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Changes in registered malaria cases and deaths in Togo from 2008 to 2017



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ABSTRACT

Objective: The WHO Malaria Report 2019 stated that “globally, the burden of malaria was lower than ten years ago, but, in the last few years, there has been an increase in the number of malaria cases around the world”. This study reported changes in malaria cases and deaths at the Togo national level (2008–2017) and presented anti-malaria fight results and eradication chances by 2030 in Togo.

Methods: Cases and deaths were collected from medical records, monthly reports, and notes of 6000 health workers; then summarized by Region, District, year, and specific subpopulations. Estimates of annual trends of numbers of cases and deaths were obtained through generalized linear models.

Results: The number of cases increased by four times, whereas the population increased by 1.3 times (2008–2017). Increases affected all regions and subpopulations; the mean annual relative increases in children <5, pregnant women, and other persons ≥ 5 were 13%, 10%, and 14%, respectively. Death rates decreased in all Regions; the mean annual relative decreases in the subpopulations were 7%, 16%, and 6%, respectively.

Conclusion: Case increases were associated with higher investments and better monitoring and death decreases to better prevention, diagnosis, and treatment. These trends should incite government and partners to maintain or intensify current efforts to meet the elimination goals by 2030.

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Introduction

Malaria is a potentially fatal infectious disease caused by several species of parasites belonging to genus *Plasmodium*. Malaria particularly affects underprivileged tropical areas of Africa, Asia, and Latin America. In 2018, most malaria cases were located in Africa (213 million cases, 93%), followed by the South-East Asia (3.4%) and the Eastern Mediterranean (2.1%) (WHO, 2020a).

Achieving a malaria-free world is an ambitious public health and sustainable development goal (WHO, 2020b). The Global Technical Strategy against Malaria (2016–2030) developed in close collaboration with the Roll Back Malaria Partnership calls for the elimination of malaria by 2030 in 35 endemic countries, including Togo (WHO, 2020b; WHO, 2020c). To achieve this goal, most strategies aim to strengthen health systems, scale up national malaria interventions, and protect people at risk by all possible means.

In Togo, malaria is endemic and a real obstacle to socio-economic development. The current aims of the Programme National de Lutte contre le Paludisme (PNLP) is to free Togolese communities and families from the burden of malaria by 2030 and contribute to the emergence and development of the country. To achieve these aims, four strategic plans have been developed for periods 2001–2005, 2006–2010, 2011–2017, and 2018–2022. Since

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2016, these plans were carried out in line with the guidelines of the WHO Global Technical Strategy against Malaria 2016–2030 (with some adaptation to the Togolese context) to reduce significantly the incidence and mortality of malaria and strengthen the PNLP at all levels (WHO, 2020d).

As part of the strategic plans, massive interventions were then launched with the aim to achieve malaria elimination targets by at least 80% (PNLP internal document “Plan Stratégique National du PNLP au Togo, 2018”). The PNLP introduced chemical larval control in Togolese households since 1975. Since 2005, Togo has been offering intermittent preventive treatment (IPT or chemoprevention) to pregnant women and seasonal malaria chemoprevention (SMC) to children aged 3 to 59 months. Management of vector resistance to insecticides was implemented in 2006. Furthermore, since 2008, vector control measures have focused on triennial mass distribution campaigns of long-lasting insecticidal nets (LLINs) to households with children under one year of age and pregnant women, as recommended by the WHO. In 2010, biolarvicide was introduced in Togolese households.

As part of the implementation of malaria control interventions on malaria morbidity and mortality, the PNLP has been compiling monthly digital information since 2007. The data concern prevention (communication, IPT, distribution of LLINs, chemoprevention), the management of antimalarial drugs, the number of malaria cases (confirmed diagnosis and/or treatment), and the number of deaths from malaria. These data are collected from medical records and Community Health Worker (CHW) monthly report forms at successive levels of the healthcare system (community, district, regional, and central).

Despite their availability since 2008, these data have never been analysed to search for trends in malaria cases and deaths over time. The purpose of the present study was to report changes in numbers of malaria cases and deaths between 2008 and 2017 using the nationwide Togolese PNLP data and to present the findings by region and by specific target subpopulation.

Materials and methods

Study type and setting

This descriptive epidemiological study presented confirmed malaria cases and malaria-specific death notifications collected prospectively and monthly between 2008 and 2017 by the PNLP at the Togo national level.

Togo is a West African country of 56,600 km² with 7.528 million inhabitants (INSEED data, 2019) (INSEED, 2020). The Togolese health system has a three-level pyramidal structure. The PNLP is located at the Central Level, the level at which national malaria control directives and policies are developed. The Regional (or intermediate) Level includes six Health Regions and is responsible for providing technical support to Health Districts. The Peripheral Level is the most decentralized and constitutes the operational level covering the 43 Health Districts and 944 Peripheral Care Units (Figure 1).

Data collection

Data are routinely collected from medical consultation records and CHWs' monthly report forms. The records are filled out at hospital admission and during hospitalization by hospital practitioners, nurses, medical assistants, or midwives; they are available in all hospitals and departments that hospitalize patients. Currently, the records include socio-demographic information, medical history, diagnosis, laboratory results, treatments, and other clinically useful data. The monthly report forms are filled out by CHWs. These forms collect information related to diagnosis and

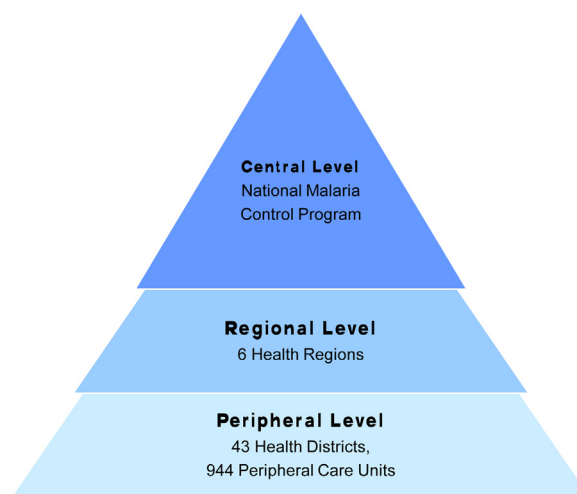


Figure 1. The Togolese health system that reports to the Programme National de Lutte contre le Paludisme (PNLP), 2008–2017.

management of simple malaria from hospital outpatient activities, home visits, and awareness-raising activities for behaviour change.

From 2008–2019, Togo recruited six thousand CHWs for all Health Regions and Health Districts. Each CHW has to collect malaria-related data within his/her community. The heads of the Peripheral Care Units and accredited Non-Governmental Organizations supervise CHWs' activities and check data quality. These data are further compiled, checked, and validated at the Regional level before transmission to the Central Level. Validation meetings take place monthly at each level in the presence of all CHWs and supervisors from the hospitals and the NGOs. Ultimately, national data are stored, analysed, interpreted, and published at the PNLP national level. To sum up, the study data were collected from 6000 CHWs' notes on all 944 Togolese Peripheral Care Units then grouped in 43 Health Districts and 6 Health Regions.

Definitions of malaria case and malaria death case

In this study, a 'malaria case' is defined as a person with fever or history of fever ($T \geq 38^\circ\text{C}$) over the past two weeks, and who had a positive result after microscopic examination of a blood smear or a positive Rapid Diagnostic Test (RDT) for malaria.

A 'malaria death case' is defined as a person whose death occurred at hospital, whose reason for hospitalization was severe malaria (positive smear or RDT, and at least one symptom of severe malaria), and whose cause of death in the hospital death registry is "malaria" as reported by a physician.

Statistical analysis

Numbers and rates of cases and deaths are given for the whole population by Region, District, calendar year (2008–2017 included), and target subpopulation (children under five years old, pregnant women, and people aged five years and over –pregnant women excluded). The rates of cases per 1000 inhabitants or deaths per 100,000 inhabitants were estimated as the ratio of the number of cases or deaths over the population number. Population data were provided by the Annuaire des Statistiques Sanitaires du Togo that reports to the Ministry of Health and Public Hygiene.

The monthly numbers of cases and deaths were modelled using a generalized linear model with the absolute number as outcome variable. These numbers were assumed to follow a quasi-Poisson distribution; i.e., the dispersion parameter was not fixed to one to allow for potential over-dispersion. The trends of changes in

incidence or mortality were modelled using two terms: a first one for the long-term annual trend and another for seasonality (namely, the month of notification). A variable that represents the District was also included to allow for heterogeneity between Districts. The model may be written as follows:

$$y \sim \text{Poisson}(\mu)$$

$$\log(\mu_{ijk}) = \beta_0 + \beta_1 \times \text{Year}_i + \beta_{2j} \times \text{Month}_j + \beta_{3k} \times \text{District}_k$$

In this equation, y is the observed number of cases or deaths, μ_{ijk} is the expected number of cases or deaths (i stands for the year, j for the month, and k for the Health District), β_0 is the intercept of the model (it corresponds to the logarithm of the expected number of cases or deaths for year 2008, January, and the District of Agoè as references), β_1 is the logarithm of the mean annual relative change in the number of cases or deaths, and, finally, β_{2j} and β_{3k} are the logarithms of the mean relative change of the number of cases or deaths for, respectively, month j , and District k , in comparison with the reference month and District.

A first analysis consisted of running one model per Health Region and target subpopulation. In a second analysis, the same model was run per District and target subpopulation with parameter β_{3k} set to 0. Because in some Regions, reporting of deaths was not started in 2008 (the beginning of the study), the model was fitted on the period with available data and predicted values were generated for missing data. The estimates of annual temporal trends of the number of cases and the number of deaths were obtained with their 95% confidence intervals and p-values. They were expressed as percentages of the mean annual relative change; i.e., $(1 - \exp(\beta_1)) \times 100$.

The observed rates of cases and deaths were mapped per Health District, year, and quarter of the year using a coloured scale in which each doubling of the rate is represented by a darker colour change.

R software was used for all analyses (R Core Team, 2017; R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL <https://www.R-project.org/>).

Results

Malaria cases

Between 2008 and 2017, the number of malaria cases increased nearly fourfold (291,362 to 1,204,192 cases), whereas the size of the population multiplied by 1.3 (5790, 000–7,351,964) (Table 1). This corresponded to an increase in the rate of cases per 1000 inhabitants from 50 to 160.

The overall mean annual relative increase in malaria cases in Togo was +13.7%, and ranged from +8.1% in Commune of Lomé to +16.7% in Centrale Region (Table 1). The number of malaria cases increased significantly in the three target subpopulations; precisely, 13.1% in children <5, 14.4% in people ≥5, and 10.4% among pregnant women (Table 2, Table S1). The highest and lowest increases in both children <5 and people ≥5 were seen in Region Centrale and Commune of Lomé, respectively (Table 2, Figure S1). In pregnant women, the Commune of Lomé showed a 3.2% mean annual relative decrease in malaria cases during the study period (Table 2, Figure S1).

Table S2 shows the changes in malaria cases by district and target subpopulation.

Malaria deaths

During the study period, malaria mortality rates decreased throughout the country as in each Region, but this decrease was less marked in Centrale Region and Plateaux (Table 3).

Table 1 Malaria cases in Togo, 2008–2017: absolute number and rate per 1000 inhabitants for each health region at the national level in Togo.

Region	Statistic	2008–2017										Annual trend ^a		
		2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Estimate (%) ^b	95 % CI	p-value
Savanes	Number	30,973	42,594	87,733	60,959	90,829	114,550	150,592	166,052	117,675	192,244	+15.8	(14.0;17.6)	<0.001
	Population	665,900	684,811	828,224	851,746	875,935	900,813	926,395	952,704	979,763	1,007,591			
	Rate	46.51	62.20	105.93	71.57	103.69	127.16	162.56	174.30	120.11	190.80	+13.5	(12.4;14.6)	<0.001
Kara	Number	57,694	68,851	100,730	101,946	103,909	175,246	206,094	192,127	159,803	192,973			
	Population	752,700	774,078	769,940	791,806	814,294	837,420	861,202	885,660	910,815	936,685			
	Rate	76.65	88.95	130.83	128.75	127.61	209.27	239.31	216.93	175.45	206.02			
Centrale	Number	36,741	52,688	90,737	64,484	75,279	145,113	163,395	182,526	149,768	171,996	+16.7	(15.2;18.1)	<0.001
	Population	585,300	601,923	617,871	635,418	653,464	672,023	691,109	710,736	730,923	751,683			
	Rate	62.77	87.53	146.85	101.48	115.20	215.93	236.42	256.81	204.90	228.81	+11.3	(10.4;12.2)	<0.001
Plateaux	Number	88,965	99,072	161,910	158,621	138,822	259,201	341,241	301,688	282,760	301,305			
	Population	1,389,600	1,429,064	1,375,165	1,414,221	1,454,385	1,495,687	1,538,166	1,581,850	1,626,781	1,672,988			
	Rate	64.02	69.33	117.74	112.16	95.45	173.30	221.85	190.72	173.82	180.10	+15.4	(14.2;16.6)	<0.001
Maritime	Number	58,229	92,124	129,467	89,432	82,854	169,295	246,373	205,643	230,555	277,061			
	Population	1,434,837	1,475,586	1,762,518	1,812,573	1,864,051	1,916,990	1,971,432	2,027,422	2,085,002	2,144,218			
	Rate	40.58	62.43	73.46	49.34	44.45	88.31	124.97	101.43	110.58	129.21	+8.6	(6.9;10.2)	<0.001
Lomé commune	Number	18,760	37,577	56,245	57,759	40,353	51,712	90,113	58,381	55,643	68,613			
	Population	961,663	988,974	837,437	861,221	885,679	910,832	936,699	963,302	990,662	1,018,799			
	Rate	19.51	38.00	67.16	67.07	45.56	56.77	96.20	60.61	56.17	67.35	+13.7	(13.1;14.3)	<0.001
Togo national level	Number	291,362	392,906	628,822	533,201	532,046	915,117	1,197,808	1,106,417	996,204	1,204,192			
	Population	5,790,000	5,954,436	6,191,155	6,366,985	6,547,808	6,733,765	6,925,003	7,121,674	7,323,946	7,531,964			
	Rate	50.32	65.99	101.24	83.74	81.26	135.90	172.97	155.36	136.02	159.88			

^a Mean annual relative change expressed in percentage. CI: confidence interval.

Table 2

Relative mean annual change in the number of malaria cases and deaths per target subpopulation in each health region and at the national level in Togo, 2008–2017.

Variable	Region	Children <5 years			People aged 5 years and over			Pregnant women		
		Trend (%)*	95% CI	p-value	Trend (%)*	95% CI	p-value	Trend (%) ^a	95% CI	p-value
Malaria cases	Savanes	+15.9	(13.7;18.2)	<0.001	+16.1	(14.3;17.9)	<0.001	+10.6	(9.3;12.0)	<0.001
	Kara	+13.0	(11.8;14.3)	<0.001	+14.1	(12.8;15.3)	<0.001	+10.3	(9.3;11.3)	<0.001
	Centrale	+16.3	(14.5;18.1)	<0.001	+16.7	(15.3;18.2)	<0.001	+19.2	(17.7;20.8)	<0.001
	Plateaux	+10.5	(9.5;11.5)	<0.001	+12.2	(11.2;13.1)	<0.001	+8.8	(8.0;9.6)	<0.001
	Maritime	+13.8	(12.5;15.1)	<0.001	+16.6	(15.3;17.9)	<0.001	+10.9	(9.7;12.2)	<0.001
	Lomé commune	+6.3	(4.6;8.1)	<0.001	+9.9	(8.2;11.7)	<0.001	-3.2	(-5.7;-0.5)	0.019
	Togo national level	+13.1	(12.5;13.8)	<0.001	+14.4	(13.8;14.9)	<0.001	+10.4	(9.9;11.0)	<0.001
Deaths from malaria	Savanes	-5.9	(-10.4;-1.3)	0.013	-9.6	(-14.4;-4.5)	<0.001	-45.8	(-54.0;-36.0)	<0.001
	Kara	-7.3	(-10.0;-4.4)	<0.001	-5.2	(-8.9;-1.4)	0.007	+12.1	(3.8;21.1)	0.003
	Centrale	-2.8	(-5.8;+0.2)	0.072	-2.5	(-6.7;+2.0)	0.272	-11.8	(-19.5;-3.4)	0.007
	Plateaux	-3.8	(-5.4;-2.1)	<0.001	-2.3	(-5.1;+0.6)	0.118	-21.2	(-31.4;-9.5)	<0.001
	Maritime	-14.3	(-17.2;-11.3)	<0.001	-8.0	(-11.5;-4.4)	<0.001	-33.8	(-44.4;-21.3)	<0.001
	Lomé commune	-11.5	(-15.4;-7.4)	<0.001	-9.1	(-13.3;-4.6)	<0.001	-15.1	(-22.9;-6.5)	<0.001
	Togo national level	-6.6	(-7.9;-5.3)	<0.001	-5.6	(-7.2;-4.0)	<0.001	-15.7	(-21.3;-9.7)	<0.001

^a Mean annual relative change expressed in percentage. CI: confidence interval.

At the Togo national level, mortality rate ranged from 22 to 26 per 100,000 inhabitants in 2008–2009 and dropped to around 13 per 100,000 inhabitants in 2016–2017 (Table 3).

At the national level, number of malaria deaths decreased in the three target subpopulations: -6.6% in children <5, -5.6% in people ≥5, and -15.7% among pregnant women (Table 2, Table S3). Malaria deaths decreased significantly in children <5 in all regions, but it was not statistically significant in Centrale Region, and in people ≥5, although it was not statistically significant in Regions Centrale and Plateaux. Among pregnant women, malaria deaths also decreased in all Regions, except in Kara where the number of deaths increased yearly by 12.1% (Table 2, Figure S2).

Table S4 shows the changes in malaria deaths by district and target subpopulation.

Seasonal considerations

Mapping of malaria cases per District and quarter of the year showed that malaria remained present in all Health Districts of Togo during all seasons (Figure 2) but, as expected, showed seasonal variations in all Districts (Figure 2) and in all subpopulations (Figure S1). The rates of malaria cases were higher during the third quarter of the year (July, August, and September), which corresponds to the rainy season (Figure 2).

Obviously, the rates of death from malaria varied according to the month of the year in all Districts (Figure 3). In addition, as expected, case rates and mortality rates showed simultaneous seasonal increases but variations in case rates was more marked than variations in death rates (Figure 3). In 2017, death rates during the rainy season were the highest in Tchaoudjo, Sotouboua, Blitta Districts of Centrale Region, as well as in Cinkassé and Tone Districts of Northern Togo (Figure 3).

Discussion

To our knowledge, this study is the first to report malaria cases and deaths at the national level in Togo, which filled a gap identified by the Ministry of Health and Public Hygiene, and PNLP, as part of the assessment of the fight against Malaria. These indicators help monitor changes in malaria transmission over the country, evaluate the impact of anti-malaria interventions, and improve decision-making toward reducing the overall burden of malaria in all regions of Togo.

Outside Africa, studies of malaria at national levels have been few (Bismil'din et al., 2001; Amangel'diev, 2001; Razakov and Shakhgunova, 2001; Grigorian and Solkhomonian, 2001). In Africa,

most studies on malaria morbidity and/or mortality have been carried out in specific cities or regions (Baudon et al., 1987; Petit and van Ginneken, 1995; Baragatti et al., 2009; (Fobil et al., 2012; Hassen and Dinka, 2020) or in several countries but in specific subpopulations (Ndugwa et al., 2008; Eisele et al., 2012; Bauserman et al., 2019). Two reviews worldwide, including African data and 'new data' on four countries (Bremner et al., 2004) and, specifically, the whole of Africa have also been reported (Dumbo et al., 2016). To our knowledge, only five countrywide field studies were carried out in Africa, specifically in the Democratic Republic of Congo (Wembonyama et al., 2007), the Republic of Congo (Koukouikila-Koussounda and Ntoumi, 2016), Cameroon, (Antonio-Nkondjio et al., 2019) Ethiopia, (Taffese et al., 2018) and Mozambique (Aide et al., 2019).

The present study results regarding malaria incidence at the national level in Togo showed a significant 4-fold increase in the number of cases from 2008 to 2017, whereas the population size increased by only 1.3 times. One important finding is that the case increase was observed in all six regions despite intensification of various strategies to fight the disease and several interventions carried out over several years (Table 4). Indeed, over the past ten years, Togo has been adopting the Global Technical Strategy against Malaria and has implemented several national strategic plans to end malaria by 2030 (Table 4). These plans were developed in accordance with the National health policy and the international guidelines for Malaria prevention and control and have led to several achievements: i) the universal access of the population to all interventions against malaria; ii) the advent and large-scale deployment of CHWs in all parts of Togo; iii) the general use of insecticide-treated mosquito nets (ITNs); iv) the free diagnosis and treatment of simple malaria for all; v) the regular seasonal prevention chemotherapy in children under five in Centrale, Kara, and Savanes Regions; vi) the use of IPT during pregnancy; vii) the implementation of sentinel surveillance of malaria; viii) mass treatment in some Districts; and, ix) support, education, and communication activities for behaviour change (Table 4).

Did all of these strategies fail? The increases in malaria cases could be explained by better registration due to efforts deployed throughout the country since 2008. Indeed, before 2008, the National malaria surveillance system lacked material and technical tools, as well as qualified and trained human resources, and logistical and financial means. Since 2008, several international agencies (IMF, World Bank, Global Fund, Roll Back Malaria, etc.) increased the financial and technical resources. For example, nationally scaling up CHWs' interventions increased the reporting of malaria cases (Table 4). These CHWs (6000 over ten years) were

Table 3
Malaria deaths in Togo, 2008–2017: absolute number and rate per 100,000 inhabitants for each health region and at the national level in Togo.

Region	Statistic	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Annual trend		
		Number	Rate	Number	Rate	Number	Rate	Number	Rate	Number	Rate	Estimate (%) ^a	95 % CI	p-value
Savanes	Number	135	258	183	73	227	139	186	164	54	95	-6.9	(-10.8;-2.8)	0.001
	Population	665,900	684,811	828,224	851,746	875,935	900,813	926,395	952,704	979,763	1,007,591			
	Rate	20.27	37.67	22.10	8.57	25.92	15.43	20.08	17.21	17.21	5.51	9.43		
Kara	Number	276	315	315	245	156	224	183	153	286	110	-6.6	(-9.4;-3.8)	<0.001
	Population	752,700	774,078	769,940	791,806	814,294	837,420	861,202	885,660	910,815	936,685			
	Rate	36.67	40.69	40.91	30.94	19.16	26.75	21.25	17.28	17.28	11.74			
Centrale	Number	173	217	280	247	192	236	175	227	137	211	-2.8	(-5.6;0.0)	0.050
	Population	585,300	601,923	617,871	635,418	653,464	672,023	691,109	710,736	730,923	751,683			
	Rate	29.56	36.05	45.32	38.87	29.38	35.12	25.32	31.94	18.74	28.07			
Plateaux	Number	317	319	390	356	324	359	331	230	274	305	-3.5	(-5.1;-1.9)	<0.001
	Population	1,389,600	1,429,064	1,375,165	1,414,221	1,454,385	1,495,687	1,538,166	1,581,850	1,626,781	1,672,988			
	Rate	22.81	22.32	28.36	25.17	22.28	24.00	21.52	14.54	16.84	18.23			
Maritime	Number	159	193	213	171	155	185	174	127	117	135	-12.6	(-15.1;-10.0)	<0.001
	Population	1,434,837	1,475,586	1,762,518	1,812,573	1,864,051	1,916,990	1,971,432	2,027,422	2,085,002	2,144,218			
	Rate	11.08	13.08	12.08	9.43	8.32	9.65	8.83	6.26	5.61	6.30			
Lomé commune	Number	221	254	126	222	143	97	156	128	107	117	-10.9	(-14.4;-6.9)	<0.001
	Population	961,663	988,974	837,437	861,221	885,679	910,832	936,699	963,302	990,662	1,018,799			
	Rate	22.98	25.68	15.05	25.78	16.15	10.65	16.65	13.29	10.80	11.48			
Togo national level	Number	1281	1556	1507	1314	1197	1240	1205	1029	975	973	-6.4	(-7.6;-5.2)	<0.001
	Population	5790,000	5,954,436	6,191,155	6,366,985	6,547,808	6,733,765	6,925,003	7,121,674	7,323,946	7,531,964			
	Rate	22.12	26.13	24.34	20.64	18.28	18.41	17.40	14.45	13.31	12.92			

^a Mean annual relative change expressed in percentage. CI: confidence interval.

able to use modern field equipment to diagnose febrile illness and treat confirmed malaria cases. As per the recommended guidelines and protocols, this allowed tracing, diagnosing, and treating cases that would go unreported otherwise. In addition, IPT in pregnant women, seasonal chemoprevention in children under five, and large-scale distribution of ITNs were implemented. Regarding malaria incidence, one informative result was the good performance of Commune of Lomé. Being the capital, Lomé and its surroundings are inhabited by people with good levels of education, better housing conditions, and easier access to health information and care, who probably best integrated and applied anti-malaria interventions. This resulted in the smallest increase in the number of malaria cases in children and adults and a decrease over time in the number of positive pregnant women.

Regarding malaria deaths at the national level in Togo, significant decreases in the numbers of deaths were observed, which is in line with the trends toward fewer deaths in Togo reported for the period 2010–2017 by the WHO, despite the increase in the Togolese population (WHO, 2020e; WHO, 2020f). These decreases may be explained by improvements in the Togolese public sector, including better coverage by the health-care system, since 2008. Indeed, the healthcare system was decentralized, mobile clinics were created, and malaria diagnosis and treatment became cost-free. In addition, a reference Regional hospital has been implemented in each Region, and a reference District hospital has been assigned in each District in addition to many Peripheral Care Units, with doctors, nurses, midwives, and trained birth assistants. Some remote villages had health huts or humanitarian dispensaries run by volunteers able to treat simple malaria cases and refer severe cases to higher structures. Each community had a CHW trained to provide health education; detect and treat simple malaria cases; and refer patients to better-equipped healthcare facilities. All these improvements of the healthcare coverage greatly reduced the use of self-medication, especially care seeking behavior with traditional healers. The supply chain of antimalarial products was also optimized to avoid recurrent stock-outs. Another enlightening result was that pregnant women had the lowest mortality rates in almost all regions, which is most probably due to the good implementation of IPT (sulfadoxine-pyrimethamine or Fansidar®) in Togo, in line with a WHO report that cited Togo among only five African countries where more than 30% of pregnant women had received ≥ 3 doses of IPT (WHO, 2020f). In contrast, the regions of North Togo (Savanes and Kara) seem to have had more deaths. This may be explained by: i) a limited access to healthcare in these Regions (populations of the North are mainly rural, and live in remote and often mountainous areas), ii) climatic factors in favour of malaria transmission, especially during the rainy seasons; iii) population mobility (mainly immigration) across the frontiers with Benin and Burkina Faso; iv) the presence in these territories of a single university hospital which may not be sufficient to ensure the follow-up of severe malaria cases.

Worldwide, from 2000 to 2015, malaria incidence rates have decreased by 37% and mortality rates by 60% (Cibulskis et al., 2016). In the WHO African Region, from 2010 to 2018, case incidence declined from 294 to 229 cases per 1000 population at risk (a 22% reduction). Also, the WHO African Region had 153,000 less deaths from malaria in 2018 vs. 2010; however, the malaria mortality reduction rate has slowed since 2016 (WHO, 2020a). This reflects the conclusions of two recent reports that: i) “globally, the burden of malaria is lower than ten years ago” but, “in the last few years, there has been an increase in the number of malaria cases around the world”; (Talapko et al., 2019); and; ii) “the number of indigenous malaria cases has progressively increased since 2013 after a significant decrease between 2000 and 2013 and the

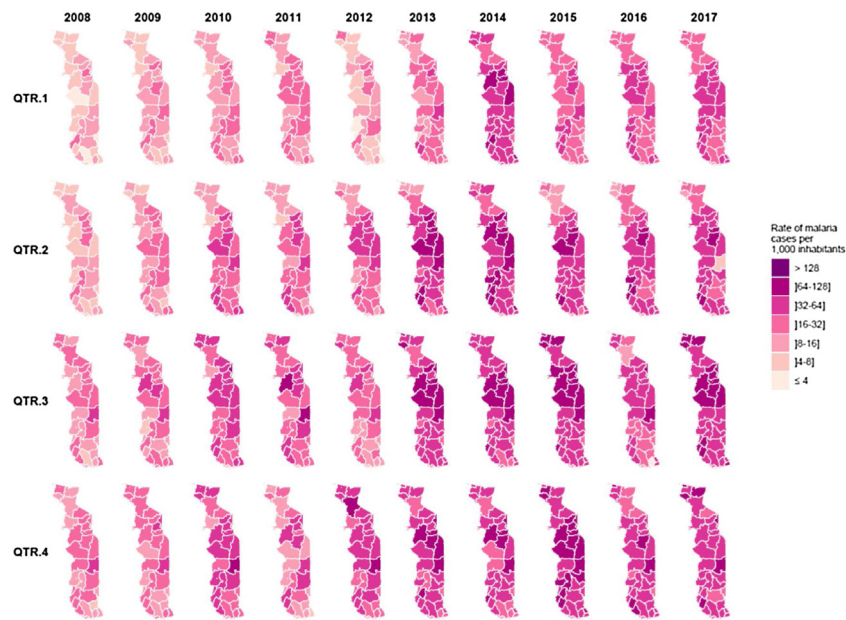


Figure 2. Rates of malaria cases per year, quarter, and district (Togo, 2008–2017).

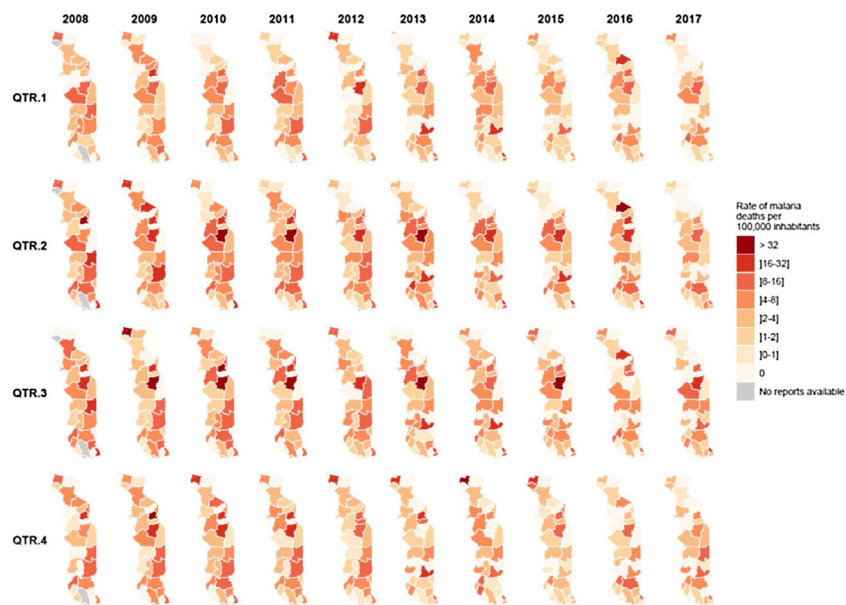


Figure 3. Rates of malaria deaths per year, quarter, and district (Togo, 2008–2017).

number of malaria-related deaths has stagnated since 2015” (Pradines and Robert, 2019). The general results of the present study are in line with these conclusions regarding the recent increases in malaria incidence but report a trend toward a decrease rather than a stagnation in malaria mortality. It is hoped the likely explanations given above (decentralization, etc.) for Togo will continue to alleviate the burden of malaria deaths and inspire the policies of other countries.

Two major lessons can be drawn from this study. First, it was possible to collect data with utmost rigor by well-informed and trained CHWs and health professionals, with a single well-funded hierarchical structure with standardized methods, and with monthly checks for quality by approved skilled associations and non-governmental organizations. Second, it was consequently possible to conduct straightforward informative analysis of morbidity and mortality data over ten years at the Togo national

Table 4
Description of continuous and intermittent interventions for prevention and control of Malaria in Togo since 2003.

Type of intervention	Name of intervention	Target Regions (Districts)	Target populations	Start date	End date	Comments
Continuous interventions	Intermittent preventive treatment (IPT or chemoprevention)	All	Pregnant women	March 2005	Continuous	
	Use of Rapid Diagnostic Test (RDT) and artemisinin-based combination therapy (ACT)	All	All	October 2006	Continuous	
	ACTFree	All	All	November 2006	Continuous	
	Continuous distribution campaigns of long-lasting insecticidal nets (LLINs)	All	All	2003	Continuous	
	Deployment of community health workers (CHWs) at the national level for Malaria care and surveillance	Plateaux (Kloto), Centrale (Sotouboua), Kara (Kozah), Maritime (Lacs) in 2003, all since 2008	All	2003	Continuous	Number of CHWs increased gradually from 2003 to reach ~6000 HCWs since 2008
Intermittent interventions	Mass distribution campaigns of long-lasting insecticidal nets (LLINs)	All	Children <5 years-old until 2010, all population since 2011	2004, 2008, 2011, 2014, and 2017		
	Seasonal malaria chemoprevention (SMC)	Centrale, Kara and Savanes (all Districts)	Children between 3 months and 5 years-old	July 2013	Continuous	3 or 4 monthly rounds since July each year
	Systematic RDT and ACT study	All	All	September 2018	October 2018	Done once
	Fast Elimination of Malaria by Source Eradication (FEMSE) Project based on ACT	Plateaux (Est-Mono)	All	March 2017	May 2017	Done once
	Sentinel surveillance pilot study	Savanes (Tone, Oti) et Plateaux (Ogou, Kloto)	All	July 2017	Continuous	17 sentinel sites (healthcare centers)

level (all health zones, all districts, and all regions), which will improve decision-making by the NMCP of Togo that reports to the Togolese Ministry of Health and Public Hygiene.

Conclusion

This first study in Togo is one of the rare national-level studies in Africa providing an overall picture of malaria burden in Togo; precisely, an increase in the number of cases and a decrease in the number of deaths over time. Togo might well have achieved an overall improvement of its malaria surveillance system and be on the right path toward meeting the objectives of the World Technical Strategy against Malaria 2016–2030. These efforts have to be continued and reinforced whenever and wherever needed “to accelerate progress towards malaria elimination” as quickly as possible.

Conflict of interests

The authors declare they have no conflicts of interest in relation with this article.

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Ethical approval

This study was approved and authorized by the Ministry of Health and Public Hygiene of Togo (Reference No. 280/17 / SPS / CAB / SG / DGPIS / DPP / DER).

Authors' contributions

TAB, MR, and NV designed the study. TAB, TA, and TT collected the data. AT, NV, and TAB analysed the data. TAB, MR, NV, and JI interpreted the results and wrote the manuscript. JI, TAB, MR, NV, and NK revised the final versions of the manuscript. NV ensured the overall coordination. All authors read and approved the final version of the manuscript.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:<https://doi.org/10.1016/j.ijid.2020.10.006>.

References

- Aide P, Candrinho B, Galatas B, et al. Setting the scene and generating evidence for malaria elimination in Southern Mozambique. *Malar J* 2019;18(1):190.
- Amangel'diev KA. [Current malaria situation in Turkmenistan]. *Med Parazitol (Mosk)* 2001;(1):37–9.
- Antonio-Nkondjio C, Ndo C, Njiokou F, et al. Review of malaria situation in Cameroon: technical viewpoint on challenges and prospects for disease elimination. *Parasit Vectors* 2019;12(1):501.
- Baragatti M, Fournet F, Henry MC, et al. Social and environmental malaria risk factors in urban areas of Ouagadougou, Burkina Faso. *Malar J* 2009;8:13.
- Baudon D, Carnevale P, Ambroise-Thomas P, Roux J. [Control of malaria in Africa: from the eradication of malaria to the control of malaria]. *Rev Epidemiol Sante Publique* 1987;35(5):401–15.
- Bauserman M, Conroy AL, North K, Patterson J, Bose C, Meshnick S. An overview of malaria in pregnancy. *Semin Perinatol* 2019;43(5):282–90.
- Bismil'din FB, Shapieva ZZ, Anpilova EN. [Current malaria situation in the Republic of Kazakhstan]. *Med Parazitol (Mosk)* 2001;(1):24–33.
- Breman JG, Alilio MS, Mills A. Conquering the intolerable burden of malaria: what's new, what's needed: a summary. *Am J Trop Med Hyg* 2004;71(2 Suppl):1–15.
- Cibulskis RE, Alonso P, Aponte J, et al. Malaria: Global progress 2000 - 2015 and future challenges. *Infect Dis Poverty* 2016;5(1):61.
- Doumbo O, Fall IS, Niaré D. [Malaria is still a leading cause of fever and death among children and pregnant women in Africa in 2015]. *Bull Acad Natl Med* 2016;200(3):453–66.

- Eisele TP, Larsen DA, Anglewicz PA, et al. Malaria prevention in pregnancy, birthweight, and neonatal mortality: a meta-analysis of 32 national cross-sectional datasets in Africa. *Lancet Infect Dis* 2012;12(12):942–9.
- Fobil JN, Levers C, Lakes T, Loag W, Kraemer A, May J. Mapping urban malaria and diarrhea mortality in Accra, Ghana: evidence of vulnerabilities and implications for urban health policy. *J Urban Health* 2012;89(6):977–91.
- Grigorian G, Solkhomonian L. [Armenia: implementation of national program of malaria control]. *Med Parazitol (Mosk)* 2001;(1):21–4.
- Hassen J, Dinka H. Retrospective analysis of urban malaria cases due to *Plasmodium falciparum* and *Plasmodium vivax*: the case of Batu town, Oromia, Ethiopia. *Heliyon*. 2020;6(3):e03616.
- INSEED. Perspectives démographiques du Togo 2011–2031. 2020. <https://inseed.tg/statistiques-demographiques/>.
- Koukouikila-Koussounda F, Ntoumi F. Malaria epidemiological research in the Republic of Congo. *Malar J* 2016;15(1):598.
- Ndugwa RP, Ramroth H, Müller O, et al. Comparison of all-cause and malaria-specific mortality from two West African countries with different malaria transmission patterns. *Malar J* 2008;7:15.
- Petit PL, van Ginneken JK. Analysis of hospital records in four African countries, 1975–1990, with emphasis on infectious diseases. *J Trop Med Hyg* 1995;98(4):217–27.
- Pradines B, Robert M-G. [Current situation of malaria in the world]. *Rev Prat* 2019;69(2):146–9.
- Razakov SA, Shakhgunova GS. [Current malaria situation in the Republic of Uzbekistan]. *Med Parazitol (Mosk)* 2001;(1):39–41.
- Taffese HS, Hemming-Schroeder E, Koepfli C, et al. Malaria epidemiology and interventions in Ethiopia from 2001 to 2016. *Infect Dis Poverty* 2018;7(1):103.
- Talapko J, Škrlec I, Alebić T, Jukić M, Včev A. Malaria: The Past and the Present. *Microorganisms* 2019;7(6):179.
- Wembonyama S, Mpaka S, Tshilolo L. [Medicine and health in the Democratic Republic of Congo: from Independence to the Third Republic]. *Med Trop (Mars)* 2007;67(5):447–57.
- WHO. World malaria report 2019. 2020. <https://www.who.int/news-room/feature-stories/detail/world-malaria-report-2019>.
- WHO. The E-2020 initiative of 21 malaria-eliminating countries: 2019 progress report. 2020. <https://apps.who.int/iris/bitstream/handle/10665/325304/WHO-CDS-GMP-2019.07-eng.pdf?ua=1>.
- WHO. Action et investissement pour vaincre le paludisme 2016–2030. 2020. https://endmalaria.org/sites/default/files/uploads/2017/07/RBM_AIM_Report_A4-FRENCH_FINAL.pdf.
- WHO. Global Technical Strategy for Malaria 2016–2030. 2020. . . Accessed: July 2020 <http://www.who.int/malaria/publications/atoz/9789241564991/en/>.
- WHO. World malaria report 2017. 2020. . . Accessed: July 2020 <https://www.mmv.org/sites/default/files/uploads/docs/publications/WMR2017.pdf>.
- WHO. World malaria report 2018. 2020. . . Accessed: July 2020 <https://www.mmv.org/sites/default/files/uploads/docs/publications/WorldMalariaReport2018.pdf>.