



Trends and Seasonal Variations for Confirmed Malaria Cases for Sierra Leone for 2012 – 2020

Angella Magdalene George¹, Alfred Kargbou², Richard Wadsworth³, Jia Bainga Kangbai^{2,4}

¹Department of Nursing, Njala University, Bo Sierra Leone

²Department of Environmental Health Sciences, Njala University, Bo Sierra Leone

³Directorate of Research and Development, Njala University Sierra Leone

⁴Tulane University School of Public Health and Tropical Medicine

Abstract

Background: Malaria is the world's deadliest mosquito-borne parasitic disease. An endemic disease in Sierra Leone it poses severe public health problems with stable and perennial transmission in all parts of the country. Worldwide, there were an estimated 241 million cases and 627,000 deaths from malaria in 2020. Many of these cases were caused by *P. vivax* which is rare in sub-Saharan Africa. The whole population in Sierra Leone is at risk of malaria and 22% of deaths among children and adults less than 70 years in 2020 were caused by malaria, mostly caused by *P. falciparum*. This study aimed to estimate malaria trends and seasonal variation using the Integrated Disease Surveillance and Response (IDSR) data (2012 – 2020) in six districts across the four regions.

Methods: The IDSR data that was collected and stored in the District Health Information System (DHIS-2) database over ten years (2011-2020) was used for this study. Statistical analysis was performed using R software for Time Series Analysis (TSA) on data from six districts across the four regions in Sierra Leone.

Results: The upward trend in positive malaria cases was statistically significant. The upward trend in positive cases was about 0.55% per year; compared to an estimated population growth of 2.1%, cases per 100,000 appeared to be declining, even though the total number of cases was increasing. Cases reported at hospitals and PHU (public health units) was highest in 2013 (1,007,356 cases in a population of 3,164,498) and least in 2020 (943,214 cases in a population of 4,222,328).

Seasonal variation in cases varied geographically with peak numbers recorded in the second quarter (beginning of the rainy season) in South-East and Northern Districts, but a peak in the third quarter (late rainy season) in the Western Area Urban.

Conclusion: The study found a high disease burden over the ten-year period in which the upward trend in positive malaria cases was statistically significant. There are seasonal variations across the four regions. The Sierra Leone National Malaria Control Program (NMCP) should be robust in monitoring the intervention activities to ensure compliance. Consistent support and regular refresher training on IDSR are also needed.

Keywords: Malaria, Seasonal Variation, annual trend, IDSR, Sierra Leone.

Introduction

Malaria is one of the leading causes of morbidity and mortality in developing countries including African countries.¹ Sub-Saharan Africa accounts for majority (95%) of all global malaria cases and deaths.² Malaria is hyper-endemic in Sierra Leone with perennial transmission occurring in all parts of the country.³ Among the different mosquito vector species that are responsible for the transmission of malaria, the *Anopheles gambiae* is the principal vector for most of the malaria cases in sub-Saharan Africa.

Malaria accounts for most of the hospitalization and deaths

in Sierra Leone.⁴ The disease also accounts for approximately 40% of outpatient morbidity across all ages; 47% of outpatient morbidity among children below five years, and has a case fatality rate of 17.6%.^{3,5} Malaria transmission among Sierra Leoneans is intense but with modest seasonal fluctuations. The disease is associated with poverty and with a great economic impact on individuals, households, and governments.⁵ Substantial amount of money is annually spent on purchasing malaria drugs, cost of seeking treatment at healthcare facilities, and the loss of working days.^{5,8} Actions to prevent and control malaria can contribute to and benefit from sustainable development as the objectives of reducing the disease burden and eliminating malaria are closely linked to several sustainable development goals.⁸

For an effective malaria control and management strategy, thorough and effective surveillance of all suspected and confirmed malaria cases are needed. The International Health Regulation requires among many issues that countries should build or strengthen their core public health capacities.⁹ In 2003 the Ministry of Health and Sanitation (MoHS) in Sierra Leone adopted the Integrated Disease Surveillance and Response (IDSR) strategy which aimed at improving the surveillance of health conditions in the country. The IDSR was faced with few challenges including the outbreak of the West African Ebola Virus

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***Corresponding author:** Angella Magdalene George, Department of Nursing, Njala University, Bo Sierra Leone

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Disease (EVD) outbreak in 2013 – 2016 which led to its brief hiatus but however reinvigorated after the EVD outbreak.⁶

There is an information gap about the impact of the IDSR on malaria surveillance in Sierra Leone. So far there is also a paucity of information on the use of IDSR for both malaria trend analysis and seasonal variation studies. The sensitivity and specificity of IDSR to capture malaria cases is also yet to be assessed. In this longitudinal study we are set to conduct a long-term trend analysis of malaria cases in Sierra Leone using IDSR data that was collected from 2012 to 2020. We will also analyze the seasonal variation of these cases for the period under investigation.

Methods

Study setting

This study made use of malaria surveillance data collected in Sierra Leone. Sierra Leone had a total population of 7.3 million in 2015. The country is located in Western Africa. Most of the country's population is engaged in subsistence agriculture; few also engage in diamond mining.

Study Design

A retrospective study design was done using IDSR data that has been collected from 2012 to 2020. The study analyzed all Outpatient Department (OPD) and Inpatient Department (IPD) confirmed and clinical reported malaria cases that were collected in government-owned health facilities in Sierra Leone within the 9 years period. Study participants included all men, women and children who resided within the study sites and who visited the various healthcare facilities as either suspected malaria cases on symptomatically diagnosed malaria cases. The study did consider whether these cases were old, recurrent or new malaria cases.

Operational terms

Suspected malaria case: - Clinical malaria diagnosis made in a patient who has fever or history of fever in the last 48 hours; and the patient lives in malaria-endemic areas or has a traveling history to such endemic zone within the last 30 days⁹.

Confirmed malaria case: - A suspected malaria case in which malaria parasites have been verified by microscopy or RDT.

Annual parasite incidence: - Total number of positive malaria parasite slides in a year \times 1000 / Total population.

Data Collection

The IDSR data is made of suspected and confirmed malaria cases who visited various healthcare facilities across the country within the study period. Malaria cases were confirmed using RDT at these healthcare facilities. The IDSR data was routinely collected during the study period and stored in the Health Management Information System (HMIS). The HMIS forms part of the national health information database known as the DHIS-2. The revised IDSR tool collects weekly data on 44 priority health events including malaria.

Study sites

This study used IDSR data collected from health facilities in six districts (Bo, Bombali, Kenema, Port Loko, Tonkolili, and Western Area Urban) located across four Sierra Leone regions. These districts were selected because they have consistently achieved the WHO standard¹⁰ of 90% data reporting rate. The healthcare workers in the various peripheral health units (PHUs) routinely record patient medical records that include clinical and socio-demographic information. These medical records are then entered into the IDSR register and are later collated and transmitted to the nearest District Health Management Team (DHMT). For each epidemiologic week, priority diseases and events of public health importance are reported with surveillance focal person summarizing the data into weekly surveillance updates. For conditions that require immediate notification to the next level, case-based forms are used for such reporting. To ensure data timeliness, all IDSR data were weekly transmitted to the nearest District Health Management Team for onward transfer to the central system in the capital Freetown.

The stored data in the DHIS-2 system were anonymized before extracting and later transformed, collated, and stored in a password-protected Microsoft Excel database for descriptive and statistical analysis.

Data Analysis

The trend and seasonal components were estimated using "STL" [(seasonal decomposition of time series using LOESS (locally estimated scatterplot smoothing) in R software package version 4.1.3¹⁰. Frequencies and proportions were analyzed using Microsoft Excel, and the 2015 Population and Housing Census projected population figures were used as denominators. The cleaned data series were read into the software package R and de-composed using the "decompose" function from the TSA (time series analysis) library. Decompose splits time series into three components; (a) long-term trend (b) seasonal component (c) random noise.

Ethical consideration

The Sierra Leone Ethics and Scientific Review Committee (SLESRC 006/09/2022) and the Njala University Institutional Review Board provided ethical clearance and approve this study. They also waived the right for an informed consent on the grounds that the study poses no risk to the study participants; as well as the fact that this study will be analyzing anonymous data.

Results

A total of 16,328,114 cases of fever (suspected malaria cases) with 9,438,595 confirmed malaria cases and 170,116 malaria deaths (CFR = 18.0%) were recorded in the study period. From Table 1 there was a small upward trend of 0.55% per year in confirmed malaria cases ($p < 0.001$). Malaria incidence was highest (31.8%) and lowest (22.3%) in 2013 and 2020, respectively. Bo District recorded the highest (40.9%) average



Table 1: Malaria Incidence and Case Fatality Rate from 2012 – 2020.

Year	Population	Malaria Cases	Incidence (%)	Death	CFR (%)
2012	3,085,342*	812,042	26.3	673	0.08
2013	3,164,498*	1,007,356	31.8	1,818	1.8
2014	3,246,489*	900,994	27.8	663	0.7
2015	3,709,142**	933,974	25.2	1,744	1.9
2016	3,821,834**	1,124,625	29.4	3,687	3.3
2017	3,921,404**	1,020,439	26.0	1,041	1.0
2018	4,019,358**	1,168,759	29.1	1,248	1.1
2019	4,121,509**	1,186,655	28.8	2,372	2.0
2020	4,222,328**	943,214	22.3	1,122	1.2

* - Statistics Sierra Leone – Population and Housing Census/Analytical Report on population projection 2004

** - Statistics Sierra Leone – Population and Housing Census 2015/Thematic Report on Population Projection 2017

Table 2: Distribution of Malaria Incidence and Case Fatality by District from 2012–2020.

Districts	Median Population (2016)	Malaria Cases	Deaths	Incidence (9-year)	Annual Risk of Death (per 100,000 population)	Case Fatality Rate (%)
Bo	593,160	1,982,524	2,622	334.2	49.1	0.13
Bombali	417,234	1,038,341	971	248.9	25.9	0.09
Kenema	629,457	2,075,713	1,380	329.8	24.4	0.07
Port Loko	546,214	1,240,932	3,482	227.2	70.8	0.28
Tonkolili	546,812	1,751,284	1,170	320.3	23.8	0.07
Western Area Urban	1,088,957	1,009,471	4,743	92.7	48.4	0.47

total of malaria incidence, while the Western Area Urban recorded the lowest (9.6%). The study further showed 2016 recorded the highest fatality rate than what was recorded for the entire period (Table 2).

Trend and seasonal analysis of malaria incidence

There was an upward trend in the number of malaria cases over the last 9 years; there was however a slight decline in malaria incidence for various districts with WHO compliant data (Figure 1). The upward trend in malaria cases is less than the annual national population growth. There were differences in malaria incidence between Bo District (35.5%) and Western Area Urban (8.2%). In Western Area Urban the highest number of malaria cases occurred in the third quarter of the year (at the end of the raining season), while in the other districts the peak malaria cases occurred in the second quarter of the year (at the beginning of the raining season).

Discussions

The overall nine years Malaria trend analysis shows an upward trend in the number of malaria cases using malaria incidence data for districts that consistently met the 80% completion rate set by the WHO data quality goal. There was a sudden drop in the monthly malaria cases. Overall, the study found a high malaria burden in the six districts for the study period; although there

was a more substantial downward trend in which can be due to the uptake in malaria prevention and control measures that were implemented by the country’s National Malaria Control Program and other health-implementing partners. This finding is similar to that reported in the U.S. President’s Malaria Initiative Strategy 2021 – 2026.¹² The high cases of positive malaria cases for districts in the Eastern and Southern regions as well as the highest CFR for the Western Area Urban requires further exploration. The highest and lowest malaria incidence rates

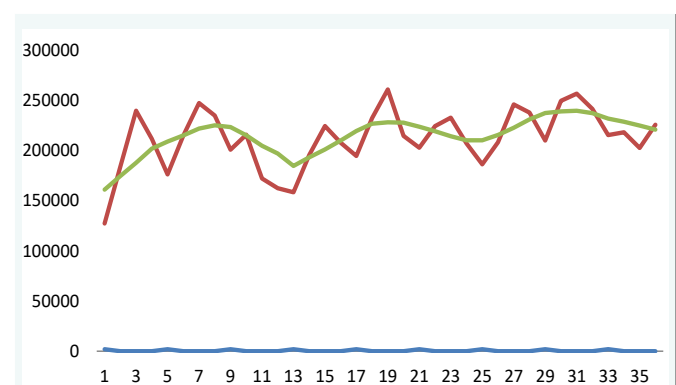


Figure 1 Trends and seasonal variation of confirmed malaria cases for the study areas for 2012 – 2020.



for the period under review were recorded in Bo District and WAU respectively. Perhaps, the low incidence reported in WAU may be due to self-medication as that is common with most individuals living in urban areas. Most people find walking into a drug store to buy pills to treat their malaria symptoms so easy, rather than going through all the bureaucracies in the hospital before they can be treated. Such self-medication naturally leads to under-reporting of the total number of malaria cases; which is a limitation to all surveillance healthcare data. This conjecture is consistent with our observation that the highest CFR was found in the WAU suggesting a selection for severity in clinics.

This study also explored whether the implicit assumptions of similar seasonal variation in all districts could be implied also; which however turned out to be entirely the case and hence sufficient to justify our overall trend and seasonal analysis. This observation is in accordance with other studies on seasonal transmission of malaria across regions in Sierra Leone.³

It further revealed that Port Loko bore the highest risk for malaria in relation to their population; while Kenema District recorded the highest number of malaria positive cases. The Western Area Urban however recorded the least but Bo District recorded the highest malaria incidence. These statistics however should be taken with caution since the case definition for malaria was based on the rapid diagnostic test based on parasitology and considering the fact that asymptomatic parasitemia is common in Sierra Leonean population it may have led to false positive malaria cases; another limitation in the using of RDT diagnostic test in surveillance data collection. The surveillance data used in this study did not fully represent what could have been obtained for the entire country as only data from six out of the 16 districts were used because they (the six districts) have achieved the WHO standard of 80% reporting for completeness. Furthermore, the IDSR system only captured data from government-owned health facilities which is not representative of the actual malaria situation in the country. Another limitation to our study is that we aggregated over all ages and both sexes. Despite all these limitations, we believe that our overall conclusion of a slightly improving malaria situation seem justified; and hope that now that the Ebola and COVID epidemic are a thing of the past, a renewed focus on malaria control will accelerate the decline in malaria morbidity and mortality.

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