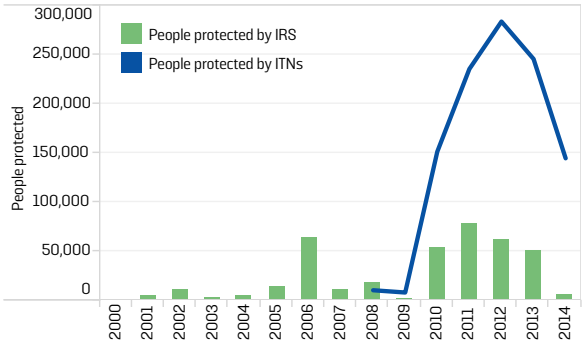
Vector Control

Both IRS and ITNs are used as a means of vector control. The amount of people protected by IRS and ITNs has decreased in 2014 by 87.8% and 41.4% in 2013 (Figure 10). This is due, in part, to the decrease in malaria incidence in areas of high endemicity. Resistance to organophosphate insecticides in Dajabon was confirmed in 2012 in *An. albimanus*, but tests yielded possible resistance in 2014. Confirmed resistance to pyrethroids was found in 3 provinces in 2013 (El Seibo and La Altagracia in the east and Montecristi in the northwest).

Funding

The government has consistently provided funds for malaria (Figure 11). The Global Fund has been the main external source for malaria funds since 2009. However, after the 2014 grant came to an end, the country is no longer eligible for new financing. Additional funding has also been provided by USAID in the past, yet new initiatives such as EMMIE and Malaria Zero will provide external support in the future for malaria elimination in Hispaniola.

Figure 10. People protected by IRS and by ITNs in Dominican Republic, 2000-2014



*Data for IRS unavailable for 2000.

Figure 8. Number of malaria cases and those treated with first-line treatment in Dominican Republic, 2000-2014

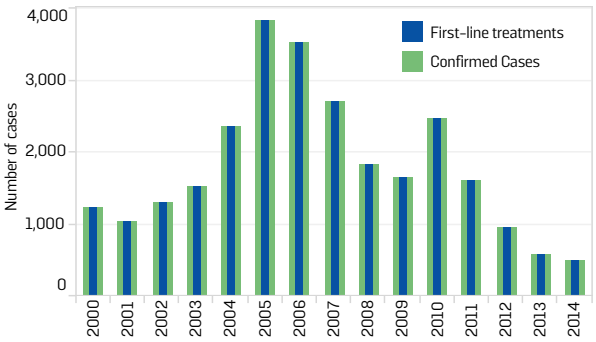
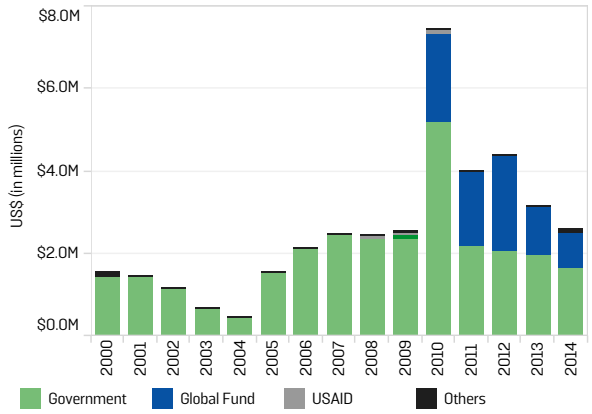


Figure 11. Funding for malaria in Dominican Republic, 2000-2014



ECUADOR

Ecuador has made significant progress in the reduction of malaria, surpassing the WHA58.2 target for MDG6C and reducing malaria by 99.8% since the year 2000 (Figures 1 and 2). Deaths due to malaria have followed a similar trend and in 2014 only one death was reported. However, the number of deaths reported to the malaria unit at PAHO/WHO are significantly less than those reported to the PAHO Regional Health Observatory (CHA/HA) during 2000–2014.

Figure 1. Malaria by Annual Parasite Index (API) by canton level (ADM2), Ecuador 2013

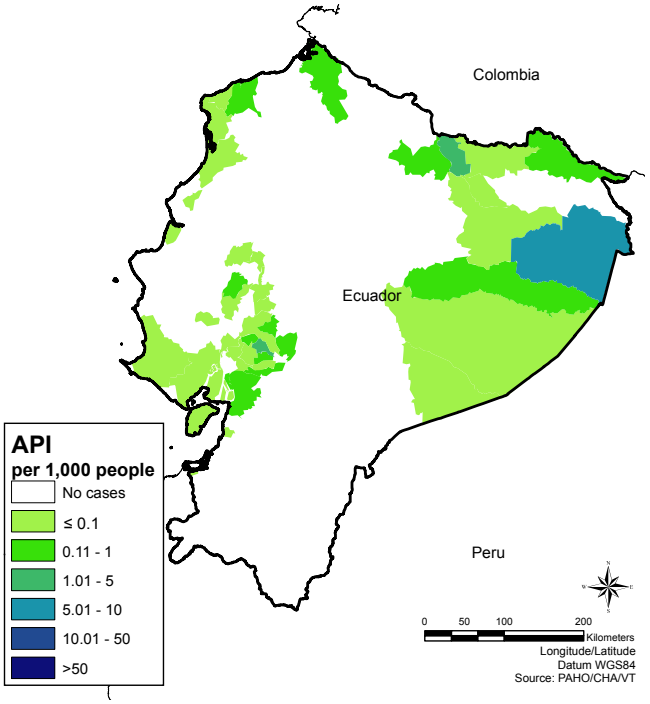
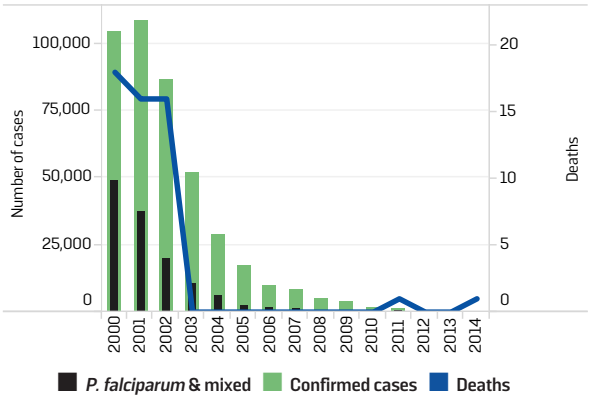
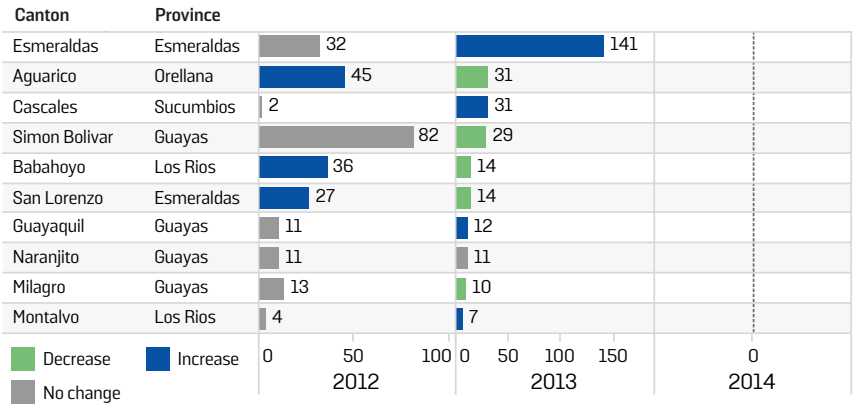


Figure 2. Number of cases and deaths due to malaria in Ecuador, 2000–2014



The number of confirmed cases, blood slides examined, number of cases by species type, and amount received for malaria from external sources were the only data available for the year 2014. All other analyses used data available until 2013. The National Service for Control of Arthropod Vector-borne diseases (SNEM, acronym in Spanish) is currently being integrated with the general health services of the Ministry of Health. In 2013, the incidence rate (API) was highest in the sparsely-populated cantons of the Amazon area; however, the highest number of cases was recorded in the densely-populated Esmeraldas canton of the Esmeraldas province located on the northwestern coast of the country (Figure 3). The principal malaria vectors in the Amazon area are

Figure 3. Cantons with the highest malaria cases in Ecuador, 2012–2014



*Data unavailable for 2014.

Table 1. Elimination profile of Ecuador, 2010-2014

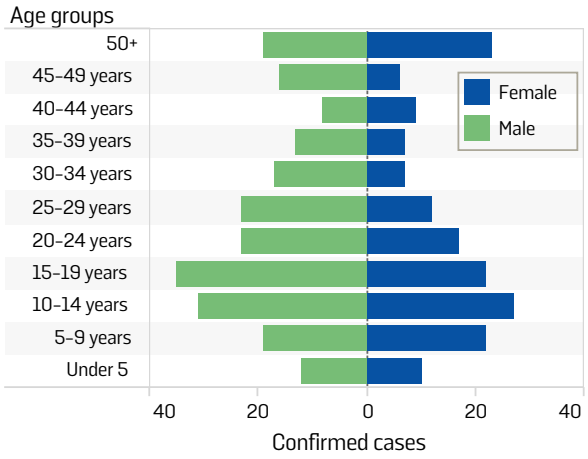
	2010	2011	2012	2013	2014
Total Cases	1,888	1,232	558	378	241
P. falciparum Cases	258	296	80	161	49
P. vivax Cases	1,630	936	478	217	199
Cases Investigated	17	96	204	100	...
Autochthonous Cases	1,871	1,219	544	368	...
Autochthonous- P.f.	245	288	68	160	...
Autochthonous- P.v.	1,626	931	476	208	...
Imported Cases	17	14	14	10	...
Imported- P.f.	13	8	12	1	...
Imported- P.v.	4	6	2	9	...
Active Foci	...	...	14	3	...

**P. f- Plasmodium falciparum, P. v. - Plasmodium vivax*
"..." indicates unavailable data.

An. albimanus and *An. neivai*, while *An. albimanus*, *An. pseudopunctipennis*, and *An. punctimacula* are principal vectors on the Pacific coast. Most cases were due to *Plasmodium vivax* in 2014; however, *P. falciparum* accounted for 19.8% of confirmed cases in 2014 and 43.0% of cases in 2013.

As the country reorients from control to elimination, surveillance has continued to improve. The proportion of cases being investigated and classified has steadily increased between 2010 and 2013 from 1% to 25% of confirmed cases (Table 1). The number of imported cases has not been higher than 20 in any of those years, with most cases being imported from neighboring countries of Peru and Colombia.

Figure 4. Malaria cases by age and sex in Ecuador, 2013



Men were more at risk for malaria, accounting for 57.1% of cases in 2013 (Figure 4). Adolescents between the ages of 15-19 years were the most affected.

Diagnosis and Treatment

Microscopy remains the primary method of diagnosis. However, RDTs were introduced in 2008 (Figure 5) and are used in remote areas and after work hours for malaria diagnosis in health centers. HRP-2 gene deletion has been reported from *P. falciparum* parasite isolates detected in several neighboring countries such as Brazil(27), Peru(28), and Colombia(29). RDTs based on HRP-2 could probably be of little use, and the country should study the presence of HRP2 gene deletion prevalence and meanwhile ensure use of alternative

Figure 5. Blood slides examined, RDTs examined, and SPR in Ecuador, 2000-2014

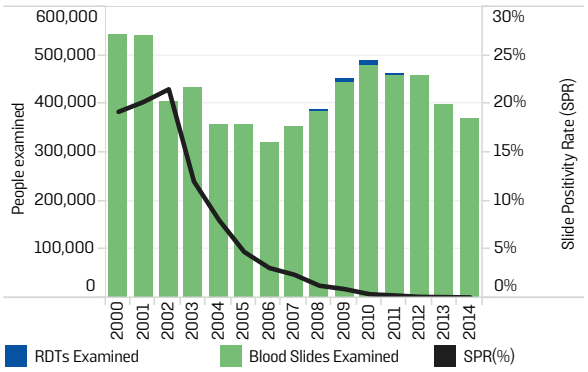


Figure 6. Number of malaria cases and those treated with first-line treatment Ecuador, 2000-2014

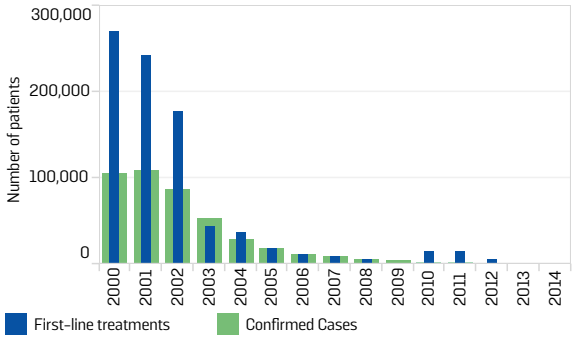
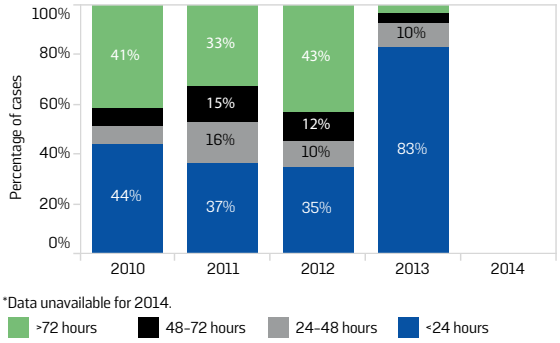


Figure 7. Time between first symptom and initiation of treatment in Ecuador, 2010-2014



RDTs in all places. As of 2013, time between the onset of symptoms and treatment improved significantly (Figure 7); 83.1% of all patients were diagnosed and treated in less than 24 hours of onset of symptoms.

The combination drug artemether-lumefantrine is the first-line of treatment for *P. falciparum*, while chloroquine with primaquine (0.50 mg/kg for 7 days) is the first-line treatment for *P. vivax*. Information about the number of people treated with first-line treatment has not been reported since 2012. However, during 2010-2012 there were more people treated than actual confirmed cases (Figure 6). The number of people treated is estimated based on the actual consumption of drugs, which is usually higher on account of administrative losses and medicines expiring before their use. This is especially the case when malaria transmission becomes very low, as is the case in Ecuador.

Vector Control

Ecuador began distributing conventional ITNs in 2004 and switched to LLINs from 2007 onwards. The last distribution of nets was reportedly in 2012 providing high coverage for a few years, but the amount of people who were protected by LLINs in 2014 may only be about 12,000 people (Figure 8). Indoor residual spraying is another method of vector control used; however, data on the amount of people protected in 2014 are unavailable. Resistance to deltamethrin insecticide (a pyrethroid used in LLINs and for IRS) has been detected in *An. albimanus* in Guayas and Los Rios provinces in 2011.

Funding

Government funding for malaria has decreased since 2010, though the amount for 2014 is not available. These funds do not include funding by the canton and province governments for malaria and funding provided for patient care in government hospitals and clinics. The AMI/RAVREDA initiative provided US$98,000 in 2014 (Figure 9). The Global Fund provided US$980,000; the largest amount they have contributed to Ecuador since 2006.

Figure 8. People protected by IRS and by ITNs in Ecuador, 2000-2014

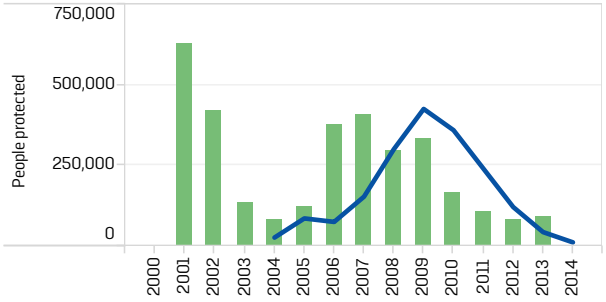
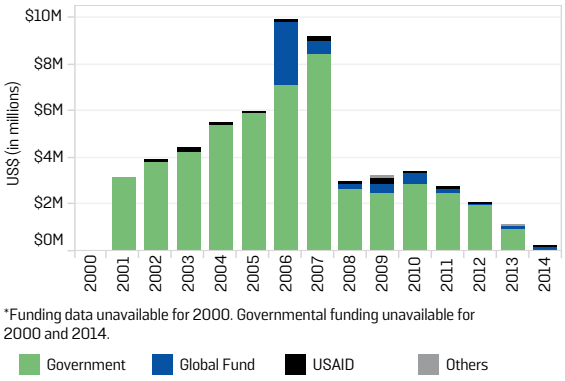


Figure 9. Funding for malaria in Ecuador, 2000-2014



EL SALVADOR

There has been a 98.9% reduction in malaria cases in El Salvador since 2000 and the country has met the WHA 58.2 target for MDG 6C, a feat accomplished by 2002 (Figures 1 and 2). El Salvador is currently in the pre-elimination phase and has reported very few cases of malaria in recent years, many of them imported. In 2014, there were a total of 8 cases and no malaria-related deaths have been reported since 1998.

Figure 2. Number of cases and deaths due to malaria in El Salvador, 2000-2014

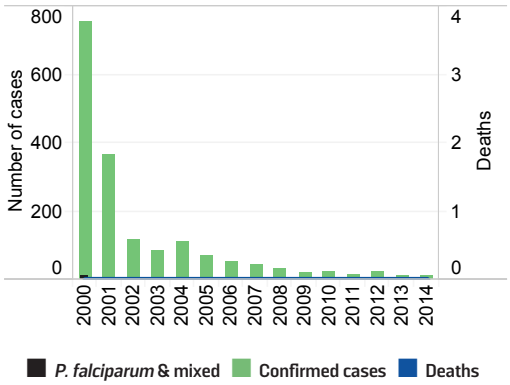
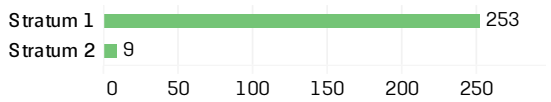


Table 1. Elimination profile of El Salvador, 2012-2014

	2012	2013	2014
Total Cases	21	7	8
Autochthonous Cases	14	6	6
Autochthonous - P.f.	0	0	0
Autochthonous - P.v.	14	6	6
Imported Cases	7	1	2
Imported - P.f.	3	0	0
Imported - P.v.	4	1	2
Active Foci	10	2	2

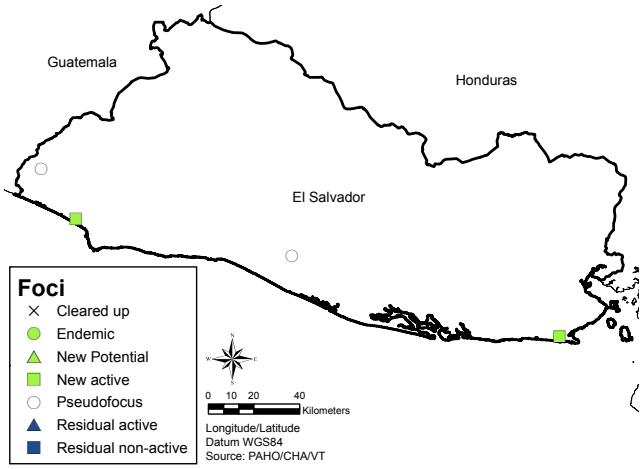
P.f.: ***Plasmodium falciparum***
P.v.: ***Plasmodium vivax***

Figure 3. Number of municipalities (ADM2) by strata in El Salvador, 2012-2014.



*Stratum 1: No autochthonous malaria case in 2012-2014;
Stratum 2: <1 case per 1000 inhabitants in 2012-2014;
Stratum 3: >1 case per 1000 inhabitants in 2012-2014.

Figure 1. Malaria in El Salvador by foci, 2014



In the past few years, all of the reported autochthonous cases have been attributed to *P. vivax* infections and currently only transmission due to that species exists in the country (Table 1). The last reported autochthonous *P. falciparum* case in the country was reported in 1995. Between 2010 and 2014, 1 in every 3 cases has reportedly been imported (total 75 cases). Most imported *P. vivax* cases have come from neighboring Guatemala. Areas along the border, especially Ahuachapan department, are an area of high vulnerability. Many workers return with malaria infections acquired while working in farms and plantations during the harvest season in malaria endemic areas of Guatemala, especially the department of Escuintla. An imported case from Guatemala was detected in Acajutla municipality in the Sonsonate department, leading to an outbreak that further caused 5 autochthonous malaria cases in 2013.

On the other hand, all *P. falciparum* infections during 2010–2014 have reportedly been imported from African countries (n=4), Honduras (n=3), and Haiti (n=1).

In 2014, only four foci were reported, two newly active and another two pseudo foci. The two new active foci were the Metalio locality in Acajulta municipality, Sonsonate department, and '*Llano los platos*' locality in Conchagua municipality in La Union department on the southeastern coast of the country (Figure 1). In the latter, only one autochthonous case was detected, but no other imported or local transmission case could be found neither in the locality nor in surrounding areas to which this autochthonous case could be related. No cases were found in a 2012 prevalence study conducted in school children aged 8-10 years (n=152) from 5 municipalities of Ahuachapan (historically endemic area of the country) using PCR (30).

Anopheles albimanus is the main malaria vector species. Nine municipalities had less than 1 case per 1,000 inhabitants in all years during 2012–2014 (Figure 3). More cases have been reported in men than in women in the last 3 years, particularly in the economically productive age groups (Figure 4).

Diagnosis and Treatment

Microscopy has been the primary method of diagnosis in El Salvador (Figure 5); the country plans to use RDTs especially in points of entry for immigrants like airports, international border crossings and ports. In 2014, all 173 laboratories in the country were reported to have participated in a quality assurance program. However this was lower than the 211 laboratories reported the year prior.

Both *P. falciparum* and *P. vivax* infections are treated with chloroquine and primaquine as a first-line treatment. Presumptive treatment and treatment with chloroprimaquine (a combination of chloroquine and primaquine in a single tablet) were given prior to 2013 after which the treatment scheme changed (Figure 6). Treatment has since been only administered to positive cases, changed from combination pills to use of separate tablets of chloroquine and primaquine, and consequently the duration increased to 14 days of treatment with primaquine instead of 5 days. However implementation was still lacking in 2014 and some cases were treated presumptively at the time of taking a slide.

Figure 5. Blood slides examined and SPR in El Salvador, 2000–2014

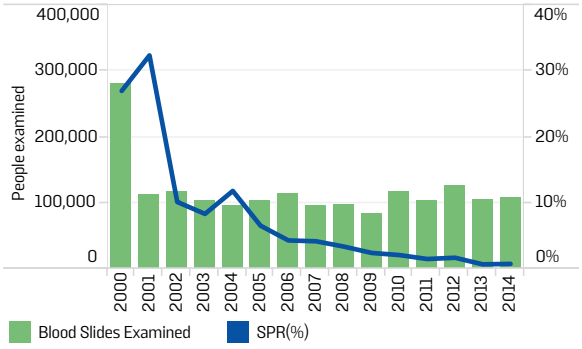
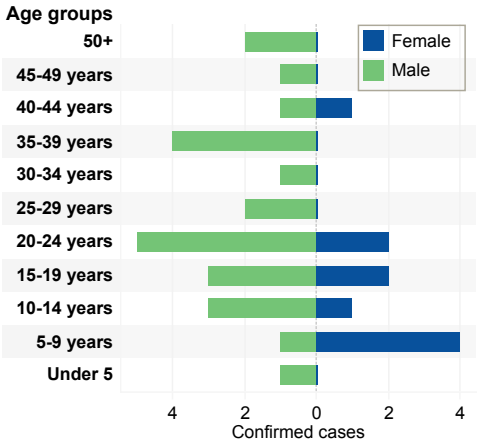


Figure 4. Malaria cases by age and sex in El Salvador, 2012–2014

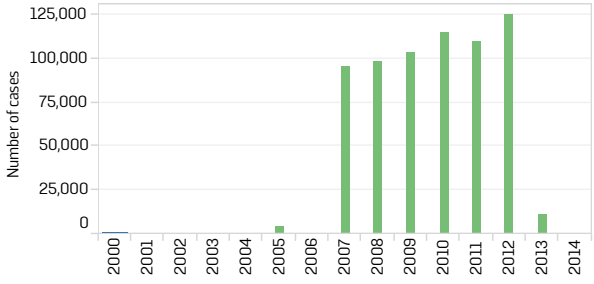


Owing to very few cases, access to diagnosis and treatment has waned within the past year and in 2014 all cases received treatment in more than 72 hours after onset of symptoms (Figure 7). In the previous year, all cases had received treatment in less than 72 hours, with the majority receiving it in 24–48 hours.

Vector Control

Use of IRS has decreased since 2007 and currently protects about 6,400 people (Figure 8). Two to three cycles of IRS are conducted per year in communities/areas that are to be protected with pyrethroid insecticides ensuring protection throughout the year. In 2013, 10,000 ITNs were reported distributed in the country; however, around 5,000 of them were actually distributed in 2014. No insecticide resistance surveillance information is available from the country for *Anopheles*.

Figure 6. Number of malaria cases and those treated with first-line treatment in El Salvador, 2000–2014



*Data for first-line treatment was unavailable for 2000.

First-line treatments Confirmed Cases

Funding

Though autochthonous cases have decreased tremendously, the government continues to provide an estimated average of US$3 million for malaria prevention and elimination (Figure 9). However, this is an estimate as the vector control program is an integrated one and thus contributing to other vector diseases such as dengue, Chagas, and chikungunya. PAHO/WHO has continuously provided technical support and financial resources for specific activities throughout 2000-2014. In 2014, the country also became part of a the Global Fund-financed EMMIE project and start-up funding of US$200,000 was available; however, it could not be used due to administrative difficulties and will be used in subsequent years.

Figure 7. Time between first symptom and initiation of treatment in El Salvador, 2010 - 2014

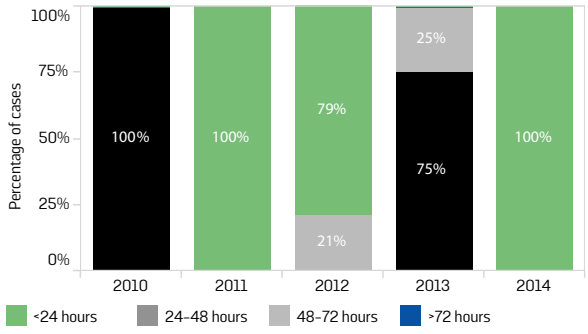


Figure 8. People protected by IRS and by ITNs in El Salvador, 2000-2014

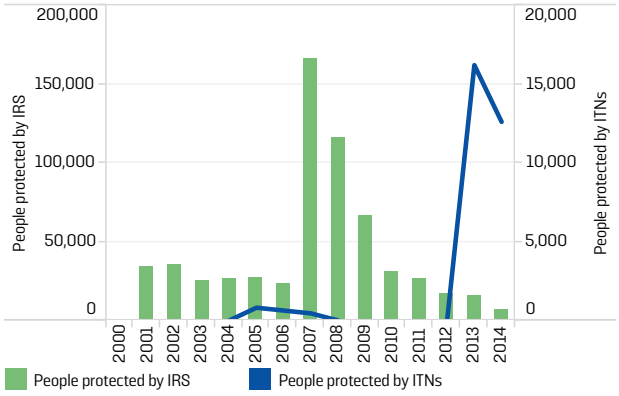
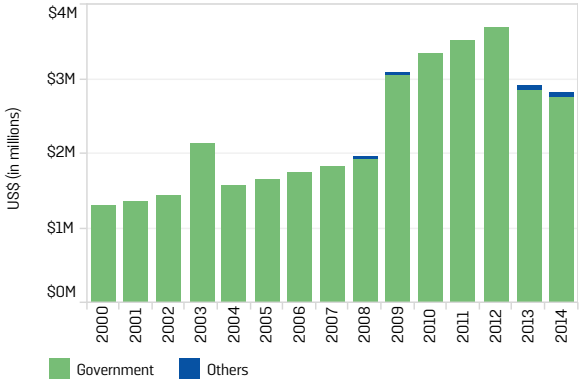


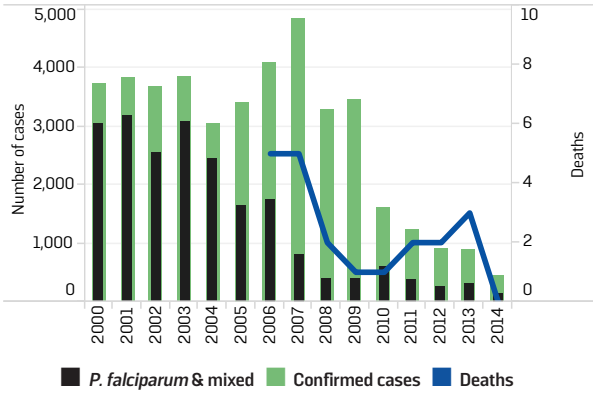
Figure 9. Funding for malaria in El Salvador, 2000-2014



FRENCH GUIANA, FRANCE

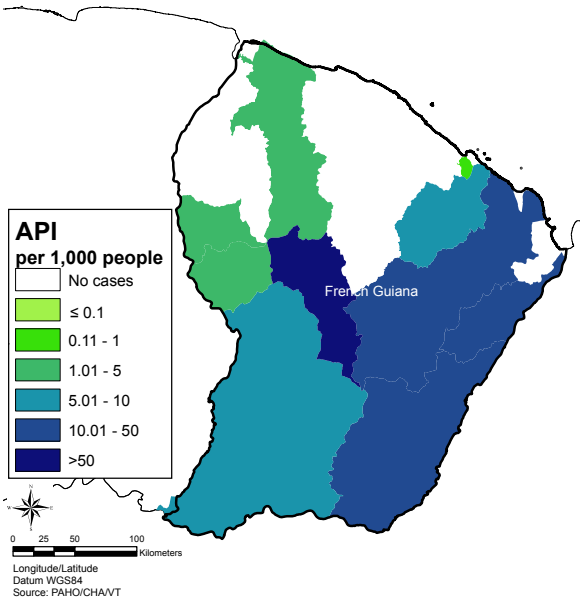
French Guiana is an overseas territory of France and is one of the only few malaria endemic areas under the French government (Figure 1). In 2014, French Guiana reported 448 confirmed cases of malaria and no recorded deaths (Figure 2). These figures are the lowest the territory has reported in decades. Overall, morbidity has decreased by 87.9% since 2000, achieving the WHA 58.2 target for MDG 6C.

Figure 2. Number of cases and deaths due to malaria in French Guiana, 2000-2014



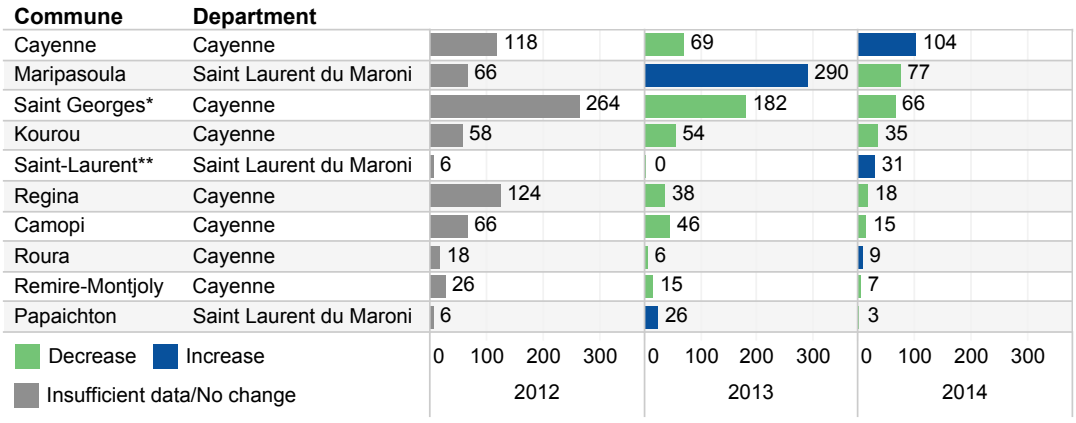
The Guiana Shield is one of the richest mineral deposits in the world and is the site of legal and illegal gold mining. The area extends into parts of French Guiana, Suriname, Guyana, Venezuela, Colombia, and Brazil. Many people migrate to the rainforest in order to participate in mining which is an occupation linked to having a higher risk of malaria (31). A 2013 study conducted in the illegal mining

Figure 1. Malaria by Annual Parasite Index (API) at commune level (ADM2), French Guiana 2014



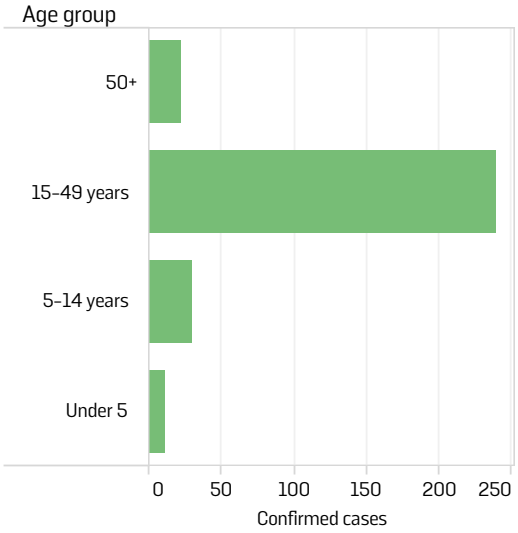
site of Eau Claire located in the Maripasoula commune found a 50% prevalence rate of malaria among miners, of which 40% of cases were asymptomatic (32). Malaria transmission is reported not to occur in the coastal area though many cases are diagnosed there. Although information about malaria cases by locale of infection is not available for all cases, information from the French military posted in the interior of the country indicates that transmission along the Maroni and Oyapock rivers (Figure 3), which form the borders with Suriname and Brazil, respectively, is lesser compared to the central interior part of the country.

Figure 3. Communes with the highest malaria cases by place of diagnosis in French Guiana, 2012-2014



Saint Georges (de l'Oyapock)
***Saint-Laurent (du Maroni)*

Figure 4. Malaria cases by age in French Guiana, 2014



Efforts to reduce malaria incidence in Suriname have benefitted French Guiana particularly during the "Looking for gold, finding malaria" project funded by the Global Fund. There has been a decrease in cases along the border with Suriname because of this project. However, French Guiana must still reinforce these interventions within its borders. Plans to coordinate efforts among countries in the Guiana Shield are forthcoming.

The principal malaria vector is *An. darlingi*. However, the previously mentioned study in Eau Claire found *An. nuneztovari* and *An. ininii* to be naturally infected with *Plasmodium* species in the mining area with the former present in high numbers (32). Another study found *Anopheles (Anopheles) intermedius* Peryassu, *An. (Nyssorhynchus) nuneztovari* Gabaldon, and *An. (Nys.) oswaldoi* Peryassu to be naturally infected with *Plasmodium* species in the country (33). In 2014, 33% of cases were caused by *P. falciparum* and mixed infections. In French Guiana, Pf/PAN RDTs are used especially in the interiors which results in *P. vivax* mono-infections and mixed infections diagnosed as "other positive RDTs" when RDTs are the only used method of malaria diagnosis. Information regarding malaria cases by sex is not reported. Those between the ages of 15–49 are the most affected by malaria (Figure 4).

Priority Groups

Miners in remote areas have difficulty accessing diagnosis and treatment and often obtain it when they cross over to neighboring Suriname or Brazil. In these countries, approximately 1,249 cases were reported to have been imported from French Guiana in 2014, which is almost 3 times that reported. In Suriname interventions to treat illegal miners have been carried out with RDTs used by community health workers who do not pose a threat to illegal miners. Interventions have been successful and as a result Suriname has been able to provide access to diagnosis and treatment to many illegal miners. Under French law, only certified health professionals are allowed to perform RDTs and prescribe treatment, which means interventions like these are not possible (34).

Medication is usually obtained across borders where it is then partially consumed and the rest is sold back in the mining sites in exchange for gold. Monotherapy of artemisinin derivatives is available from illegal pharmacies in mining areas throughout most of the Guiana Shield. Self-medication is common in mining sites, especially illegal ones, and often incomplete; this could possibly lead to development of parasite resistance to artemisinin. Other populations at risk are those that live along the rivers and in forest areas.

Figure 5. Blood slides examined and SPR in French Guiana, 2000–2014

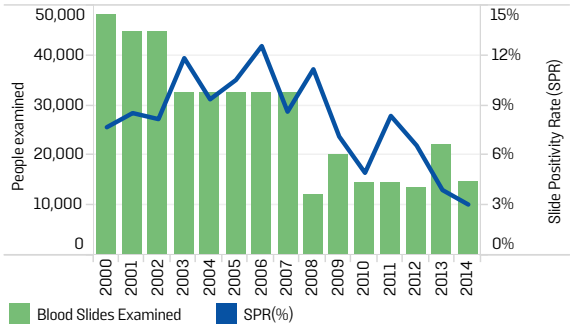
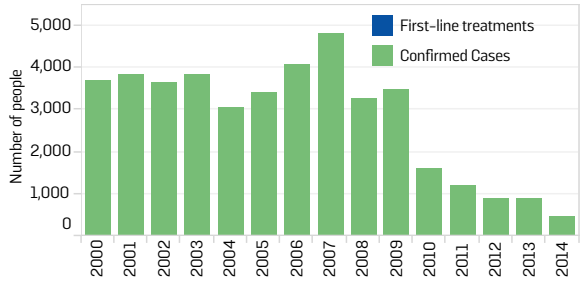


Figure 6. Number of malaria cases and those treated with first-line treatment in French Guiana, 2000–2014

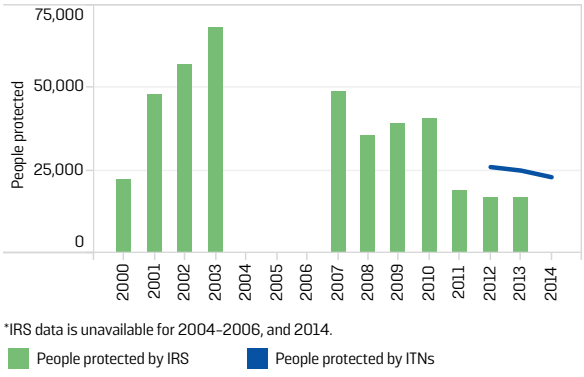


*First-line treatment data is unavailable for 2000–2014.

Diagnosis and Treatment

The SPR was 3.06 in 2014, and a total of 14,651 slides were examined (Figure 5). Artemether and lumefantrine combination is the first line treatment used for *P. falciparum* cases, while chloroquine and primaquine (30 mg/kg for 14 days) are used for *P. vivax*. However, prescription of primaquine requires G6PD screening which is difficult to conduct in remote areas. Single-dose primaquine for *P. falciparum* is restricted as it is not officially approved in the European Union for this purpose (31).

Figure 7. People protected by IRS and by ITNs in French Guiana, 2000-2014



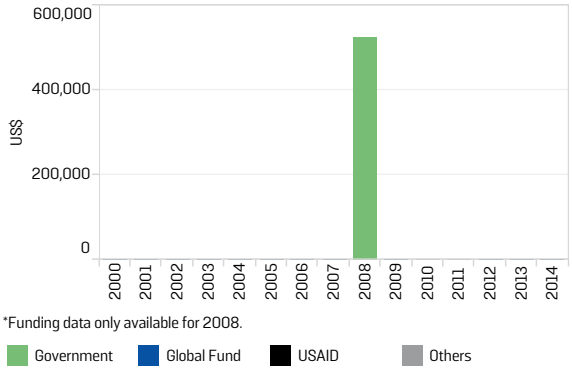
Vector Control

IRS has been used in villages in the past to control vectors, though information for the year 2014 is not available. Since 2012, ITNs have been distributed in the territory and current estimates predict that around 23,000 people would be protected (Figure 7). However, as most people at risk are those involved in illegal mining, the proportion of these that would have been protected by government-funded vector control interventions is minimal.

Funding

Funding data is not regularly reported by French Guiana (Figure 8). Malaria control in the country is exclusively funded by the government.

Figure 8. Funding for malaria in French Guiana, 2000-2014



GUATEMALA

Guatemala achieved the WHA 58.2 target for MDG 6C in 2008, and by 2014 had decreased malaria morbidity by 90.3% compared to 2000 (Figures 1 and 2). There was a reported reduction of 20.7% of cases from 2013. Two malaria-related deaths have been reported in the past 2 years.

Figure 1. Malaria by Annual Parasite Index (API) at muncipality level (ADM2), Guatemala 2014

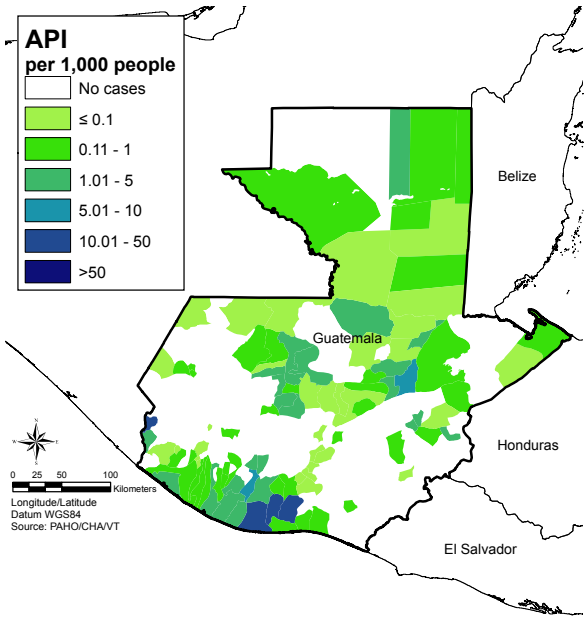
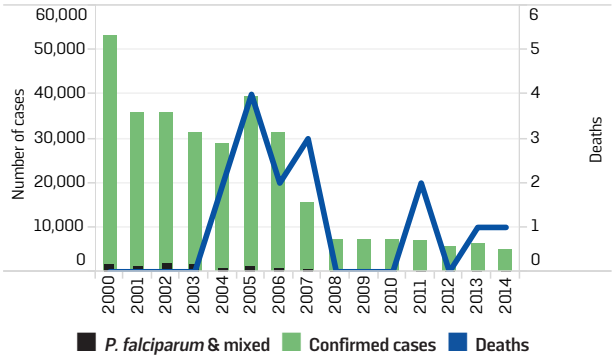
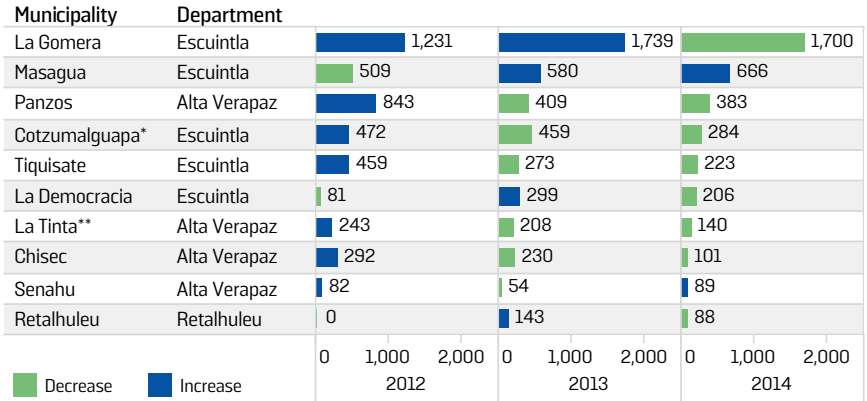


Figure 2. Number of cases and deaths due to malaria in Guatemala, 2000-2014



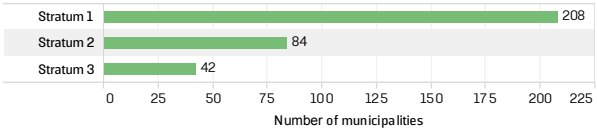
The area along the Pacific coast has the highest incidence of malaria, particularly in the department of Escuintla. Two adjacent municipalities in Escuintla, La Gomera and Masagua, accounted for 48% of all cases in 2014 (Figure 3). The people residing in these municipalities mostly work in agricultural farms and sugar-cane plantations. In 2014, La Gomera was the municipality with the highest amount of cases in the Mesoamerican sub-region. The precarious conditions in which migrant laborers from Guatemala and other Central American countries live in this department during harvest season are ideal for malaria transmission. El Salvador has reported imported cases infected in Escuintla that have led to outbreaks of malaria in that country in recent years.

Figure 3. Municipalities with the highest number of malaria cases in Guatemala, 2012-2014



*Santa Lucia Cotzumalguapa
**Santa Catalina La Tinta

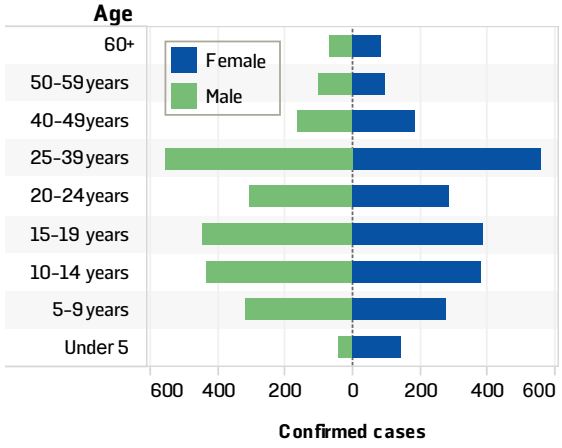
Figure 4. Number of municipalities (ADM2) by strata in Guatemala, 2012-2014



*Stratum 1: No autochthonous malaria case in 2012-2014;
Stratum 2: < 1 case per 1000 inhabitants in 2012-2014;
Stratum 3: > 1 case per 1000 inhabitants in 2012-2014.

The northern department of El Peten previously was highly endemic for malaria at the beginning of the millennium, but in 2014 only reported 2.3% (n=100) of all cases in the country. El Peten department is comprised of three health areas: Peten south-east (sur oriental), Peten north (norte), and Peten south-west (suroccidental). In 2014, the Peten south-east health area (encompassing 5 municipalities of the El Peten department) reported only one case originating within this health area, while the rest were all infected in other parts of the country. Alta Verapaz is a department with high poverty rates and a large community of the Q'eqchi' indigenous people, which reports many malaria cases. Guatemala has a constant migration of agricultural workers moving into and out of malaria endemic areas, which increases the rate of malaria importation into non-endemic areas. The quality of surveillance information is not adequate and does not cover all public and private health units. Thus, actual number of cases could be higher than reported.

Figure 5. Malaria cases by age and sex in Guatemala, 2014



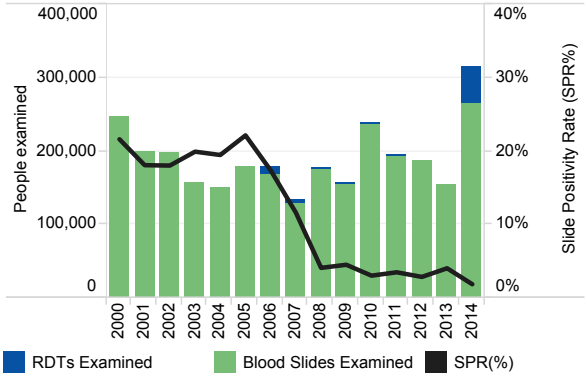
Anopheles albimanus, *An. pseudopunctipennis*, and *An. darlingi* are the principal malaria vectors in the country. Most malaria cases are due to *Plasmodium vivax*, though *P. falciparum* is present in the country, especially in Escuintla department. Although there have been cases of *P. malariae* diagnosed in the country in the past (48 cases in 2005), none have been officially reported highlighting the gaps in the surveillance system.

The most affected age group was that of 25-39 years old (Figure 5). This suggests that malaria is related to occupation and that perhaps those who spend more time outdoors are at a higher risk of malaria. Transmission is high during the dry season occurring from January to March.

Diagnosis and Treatment

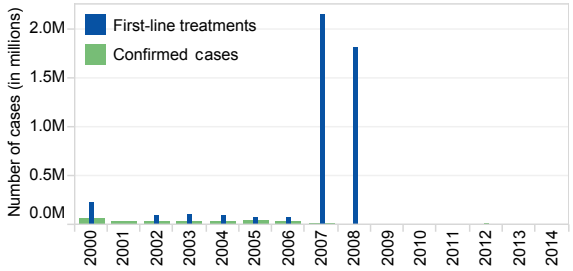
The number of blood slides and RDTs examined increased in 2014 (Figure 6). Though a record number of RDTs were used to detect disease in 2014, microscopy remains the principal method of diagnosis. RDTs were used in endemic areas to detect more cases, especially in rural areas. The SPR has continued to decrease in recent years (consistent with case reporting) and was 1.87% in 2014.

Figure 6. Blood slides examined, RDTs examined, and SPR in Guatemala, 2000-2014



Chloroquine and primaquine are used as a first-line treatment for both *P. falciparum* (3-day treatment) and *P. vivax* infections (14-day treatment). It is reported that in 2007 and 2008 nearly 2 million people received first-line treatment for malaria in each year (Figure 7). Recently, stock-outs of antimalarials has been reported by the country. The availability of antimalarials is of utmost importance for elimination of the disease.

Figure 7. Number of malaria cases and those treated with first-line treatment in Guatemala, 2000-2014

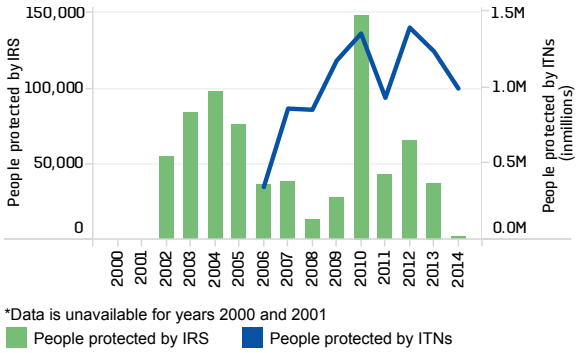


* First-line treatment data is unavailable for 2001, 2009, 2010, 2013, 2014.

Vector Control

Use of ITNs decreased from 2013, yet still protected nearly 1 million people (Figure 8). Protection by IRS decreased substantially in 2014 due to scarce resources. Instead the focus was on cleaning breeding sites and using ITNs. Intervention campaigns engage community members and train them on vector control methods.

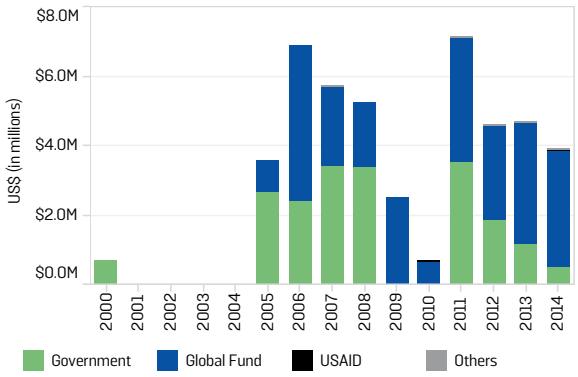
Figure 8. People protected by IRS and by ITNs in Guatemala, 2000-2014



Funding

The government provides funding for the malaria budget (Figure 9). Information about governmental funding was unavailable for 2001-2004 and 2009-2010. The majority of funding from external sources is provided by the Global Fund. USAID has also contributed via the AMI/RAVREDA project. The EMMIE initiative began in 2014 and has provided additional resources. CHAI has also provided support as a technical partner in 2014. The private sector agricultural companies implement social responsibility policies as company employees and surrounding communities are directly affected by malaria.

Figure 9. Funding for malaria in Guatemala, 2000-2014



***Data unavailable for 2001-2004.**

GUYANA

Most cases occur in the interior of the country in the Amazon rainforest area, with rates being particularly high in the areas bordering the Venezuelan and Brazilian border (Figure 1). In 2014, Guyana reported 12,353 cases of malaria and 11 deaths (Figure 2). Morbidity has decreased by 48.6% from 2000 and mortality decreased by 62.1%. Despite these achievements, the WHA 58.2 target for MDG 6C has yet to be achieved.

Figure 2. Number of cases and deaths due to malaria in Guyana, 2000-2014

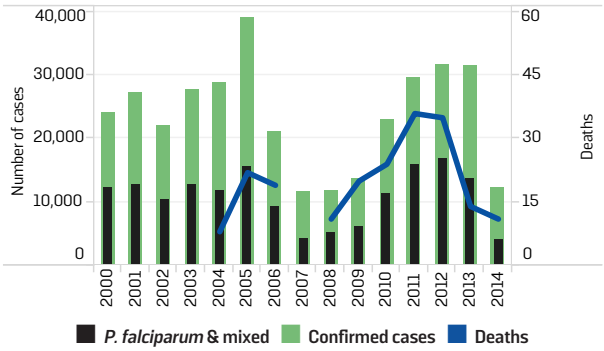
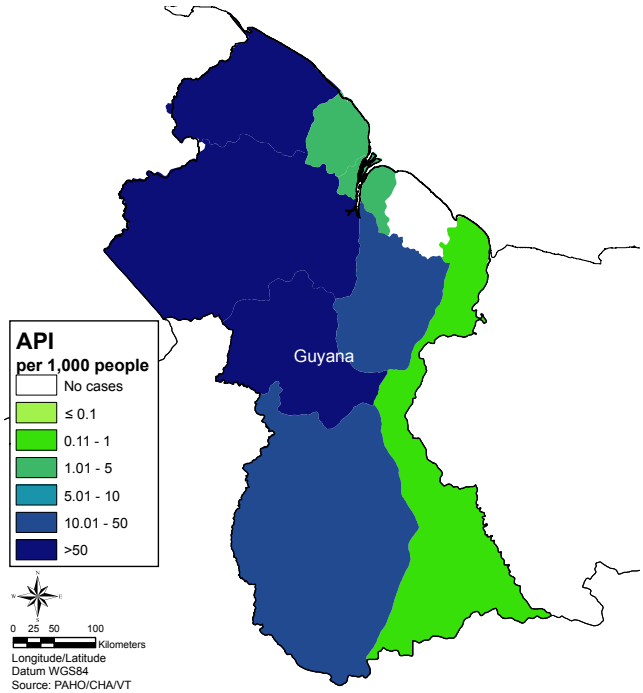


Figure 1. Malaria by Annual Parasite Index (API) at region level (ADM1), Guyana 2014



Similar to other parts of the Guiana Shield, malaria has been highly prevalent in gold miners who are often working in unregistered mines or are from foreign countries. These miners often have limited access to health care due to remoteness of the places they work in. Between 2013 and 2014 Guyana had a 60.8% decrease of confirmed cases which may be attributable to the decrease in gold prices and subsequent decrease in the number of miners in the country. The API rates in the interior areas are also artificially high; the population at risk is higher than the reported people living in a city or area as it is difficult to estimate the exact population of miners in that area. Another factor to take into consideration is the noted underreporting of cases. In 2013, only 61% of expected reports from public health institutions were received, which decreased to 57.8% in 2014.

An. darlingi is the primary malaria vector found in Guyana. In 2014, *P. vivax* caused 58.1% of all cases, though *P. falciparum* also causes a significant amount of cases every year. *P. malariae* is also present in the country, though it accounted for <1% of all cases since 2008.

Figure 3. Districts with the highest number of malaria cases in Guyana, 2012-2014

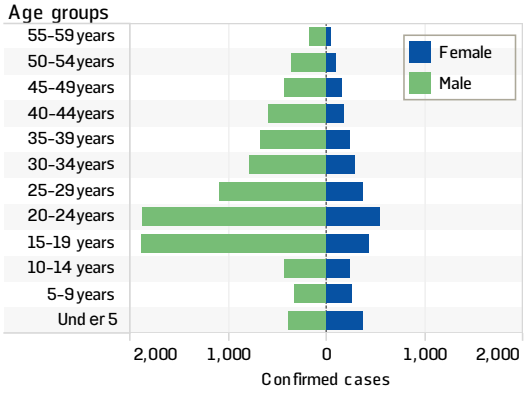
District	Region	2012	2013	2014
Barima/Amakura	Region 1	4,188	6,412	3,582
Mazaruni/Left Bank Essequibo R.	Region 7	6,996	5,063	1,756
Cuyuni	Region 7	4,767	3,659	1,613
Lower Potaro/Ladysmith Creek	Region 8	7,265	5,592	1,312
Waini	Region 1	1,885	2,558	805
Rewa/Upper Essequibo*	Region 9	17	20	668
Right Bank Essequibo**	Region 10	1,431	1,648	601
Ireng/Upper Potaro	Region 8	1,031	1,277	540
Bonasika/Boerasirie	Region 3	29	9	140
Somerset and Berks/Supenaam R.	Region 2	17	11	118

Decrease Increase

0 8,000 0 8,000 0 8,000

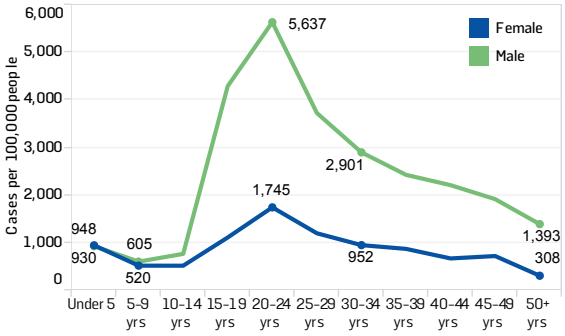
*Rewa (Illiwa)/Upper Essequibo (Rupununi East)
**Right Bank Essequibo/Upper Demerara

Figure 4. Malaria cases by age and sex in Guyana, 2014



Generally, men are more affected than women, especially in the early adult years between the ages of 15-24 (Figures 4 and 5). In 2014, approximately 68% of malaria cases occurred in men, which resulted in a malaria incidence of 2,324 cases per 100,000 people. Comparatively, women had a much lower malaria incidence of 813 cases per 100,000 people. As mentioned previously, occupational activity is a risk factor for men.

Figure 5. Malaria incidence by age and sex in Guyana, 2014



Priority Groups

Indigenous and ethnic groups, also known as Amerindians in Guyana, have a high risk of malaria in Guyana. More than 4,500 cases were reported among Amerindians in 2014, accounting for 37% of total cases. The incidence of Amerindians (6,052 cases per 100,000 people) is 5-fold higher than the rest of the population (1,152 cases per 100,000 people). The highlands in the interior of the country are where the indigenous populations abound. Malaria is prevalent here albeit at a lower rate than that in mining areas. The prime reason for continued malaria transmission among them has been limited access to healthcare and unprotected housing.

Figure 6. Blood slides examined and SPR in Guyana, 2000-2014

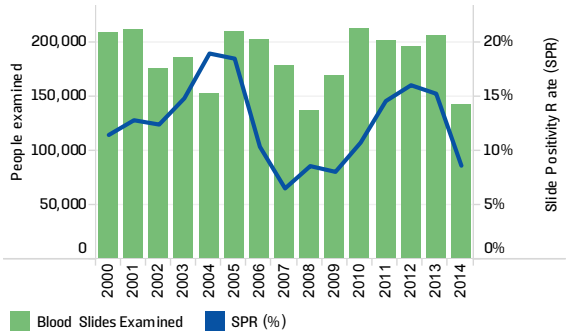
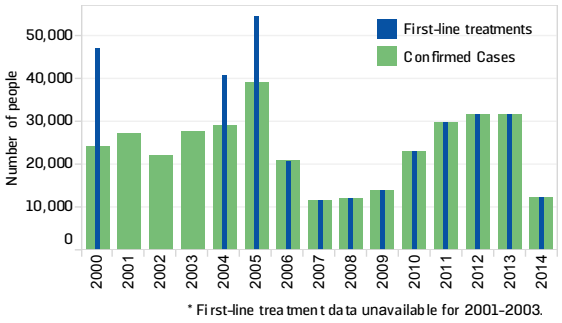


Figure 7. Number of malaria cases and those treated with first-line treatment in Guyana, 2000-2014



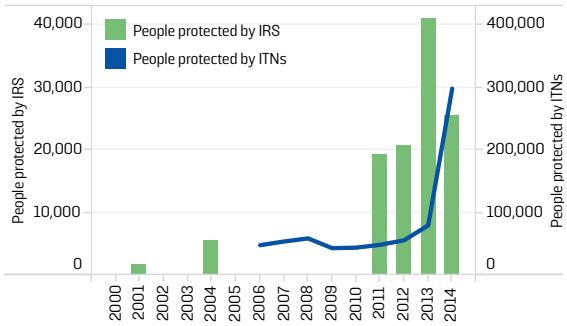
Malaria in pregnancy rates are the highest in the Americas and have consistently been higher than that in non-pregnant women of child-bearing age. In 2014, the incidence rate (1,321 cases per 100,000 pregnant women) decreased from that of 2013 (2,756 cases per 100,000 pregnant women).

Diagnosis and Treatment

Microscopy is the primary method used to determine malaria infection (Figure 6). The SPR decreased in 2014, however, as have the overall number of cases. The number of people examined for malaria through active surveillance has decreased from around 59% of all slides examined per year in 2007 to 26% in 2014; however, this has been primarily due to the increase the number of people being examined through passive case surveillance (73,000 to 105,000). The proportion of confirmed cases being detected through active surveillance in 2014 (5.7%) has remained similar to that in 2013 (5.6%)

Though all confirmed cases were reported to have received first-line treatment (Figure 7), self-treatment is common in Guyana and may be a contributing factor

Figure 8. People protected by IRS and by ITNs in Guyana, 2000-2014



***IRS data unavailable for 2000, 2002, 2003, 2005-2010. ITN data unavailable 2000-2005.**

to artemisinin resistance. Current studies are underway to research possible K13 gene mutations in Guyana, French Guiana, and Suriname. Unpublished data have indicated that there is no reduction in artemisinin sensitivity in Guyana. At this time, first-line treatment for *P. falciparum* remains the artemisinin combination treatment of artemeter-lumefantrine. Chloroquine with primaquine is used as the first-line of treatment for *P. vivax* infections.

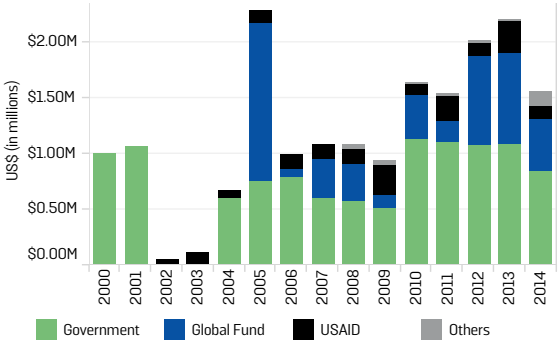
Vector Control

Indoor residual spray and ITNs are both utilized methods of vector control. Approximately 300,000 people were protected by ITNs in 2014, which is the highest estimate to date (Figure 8). IRS use is also high, though the amount of people protected decreased from 2013 to 2014. Use of IRS in mining sites remains a challenge as houses and living areas have no walls. Insecticide susceptibility studies have not been reported.

Funding

Government funds are the biggest source of malaria resources and amounted to about US$850,000 in 2014 (Figure 9). The Global Fund has provided support since 2005 and, along with Suriname, Guyana is one of only a few countries in the Guiana Shield to be eligible for Global Fund resources. The AMI/RAVREDA project funded by USAID has also supported the country particularly in surveillance network for antimalarial resistance initiatives. This project has continually provided funding since its establishment in 2002.

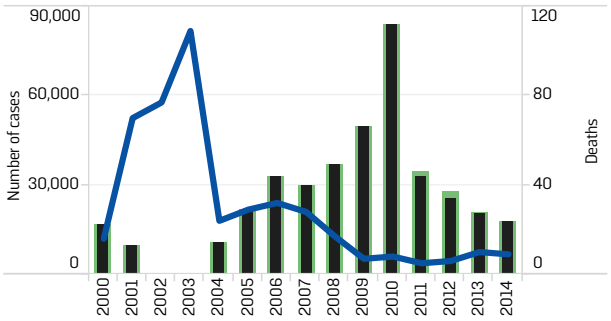
Figure 9. Funding for malaria in Guyana, 2000-2014



HAITI

Haiti has the highest number of malaria cases among the Caribbean Islands and Central American countries (17,696 in 2014). Inadequate coverage of surveillance in previous years preempts assessing progress of the country towards meeting its RBM and WHA 58.2 goals for MDG 6C (Figures 1 and 2).

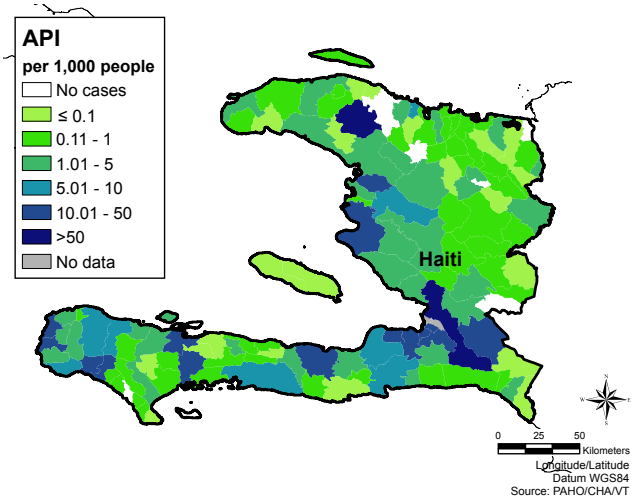
Figure 2. Number of cases and deaths due to malaria in Haiti, 2000-2014



*Confirmed cases were not reported during 2002-2003.

P. falciparum & mixed Confirmed cases Deaths

Figure 1. Malaria by Annual Parasite Index (API) at commune level (ADM3), Haiti 2014



After the 2010 earthquake, malaria increased dramatically, though it is difficult to assess the validity of data collected during this period. Data collected from years prior to the earthquake were of poor quality, and that from 2010 may include people tested more than once due to the chaotic atmosphere following the disaster. There were 9 malaria-related deaths reported in 2014, though considerable under-reporting is presumed. A death registry has not been available in the country since 2004, when there were reported 24 deaths or 0.5% of all deaths reported and classified that year. In neighboring Dominican Republic with similar epidemiology, better surveillance, and quality of health-care, case fatality rates of 8 deaths per 1,000 malaria cases were reported, much higher than that estimated in Haiti (0.5 deaths per 1,000 malaria cases).

Recently, there has been a country-wide effort of improving testing with the roll-out of RDTs, moving away from giving treatment to patients presumptively, and increased focus on receiving complete reports from all health centers as part of the Test-Treat-Track (T3) strategy. In 2014, 94.5% of the 273,707 suspected

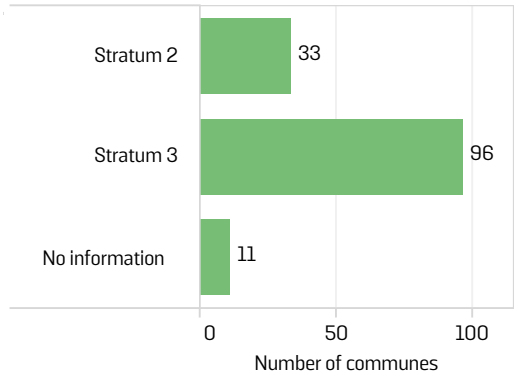
Figure 3. Communes (ADM3) with the highest malaria cases in Haiti, 2012-2014

Commune	Department	2012	2013	2014
Croix Des Bouquets	Ouest	3,076	1,842	1,989
Delmas	Ouest	2,284	1,919	1,822
Petit Goave	Ouest	1,510	1,336	1,164
Carrefour	Ouest	1,025	1,059	1,036
Port au Prince	Ouest	1,342	856	767
Dame Marie	Grand-Anse	71	160	642
Cabaret	Ouest	182	205	516
Ganthier	Ouest	1,041	753	502
Gros Morne	Artibonite	112	72	490
Jeremie	Grand-Anse	557	587	465
Petion Ville	Ouest	626	326	404
Port De Paix	Nord-Ouest	2,931	1,123	395
Leogane	Ouest	321	67	370
Gressier	Ouest	117	548	359
Anse d'Hainault	Grand-Anse	84	33	334

Decrease
Increase

0 3,000 (2012) 0 3,000 (2013) 0 3,000 (2014)

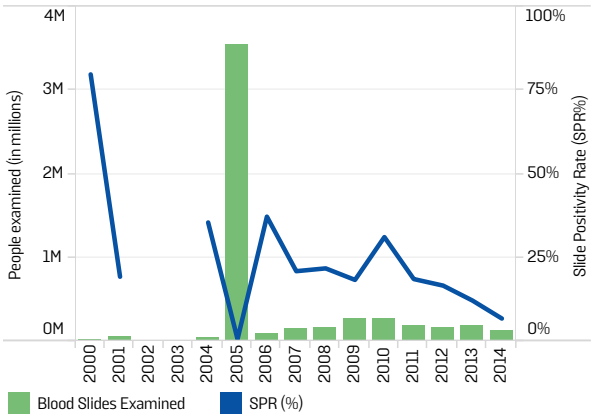
Figure 4. Number of communes (ADM3) by strata in Haiti, 2012-2014



*Stratum 1: No autochthonous malaria case during 2012-2014;
Stratum 2: <1 case per 1000 inhabitants during 2012-2014;
Stratum 3: >1 case per 1000 inhabitants in more than 1 year during 2012-2014

malaria cases were tested with microscopy or RDT, increasing from 72.4% and 68.9% in 2013 and 2012, respectively (Figure 6). Only 11.9% of suspected cases were treated presumptively decreasing from 41.8% and 36.3% in 2012 and 2013, respectively (Figure 5). Furthermore, the proportion of health units reporting monthly to the national malaria program increased to 83% in 2014 from 60% in 2013 and 67% in 2012. This implies that data reported by Haiti have become more reliable and trends can be aptly measured in subsequent years.

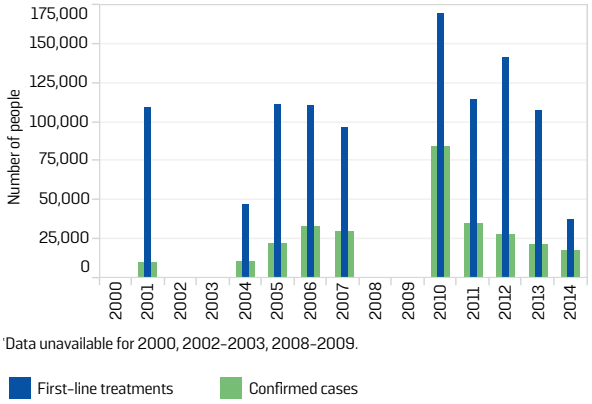
Figure 6. Blood slides examined and SPR in Haiti, 2000-2014



*Data unavailable for 2002-2003.

Owing to this improvement in surveillance, it becomes more reasonable to believe that the Marmelade commune in Artibonite department had zero (0) cases in 2014. All of the 466 suspected cases in 2014 were tested, 54% with RDTs, and none were confirmed positive with reports having been received for all 12 months. However, the Artibonite department itself received only 85% of monthly reports from its health centers in 2014 for a total of 2,001 confirmed malaria cases reported. Studies conducted in the department have reported prevalence of malaria parasite in rural areas of 3.1% and 3% in women of child-bearing age (35,36).

Figure 5. Number of malaria cases and those treated with first-line treatment in Haiti, 2000-2014



*Data unavailable for 2000, 2002-2003, 2008-2009.

Although the department of Ouest contains the communes with the highest malaria cases in the country and accounts for 53% of all cases (Figure 3), prevalence in the department in subsequent surveys has been reportedly low (0.3-3%) (35). This could be because the department contains about one-third of the population of the country. The national capital is located in the department, with migration from other departments leading to a sizable amount of malaria cases diagnosed and possibly imported from other departments. Nonetheless, only 68% of monthly reports expected were received from its health centers in 2014. Port-de-Paix commune in Nord-Ouest department has reported a notable decrease (86.5%) in confirmed malaria cases since 2012: from around 3,000 (2012) to 400 (2014) with around 9,000 suspected cases each year of which 88%, 84%, and 95% were tested in 2012, 2013, and 2014 respectively. In 2014, 39% were tested using RDTs and completeness of reporting was adequate: 89% (2012), 94% (2013), and 94% (2014).

Along the Dominican Republic border, the communes Ouanaminthe in Nord-Est and Ganthier in Ouest report many cases. Good quality passive surveillance along with active case detection conducted as part of the Haiti-Dominican Republic binational project has led to a relatively accurate estimation of malaria burden in Ouanaminthe. However, active case detection is not conducted in other parts of the country.

Grand Anse has a reportedly high transmission of malaria – six deaths due to malaria were reported in the department in 2014. Yet parasite prevalence surveys conducted in the department show that the transmission intensity varies between localities. This is also the case in other parts of the country: in Sud–est department the prevalence by quality-assured microscopy varied between 0–34.5% (37). Thus, country-wide parasite prevalence surveys are of limited use and efforts should be directed at improving surveillance and reporting of individual malaria cases.

Malaria cases are currently reported and mapped by the health center where they were diagnosed, which may not represent an accurate picture. In one study conducted in Corail commune in Grand Anse, it was found that 85% of patients diagnosed in the hospital were from the same commune (38). This may also be the case in some other communes. Nonetheless, an effort to build a case-based surveillance system with cases mapped to origin of infection is advisable. Although a case notification form was designed and approved by the National Malaria Program, it is still to be implemented across the country.

A weekly integrated disease surveillance program (IDSP) is slowly but steadily being implemented across the country by the epidemiology department- 182 of over 900 health centers were included at the end of 2014 in IDSP (39). It will support the case-based surveillance in prompt identification of outbreaks.

As cases are not investigated, malaria cases reported are considered to have been transmitted locally. Based on the stratification methodology used in the country's current strategic plan, 7 communes in Haiti reported having insufficient data in the last 3 years (2012-2014). A total of 96 communes had more than 1 case per 1,000 inhabitants in one or more of the last 3 years (stratum 3) (Figure 4), while another 33 had less than 1 case per 1,000 inhabitants in all 3 years (stratum 2). No commune has reported data with sufficient quality to be included in stratum 1 (3 years without a single locally transmitted malaria case).

Almost all malaria cases in Haiti are caused by *P. falciparum*, although there have been reports of *P. malariae* cases having been imported from the island (40). No *P. vivax* case has been reported since 2008, although cases in the Dominican Republic were identified. Inadequate surveillance and inadequate quality of diagnosis are considered as reasons for this discrepancy in Haiti.

Anopheles albimanus is the main malaria vector in the country as well as the entire Hispaniola Island. However, entomological surveillance is not routinely conducted in Haiti. The vector is considered to be largely zoophilic, exophagic, and exophilic; however, this varies widely. In human landing catches conducted in 2013 in Dajabon province of Dominican Republic, which borders the Ouanaminthe commune of Haiti, 49.6% of *An. albimanus* bit indoors with a peak biting rate of 14 bites per person-hour between 11p.m. –12a.m. indoors. *An. pseudopunctipennis* has been found in the south of the country, but has not been implicated in malaria transmission due to paucity of data. *An. vestitipennis* and *An. grabhamii* have also been found to bite humans in Dajabon province and could be present in adjoining areas of Haiti.

Priority Groups

Gender and age data were not available with the exception of cases in children under the age of 5 in 2014. Children <5 years had 22.4% of all malaria infections in Haiti, although they were found to have 11% of all malaria infections in Corail commune of Grand Anse department during 2012–2013 (38). However, at the national level, the incidence of malaria in 2012 in children under 5 years was almost twice (403 cases per 100,000 children) that of any other age group.

Reported incidences in pregnant women decreased from an estimated 307 to 166 malaria cases per 100,000 pregnant women between 2011 and 2014. In 2012, the incidence rate in pregnant women (292 cases per 100,000 pregnant women) was significantly higher than that in women of child-bearing age (195 cases per 100,000 15-49 year old women). The high incidence in children under 5 years of age and in pregnant women could indicate that a significant proportion of malaria is being transmitted inside the house and interventions targeted at household risk factors like long-lasting insecticide-treated bed nets (LLINs) and indoor residual spraying (IRS) would be a useful asset in reducing malaria transmission in areas of high and moderate transmission.

The paucity of case-based surveillance impedes the identification of other high-risk groups in the country.

Diagnosis and Treatment

Microscopy is the main method of diagnosis, though use of RDTs has increased in the past 3 years: from 46 patients examined with RDTs in 2012 to around 124,000 patients examined in 2014 (Figure 6). This has led to a veritable increase in the number of suspected patients being tested

before treatment in all 10 departments, of the country. Especially in the Center, Nord, and Nord-est departments, over 90% of the health centers had more people tested than treated presumptively in 2014, increasing from <50% in previous years. Yet more than 25% of health centers in Artibonite and Ouest departments and over 20% in Nippes and Grand Anse treated more patients than they tested.

Chloroquine is used as the first-line treatment for *P. falciparum* infections. Some studies have suggested that resistant strains may be present in Haiti and surveillance of anti-malarial efficacy is necessary (41). A recently published drug efficacy trial conducted by Okech et al. found that chloroquine continues to be efficacious for treatment of *P. falciparum* (5).

Additionally, primaquine as a 1-day dose equivalent to 0.75 mg/kg of body weight has been recently included for treatment of *P. falciparum* infections in 2012. Severe and moderate glucose-6-phosphate dehydrogenase (G6PD) deficiency was reported to be present in 22.8% of study participants in Ouest and Sud-est departments of the country and 10.6% were considered to be at risk of developing severe adverse reactions (drug-induced hemolysis) due to primaquine (42). Use of a single dose of 0.25 mg/kg of body weight has been recommended by WHO to be safe for use in all patients irrespective of the G6PD deficiency status. Nonetheless, no adverse event reporting and monitoring program exists in the country and in its absence may be appropriate to consider reducing the dosage. It is imperative that health centers be trained in identifying and managing adverse events that may arise as a consequence of anti-malarial treatment.

Vector Control

Haiti has not used IRS for vector control in recent years and instead focuses on the use of LLINs since 2007 (Figure 7). A study conducted in 2011 found that only 6.4% of all households surveyed had at least one LLIN, while only 0.002% of households had 3 LLINs – the latter may be considered adequate to protect everyone in the family (average family size is considered to be 5.5 in Haiti) (43). Besides decreasing individual risk of malaria, high LLIN coverage both at the household level and at the locality/community level is recommended to have an adequate population effect. Despite the low coverage with LLINs, around 16% of children <5 years old and 11.8% of pregnant women were using bed nets. In 2012, around 3 million bed nets were distributed as part of the Global Fund project. It is estimated that more than 2.6 million Haitians currently possess an LLIN (Figure 7). A country-wide study conducted in 2013 demonstrated that the primary malaria vector remains susceptible to pyrethroids, the insecticide used in LLINs.

Haiti uses chemical and biological larvicides for treating breeding spots of *An. albimanus* to reduce mosquito density. It also uses fumigation with malathion insecticide in peri-domicillary settings, especially when there are malaria outbreaks or malaria cases increase. An investigation for testing the efficacy of these measures has been included in the new Global Fund project to commence from 2016.

Funding

The majority of the funding for malaria has come from external sources (Figure 8). Projects financed by the Global Fund have provided the majority of funds for malaria in the past decade. USAID provides resources through the Umbrella Grant Agreement with PAHO/WHO for reinforcement of malaria efforts in the country. CDC and CHAI are other agencies that have provided technical support to the country. New initiatives have been launched recently that will provide more resources for the country: around 30 million dollars (over 5 years) will be provided by the Malaria Zero project funded by the Bill and Melinda Gates Foundation. EMMIE, a Global Fund-financed multi-country project aimed at elimination, also provides technical support and might provide more financial resources in the future. In the past, the Carter Center has provided resources to improve surveillance along the border of Haiti and the Dominican Republic, especially in the Ouanaminthe - Dajabon area. The country aims to eliminate malaria by the year 2020 and the aforementioned agencies and projects are supporting this goal.

Figure 7. People protected by IRS and by ITNs in Haiti, 2000-2014

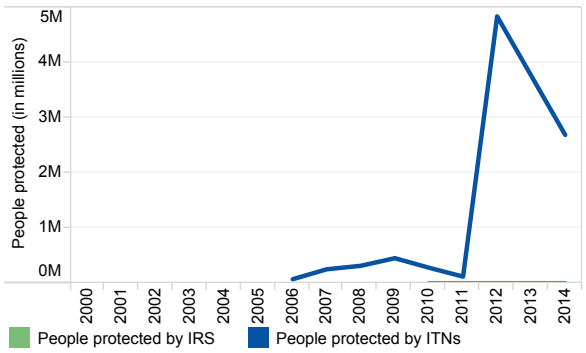
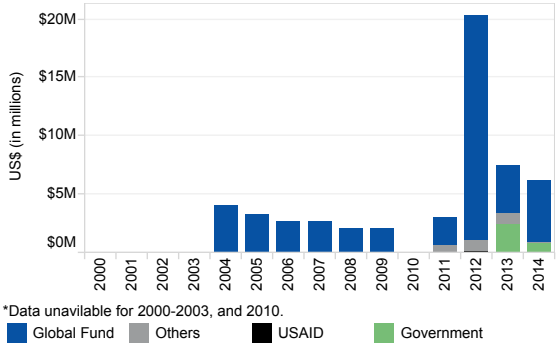


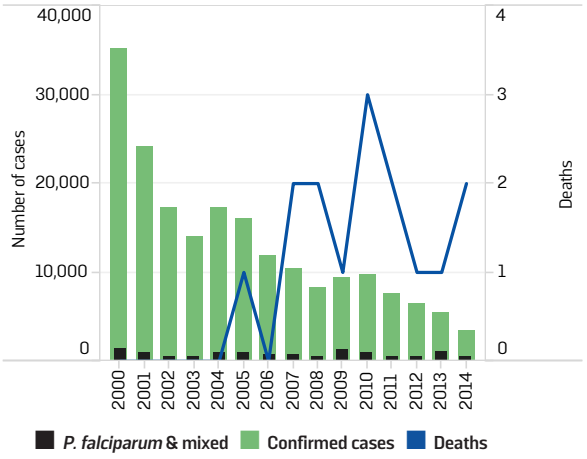
Figure 8. Funding for malaria in Haiti, 2000-2014



HONDURAS

Since 2010, malaria in Honduras has continuously declined after having increased in previous years. Honduras successfully accomplished the WHA58.2 target for MCG 6C, and in 2014, achieved a 90% decrease in morbidity compared to 2000 (Figures 1 and 2). A reduction of 37.7% of cases was reported in 2014 from the previous year. About 31 municipalities had more than 1 case per 1,000 inhabitants in one or more years (stratum 3), while 90 municipalities had less than 1 case per 1,000 inhabitants in all 3 years during 2012-2014 (stratum 2) (Figure 3).

Figure 2. Number of cases and deaths due to malaria in Honduras, 2000-2014



The northeastern rainforest area of La Moskitia lies along the Atlantic coast and has the highest incidence of malaria in the country as well as the Mesoamerican sub-region. Combined, the departments of Gracias a Dios and Colón reported 69.1% of all cases in the country in 2014. The municipality of Puerto Lempira in Gracias a Dios had the highest number of cases in Honduras (Figure 4).

Figure 1. Malaria by Annual Parasite Index (API) at municipality level (ADM2), Honduras 2014

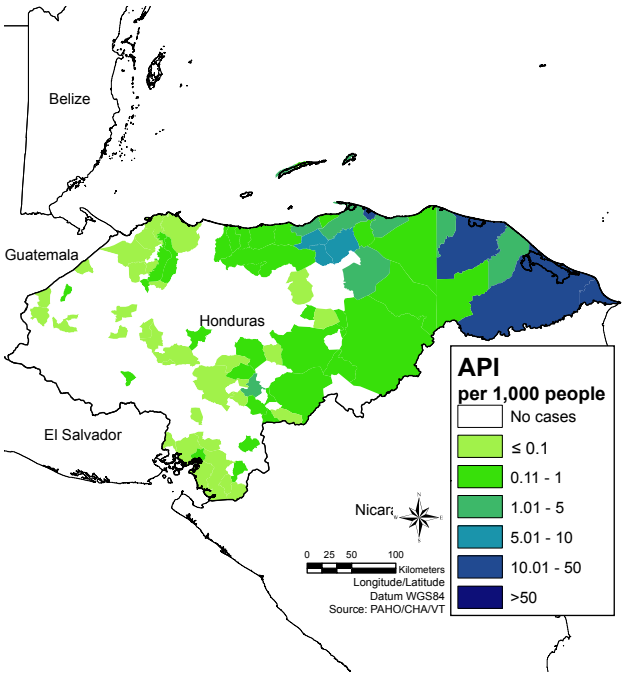
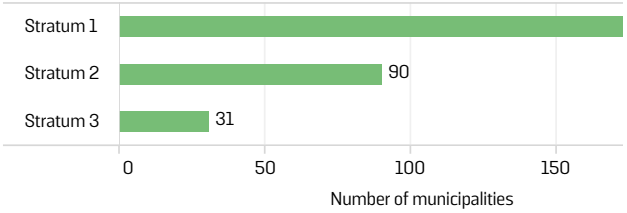


Figure 3. Number of municipalities (ADM2) by strata in Honduras, 2012-2014.



*Stratum 1: No autochthonous malaria case in 2012-2014;
Stratum 2: <1 case per 1000 inhabitants in 2012-2014;
Stratum 3: >1 case per 1000 inhabitants in 2012-2014.

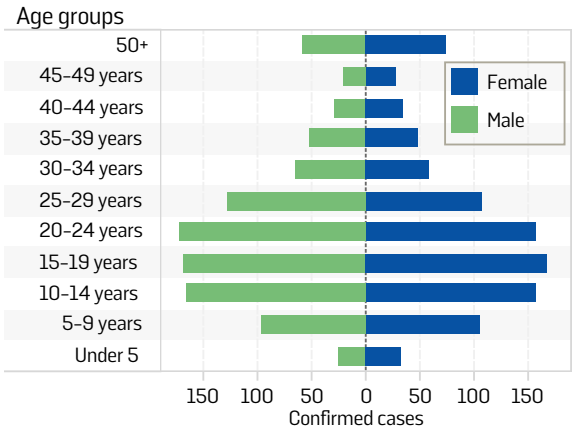
Figure 4. Municipalities with the highest number of malaria cases in Honduras, 2012-2014

Municipality	Department	2012	2013	2014
Puerto Lempira	Gracias A Dios	870	1,769	742
Tocoa	Colon	513	332	460
Trujillo	Colon	1,376	466	290
Villeda Morales	Gracias A Dios	274	390	238
Sonaguera	Colon	560	442	217
Brus Laguna	Gracias A Dios	167	234	182
Saba	Colon	244	126	179
Danli	El Paraiso	54	181	155
Olanchito	Yoro	279	147	86
Roatan	Bay Islands	149	119	80

Decrease Increase

0 500 1000 1500

Figure 5. Malaria cases by age and sex in Honduras, 2014



*58% of cases were classified in the presented age groups.

Particularly, the municipality of Wampusirpi in Gracias a Dios and Jose Santos Guardiola in the Bay Islands have shown significant decline in malaria: from 702 cases in 2009 to 2 cases in 2014 and from 184 cases to 11 cases, respectively. This has been achieved through a massive distribution of LLINs coupled with improved quality of surveillance and community participation in both municipalities. The agrarian conflict in the valley of Bajo Aguan and ensuing social unrest led to an outbreak of malaria in 2012 in Colon and Yoro departments.

Anopheles albimanus is the main malaria vector species. Malaria due to *P. vivax* is predominant, though Honduras has the highest amount of *P. falciparum* cases in the Mesoamerican sub-region. The number of *P. falciparum* cases, however, reduced by 52.4% during 2013-2014. Lately, *P. falciparum* transmission has expanded and been established in Tocoa municipality of Colon department.

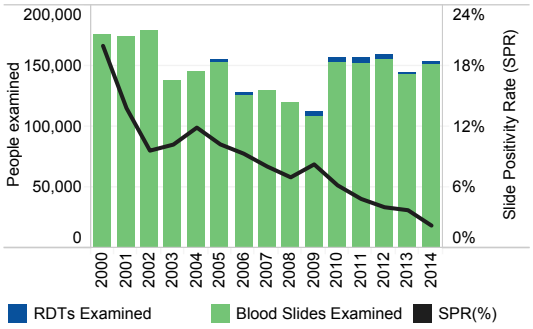
The number of cases in males was only slightly higher than females in 2014 with both sexes having an incidence rate of nearly 22 cases per 100,000 people (Figure 5). Younger age groups are more at risk for malaria particularly those aged 10-24 years old.

The malaria in pregnancy rate in 2014 was 34 cases per 100,000 pregnant women, which was lower than the rate for non-pregnant women of child-bearing age (50 cases per 100,000 women). Country guidelines indicate that all pregnant women should be tested for malaria at each prenatal visit in all endemic areas. The policy is largely followed in some departments but not in the entire country. The lower incidence in pregnant women, thus, seems due to inadequate quality of surveillance data. This can be further corroborated by the fact that between 2010 and 2013 the number of malaria cases in pregnant women increased from 22 to 92 although the total number of cases decreased, implying that surveillance has improved in recent years.

Priority Groups

The most affected populations in Honduras are the indigenous peoples, especially those of the Miskito ethnic group who reside in Gracias a Dios. Other affected ethnic groups are the Tawaka in Wampusirpi and the Pech in Olancho. Migratory populations, especially along the Nicaraguan border, report a high number of cases. These are mostly the Miskito people who have families in both countries.

Figure 6. Blood slides examined, RDTs examined, and SPR in Honduras, 2000-2014

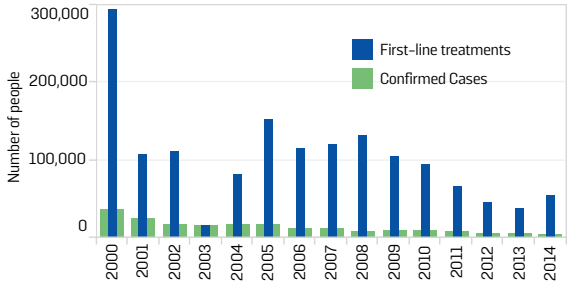


Diagnosis and Treatment

Microscopy is the primary method for diagnosis (Figure 6). In 2013, the country embarked on a process of establishing community health posts with voluntary collaborators using RDTs for diagnosis in Puerto Lempira. This is being expanded to other areas in the department of Gracias a Dios. The number of people examined through active case detection has more than doubled in 2014 from the previous year. The SPR has continued to decrease in recent years (consistent with case reporting) and was 2.23 in 2014.

Chloroquine with primaquine is used as the first-line treatment for both *P. falciparum* and *P. vivax* infections. A 2009 study found cholorquine to be an efficacious treatment for *P. falciparum* in Honduras (14). Since then, antimalarial resistance surveillance through molecular markers has demonstrated that the *P. falciparum* parasite continues to be sensitive to chloroquine. Deaths in recent years have occurred in people returning from Africa with malaria resistant to chloroquine.

Figure 7. Number of malaria cases and those treated with first-line treatment in Honduras, 2000-2014



The percentage of cases treated in a timely manner appears to have worsened since 2012 (Figure 8); however, measurements of time changed throughout these years, thereby biasing the data. Therefore data from previous years cannot be compared accurately.

Vector Control

A campaign to distribute ITNs in the departments of Gracias a Dios and Colon occurred in 2013, which most likely contributed to the reduced incidence in these departments (Figure 9). The use of IRS has also increased in recent years and currently protects more than 100,000 people. Confirmed resistance to pyrethroid insecticide was found in Catacamas, Olancho and in Comayagua departments among *An. albimanus* in 2013 and 2014. No resistance has been found to pyrethroids elsewhere in the country.

Figure 9. People protected by IRS and by ITNs in Honduras, 2000-2014

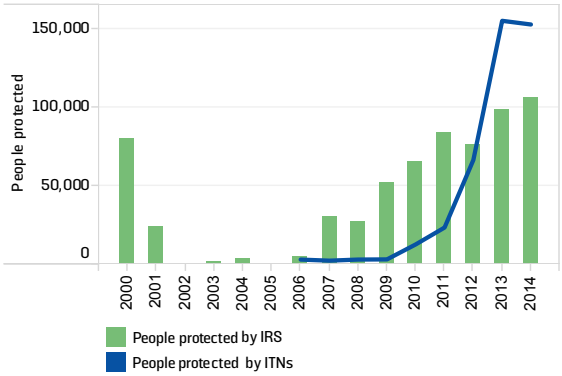
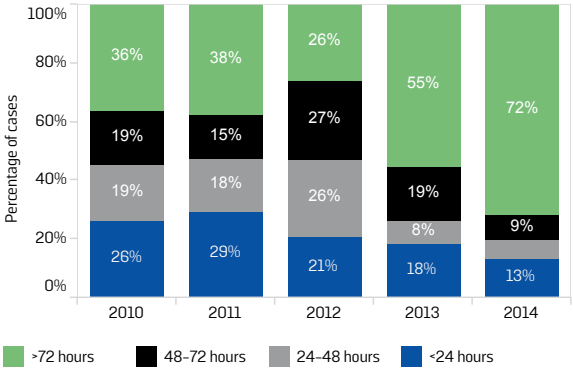


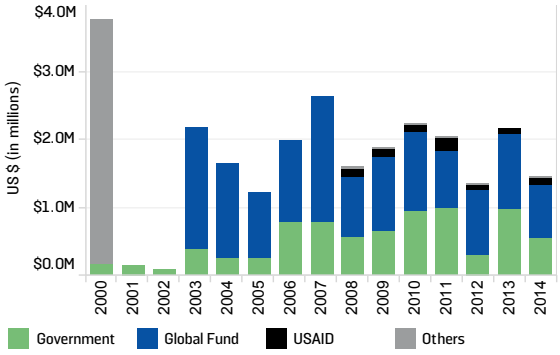
Figure 8. Time between first symptom and initiation of treatment in Honduras, 2010-2014



Funding

The government has allotted funds for malaria control. The Global Fund has been the main contributor of external funding since 2003 (Figure 10). Additional funding has been provided by USAID through the AMI/RAVREDA project since 2008. PAHO/WHO has continuously provided technical support and financial resources for specific activities.

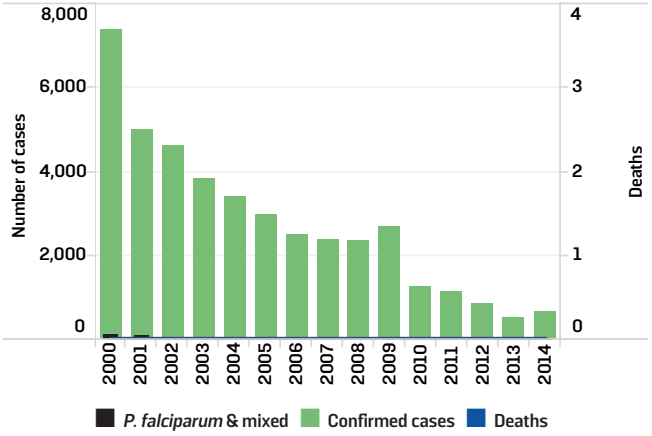
Figure 10. Funding for malaria in Honduras, 2000-2014



MEXICO

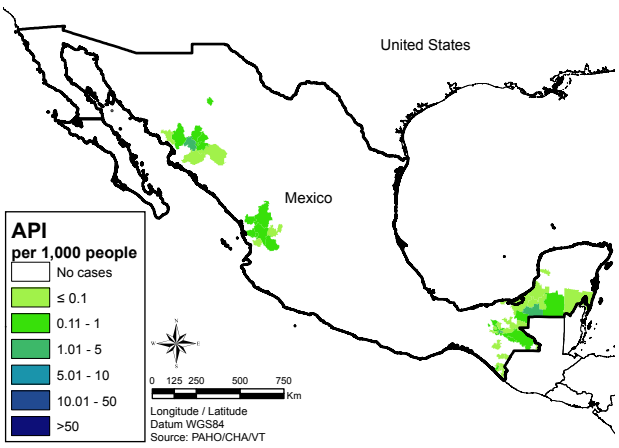
Mexico has had a 91.0% reduction in malaria cases since 2000, achieving the WHA 58.2 target for the MDG 6C of reducing malaria by 75% in 2010 (Figures 1 and 2). Mexico is currently in the pre-elimination phase, though some malaria endemic areas of substantial transmission intensity exist in the country. There were 664 cases reported in 2014, a 33.1% increase from the previous year. No malaria-related deaths have been reported since 1998.

Figure 2. Number of cases and deaths due to malaria in Mexico, 2000-2014



Malaria transmission in the country is exclusively due to *P. vivax* infections. Transmission has been largely limited to southern states of Chiapas, Campeche, and Quintana Roo along the border with Guatemala and Belize (Figure 3). Two other important areas of transmission exist along the borders of Sinaloa, Sonora, and Chihuahua states in the north and Nayarit, Durango, and Jalisco states in the center of the country.

Figure 1. Malaria by Annual Parasite Index (API) at municipality level (ADM2), Mexico 2014



All cases caused by *P. falciparum* have reportedly been imported in those returning from endemic countries during the 2010 to 2014 period (Table 1). Most of these imported cases have been imported from countries in the Americas (50%) followed by those in Africa (41%). In 2014, two imported cases of *P. vivax* were reported imported from Belize and Colombia each. The former reported new active foci of *P. vivax* malaria along its border with Mexico in 2014 with movement of people across the border being the reason for re-establishment of transmission. The primary malaria vectors are *An. albimanus* and *An. pseudopunctipennis*.

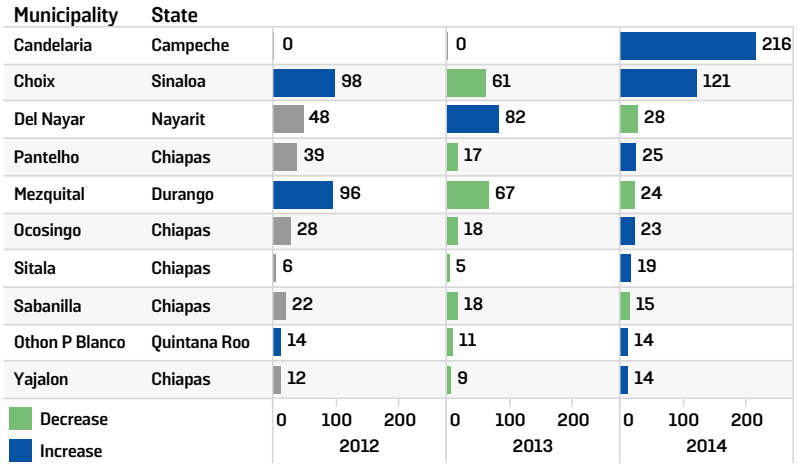
Men accounted for 56.3% of all cases in 2014 (Figure 4). There were more cases reported among children (5-9 years old) and teenagers (10-14 and 15-19 years old) than in any other 5-year age group. Information about number of malaria cases in pregnant women was not available as this is not presently captured by the national information system.

Table 1. Elimination profile of Mexico, 2012-2014

	2012	2013	2014
Total Cases	842	499	664
Cases Investigated	842	499	664
Autochthonous Cases	833	495	656
Autochthonous- P. f	0	0	0
Autochthonous- P. v	833	495	656
Imported Cases	9	4	8
Imported- P. f	9	4	6
Imported- P. v	0	0	2
Active Foci	71	61	56

*P. f-*Plasmodium falciparum*
P. v.-*Plasmodium vivax*

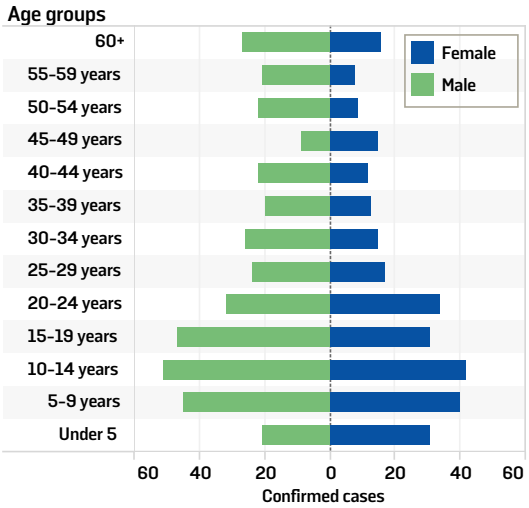
Figure 3. Municipalities with the highest number of malaria cases in Mexico, 2012-2014



The municipality of Candelaria in Campeche state, near the Guatemalan border, reported an outbreak of malaria in 2014, although it had no cases in previous years. A change in migratory patterns has been suggested as a possible reason for this outbreak. This area is endemic as a result of human trafficking and movement of illegal migrants along the train routes. Inadequate surveillance quality was another reason for the outbreak in Candelaria wherein detected cases were reported to have been infected elsewhere upon case investigation thereby delaying the detection of increasing transmission and consequently the response.

Another vulnerable group affected by malaria is the indigenous people who live in rural areas. The states of Chiapas and Oaxaca have large indigenous populations that have been affected due to lack of healthcare access. Development of intervention programs is difficult because of language barriers. Prevention efforts have been implemented in Chiapas along the train route and focused on increasing microscopy, improving access to treatment, distributing bed nets, and engaging indigenous peoples. The Oaxaca state in particular has demonstrated significant achievements in eliminating malaria; no malaria case was reported in 2014, decreasing from 902 cases in 2009. This has been achieved by modifying the treatment scheme to the PAHO/WHO recommended 14-day treatment with chloroquine and primaquine for *P. vivax* in 2011, supervised treatment, vector control interventions, and improving access to prompt diagnosis and treatment.

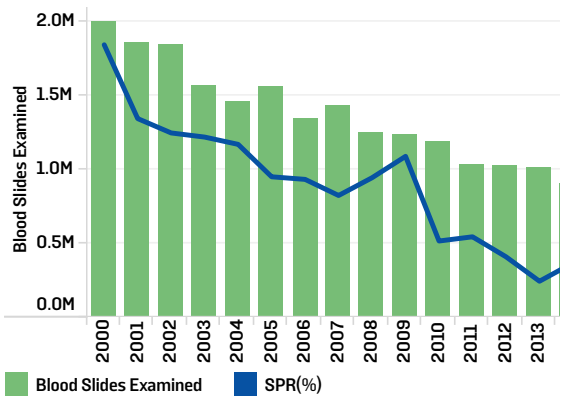
Figure 4. Malaria cases by age and sex in Mexico, 2014



Diagnosis and Treatment

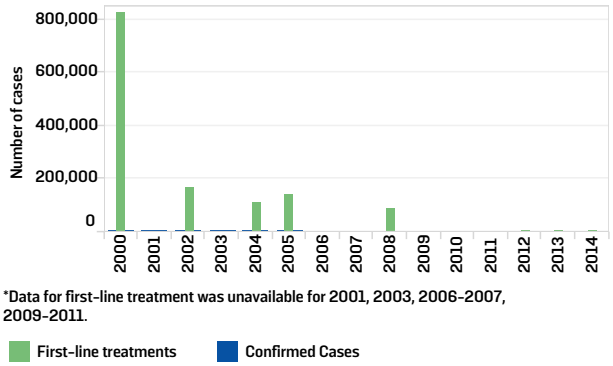
Microscopy has been the primary method of diagnosis. The number of blood slides examined has decreased by 55.1% since 2000 (Figure 5); however, this follows the trend of decrease in cases. In 2014, all 282 laboratories were reported to have been included in a program of quality assurance for microscopic diagnosis.

Figure 5. Blood slides examined, RDTs examined, and SPR in Mexico, 2000-2014



Both *P. falciparum* and *P. vivax* infections are treated with chloroquine and primaquine as a first-line treatment (Figure 6). A 3x3x3 treatment scheme for *P. vivax* is recommended in the country wherein a single dose is administered monthly for 3 months, followed by 3 months without treatment. This is repeated twice in a year and continued for 3 years; in total 18 single doses are given per patient. A recent study demonstrated that this scheme (50% relapsed after 1 year of follow-up) is not efficacious in preventing relapses compared to the WHO recommended 14-day treatment with chloroquine and primaquine (12.1% relapsed) (44). Some states, especially Chiapas and Oaxaca, have switched to the WHO recommended 14-day treatment and the latter has nearly eliminated malaria.

Figure 6. Number of malaria cases and those treated with first-line treatment in Mexico, 2000-2014

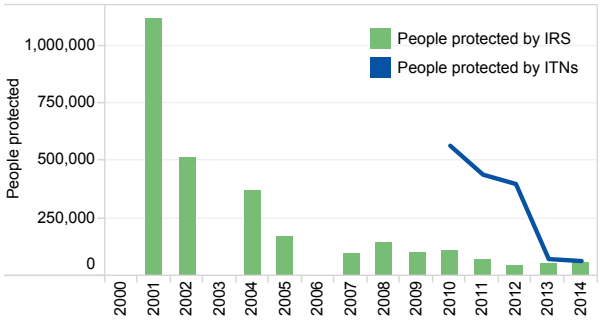


*Data for first-line treatment was unavailable for 2001, 2003, 2006-2007, 2009-2011.

Presently the 14-day treatment is also recommended in the national treatment guidelines although its adoption is patchy.

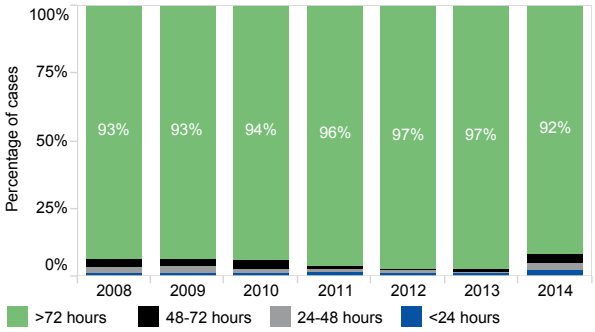
The country reported that 92% of all cases in 2014 were diagnosed in more than 72 hours after onset of the first symptoms (Figure 7). This was only slightly less than in previous years suggesting that access to malaria diagnosis and consequently treatment is limited and a continuing challenge for malaria elimination. Information about time taken to treat was not available.

Figure 8. People protected by IRS and by ITNs in Mexico, 2000-2014



*IRS data unavailable for 2000, 2003, and 2006. ITN data unavailable for 2000-2009.

Figure 7. Time between first symptom and result of diagosis in Mexico, 2008 - 2014



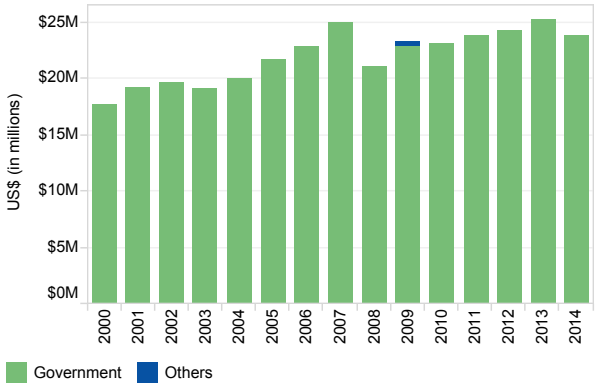
Vector Control

IRS usage has declined since 2011, but it has remained near constant in the past 4 years and an estimated 57,000 people were still protected by it in 2014 (Figure 8). In 2010, about 350,000 ITNs were distributed, protecting an estimated 567,000 people. As of 2014, an estimated 65,000 people are protected by ITNs. Larval control is used in the country, especially in endemic foci. Insecticide resistance surveillance for *Anopheles* has not been conducted in recent years.

Funding

Malaria prevention and elimination is almost exclusively funded by the government who provided an estimated US$23.8 million in 2014, US$1.5 million less than 2013 (Figure 9). This decline is due to a change in the exchange rate between those 2 years. Information about funding is reported from national level, which does not take into account funds available at the state and other lower levels. PAHO/WHO provides technical assistance and financial resources for specific malaria related activities. No other external funding is received by the country.

Figure 9. Funding for malaria in Mexico, 2000-2014



NICARAGUA

Malaria is endemic in the Moskitia area along the Atlantic coast in the northwestern part of the country that shares a border with Honduras (Figure 1). In 2014, Nicaragua had reported 1,163 cases of malaria and no deaths (Figure 2). The department of North Caribbean Coast Autonomous Region (RACCN) has the highest amount of cases and is home to some of the country's most affected municipalities such as Waspan (26.2% of all 2014 malaria cases), Rosita (22.6%), Puerto Cabezas (15.4%), and Prinzapolka (9.8%) (Figure 3). However, malaria is also present in other parts of the country including along the northern Pacific coast in the department of Chinandega where sugar-cane plantations are areas of mosquito proliferation. The department of South Caribbean Coast Autonomous Region (RACCS) has had an increase in the past few years. Cases in Desembocadura de la Cruz de Rio Grande

Figure 1. Malaria by Annual Parasite Index (API) at municipality level (ADM2), Nicaragua, 2014

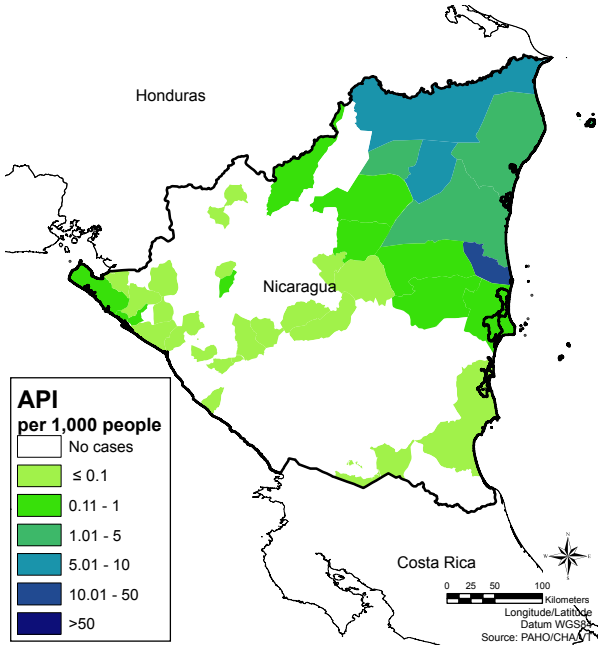
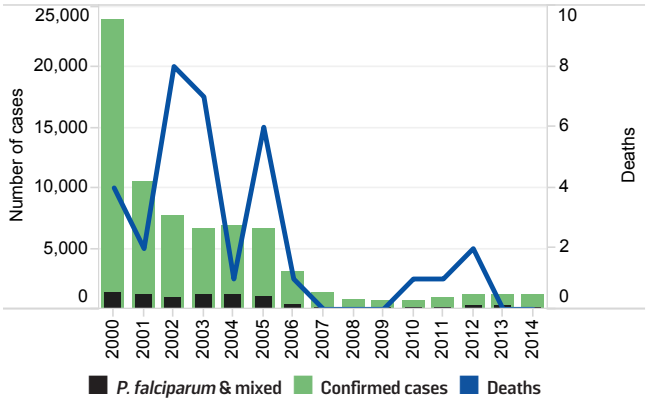
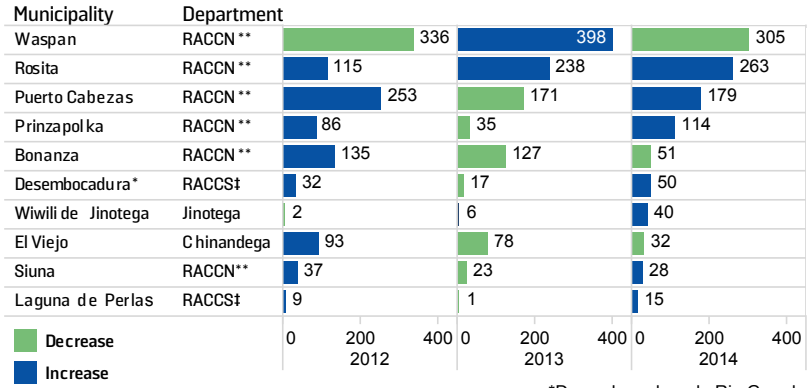


Figure 2. Number of cases and deaths due to malaria in Nicaragua, 2000-2014



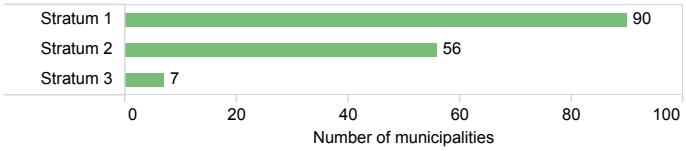
municipality almost tripled in 2014 from the previous year. Together, RACCN and RACCS account for 90% of all malaria cases in Nicaragua. During 2012-2014, there were 7 municipalities reporting more than 1 case per 1,000 inhabitants in one or more years (stratum 3) (Figure 4). Main factors contributing to malaria in Nicaragua are migration, natural disasters (floods), and drug trafficking. Improved surveillance has also led to the detection of more cases. Approximately 2% of cases were reported imported in 2014. On the contrary, Costa Rica has reported five imported cases from Nicaragua since 2011.

Figure 3. Municipalities with the highest number of malaria cases in Nicaragua, 2012-2014



*Desembocadura de Rio Grande
**North Caribbean Coast Autonomous Region
‡South Caribbean Coast Autonomous Region

Figure 4. Number of municipalities (ADM2) by strata in Nicaragua, 2012-2014



*Stratum 1: No autochthonous malaria case in 2012-2014;
Stratum 2: <1 case per 1,000 inhabitants in 2012-2014;
Stratum 3: >1 case per 1,000 inhabitants in 2012-2014.

Men were more affected than women in 2014 (Figure 5), and were found to have incidence rates of 17.7 and 14.9 cases per 100,000 people, respectively. Analysis by age groups shows that men have higher incidence at most ages (Figure 6). Children (10-14) and adolescents (15-19) had the highest incidence of malaria. There were an estimated 17 malaria cases per 100,000 pregnancies in 2014, which was similar to the incidence in non-pregnant women of child-bearing age, implying that pregnant women were not at a higher risk of having malaria.

Figure 6. Malaria incidence by age and sex in Nicaragua, 2014

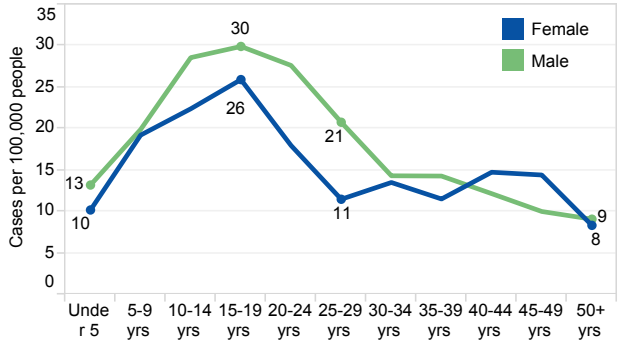


Figure 7. Blood slides examined, RDTs examined, and SPR in Nicaragua, 2000-2014

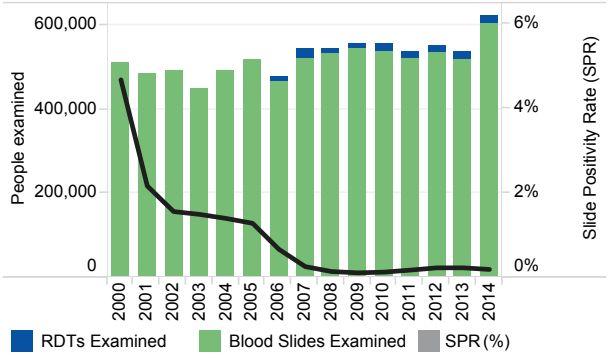
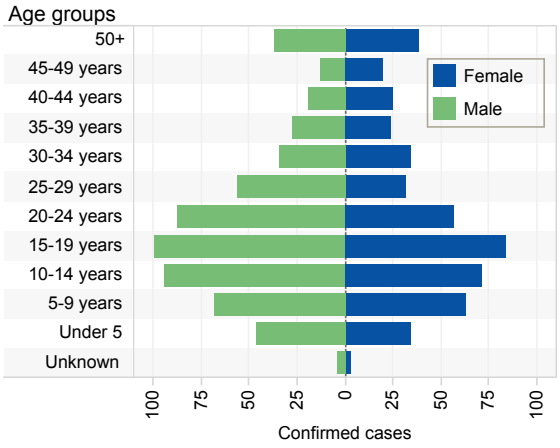


Figure 5. Malaria cases by age and sex in Nicaragua, 2014



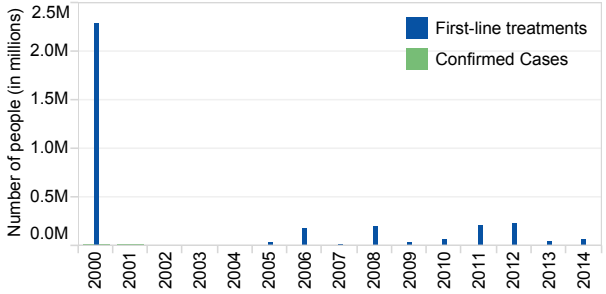
Priority Groups

The Miskito people of Nicaragua are disproportionally affected by malaria due to poverty, underdevelopment, and limited access to healthcare compared to the rest of the country. The area they inhabit traverses the Honduran border, which poses a problem for disease tracking.

Diagnosis and Treatment

Microscopy is the primary method of diagnosis in the country, though RDTs were introduced in 2006 for use in places that are difficult to access (Figure 7). Nicaragua's first-line treatment is chloroquine and primaquine for both *P. falciparum* and *P. vivax* infections. An observed dosage of chloroquine and primaquine (30 mg/kg/day) is given over the course of 7 days for treatment of *P. vivax* in Nicaragua as compared to a 15 mg/kg/day dosage for 14 days that is given in Honduras. The difference in dosage may cause confusion along the border for those with *P. vivax* infections due to the varying treatment schemes.

Figure 8. Number of malaria cases and those treated with first-line treatment in Nicaragua, 2000-2014

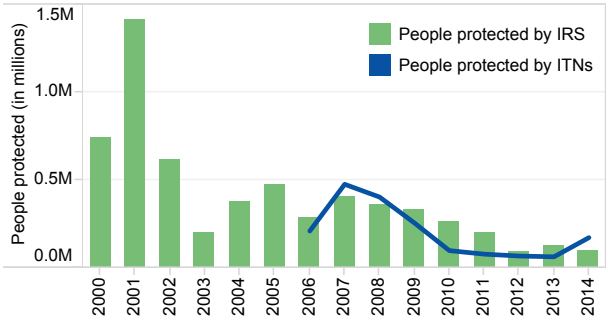


* First line treatment data is unavailable for 2001-2004.

Vector Control

Nearly 95,000 people are estimated to be protected by IRS in Nicaragua, which has decreased steadily since 2007 (Figure 9). Tests conducted in 2012-2014 found both *An. albimanus* and *An. pseudopunctipennis* to be susceptible to pyrethroids. More people are estimated to be protected by ITNs that IRS in 2014, with ITNs protecting 173,000 people.

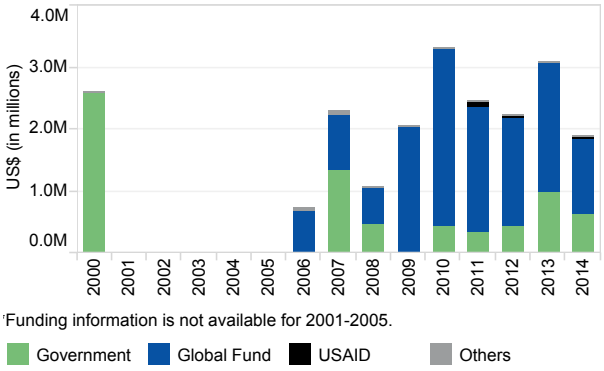
Figure 9. People protected by IRS and by ITNs in Nicaragua, 2000-2014



Funding

Governmental funding for malaria at the national level has varied from one year to the other. In 2014, it was less than that in 2013, but higher than any year during 2010-2012. The Global Fund has been the main contributor of external resources since 2006 through national grants as well as providing resources through the EMMIE initiative (Figure 10). Other external funders include USAID via the AMI/RAVREDA project and PAHO/WHO.

Figure 10. Funding for malaria control in Nicaragua, 2000-2014

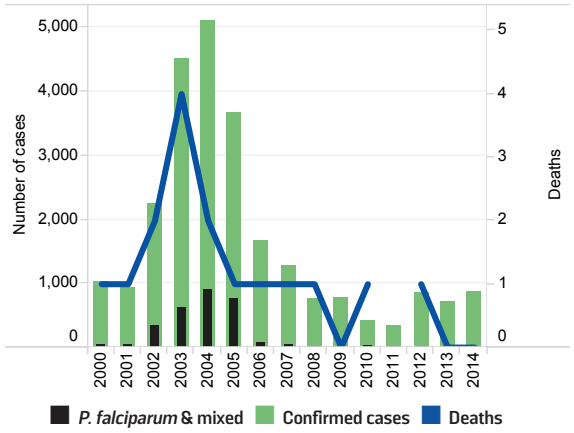


'Funding information is not available for 2001-2005.

PANAMA

In Panama, there were 874 cases reported in 2014, representing only a 15.6% decrease from 2000 (Figures 1-2). While the WHA 58.2 target for MDG 6C was not met as of 2014, efforts to combat past malaria epidemics have been made. Ten years ago, malaria incidence was at a record high in Panama, but has since declined by 82.9% in 2014. In the past 2 years, there have been no reported deaths due to malaria. The slide positivity rate was 1.08 in 2014.

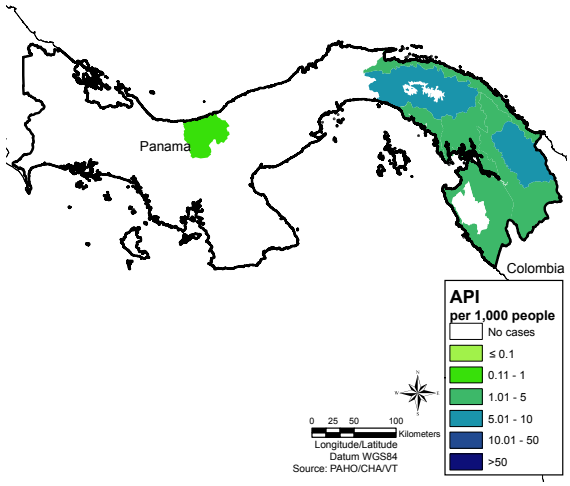
Figure 2. Number of cases and deaths due to malaria in Panama, 2000-2014



As of 2014, malaria was highly prevalent in the eastern area of the country, particularly in the district of Chepo where 49% of all malaria cases were reported (Figures 1 and 3). The *comarcas* of Guna Yala and the province of Darien are two other areas that report the majority of the malaria cases.

Anopheles albimanus is the primary malaria vector but its abundance varies across the country. A recent study conducted in the Guna Yala area

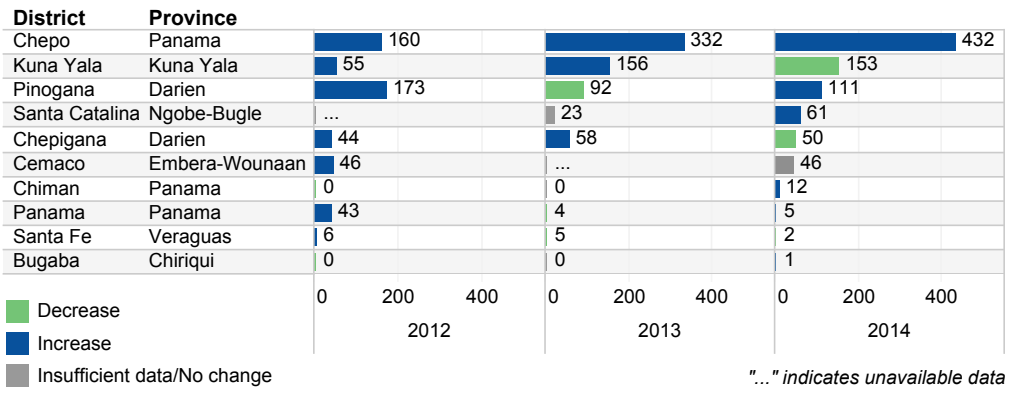
Figure 1. Malaria by Annual Parasite Index (API) at district level (ADM2), Panama 2014



demonstrated that although *An. punctimacula* and *An. aquasalis* are abundant, only *An. albimanus* was found to be infected with *Plasmodium* species (1). Around 99% of cases in 2014 were caused by *P. vivax* infections. *P. falciparum* used to cause a significant number of cases, but has declined since 2005. All cases due to that species have been imported from other countries since 2011. An outbreak due to imported *P. falciparum* infections from Colombia was reported in Darien in 2010 and the area remains at risk of such outbreaks in the future.

Overall, men are more at risk of contracting malaria as compared to women (age standardized incidence of 25.3 malaria cases per 100,000 men versus 14.9 cases in women during 2013-2014) (Figures 4 and 5). However, the incidences vary across age

Figure 3. Districts with the highest number of malaria cases in Panama, 2012-2014



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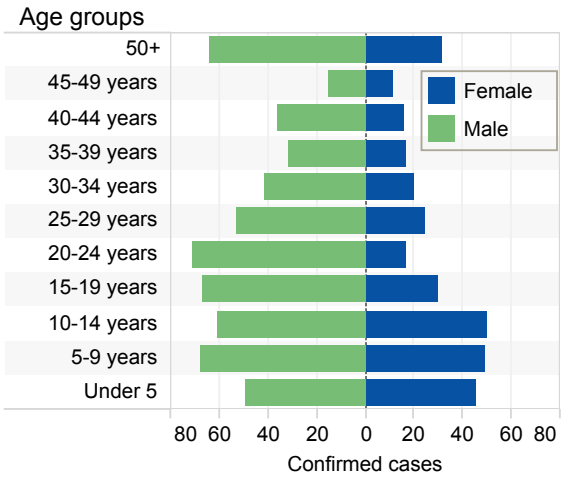
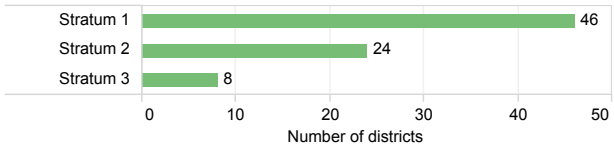
groups, being highest in men of 20-24 years old (43 cases per 100,000 men), indicating possible malaria transmission linked to occupational activities. On the other hand, transmission in women is highest in those under 5 years old (24 cases per 100,000 women) owing to increased transmission within the household. This contrasting risk could be explained by the dichotomy in the epidemiology varying across malaria endemic areas in the country.

Figure 4. Malaria cases by age and sex in Panama, 2014



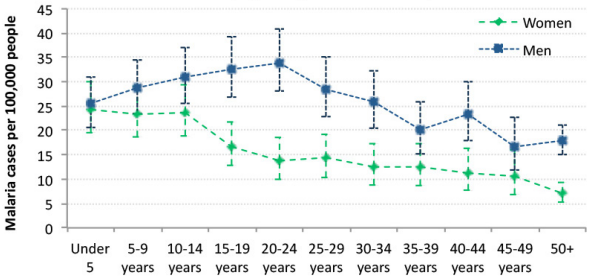
There were an estimated 8 malaria cases in pregnant women per 100,000 pregnant women in 2014, which was lower, albeit non-significantly, than that in non-pregnant women in the reproductive age group of 15-49 years (14.28 malaria cases per 100,000 women). Based on the reported data, pregnant women did not have a higher risk of having malaria even when the data were pooled for the period 2010-2014. This is in contrast with the higher incidence in children less than 5 years old and perhaps points to under-diagnosis of pregnancy status in malaria patients.

Figure 6. Number of districts (ADM2) by strata in Panama, 2012-2014



*Stratum 1: No autochthonous malaria case in 2012-2014;
Stratum 2: <1 case per 1000 inhabitants in 2012-2014;
Stratum 3: >1 case per 1000 inhabitants in 2012-2014

Figure 5. Malaria incidence by age and sex in Panama, 2013-2014



Priority Groups

In Panama, many ethnic groups live in areas known as *comarcas*, which are autonomous territories for these populations. Guna Yala and Madungandi are *comarcas* in the northeast Atlantic coast with large indigenous populations. The Chepo district adjoins the *comarca* of Madungandi and reported the most malaria cases followed by the *comarca* of Guna Yala. Many of the problems in the *comarcas* are believed to stem from cultural and language barriers leading to challenges in access to healthcare.

Diagnosis and Treatment

Although rapid diagnostic tests have been introduced in the country, they are still only used in laboratories. Diagnosis is not quick as the time taken between onset of symptoms and result of diagnosis was over 3 days in more than 75% of the cases during 2011-2014 (Figure 8). This is despite the fact that over 90% of the suspected cases tested for malaria and over 70% of confirmed cases during 2012-2014 have been detected through active surveillance with the rest detected through passive surveillance at health centers. Most malarious areas in

Figure 7. Blood slides examined and SPR in Panama, 2000-2014

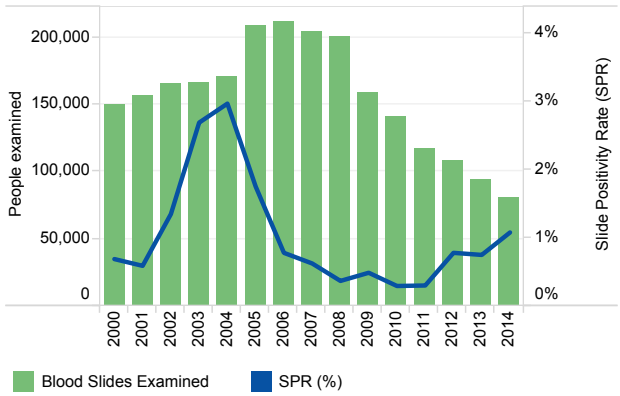


Figure 8. Time between first symptom and initiation of treatment in Panama, 2011-2014

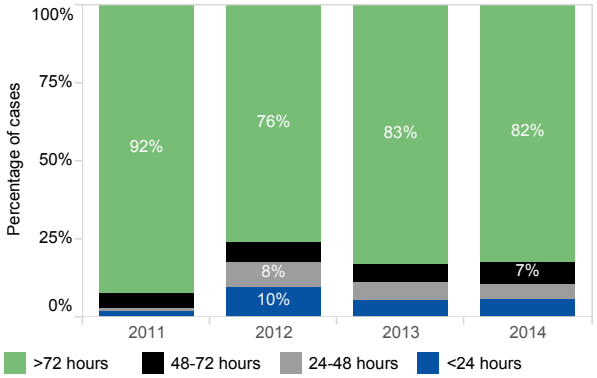
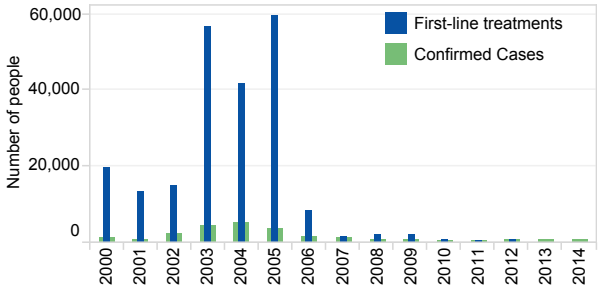


Figure 9. Number of malaria cases and those treated with first-line treatment Panama, 2000-2014



*Data was unavailable for 2013 and 2014.

the country are hard to reach; thus, the introduction of RDTs is of utmost importance. Panama currently plans to introduce RDTs on a massive scale in 2016. In 2012, annual blood examination rates (ABER) of 10% of total population or higher were reported from 24 districts, although 10 of these had no confirmed cases reported in 2011 or 2012. A reorientation since then has decreased the total number of slides examined with an improved focus on active case surveillance. All but one of these 10 districts reported 0 cases for 2013 and 2014 and the ABER has declined in all of these.

Chloroquine and primaquine are used as first-line treatment for *P. vivax* infections, with primaquine administered for 7 days in a majority of the country although a 14-day treatment is also recommended by the national guidelines. The country also used a fixed dose combination of chloroquine and primaquine in 2014. Panama is the only country in Central America to use artemether-lumafantrine as the first-line treatment for *P. falciparum*; all infections by this species in recent years have been imported from other countries of South America and Africa, mostly Colombia where resistance to chloroquine is well documented. Mass drug administration (MDA) is still conducted by the country. Supervised treatment with chloroquine and primaquine for 7 days is given en masse to localities considered at high-risk or having an outbreak.

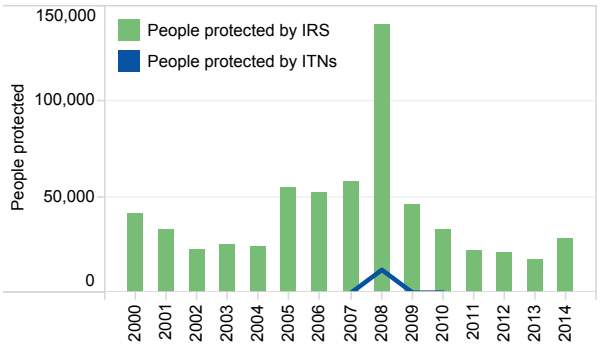
In many hard-to-reach areas, people are treated at the time of taking a blood smear while results are awaited; however, most cases are given the full dose of radical treatment even when being treated presumptively. Thus, information about the number of first-line treatments given is inaccurate and grossly underestimated.

Vector Control

Indoor residual spraying (IRS) is currently used for vector control and protected almost 28,000 people in 2014 (Figure 10). However, coverage at the locality level is low and often inadequate (<80% of households). Cultural barriers are significant reasons why IRS coverage has not been high in malarious areas where ethnic populations predominate. Insecticide-treated bed nets (ITNs) were introduced in 2008 but have not been distributed after that year. Cultural resistance to ITN use was linked to having no impact in areas where ITNs were distributed. However, the type of bed net distributed (regular bed net) did not take into account the fact that most people in these areas sleep in hammocks for which normal ITNs are inadequate. Use of ITNs specially designed for hammocks should be strongly considered as another tool for prevention.

On the other hand, insecticide resistance studies conducted in the malaria endemic localities of Madungandi *comarca* found that the principal malaria vector, *An. albimanus*, had confirmed resistance to pyrethroids (deltamethrin, lambda-cyhalothrin, cyfluthrin and cypermethrin) but was susceptible to organophosphates and carbamates. Studies to ascertain

Figure 10. People protected by IRS and by ITNs in Panama, 2000-2014

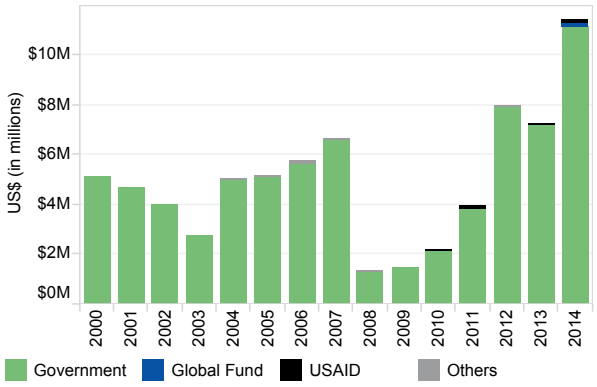


the mechanism of resistance are needed in Madungandi to define the future course of action in that area. Efforts are required to establish a program for regular surveillance of insecticide susceptibility in the country.

Funding

The government has provided the majority of funding for malaria, with additional support provided by the USAID-funded AMI/RAVREDA project and PAHO/WHO in the past. During 2014, the government reportedly provided almost US$11 million for malaria (Figure 11). In 2014, the Global Fund provided US$200,000 as startup funds for the country as part of the EMMIE initiative, although not all of these funds were used in 2014. USAID provided over US$75,000 in funding with technical support provided by PAHO/WHO and other AMI partner agencies – CDC, MSH, USP, and Links Media.

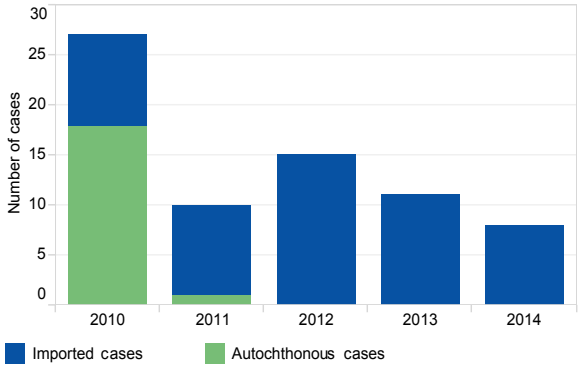
Figure 11. Funding for malaria in Panama, 2000-2014



PARAGUAY

Only new potential foci were reported by Paraguay in 2014, most centering around the capital of Asuncion (Figure 1). There have been no autochthonous cases reported in the past 3 years (Figure 2 and Table 1) and most of the imported cases were *P. falciparum* infections from endemic countries in Africa, particularly Equatorial Guinea (n=22), Angola (n=2), and Mozambique (n=1). Imported *P. vivax* cases were also reported from Equatorial Guinea (n=6), Brazil (n=2), and Peru (n=1).

Figure 2. Autochthonous and imported cases in Paraguay, 2000-2014



Paraguay is currently in the elimination phase and has reached a 99.9% decrease in morbidity surpassing the WHA 58.2 targets for MDG 6C (Figure 3). In 2014, only 8 cases were reported in the entire country, all imported. No deaths due to malaria have been reported between 2000 and 2014. Under Paraguay's National Plan for Malaria Elimination 2011-2015 (PEP), the country is committed to elimination of malaria and focuses on prevention of reintroduction and certification of malaria-free status.

Figure 1. Malaria in Paraguay by foci, 2014

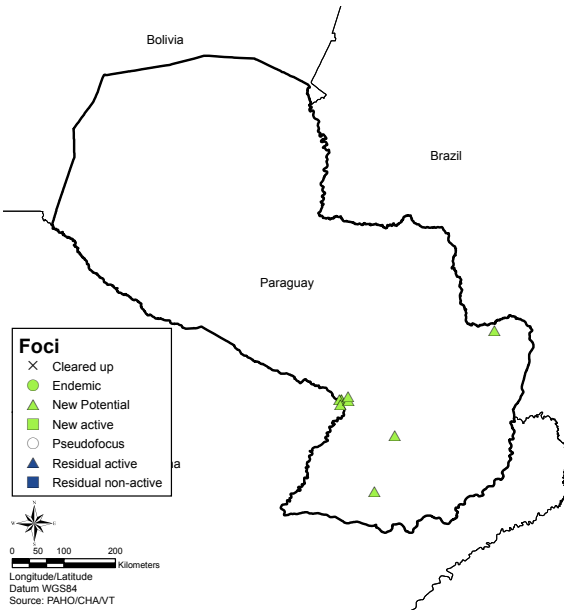


Figure 3. Number of cases and deaths due to malaria in Paraguay, 2000-2014

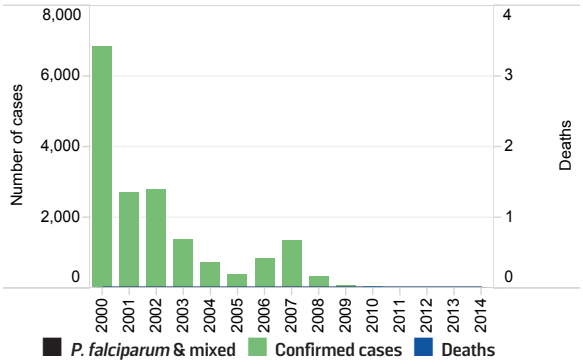


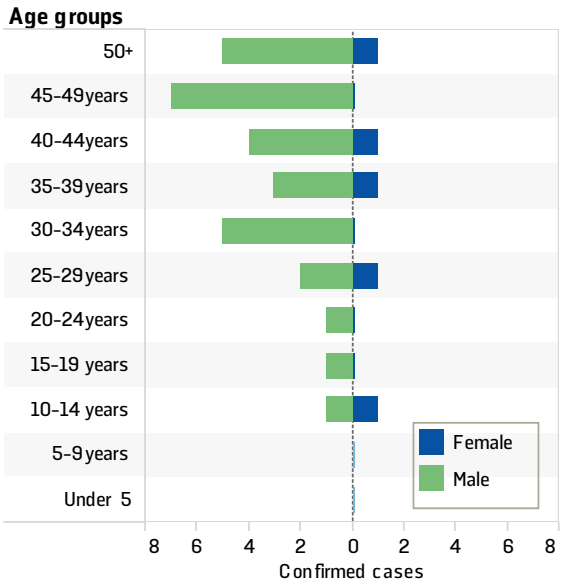
Table 1. Elimination profile of Paraguay, 2010-2014

	2010	2011	2012	2013	2014
Total Cases	27	10	15	11	8
Cases Investigated	27	10	15	11	8
Autochthonous Cases	18	1	0	0	0
Autochthonous- P. f	0	0	0	0	0
Autochthonous- P. v	18	1	0	0	0
Imported Cases	9	9	15	11	8
Imported-P. f	5	7	11	7	7
Imported-P. v	4	2	4	3	1
Imported-P. o	0	0	0	1	0

*P. f.-*Plasmodium falciparum*
P. v.-*Plasmodium vivax*
P. o.-*Plasmodium ovale*

Among the imported cases, there have been more cases in men than women during 2012-2014 (Figure 4). Most cases were in those men aged 45-49 years. Other notable age groups were those between 30-39 years and 50+ years, all age groups in economically productive years of life.

Figure 4. Malaria cases by age and sex in Paraguay, 2012-2014



Diagnosis and Treatment

Microscopy is the main method for diagnosis; however, nearly 2,000 RDTs were used in 2008 to detect cases (Figure 5).

Artemether-lumefantrine combination drugs are used as first-line treatment for *P. falciparum* in those cases imported from Africa, while chloroquine and primaquine (0.25mg/kg for 14 days) are used for *P. vivax* infections.

Figure 5. Blood slides examined, RDTs examined, and SPR in Paraguay, 2000-2014

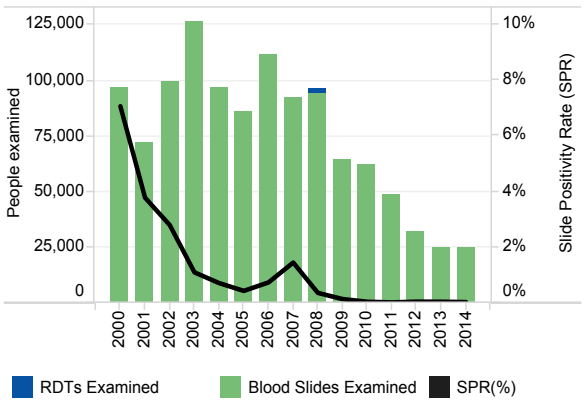
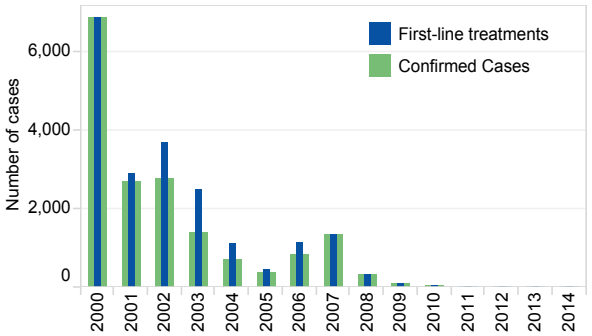


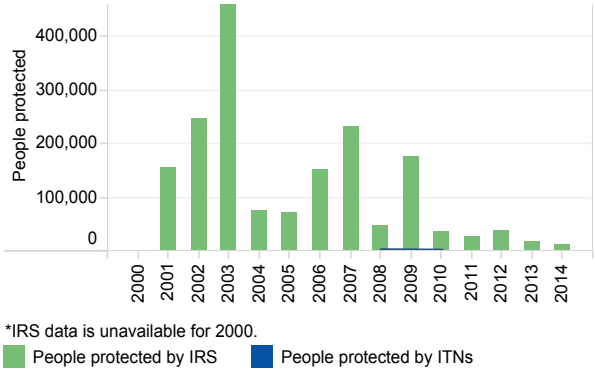
Figure 6. Number of malaria cases and those treated with first-line treatment in Paraguay, 2000-2014



Vector Control

ITNs were distributed once in 2008 (Figure 7). Over the years, IRS usage has decreased substantially and currently only protects about 13,000 people as local malaria transmission has ceased.

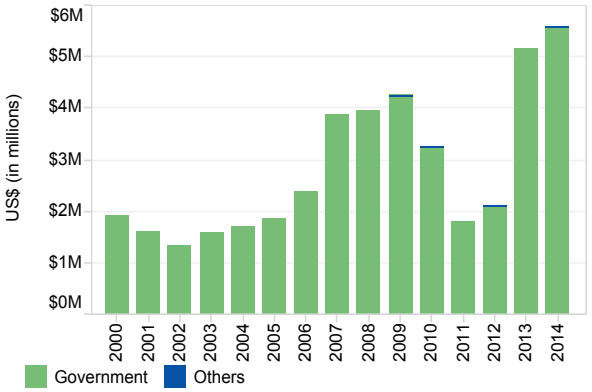
Figure 7. People protected by IRS and by ITNs in Paraguay, 2000-2014



Funding

The government has provided a generous amount of funds for malaria. In 2014, almost US$5.6 million was provided domestically, the largest amount of funding since 2000 (Figure 8). The government has been the primary source for malaria funding during 2000-2014. The country is also eligible and was recently approved for a new Global Fund grant.

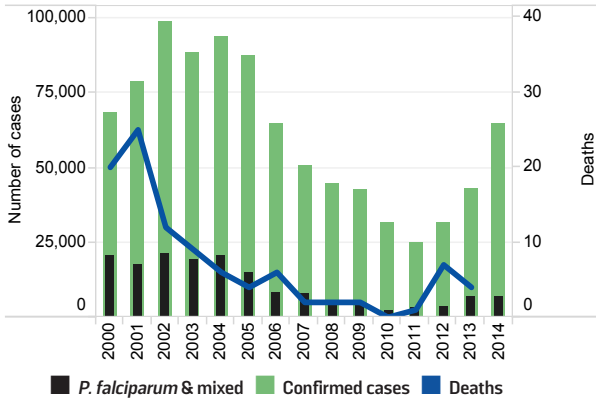
Figure 8. Funding for malaria in Paraguay, 2000-2014



PERU

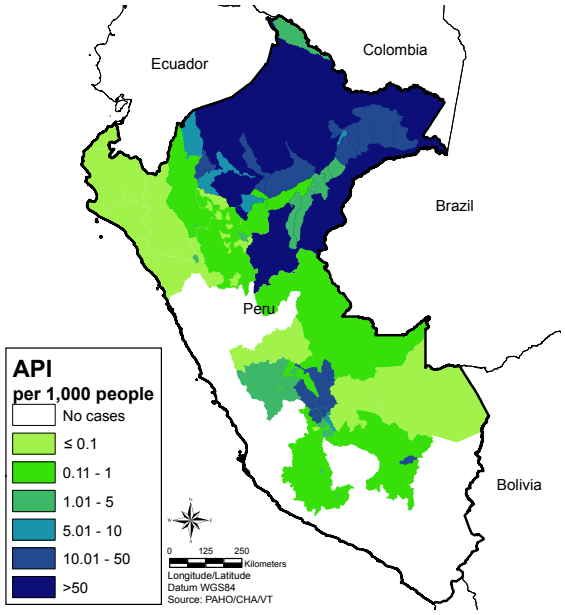
Malaria in Peru has fluctuated during the 2000–2014 period. Peru was once on track to meet WHA 58.2's MDG 6C targets for malaria, having decreased the number of cases by 63% by 2011 compared to 2000 (Figures 1 and 2). However, malaria has more than doubled since then and in 2014 around 65,000 cases were reported. Peru had a 32.7% increase in cases between 2013 and 2014. Although deaths were not officially reported, the epidemiological bulletin reports that there were 4 reported deaths in 2014, which was an 80% decrease from the 20 deaths reported in 2000.

Figure 2. Number of cases and deaths due to malaria in Peru, 2000–2014



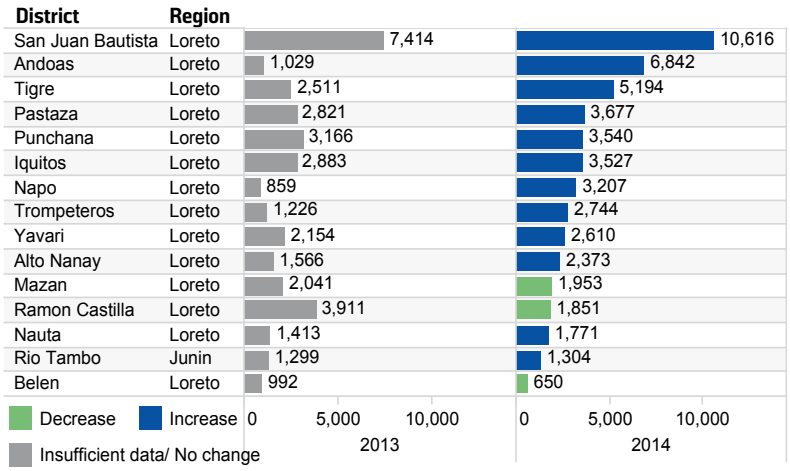
The Amazonian forest area has the highest incidence in the country, particularly in the region of Loreto, which reported 93.6% of all confirmed cases in 2014 (Figure 3). The most common vector in the Amazon area is *An. darlingi*. *Plasmodium vivax* is the main malaria-causing

Figure 1. Malaria by Annual Parasite Index (API) at region and district levels (ADM1 and ADM3), Peru 2014



species, accounting for 83.1% of all cases in the country. *P. falciparum* accounts for about 16.9% of malaria cases and is mostly limited to Loreto where almost all (99.6%) of infections due to this species were reported. Located in Loreto region, Alto Nanay (850.8 cases per 1,000 people), Tigre (621.6 cases per 1,000 people), and Pastaza (573.5 cases per 1,000) were the districts with the highest malaria incidence in the country. Malaria has increased alarmingly in Loreto. Although initially, floods and associated environmental changes were believed to

Figure 3. Districts with the highest number of malaria cases in Peru, 2013–2014



be related to this increase lately, the lack of vector control interventions and inadequate surveillance quality with low supervision are reasons for the continued increase in that region. On the other hand, malaria has decreased in the region of Tumbes after an outbreak during 2010-2012, reporting only 1 case in 2013 and none in 2014.

Men are more affected by malaria than women, making up 53.7% of all cases in 2014 and having an incidence rate higher than that in women (176 cases per 100,000 men vs. 137 cases per 100,000 women) (Figure 4). Young children between the ages of 5-9 had the highest malaria incidence (Figure 5). Since children would most likely spend much more time at home as would pregnant women, it is presumed that both would have similar risk of having malaria. However, the malaria in pregnancy incidence was lower than that in non-pregnant women of child-bearing age (94 cases vs. 115 cases per 100,000 women). This indicates under-diagnosis of pregnancy status in malaria cases in women; improvement in surveillance quality is thus necessary in the country.

Figure 4. Malaria cases by age and sex in Peru, 2014

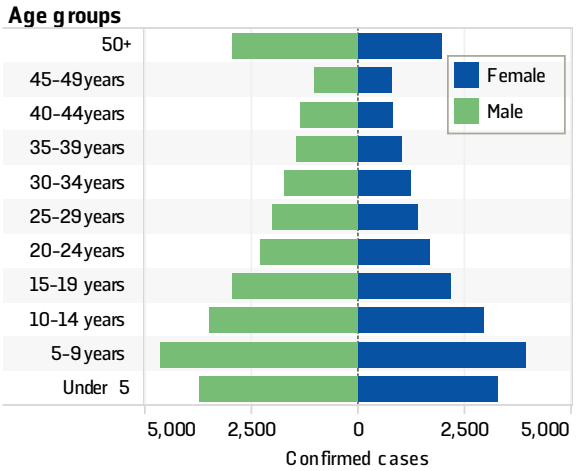


Figure 5. Malaria incidence by age and sex in Peru, 2014

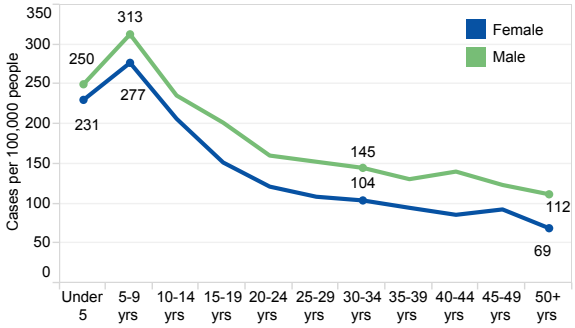
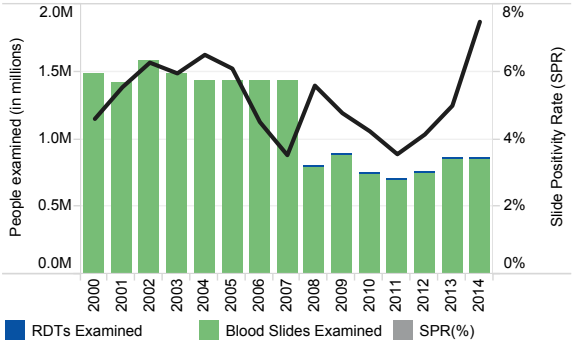


Figure 6. Blood slides examined, RDTs examined, and SPR in Peru, 2000-2014



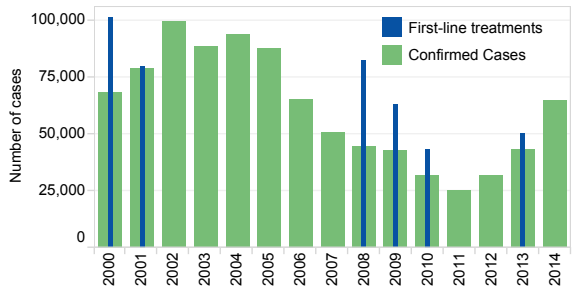
Diagnosis and Treatment

Microscopy has been the main method of diagnosis in Peru, though RDTs were introduced in 2010 (Figure 6). The SPR was 7.5 in 2014 and has been increasing since 2011. Chloroquine and primaquine (0.5 mg/kg/day for 7-day course) is the first-line treatment for *P. vivax* infections. Artesunate and mefloquine therapy along with primaquine is used as the first-line treatment for *P. falciparum*. Although data is not available for many years, consumption of antimalarials has always been higher than the number of reported cases (Figure 7).

Vector Control

Peru has significantly increased its ITN coverage in 2014, protecting more than 68,000 people (Figure 8). IRS is also used as a vector control intervention protecting 107,315 people. Tests conducted in 2013 found confirmed resistance in *An. albimanus* to pyrethroid insecticides in Bagua Grande in Amazonas, Bellavista in San Martin, and also in the region of Cajamarca.

Figure 7. Number of malaria cases and those treated with first-line treatment in Peru, 2000-2014

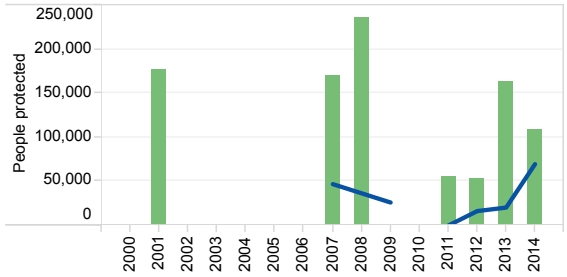


*First-line treatment data is unavailable for 2001, 2009, 2010, 2013, 2014.

Funding

The government has provided the majority of malaria funding, although data for 2014 were not available (Figure 9). The AMI/RAVREDA initiative has also provided additional funding since the start of the project in 2002. These funds have contributed primarily towards improving surveillance and antimalarial sensitivity monitoring. The PAMAFRO project, supported by the Global Fund, also provided additional malaria support during 2007–2010.

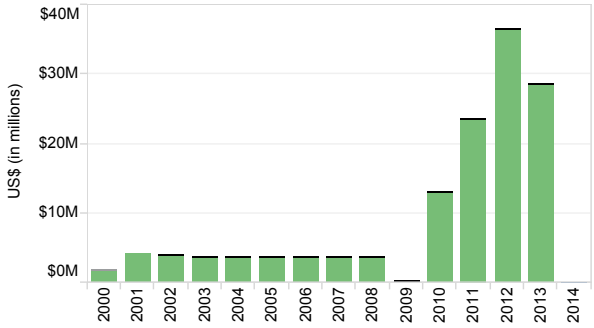
Figure 8. People protected by IRS and by ITNs in Peru, 2000–2014



*IRS data not reported in 2000, 2002-2006, and 2009-2010. ITN data reported before 2007 or in 2010.

People protected by IRS People protected by ITNs

Figure 9. Funding for malaria in Peru, 2000–2014



*Funding data not available in 2014.

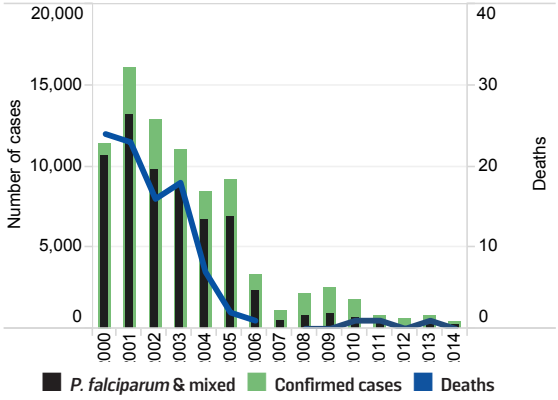
Government Global Fund USAID Others

SURINAME

Suriname had 401 confirmed cases of malaria and no recorded deaths in 2014 (Figures 1 and 2). Morbidity has decreased by 96.5% compared to 2000. In the past 9 years, there have only been 6 malaria-related deaths reported.

The Guiana Shield, an area rich in minerals and lush with rainforest, encompasses Suriname, French Guiana, Guyana, and parts of Venezuela, Colombia, and Brazil. Many people move to this area to participate in legal and sometimes illegal gold mining, leading to a large mobile population that transcends borders. The Maroni River area between Suriname and French Guiana has been of particular concern.

Figure 2. Number of cases and deaths due to malaria in Suriname, 2000-2014

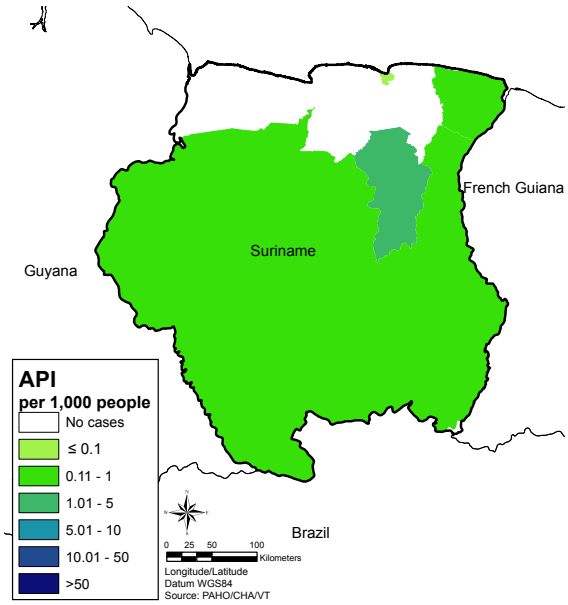


Although the map (Figure 1) shows malaria in most of the interior parts of the country, malaria is largely focalized to mining areas along the French Guiana border. Transmission in the villages in interior areas used to be primarily due to *P. falciparum* and has been almost eliminated. It has been suggested that the Maroon people who live in that part of the country may have protected it due to the lack of the Duffy antigen that is needed to manifest *P. vivax* in red blood cells (45). A significant proportion of cases are imported from French Guiana. In 2014, 76% of cases were imported from French Guiana, where miners become infected and cross into Suriname to obtain treatment.

Men were more affected than women, accounting for 55.7% of all cases in 2014 (Figure 3). The malaria incidence in men was higher than that in women, being 82 and 66 cases per 100,000 people per year, respectively. Men aged 30-34 were the highest incidence (Figure 4). Occupation is a risk factor for men, especially those working in mines.

An. darlingi is the main vector in Suriname and *P. falciparum* has been the primary malaria species of

Figure 1. Malaria by Annual Parasite Index (API) at district level (ADM1), Suriname 2014



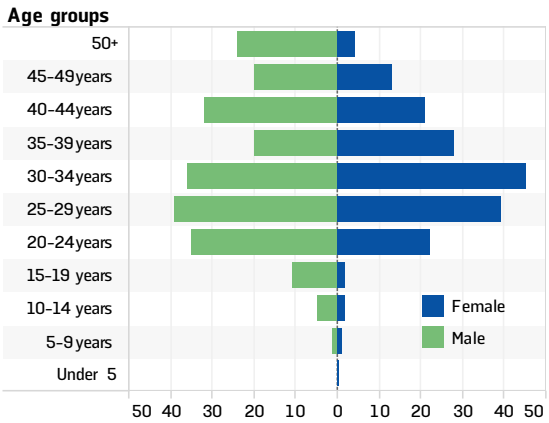
infection in previous years. In 2014, 41% of cases were caused by *P. falciparum* and mixed infections as malaria is now largely limited to mining areas.

Priority Groups

The program *Decreasing the incidence of malaria in the populations of the interior of Suriname* started in 2006 and focused on case detection, IRS, and LLIN interventions in villages within the interior of the country who had limited access to healthcare. The results of this project were successful and decreased malaria in this area.

Gold miners working in the Guiana Shield were the next target population for interventions, especially

Figure 3. Malaria cases by age and sex in Suriname, 2014



illegal foreigners such as those from Brazil known as *garimpeiros*. A subsequent program called *Looking for gold, finding malaria* targeted the mining workers specifically.

Figure 4. Malaria incidence by age and sex in Suriname, 2014

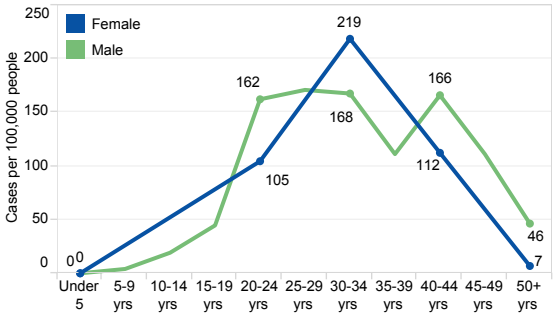
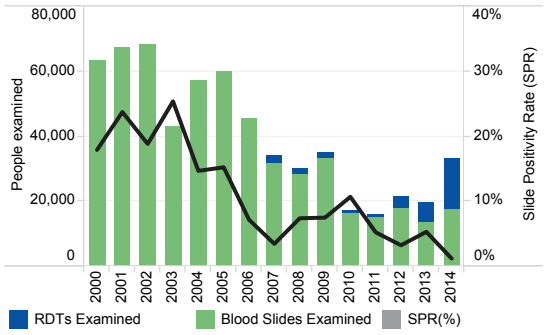


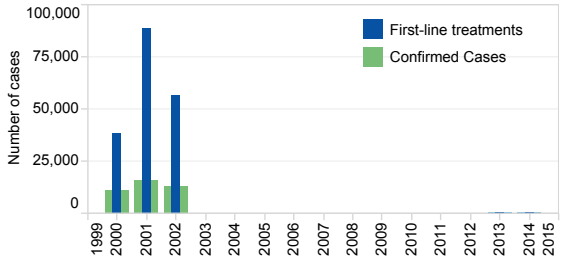
Figure 5. Blood slides examined, RDTs examined, and SPR in Suriname, 2000-2014



Diagnosis and Treatment

Suriname began to use RDTs in 2007, yet they have become pivotal in identifying cases in gold miners where tests are performed by lay persons trained as health workers. As of 2014, the number of RDTs examined almost equaled the number of slides examined (Figure 5). All RDTs are supposed to be followed by microscopy diagnosis according to country guidelines. Although owing to the precarious conditions in the field, it is not possible to enforce or implement this directive. The SPR was 1.21 in 2014, and a total of 17,608 slides were examined. Artemether-lumefantrine combination therapy is the first-line of treatment used for *P. falciparum* cases, while chloroquine and primaquine are used for *P. vivax* (Figure 6). The decrease in sensitivity of artemisinin was reported in *P. falciparum* in Suriname, though further unpublished studies demonstrate no such decrease. However, conditions in the Guiana Shield, especially mining areas are propitious for development of resistance. Artemisinin monotherapy is available though it is of low quality and the treatment regimen not completely adhered to by miners.

Figure 6. Number of malaria cases and those treated with first-line treatment in Suriname, 2000-2014



*Data unavailable for 2003-2012.

Vector Control

ITNs have been used in Suriname as a means of vector control, but usage has been declining since 2010 and only 6,164 people were protected by them in 2014 (Figure 7). IRS is not used in the country for malaria prevention.

Funding

The Global Fund has supported the two projects mentioned previously, while USAID supports AMI/RAVREDA. The USAID has continually provided funding to Suriname since 2001 (Figure 8). Governmental funding for malaria was not reported from 2006-2010. Estimates were made for the concept note submitted to the Global Fund in 2015. They indicate that over the years the government has provided the majority of the financial resources.

Figure 7. People protected by IRS and by ITNs in Suriname, 2000-2014

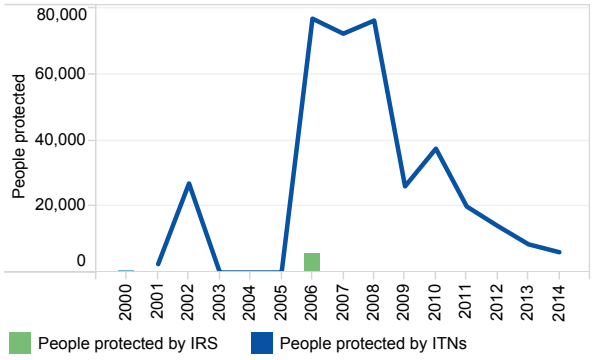
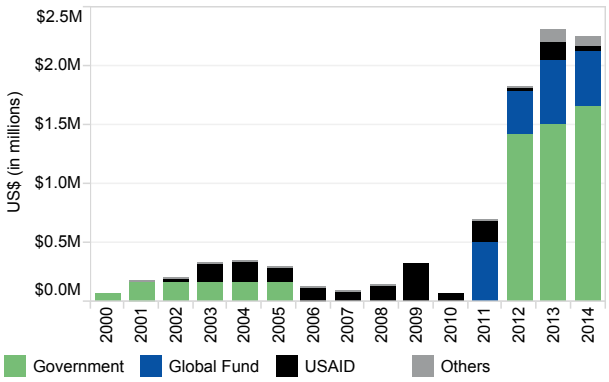


Figure 8. Funding for malaria in Suriname, 2000-2014



VENEZUELA, BOLIVARIAN REPUBLIC OF

Venezuela is one of the few countries in the Americas that has had an increase of cases since 2000 and ranks as the country with the highest increase at 205% of cases. There were 90,708 cases reported in 2014, which is more than the country has reported in over 50 years (Figures 1 and 2). In the 1950s, Venezuela actually served as a model for elimination efforts and was certified by WHO to have eliminated malaria in its northern part. Despite the current alarming morbidity, the death rates have not mirrored the morbidity trends and there has been a 79% decrease since 2000.

Malaria mostly occurs in the southern states of Amazonas and Bolivar. Sifontes, a municipality in Bolivar state that shares a border with Guyana, has reported 58% of all cases in the country (Figure 3). The areas most affected are those where gold mining occurs. The large population in mining areas, poor living conditions, and lack of development have all led to the increase of malaria in this area.

In 2014, *P. vivax* caused 69.3% of malaria infections in the country, while *P. falciparum* caused 23.2% of cases. There were also 15 reported cases of *P. malariae* in 2014. *Anopheles darlingi* is the predominant vector in the country.

Figure 1. Malaria by Annual Parasite Index (API) at municipality level (ADM2), Venezuela 2014

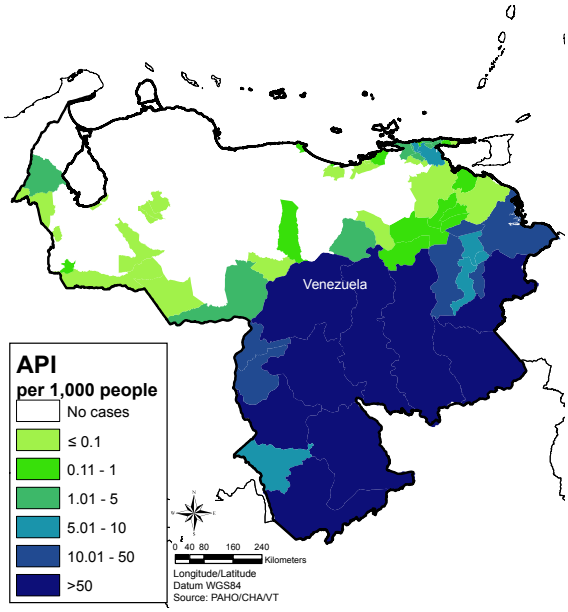


Figure 2. Number of cases and deaths due to malaria in Venezuela, 2000-2014

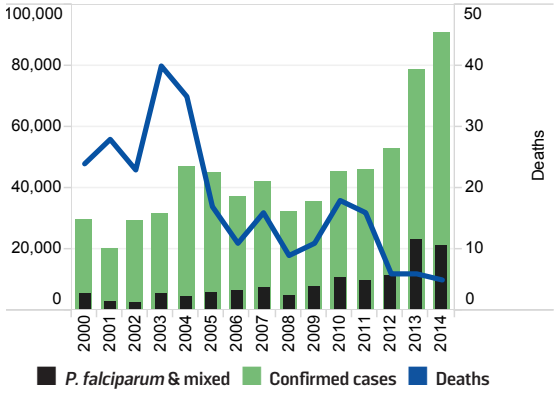


Figure 3. Municipalities with the highest number of malaria cases in Venezuela, 2012-2014

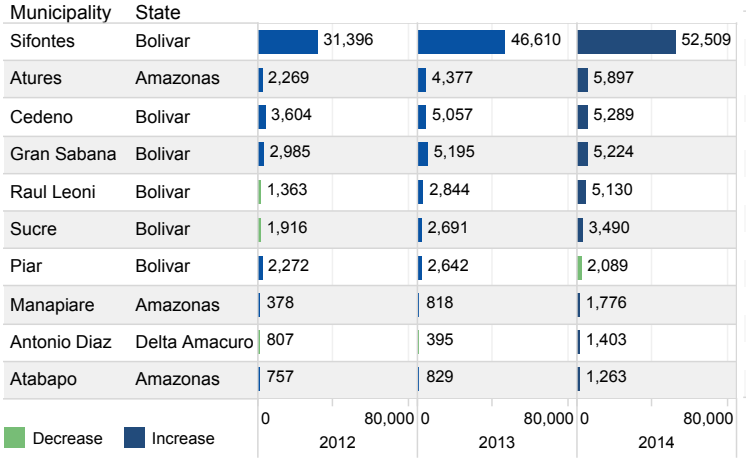
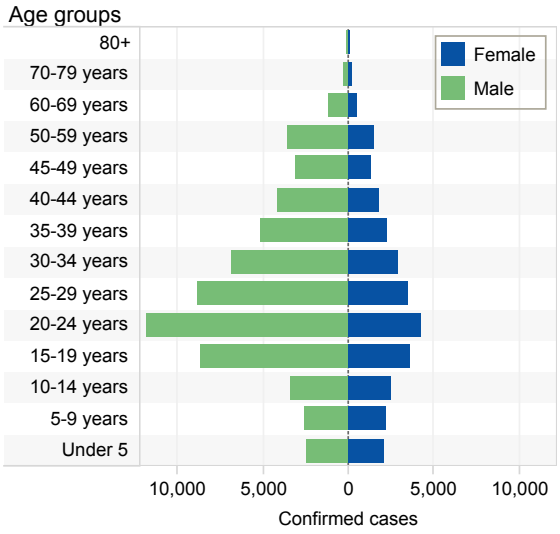


Figure 4. Malaria cases by age and sex in Venezuela, 2014



Generally, young men between the ages of 20-24 years were the most affected (Figure 4). The malaria incidence in women (14.5 cases per 100,000) was less than half of that in men (36.5 cases per 100,000 men) in 2014 (Figure 5). Occupation is a risk factor for men. The incidence in pregnant women was 69 malaria cases per 100,000 pregnant women in 2014, which was significantly lower than that in non-pregnant women of child-bearing age (267 cases per 100,000 women for that year). This is perhaps because malaria transmission largely happens outdoors.

Priority Groups

Gold miners are the principal population of concern as well as those who live in populated areas near gold mines. There is also a significant amount of indigenous people that are affected including the Guahibos and Yanomamis who reside in the Amazon area near the Colombian and Brazilian borders.

Figure 5. Malaria incidence by age and sex in Venezuela, 2014

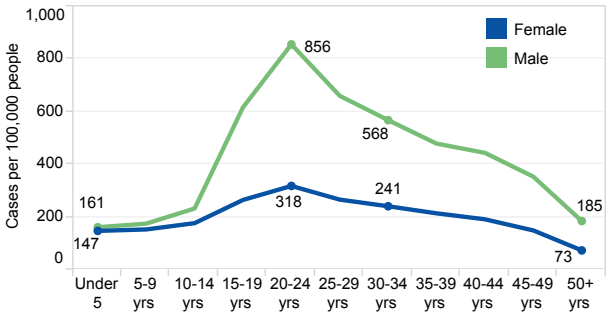
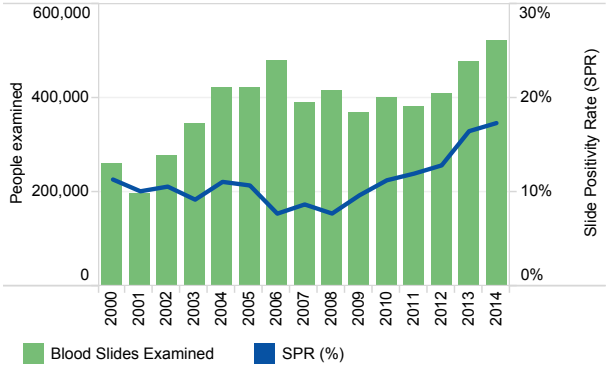


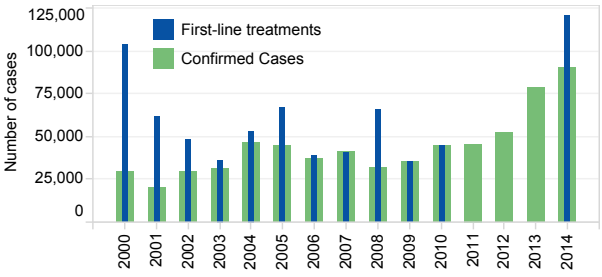
Figure 6. Blood slides examined and SPR in Venezuela, 2000-2014



Diagnosis and Treatment

Microscopy is used to diagnose malaria, though the Global Fund via PAMAFRO donated RDTs in 2007 for a pilot study conducted in the Amazon forest area (Figure 6). In 2014, the SPR was 17.36% which, has risen in the past few years along with the incidence rate. Medication is free in the public health system, but stock-outs have been reported. A 14-day treatment of cholorquine and primaquine is the first-line treatment for *P. vivax* infections, while the combination drug of artesunate-mefloqiune-primaquine is used for *P. falciparum*. Drug efficacy studies have not been reported in the past 10 years even as the probability of development of resistance to artemisinin remains high in the Guiana Shield area.

Figure 7. Number of malaria cases and those treated with first-line treatment in Venezuela, 2000-2014



*Data for first-line treatment unavailable for 2011-2013.

Vector Control

Vector control interventions have been used extensively in the past 7 years. In 2014, more than 4 million people were estimated to be protected by IRS (Figure 8). Insecticide-treated nets have also been used as a means of vector control, but usage has been declining since 2008 and only protected an estimated 5,400 people in 2014.

Funding

Financial resources for malaria have mostly come from government during the past 5 years (Figure 9). Venezuela is currently not eligible for funding from the Global Fund. Since 2010, governmental funding has decreased by US$11 million, though the reported decrease in funding during 2009-2010 could be due to inconsistencies in reporting. Funding increased thereafter between 2012 and 2014. However, the funding reported in 2014 is less than that reported in 2000, while malaria incidence has reached a record high. The increase in funding reported during 2012-2014 is not proportional to the dramatic increase in malaria cases.

Figure 8. People protected by IRS and by ITNs in Venezuela, 2000-2014

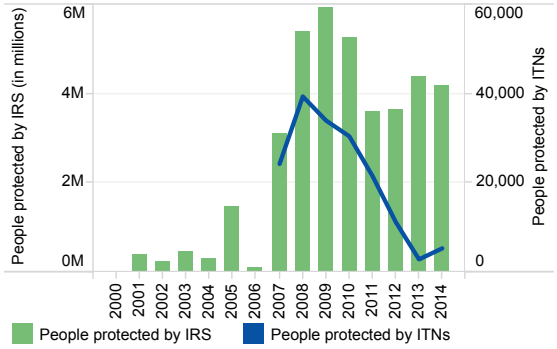
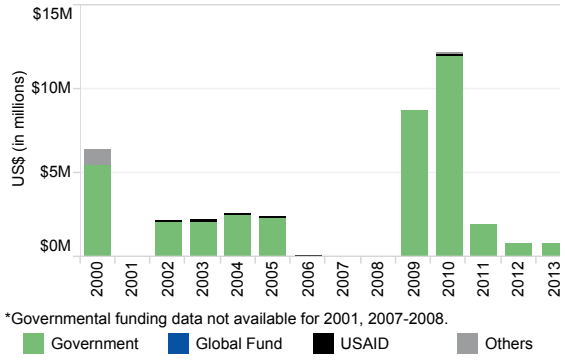


Figure 9. Funding for malaria in Venezuela, 2000-2014



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ANNEX

Methodology

The data used for this report were officially provided by the Member States to PAHO/CHA/VT as part of the annual requests sent to the national health authorities. Data were collected from endemic countries using a standardized form designed by the WHO's Global Malaria Programme with the intention of collecting information for the World Malaria Report and was coordinated by PAHO. A PAHO Annex form requesting supplementary information is also requested of all endemic countries and includes other data points relevant to the Region of the Americas. PAHO's form for non-endemic countries was used to collect information from malaria-free countries and territories in the Americas. The forms and resulting databases were created using Microsoft Excel® and Access® to manage data. Tableau®, R and Microsoft Excel® were used for statistical analyses for this report while mapping was done using ArcGIS®.

The focus of this report is mostly on information from the year 2014 or the most recently available data reported by the countries as well as information from the time period during 2000-2014. Known data limitations are Ecuador's reporting in 2014, where the only data reported consisted of the number of malaria cases, blood slides examined, species information, and external funding contributions. Similarly, data have been unavailable for specific indicators and countries for certain years during the 2000-2014 period, which has been duly noted where appropriate. Discrepancies were observed in the number of deaths due to malaria reported by countries to PAHO/CHA/VT compared to the deaths due to malaria registered in PAHO's Regional Health Observatory. Both these data were officially reported by the countries, although their respective source within the Ministries of Health varied. Though this discrepancy exists, we only used the officially-reported death figures provided on the World Malaria Report forms for our analyses. Over the years, countries have enhanced their surveillance systems further increasing the possibility of biases in our overall measurement of long-term trends. Specific gaps in data and possible errors have been noted where identified.

The majority of the maps in this report were created with data collected at the second level administrative division (ADM2) otherwise known as municipalities, districts, cantons, etc. Haiti and Bolivia reported data at the third-level administrative division (ADM3) known as communes and municipalities respectively. Guyana and Suriname reported data at the first level administrative division (ADM1) known as regions and districts respectively. For Peru, data were only partially available at the district (ADM3) level for some regions (ADM1). Data at the ADM1 level were used for maps of Peru where ADM3 data were not available. Foci information was reported at the smallest administrative unit available for some countries in the pre-elimination and elimination phase which included: Argentina, Belize, Costa Rica, El Salvador, and Paraguay. While the objective of geographical data is to locate where transmission occurs, errors may be introduced when countries record the cases by place of diagnosis instead of place of infection. It may also be difficult to visualize disease distribution when data is reported at the ADM1 level due to the larger and less specified area covered by ADM1 units. The boundaries and names shown and the designations used on the maps in this report do not imply the expression of any opinion whatsoever on the part of PAHO/WHO concerning the legal status of any country, territory, city or area of its authorities, or concerning the delimitation of its frontiers or boundaries.

The total population at risk for malaria has not been consistently defined for countries across the years or for a single year across countries and is an estimated figure at best. Thus this variation in population at risk affects analyses where it is used as a denominator to measure incidence or coverage. Countries have provided the total number of people at risk both at national level and sub-national level allowing for the calculation of incidence at both levels.

Ranking of municipalities (ADM2) by the highest number of cases and by API was conducted using data at the smallest administrative unit available: ADM3 in Peru, Bolivia, and Haiti; ADM1 in Guyana and Suriname. Relative change in number of cases and API was determined by comparing figures from the previous year. The year 2012 was compared with information from 2011, although the latter was not displayed in any of the figures.

In figures displaying the number of municipalities (ADM2) by strata, the strata were defined as follows: Stratum 1 – no autochthonous cases in 2012-2014, Stratum 2 – less than one case per 1,000 inhabitants in 2012-2014 and Stratum 3 – more than one case per 1,000 inhabitants in one or more year. Municipalities, for which no data was provided for all three years, were classified as "No information". New municipalities created after 2012 or those for which data was available for two or one year only, were classified as "Stratum 2" if zero autochthonous cases were reported for the years for which information was available.

Additional information collected through the PAHO Annex form including malaria cases by age, sex, ethnicity, occupation, urban or rural residence, current malaria treatment regimen, antimalarial efficacy studies, insecticide resistance surveillance, and access to diagnosis and treatment was not reported by some countries and corresponding tables and figures based on their analyses reflect this unavailability of data.

Time between first symptom and initiation of treatment reported by countries is not always measured in a standardized manner across the Americas or within the same country over the years. Therefore results from this analysis require careful scrutiny in determining the timeliness of treatment. Furthermore, the number of people treated with first-line treatment or by ACTs only must also be carefully analyzed since some countries calculate this based on the number of antimalarial tablets consumed or distributed in a year.

For countries that had only a few cases in 2014, cases from more than one year were included to ascertain age and sex composition of confirmed malaria cases. These countries were Argentina, Belize, Costa Rica, El Salvador, and Paraguay. Malaria incidence by age and sex was calculated using the number of malaria cases reported by countries and population estimates by respective age and sex for the entire country from the UN Population Division Databases available online. Bias may occur as the population structure at the national level could be different from malaria endemic areas of the country leading to inaccuracies in analyses of risk; nonetheless population estimates by age and sex at subnational level is not available for all countries to PAHO/WHO and were not used. Incidence rates by age and sex from 2013 and 2014 were compared for each country to ascertain significant changes in risk profiles from one year to the other. Data for these two years were combined to calculate age and sex-specific incidence in Panama due to widely varying results for each year; 95% confidence intervals are shown as a good practice to foment analyses by individual countries.

The "Proportion of malaria cases by species, 2014" graph was produced using the total number of confirmed cases in each country as the denominator in order to visualize proportions.

To measure vector control interventions, ITN and IRS information was analyzed. The "ITN coverage by countries in the Region of the Americas, 2014" graph contains estimated figures of the number of people protected by ITNs. The number of bed nets distributed by countries has been routinely reported. However, to obtain a more accurate figure of the amount of people protected by ITNs year after year, a model was used. This model assumes that each bednet protects 1.8 people presuming that not all bednets are used by two people; especially in houses where there are an odd number of people living at least one bed net would protect only one person. Also children would usually sleep with parents while older children and elderly people might sleep alone. A 10% administrative loss was assumed for the number of bed nets reportedly distributed. The relative efficacy period of an LLIN is approximately 3 years; however a loss of 20% of the amount of LLINs distributed in mass campaigns were presumed on account of physical wear and tear for each successive year (year 1 = 20%, year 2 = 40% and year 3 =100%). For conventional ITNs the efficacy was presumed for one year only.

The estimate of the amount of people protected by ITNs for 2014 was divided by the number of malaria cases reported in the same year, and multiplied by 10 to get an estimate for 'number of people protected by ITNs per 10 cases of malaria' thereby demonstrating another way to analyze ITN coverage in countries. The number of people protected by IRS is also routinely reported by countries. The total number of people protected by IRS was divided by the number of malaria cases in 2014 and multiplied by 10 to get an estimate of the 'number of people protected by IRS per 10 cases of malaria.'

Data for malaria cases in ethnic groups and indigenous populations were provided by the countries via the PAHO Annex form. In Guyana, incidence rates for these groups were calculated using population data from the year 2012 Guyana national census.

Data about malaria in pregnancy were also requested by the WHO. For the "Malaria in priority groups in the Region of the Americas" graph, the percentage of malaria cases in women of child-bearing age was calculated with a denominator derived from the number of women between the ages of 15-45 in each country as estimated by the UN Population Division for the corresponding year. The number of pregnancies in a year was used as a denominator for calculating the incidence of malaria in pregnancy. The crude birth rate in a country from the UN Population Division was used to estimate number of live births. Stillbirths and miscarriages were estimated to be around 15% of live births in a country in a year. Each full term pregnancy contributes 9 months of person-time at risk in a year while miscarriages and abortions account for lesser time at risk. A weighted estimate of full-term pregnancies plus those pregnancies that terminate early was estimated to be 70%, i.e. every pregnancy was considered to contribute 0.7 person-risk year. The incidence of malaria in pregnancy was compared to the incidence of malaria in non-pregnant women of child-bearing age. The latter was calculated by using the difference of the number of malaria cases in women aged 15-45 years and those in pregnant women as the numerator. In countries where malaria incidence data by 15-45 years was not available, 15-49 year age group was used. The difference of the number of women of that age range and the number of pregnant women in a year was used as the denominator. A relative risk was calculated using these two incidences. Furthermore, 95% confidence intervals were calculated assuming Poisson distribution in R statistical software. Only significant results are discussed in this report.

A draft of this report was shared with country counterparts to identify inaccuracies in presented data or analyses.

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