ORIGINAL RESEARCH

The Epidemiology of Malaria in Colombia: A Heretical View

Jaime Carmona-Fonseca

Abstract

Background: Studies on the long-term behavior of malaria are scarce in Colombia and, in general, are aimed at explaining this behavior from a perspective that adjusts to the function of the apparatuses responsible for the control of the disease, without applying a critical vision. **Objective***:* To present epidemiological data on malaria in Colombia and to try to explain its long-term behavior from a point of view that questions the functionalist vision. **Methodology***:* The data presented in this paper was collected in a non-systematic review. The authors sought to find data and arguments that sustain the criticism of the issues addressed. **Results:** The tendency of malarial morbidity, as expressed with the annual parasitic index adjusted for the exposed population, increased in the period 1935-2020. None of the ideological or administrative changes used in control or eradication programs has managed to affect this trend. The supposed influence of the "resistance of parasites to medicines" and of anophelines to insecticides has been scarce and unimportant. **Conclusions**: the why of malarial morbidity behavior in Colombia should be studied thoroughly, systematically, and critically, giving priority to the study of the processes of social determination of the disease. **Key words:** Malaria, *Plasmodium*, epidemiology, Colombia.

Introduction

Studies on the long-term evolution of malaria in Colombia are few. In general, they are oriented towards the interests of those who are involved in malaria control and/or they address the interests of those in charge of malaria control.

As a result, a body of knowledge (more or less, extensive on a particular topic), emerges until finally a large body of knowledge develops among those in charge of malaria control. Many people outside of those in malaria control, will end up repeating a given slogan without thinking about it critically. This procedure describes very well what is known as a chain of rumors.

> Rumor has it: vague news that runs among people; the confused noise of voices; dull, vague and continuous noise; it has multiple synonyms: noise, whisper, murmur, *runrún*, *bisbiseo*, *cuchicheo*, sound, gossip, talk, murmuring, tale, mess, history, *bulo*, etc. (http://www.wordreference.com/sinonimos/rumor, accessed May 19, 2019).

Rumor is a specific proposition designed to be believed, passing from person to person, with no sure means of proof. It has been pointed out that sometimes a "scientific truth" is repeated with such frequency that we end up considering as a standard of science.

This piece seeks to demonstrate which rumors have circulated on matters such as are of malaria transmission and the number of people exposed to such parasites; plasmodial resistance to antimalarial drugs or anopheline resistance to insecticides, among many other issues. The data and arguments used are taken from academic and scientific publications that are clearly and precisely cited.

Malarial Territory and "at risk populations." Colombia's surface area is 1,141,748 km²). More than 60 years ago, it was found that, once again, 85% (1,019,420 km²) of the territory was susceptible to malaria (2-4). According to official data and government officials (Table 1), it is exceedingly difficult to understand how large the malarious area is and how many people live there.

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Table 1.
Malarial area and its population, Colombia, different years, and sources

Source	Area (km^2)	Population at risk for illness or death
Padilla & Peña 2002	a) 85% of total territory: 1,141,748 km² [www.urosario.edu.co/CMUDE2015/Sedes/faqs/], 970,486 km²). b) Under 1,500 meters over sea level (MOSL). c) "Active transmission area": 683,863 km² d) 59,9% of total country area and 70,5% of the susceptible area of 970,486 km².	a) 60% of the population "at risk for illness or death" (24,797,400 of 41,329,000 [Dane]). b) ≈ 21,556,452 inhabitants live in "susceptible to transmission" areas ("with eco-epidemiological and socioeconomic characteristics which favor the transmission of mosquitos" (that is, in 970,486 km²). c) 23,33% (9,548,933/40,926,058) [Dane] or 44,30% (9,549,508/21,556,452) [authors] live in an area of "active transmission."
Colombia, Minprotección 2003	85% of territory below 1,600 (MOSL).	≈ 25 million
Colombia, INS 2010	c) Below 1,500 (MOSL).	12 million live in "zones at risk for transmission".
Gobernación de Antioquia 2014	No data	≈ 60% of the total population "at risk for illness or death" (in 2014: 45,650,000 inhabitants [Dane], thus, total exposed population is ≈27,390,000).
WHO 2008, 2014, 2017	No data	7,911,000; 10,620,000; 10,800,000 exposed persons, respectively; 2008-2017 average= 9,777,000. This value is like Padilla & Peña 2002, regarding the population in active transmission areas.
Summary for five sources	"Susceptible to transmission" area: 970,486 km^2 "Susceptible to transmission" area: below 1,500-1,600 (MOSL) "Active transmission" area: 683,863 km^2	60% of the total population, i.e. 24.8 million (Padilla & Peña 2002; Col-Minprot 2003; GobAnt 2014). Another source says it is 1/5 of previous figure of 60%, i.e 12 million (Colombia, INS 2010). Two other sources refer to ≈9,663,000 (Padilla & Peña 2002; WHO 2008-2017).

Source: self- elaboration.

The National Health Institute (INS) decided to indicate the number of cases and the corresponding annual parasitic index (API) coming from a "population at risk (rural area), but INS did not define "rural"; which we understand as:

> Rural area or municipal rest: it is characterized by the dispersed arrangement of housing and farms existing on it. It does not have a clear layout or nomenclature of streets, roads, avenues, and so on. It also does not generally have utilities and other facilities typically found in urban areas (Access: June 4, 2018, https://www.dane.gov.co/files/inf_geo-/4Ge_ConceptosBasicos.pdf, accessed: April 4, 2018).

-- Quantity of people exposed, according to different editions of World Malaria Report (WMR), which reproduces government data, show significant, unexplained variations between years. For example: In 2011 there were 15.5 million exposed (WMR 2011) and in 2013 there were 10.6 million exposed (WMR 2013). This is a decrease of 4.9 million, which corresponds to decreases those exposed by 69%.

-- The Ministry of Health (MSP) and WHO report an exposed population of 22.4- 34.0% of the total (minimum 10,730,000 inhabitants in 2015, or 22.50% of the total 47,730,000).

-- MSP y WHO consider places with API > 0 (WMR 2013) as being at risk, (the equivalent to "case-occurring", as anywhere from one to thousands of cases are greater than zero).

Our calculations with rural population data and a meters above sea level (MOSL) of Colombian municipalities indicate that, in 2019, 821 municipalities (73% of 1,122) had their headers located up to 1,800 MOSL; the rural population living there were 9,272,54 people (18.4% of 50,374,644 and 79.9% of the rural total 11,604,141). Data adjusted according to the 2018 census indicate: Total population: 45,500,000; rural: “scattered rural” 15.1% + “rural populated centers” 7.1%; total: 22.2% rural population; the rural population living in the 821 municipalities referred to is 8,375,631 people (18.4% of the total).

“The 821 municipalities” include extensive areas with relatively good mosquito control. This could suggest that these municipality aren’t areas of active transmission whose population “isn’t at risk” with the proper licenses. If the rural population living in these “controlled areas” is subtracted from “the 821 municipalities” (where 5,938,838 people live), the rural population resident in such municipalities and where there is no malaria control will be reduced to 3,334,116 inhabitants (3.34% of 45.5 million); this is the “truly exposed population” or “resident in areas with active transmission.” There are 241 municipalities truly exposed (21.5% of 1,122; 29.3% of 821). Annex 1 Part A sets them out.

All this problem of the really exposed population is illustrated with Graph 1, which

All this problem of the really exposed population is illustrated with Graph 1, which shows three different values of API, all logical but with different logics. Series 1 are data from the *Boletín Epidemiológico Semanal* (*Weekly Epidemiological Bulletin*); Series 2 corresponds to the assumption that the population living in areas with active malaria transmission went from 9.2 million (22.9% of the total) in 2000 to 11.8 (25.9%) in 2018; Series 3 corresponds to the API adjusted according to the exposed population residing in municipalities with headwaters up to 1,800 MOSL in which there is no adequate malaria control; it assumes the same exposed population from 2000 to 2019 (3,334,116; in reality, it must be reduced in absolute figures and the API must increase if the same cases reported by INS-Sivigila are maintained) (Annex 1 part B).

The official API varies in those 19 years between 3.90 and 11.50, with an average of 6.52 and its trend is stable; the API based on the population residing in transmission areas (data used by other sources) ranges between 3.21 and 24.66; that is, it varies much more than the “official”, the average is 10.94 and its trend is “moderately ”decreasing; the API obtained with assumptions of the resident population in height ≤1,800 MOSL and in municipalities without adequate malaria control varies much more than the others, between 10.09 and 69.35, its average is 32.71 and has a strongly decreasing trend .

Trend morbi-mortality long term

The incidence of malaria in 1935-2018 (with adjusted API) appears in Graph 2. There is a clear increasing trend of the API in those 84 years, with important temporal variations.

The trend in cases is decidedly increasing between 2000 and 2010, but the outlook worsens with the addition of the great epidemic of 2015-2017 (3). No change in the ideological or administrative orientation of the control or eradication programs has managed to affect the essence of the epidemiology of Colombian malaria, except for the extraordinarily strong reduction in mortality, analyzed by other authors (5).

The alleged "resistance to antimalarials"

One author wrote in 1986:

> references to in vivo or in vitro resistance studies are very scarce, but are cited repeatedly, creating an endless chain made up of very few links (6).

That describes very well what is known as a chain of rumors. She said:

> Repeatedly reference is made to the resistance of *P. falciparum* to chloroquine in Colombia with expressions such as:" the geographic distribution of this resistance corresponds to the distribution of *P. falciparum* (PAHO. Guidance on malaria chemotherapy. Washington: PAHO, 1979; Scientific Publication 373) (6).

She also expressed:

> all areas in Colombia malarial, except the Pacific Coast, are resistant to chloroquine by *P. falciparum* ("Areas with P. falciparum resistant to chloroquine." *Medical Letter*, 1980, 21:8) (6).

She noted they state that:

> … in most malarial areas there is resistance to the main drugs such as chloroquine and amodiaquine and both in vivo and in vitro it has been shown that between 70 and 90% of infections are resistant to amodiaquine and a 60% to chloroquine and quinine (Espinal CA. Colombian experience in malaria. Roche Malaria Forum 1984) (6).

She picked up another rumor:

> the resistant strains are scattered throughout the territory; most resistant grades 1 and 2, but clearly increased resistance grade 3 (Restrepo A. Treatment with clindamycin malaria P. *falciparum* resitente Acta. Phys Colomb 1984; 9: 15-21) (6).

She picked up one more whisper:

> antimalarial resistance has a: causal role in the failure of malaria eradication in the country (Espinal CA, Toro G. Malaria. Mimeographed; Espinal CA, Eslava A. In eight years, Colombia will produce antimalarial vaccine". Consulta Magazine 1981) (6).

To confront her suspicion that antimalarial therapy resistance and failure in Colombia were more than reality rather than gossip/story/hoax, she reviewed the relevant literature for 1961-1986. What did she find?

> Of the 48 articles, 12 are studies on resistance carried out in Colombia (in vivo, in vitro, or both); of the rest, some refer to the subject, but there are several that do not say anything about it, they were cited as a reference in this regard; There are even articles on resistance in other countries that, taking up repeatedly cited bibliographies, make mention of resistance in Colombia" (6). A conclusion: "drug resistance in Colombia is unknown, making scientific studies of the problem necessary to measure its prevalence, avoiding the paralyzing effect of said conclusions.

Other authors have said:

> The therapeutic failures of chloroquine (CQ) in patients with uncomplicated *P. falciparum* malaria in Colombia are well documented in some areas of the Pacific coast, the Amazon Region and in the department of Antioquia (Espinal et al. 1985; Blair 1986; Osorio et al. 1999). On the other hand, the susceptibility of *P. vivax* to CQ has not been sufficiently studied. However, recent reports of CQ treatment failures in *P. vivax* cases in Brazil, Guyana, and Guatemala (Padilla *et al*. 1998, Alecrim *et al*. 1999, Baird & Martin 1999) point to the need to evaluate and monitor the susceptibility of *P. vivax* to CQ in other countries of the region (7).

If "therapeutic failures" mean that they exist, that they occur in isolated cases, we totally agree, but if we want to imply that they have played a key role in the epidemiological behavior of malaria in Colombia or in the failure of the government program to control malaria, the discrepancy is absolute and then we will show the figures and their interpretation to refute it.

Subsequent reports confirm Blair 1986 findings, which are current, and therefore such additional writings confirm that the issue of the impossibility of controlling malaria in this country as a result of the powerful influence of resistance to antimalarial drugs (evaluation in vitro) and their therapeutic failure (in vivo evaluation) is a simple hoax or, at best, is crass ignorance. For example, the first thing to be clear about is that after the use of any antimicrobial, treatment failure/therapeutic failure (*in vivo* evaluation) or resistance of the microbe to it (*in vitro* resistance) occur in a percentage of cases, which It varies according to the dose, from one place to another, from one parasite to another, in time, the way to measure it, etc.

This is due to genetic variants/mutants, which exist in the microbial population and are not induced or caused by the drug. Prolonged use of the drug, even under optimal conditions, will gradually select the variants / mutants with natural resistance and these will increase their percentage participation in the microbial population mass and could become the majority. In short, "the drug used, the mutant detected". For example, in *Plasmodium*, mutations appear with a frequency of 9.5-71.2×10^{-10} mutations per genetic site and year in the gene coding regions (8) and with a frequency of 1.5910×10^{-4} mutations per genetic site and year in microsatellites (9).

In Colombia, in 1961-2003, the unweighted average failure of monotherapies for uncomplicated falciparum malaria was 66% for CQ (13 reports), 22% for amodiaquine (AQ) (9 reports), and 15% for sulfadoxine-pyrimethamine (SP) (14 reports) (Table 2). Bear in mind that monotherapy was used when there were not enough drugs and the serious risk of failure and resistance that they imply was not known; now they are outlawed. In 2000-2009, studies with similar methodology were carried out, according to the WHO 1998 protocol, to evaluate therapeutic failure:

- **2000-2004,** Turbo (Urabá), El Bagre and Zaragoza (Bajo Cauca); uncomplicated falciparum malaria; follow-up: 21-28 days; evaluated monotherapies and combined treatments (10).
- **2000-2004**, Quibdó (Chocó); evaluated amodiaquine- placebo (almost equivalent to monotherapy with AQ) and amodiaquine-artesunate, each with 42-43 patients (11).
- **2007-2008**, Urabá; mefloquine-artesunate was evaluated in 50 patients, followed for 42 days (12).
- In Tadó and Quibdó in Chocó, 105 patients per group, uncomplicated falciparum malaria; evaluated amodiaquine-artesunate and artemether-lumefantrine (13).

Summary of results (percentage of failure): CQ 82%, AQ 30%, SP 24% and mefloquine 4%, respectively. In no study with combined therapies, not even in those without artemisinin derivative, the failure reaches 18% and only in one is it 17.2% (CQ-SP).

Table 2.
Frequency (%) of *in vivo* failure of antimalarial monotherapies by site, Colombia, 1961–2003 (a)

Place	**CQ** (b)	**AQ**	**SP**	**Reference**
Colombia	82.0			Walker 1968
Colombia (d)	16.4	28.3	34.7	Blair 1986
Colombia (e)			24.0	(cited in Ravreda 2003 meeting)
Colombia (e)			25.0	(cited in Ravreda 2003 meeting)
Colombia *in vitro*	96.0	3.3		Espinal 1985 (c)
Average	64.8	15.8	27.9	5 reports
Antioquia			34.0	(Restrepo cited in Ravreda 2003 meeting)
El Bagre (Antioquia)	82.0	38.0	10.0	Flórez 1988
El Bagre (Antioquia)	71.0	12.0	15.0	López 1999
Zaragoza (Antioquia)	67.0	3.0	9.0	Blair 1999, 2002
Turbo (Antioquia)	97.0	7.0	13.0	Blair 1999, 2001
Collided	52.0			Comer 1968
Quibdó, (Chocó)	44.0			Osorio 1999
Quibdó, (Chocó)			6.0	Osorio 1999
Tadó (Chocó)		27.0	16.0	(González 2002 cited in Ravreda 2003)
Cali Valley)	78.0			Castillo 2002
Buenaventura (Valley)			3.0	Méndez 2002
Tumaco (Nariño)	70.0	54.0		Flórez 1988
Tumaco (Nariño)	40.0	18.0	0.0	Flórez 1988
Tumaco (Nariño)		50.0	15.3	González 2003
El Charco (Nariño)		0.0	0.0	González 2003 (f)

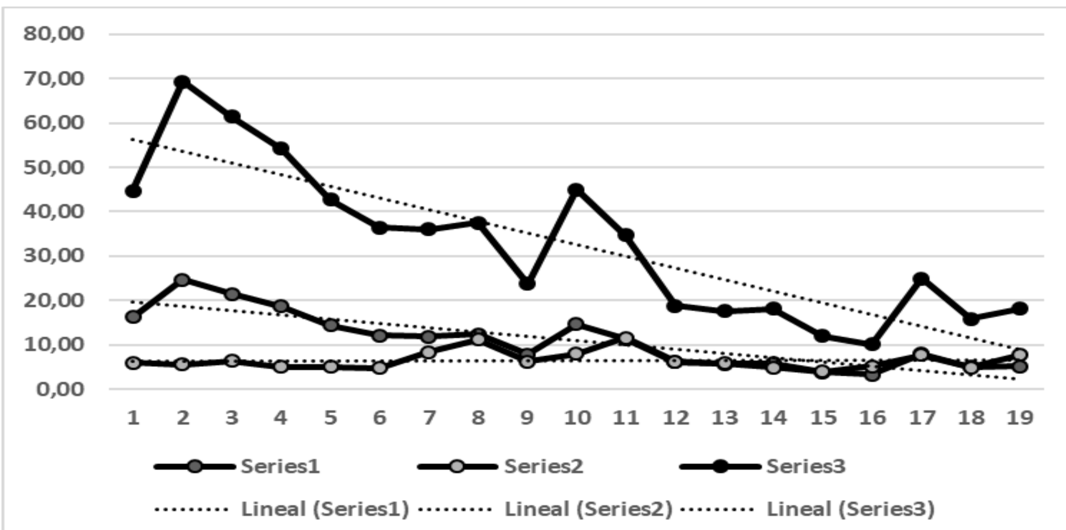
Orinoquia and Amazonia			(3)	Espinal 1985
Arithmetic average	70.0	19.9	14.6	

(a) Response evaluated in patients (*in vivo*), except where stated otherwise (*in vitro*). Duration: approximately 1961–2003. Blank cell: no information.
(b) AQ amodiaquine, CQ chloroquine, SP sulfadoxine-pyrimethamine, CL clindamycin, MQ mefloquine.
(3) Espinal 1985 report: it does not say the percentage of failure to SP; it only states that there were 3 cases in Orinoquia and 9 in Amazonia.
(d) AQ-CL: Blair 1986 reports a study with 3.8% failure.
(e) MQ-SP: 0% failure in 1982 and 1985; fails 0% in Botero *et al*. 1985. MQ: 8.3% failure in Amazonia.
(f) AQ-SP: González reports 11.0% failure at this location.
Source: our elaboration.

The AQ-SP scheme failed by 2.2%, comparable with schemes with artemisinin's, such as SP-AS (3.4%), AQ-AS (2.4%).

Conclusion: in Colombia, the therapeutic failure of combined antimalarial treatments has never been a major problem, not even those that have not included artemisinin derivatives.

Graph 1
Incidence of malaria in Colombia, 2000-2018, according to three exposed populations used to calculate the annual parasitic index (API)

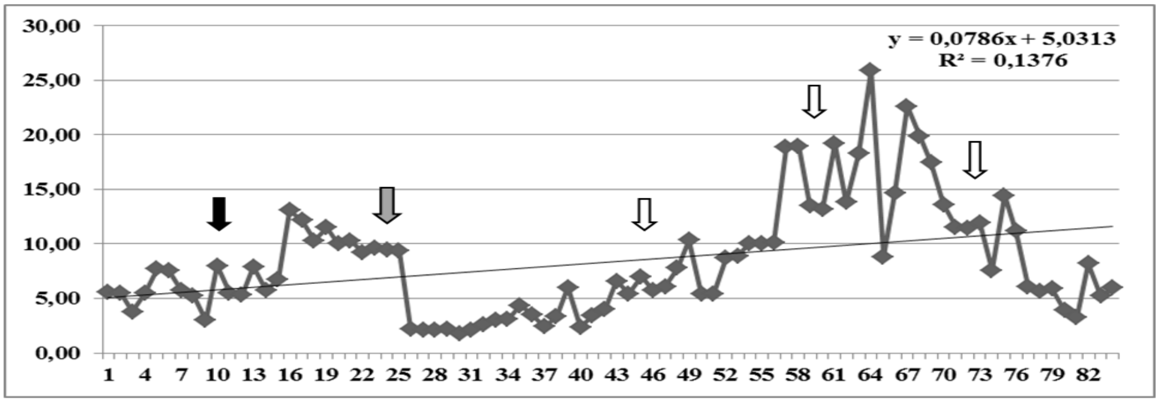


1= 2000 6= 2005 11= 2010 16= 2015 19= 2018

Series 1: the lowest line: data from the Sivigila -INS (*Boletín Epidemiológico Semanal*); is the "official data".
Series 2: line in the middle area: population living in areas with active malaria transmission went from 9.2 millions (22.9% of the total) in 2000 to 11.8 million (25.9%) in 2018.
Series 3: highest line: exposed population: 3,334,116; it is supposed to be the same from 2000 to 2019; it is population living in municipalities with head ≤1.800 MOSL and uncontrolled malarious effective.
Official API: it varies in those 19 years between 3.90 and 11.50, the average is 6.52 and its trend is stable.
API based on population living in areas of active transmission (data used by other sources): it ranges between 3.21 and 24.66, that is, it varies much more than the "official" one, the average is 10.94 and its trend it is "moderately" decreasing.
API obtained by the author with the assumptions of resident population in height ≤1,800 MOSL and in municipalities without adequate malaria control it changes much more than the others, between 10.09 and 69.35, its average is 32.71 and has a trend strongly decreasing.
Source: own construction based on data from sources and author's calculations and adjustments.

Graph 2

Incidence of malaria in Colombia, 1935 and 2018, according to the annual parasite index (API), adjusted for the rural population living in municipalities whose head is located at ≤ 1,800 MOSL



Solid line represents the trend in the 84-year period (1935-2018).

Black arrow: National Malaria Control Campaign is established, around 1944.

Gray arrow: the SEM Malaria Eradication Service is created, around 1957.

Arrow with oblique stripes: the eradication strategy was changed to that of control, around 1978.

Arrow with horizontal stripes: the eradication-control program went from having a vertical structure and operation (in charge of the Nation) to having them horizontal (in charge of the departments), around 1993.

Blank arrow: Artemisinin- based treatments are adopted for falciparum malaria, which represents 30-40% of the country's total, by 2006-2007.

The API for 1935-1970 was obtained as *follows*: the census populations of 1938, 1951, 1964 and 1973 were taken; Based on these populations, the annual intercensal populations were calculated. On the other hand, the list of Colombian municipalities was obtained in Wikipedia (https://es.wikipedia.org/wiki/Municipios_de_Colombia) and the data on the height above sea level at which its municipal head is located was obtained. It was assumed, with remarkable laxity, a header over 1,800 MOSL implies that the inhabitants of the municipality are risk malarial, while a header located up to 1,800 MOSL it implies that people are at risk malarial potential. The total population of 2019 projected by the Dane (N = 50,374,644) was taken, not that of the 2018 census, and the rural population of the same year that lives up to 1,800 MOSL (N = 9,272,954); the quotient between the rural and the total was made, which is 0.1841. This decimal was used to multiply the total population for each year between 1935 and 1970 and obtain the rural resident population up to 1,800 MOSL, which we consider the "*population exposed"* to malaria.

The API for 1971-2018 was obtained as *follows*: the procedure was the same except that 0.0662 was used instead of 0.1841 to obtain the decimal that multiplies the total annual population. The decimal resulted from adding a second criterion to define the exposed population; This criterion is the validity in each municipality of a relatively effective malaria control, judging by the regularity with which it reports cases. In the country there are large areas that meet this condition, although not absolutely, but the INS considers them "areas with control of the malaria problem ", as are many of the Atlantic Coast: departments of Guajira, Atlántico, Magdalena, for example. Dividing the rural population residing up to 1,800 MOSL and in areas *without* relative effective malaria control (N = 3,334,116) by the total population (N = 50,374,644) yields 0.062. This decimal was used to multiply the total population of the country in each year between 1971 and 2018.

Source: own construction based on data from sources and author's calculations and adjustments:

1935 1937-1939 average
1936 Average of 1935 and 1937
1937-1951 Ministry of Labor, Hygiene and Social Protection (MTHPS) according to: Ministry of Public Health, National Malaria Eradication Service (SEM). Bogotá: SEM, 1957 (MSP-SEM 1957).
1952-1956 MSP-SEM 1957, tables 20, 21, 22, 23, 24.
1957-1959. Our estimate.
1960-2000. Data from the Ministry of Public Health-Epidemiology Division, Bogotá.
2001-2017:
2001. *Informe Quincenal Epidemiológico Nacional* Colombia (IQEN) 2002; 7 (19): 335-48
2002 IQEN 2003; 8 (1): 17
2003 Colombia *Boletín Epidemiológico Semanal* (BES) 2004; week 8: 1-4
2004 IQEN 2005; 10 (3): 39-44
2005 IQEN 2006; 11 (4): 49-53
2006 PAHO-Col 2007: 3
2007 IQEN 2008; 13 (4): 49-58
2008 PAHO-Colombia 2008.
2009 IQEN 14 (23): 365; 14 (24): 381
2010 BES 2010; 52: 11-12
2011 BES 2011; 52:13
2012 BES 2012; fifty; 9-15
2013 BES 2013; 51; 15-16
2014 BES 2014; 51; 27-29
2015 BES 52; 2015; 35-39
2016 BES 41; 2016; 96-102
2017 BES 45; 2017; 19-22.
2018: BES 52; 2018; 18-20

The alleged "resistance of anophelines to insecticides"

This issue is accused of failing to effectively control malaria, but the arguments are as weak as in the case of antimalarial drugs. A study in 2015 reviewed the status of insecticide resistance in all WHO regions. In Latin America, including Colombia, it found the following (14):

- *Anopheles darlingi*: main vector in this subcontinent and in the Amazon; generally susceptible to all insecticides throughout its distribution. A population of Chocó, Colombia, showed resistance to DDT in 1990 and 2005-2009 DDT and pyrethroid (permethrin, lambda cyhalothrin and deltamethrin), but showed susceptibility to malathion and fenitrothion.

- *An. albimanus*: in Central America, it showed resistance to various insecticides in 1970 and was mainly associated with its use in agriculture. In Panama, this species has shown resistance to pyrethroids (cyfluthrin, cypermethrin, deltamethrin and lambda-cyhalothrin) and susceptibility to malathion and fenitrothion. This species has shown alarming resistance to all insecticides evaluated on the northwest coast of Peru. The distribution pattern of *An. albimanus* in Peru overlaps with rice growing areas where insecticides are used frequently.

- *An. nuneztovari* s.l: one of the main malaria vectors in Colombia and Venezuela. Endophagic but exophilic species, with a tendency to avoid contact with insecticide-sprayed walls. In Colombia, this species showed resistance to pyrethroids, organophosphates and DDT in a population on the Colombia-Venezuela border.

- *An. benarrochi* and *An. pseudopunctipennis*: they are important vectors in Peru. *An . benarrochi* is susceptible to pyrethroids except for the population of Ucayali (border with Brazil) that demonstrated resistance to permethrin, while *An. pseudopunctipennis* of Cajamarca (Peru northwest) has shown mortality <95% for all tested insecticides (permethrin, deltamethrin, lambda-cyhalothrin, cypermethrin, malathion).

Other reports from Colombia ratify what has been described (15-17). In short, in Colombia, anopheline resistance to insecticides has never been a major problem. The scarce and sporadic reports on the matter cannot be used as a scientific argument to explain the permanence of malaria in the country and less so in the most endemic areas, and the same happens with the rumor of plasmodial resistance to drugs.

The processes for determining malaria in Colombia

The problem of antimalarial failure and resistance to insecticides is, above all, a social issue in the sense that it is determined and maintained by eminently social processes; wars and massive and chronic population displacement are included; non-armed social conflicts due to economic inequities (others say "poverty"); due to racial, political, and other discrimination; due to political-governmental instabilities.

The adoption of artemisinin-based therapy was made in Colombia in mid-2006 and began to be applied around a year later (18, 19). It cannot be said or suggested, in 2011 (3), that the decrease in malaria incidence after those dates is a consequence of having chosen this therapy, since in three or four years it is impossible to have and measure this sustained effect, especially without studies scientists to confirm it.

Nor can it be stated that "in the last seven years (between 2003 and 2010), a slow and modest decline has been recorded in transmission, which was probably due to improvements in diagnostic coverage and timely treatment.

More recently, the introduction of artemisinin derivatives "combination therapy (ACT) in combination with a clear reduction in the extent of endemic areas…" (3).

Neither sight nor reason can be closed to chronic events, sustained some of them and recurring others, such as the one pointed out by some:

> The study (of evaluation of the amodiaquine-placebo and amodiaquine-artesunate schemes , in Chocó) was carried out during two periods due to *restrictions with the availability of* study *drugs* (my italics): from April 27, 2000 to November 30, 2001 and from November 11, 2002 to February 27, 2004 (11) , deficiencies also indicated by us and others.

Right now, with high frequency there is a lack of drugs and it happens throughout the country and in all ancient and recent times, there is a lack of employment contracts for microscopists (there are positions created but vacant); All of this is known to us by researchers and is reported by patients and the media. This is a determining social process, which has nothing to do with parasite genes. Are these "improvements in coverage for early diagnosis and treatment"?

The exceptionally long absence of insecticide application in homes is another social process and, by no means, a perverse genetic makeup of our mosquitoes. The uncontrolled use of insecticides for agricultural purposes is eminently social:

> In 20 years, Colombia increased the use of pesticides by 360%. The most toxic pesticides in the country are used in crops such as rice and tomato; a consultancy carried out by the UN National University identified that farmers apply up to ten types of said substances in these products (20, 21).

Since 1973, García & Nájera have warned:

> Today insecticides play an essential role in the fight against malaria. Consequently, if insecticide spraying programs are not continued, malaria is likely to reappear in areas that are already nearly free from it. Likewise, the abuse of insecticides in agriculture can cause the resistance of the vector to these substances, and lead to also regrettable results (22).

Household spraying was not continued, nor has the perverse use of insecticides in agriculture been controlled. It must be borne in mind that, in malaria endemic countries, landowners and agro-industrial capitalists are also the owners of political power and this blocks any attempt to control their misuse of these substances.

"Efforts to control malaria" include both successful and obvious failures. It is necessary to highlight a very recent one that shows the lack of commitment of the Colombian State with the health of the people. This is the ephemeral success of the "Colombia Malaria Project" carried out between 2010 and 2013: it reduced the incidence of malaria by 67% in two or three years in the 43 municipalities that were its target and that are among those that produce the most malaria (23, 24). At the end of operational activities in March 2014, it did not publish a final report and, worst of all, in 2015 a huge epidemic broke out that lasted for more than two years. This had as its epicenter the department of Chocó and was of such magnitude that the vivax: falciparum ratio, which was 2: 1 for more than 40 years, became 1:2 (4). Neither the municipalities nor the country's departments assumed the economic burden of keeping the tasks of the terminated PMC in operation and neither did the national level, which does not consider the obligation to be theirs, imbued as it has been for more than 30 years in ideology and practice economic neoliberalism, since in health matters it is only guided by the business idea, for which it gave the capitalists the health insurance and left the users the monetary price and the illness, through the famous law 100 of 1993 and its monstrous of attached standards.

Conclusion

The reason for the behavior of malaria morbidity in Colombia should be studied, in a systematic and critical way. Priority must be given to the study of the processes of social determination of the disease.

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Appendix 1

A. Municipalities (n= 241) with header city located up to 1,800 MOSL that ***do not*** have monitoring of the transmission of malaria; Colombia, March 2019. Order: Region and then, inside of each region, by department.

Municipio	**Departamento** (se indica el número de municipios)	**Región Natural** (se indica el número de municipios)
El Encanto	Amazonas=11	Amazonia=45
La Chorrera		
La Pedrera		
La Victoria		
Leticia		
Mirití-Paraná		
Puerto Alegría		
Puerto Arica		
Puerto Nariño		
Puerto Santander		
Tarapacá		
Albania	Caquetá=16	Amazonia=45
Belén Andaquies		
Cartagena del Chairá		
Curillo		
El Doncello		
El Paujil		
Florencia		
La Montañita		
Morelia		
Puerto Milán		
Puerto Rico		
S Vicente Caguán		
San José del Fragua		
Solano		
Solita		
Valparaíso		
Barranco Minas	Guainía=9	Amazonia=45
Cacahual		
Inírida		
La Guadalupe		
Mapiripana		
Morichal Nuevo		
Pana Pana		
Puerto Colombia		
San Felipe		
Mocoa	Putumayo=9	Amazonia=45
Orito		
Puerto Asís		
Puerto Caicedo		
Puerto Guzmán		
Puerto Leguízamo		
San Miguel		
Valle Guamuez		
Villagarzón		

Carurú	Vaupés=6	Amazonia=45
Mitú		
Pacoa		
Papunaua		
Taraira		
Yavaraté		
Mistrató	Risaralda=2	Andina Centro=2
Pueblo Rico		
Convención	Norte Santander=5	Andina Este=12
El Carmen		
El Tarra		
Teorama		
Tibú		
Barrancabermeja	Santander=7	Andina Este=12
Cimitarra		
Puerto Parra		
Puerto Wilches		
Rionegro		
Sabana de Torres		
Simacota		
Amalfi	Antioquia=28	Andina Norte=28
Anorí		
Apartadó		
Arboletes		
Cáceres		
Carepa		
Caucasia		
Chigorodó		
Dabeiba		
El Bagre		
Frontino		
Ituango		
Murindó		
Mutatá		
Nechí		
Necoclí		
Peque		
Remedios		
San Juan de Urabá		
San Pedro de Urabá		
Segovia		
Tarazá		
Turbo		
Urrao		
Valdivia		
Vigía del Fuerte		
Yalí		
Yondó		
Achí	Bolívar=10	Atlántica=43

Arenal		
Cantagallo		
Montecristo		
Morales		
Pinillos		
San Jacinto del Cauca		
San Pablo		
Santa Rosa del Sur		
Simití		
Ayapel		
Buenavista		
Canalete		
Cereté		
Chimá		
Chinú		
Ciénaga de Oro		
Cotorra		
La Apartada		
Lorica		
Los Córdobas		
Momil		
Montelíbano		
Montería		
Moñitos	Córdoba=30	Atlántica=43
Planeta Rica		
Pto Libertador		
Pueblo Nuevo		
Puerto Escondido		
Purísima		
S Andrés Sotavento		
Sahagún		
San Antero		
San Bernardo del Viento		
San Carlos		
San José de Uré		
San Pelayo		
Tierralta		
Tuchín		
Valencia		
Guaranda		
Majagual	Sucre=3	Atlántica=43
Sucre		
Arauca		
Arauquita		
Cravo Norte		
Fortul	Arauca=7	Orinoquia=63
Puerto Rondón		
Saravena		
Tame		
Aguazul		
Chámeza		
Hato Corozal		
La Salina		
Maní	Casanare=19	Orinoquia=63
Monterrey		
Nunchía		
Orocué		
Paz de Ariporo		
Pore		

Recetor		
Sabanalarga		
Sácama		
San Luis de Palenque		
Támara		
Tauramena		
Trinidad		
Villanueva		
Yopal		
Calamar		
El Retorno	Guaviare=4	Orinoquia=63
Miraflores		
S José Guaviare		
Acacías		
Barranca de Upía		
Cabuyaro		
Castilla la Nueva		
Cubarral		
Cumaral		
El Calvario		
El Castillo		
El Dorado		
Fuente de Oro		
Granada		
Guamal		
La Macarena		
La Uribe		
Lejanías	Meta=29	Orinoquia=63
Mapiripán		
Mesetas		
Puerto Concordia		
Puerto Gaitán		
Puerto Lleras		
Puerto López		
Puerto Rico		
Restrepo		
San Carlos de Guaroa		
San Juan de Arama		
San Juanito		
San Martín		
Villavicencio		
Vistahermosa		
Cumaribo		
La Primavera	Vichada=4	Orinoquia=63
Puerto Carreño		
Santa Rosalía		
Guapi		
López	Cauca=3	Pacífica=42
Timbiquí		
Acandí		
Alto Baudó		
Bagadó		
Bahía Solano		
Bajo Baudó	Chocó=29	Pacífica=42
Bojayá		
Cantón de San Pablo		
Cértegui		
Condoto		
El Atrato		

El Carmen del Darién		
Istmina		
Juradó		
Litoral de San Juan		
Lloró		
Medio Atrato		
Medio Baudó		
Medio San Juan		
Nóvita		
Nuquí		
Quibdó		
Río Iró		
Río Quito		
Riosucio		
San José del Palmar		
Sipí		
Tadó		

Unguía		
Unión Panamericana		
El Charco	Nariño=9	Pacífica=42
Francisco Pizarro (Salahonda)		
La Tola		
Magüí Payán		
Mosquera		
Olaya Herrera (Bocas Satinga)		
Roberto Payán (San José)		
Santa Bárbara (Iscuandé)		
Tumaco		
Buenaventura	Valle Cauca=1	Pacífica=42

B. Population rural exposed to malaria in Colombia, 2019, by Region Natural considering only the municipalities whose header is up to 1,800 MOSL and you do not have controlling malarial effective (total exposed = 3334116)

Amazonia	Andina				Atlantic	Orinoquia	Pacific
	Andina Central	Andina East	Andina North	Andina South			
	Risaralda	Norte Santander Santander	Antioquia	Tolima Huila			
45 municipalities	2	12	28	0	43	63	42
471,578	22,732	164,605	557,457	0	1,030,044	527,044	560,656
X= 9,247	X= 11,366	X= 13,717	X= 19,909	0	X= 23,955	X= 8,366	X= 13,349
DE= 8,778	DE= 1,383	DE= 8,332	DE= 19,652	0	DE= 18,403	DE= 7,925	DE= 15,357

Note: in 2018, no cases were registered in Tolima, Cundinamarca, Boyacá, and San Andrés y Providencia. E n 2017 all departments except San Andres and Providencia reported cases of malaria native, but with situations as strange as this: Amazonas, Cauca and Bolívar only reported one case each one. In 2016, no cases were registered in Tolima, Huila and San Andrés y Providencia. In 2015, no cases were registered in 8 of 32 departments: San Andrés y Providencia, Guajira, Cesar, Arauca, Casanare, Boyacá, Santander and, inexplicably, Vaupés.
Source: authoring our according to data from the Dane and Wikipedia (https://es.wikipedia.org/wiki/Municipios_de_Colombia, accessed: November 14, 2018).