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Epidemiology of Malaria Cases, Sunyani Municipality, Ghana, 2020

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KEYWORDS: Malaria, Sunyani, Trend, Surveillance, Municipality, OPD, SMC, threshold

ABSTRACT

Introduction: Malaria is endemic in Ghana, accounting for about 40% of all Outpatient Department (OPD) diagnoses. Data on malaria is routinely collected as part of the IDSR monthly reporting forms. Sunyani municipality recorded 56,540 malaria cases in 2016 with about 35% of the cases occurring in children under five years of age. We analyzed malaria surveillance data to identify the distribution of malaria cases by person, place, and time and determine the timeliness and completeness of malaria report submissions in the municipality. **Methods:** We analyzed malaria surveillance data in Sunyani municipality reported between 2015 and 2019 from the District Health Information Management System (DHIMS 2). We calculated morbidity and mortality rates of cases by person and estimated the proportion of cases by sub-districts. We performed trend analysis and calculated disease threshold levels. We presented the findings using tables and figures. **Results:** Of 639,361 malaria cases suspected, 93.5% (597512/639361) were tested, of which 49.4% (295458/597512) were positive. Females accounted for 55.7% (164436/295458) of confirmed cases. Children under 5 years recorded the highest proportion, 29.9% (88135/295458) of cases in the municipality. The case fatality rate was 3.7% (18/484) and 1.4% (7/484) for persons under five years and five or more years, respectively. Abesim subdistrict (6276.03 per 10000) recorded the highest number of cases, and the lowest case count was in New Dormaa subdistrict (1890.97 per 10000). The majority of malaria cases were in May and October of each year. Antwi-krom subdistrict recorded the highest rates of report completeness and timeliness at 41.9% and 40.0% respectively. **Conclusion:** More females were diagnosed with malaria and children <5 years recorded the highest proportion of cases in the municipality. Abesim recorded the highest proportion of malaria cases during the period. High patterns of malaria transmission occurred during months of high rainfall. None of the sub-districts met the World Health Organization (WHO) target for timeliness and completeness of report submission. The National Malaria Elimination Programme (NMEP) should consider interventions such as Seasonal Malaria Chemoprevention (SMC) among children under five, in the municipality.

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Introduction

In 2018, 228 million cases of malaria were reported globally, with an estimated 405,000 malaria-related deaths. The WHO African Region accounted for 94% of all these deaths [1]. Particularly vulnerable to malaria are pregnant women and children under five years [2]. The illness claims a child´s life every 2 minutes, making it the second-largest cause of death from infectious diseases in Africa [3]. About 67% (272, 000) of all malaria-related deaths in 2018 occurred in children under five years of age [1].

Malaria remains a hyperendemic disease posing a significant public health challenge in Ghana [4,5]. It is the leading cause of morbidity and mortality despite the scale-up of new malaria preventive and control interventions [6,7]. In 2020, the country recorded over 5.2 million confirmed cases of malaria with 308 malaria-associated deaths [8]. Malaria transmission is generally stable in Ghana with varying endemicity across the regions in Ghana. Malaria Indicator Survey 2019 showed a parasite prevalence of 14.1%, a decrease from 27.5% in 2011 with prevalence ranging from approximately 2.4% in Greater Accra to 27.0% in the Western Region [9].

Various malaria control interventions such as mass and school-based distribution of insecticide-treated nets and intermittent preventive treatment of malaria among pregnant women have been implemented in the Bono region to control the burden of malaria. Despite these measures, there is still a high malaria burden in the area [10]. Sunyani municipality recorded an upward trend of malaria cases from 43,467 in 2013 to 56,540 cases in 2016, with about 35% of the cases occurring in children under five [11]. Malaria morbidity and mortality data in the municipality is collected through the passive surveillance approach. Even with the malaria surveillance system in the municipality, there has been limited epidemiological analysis of the data gathered to inform decision-making on malaria preventive and control measures. We thus analyzed the five years´ malaria morbidity and mortality data to determine the distribution of malaria cases by person, place and time and to determine the timeliness and completeness of malaria report submission in the municipality.

Methods

Study design

We analyzed malaria surveillance data in Sunyani municipality reported between 2015 and 2019 from the District Health Information Management System (DHIMS 2). Malaria dataset from the system was reviewed and extracted for analysis. We conducted the study from July 27 - September 05, 2020.

Study setting

Sunyani municipality is one of the 12 districts of the Bono region of Ghana. The projected 2019 population of the municipality was 151,378 [12]. About 18.5% of the total population are children <5 years old. The Sunyani municipality is in the semi-equatorial climate zone. The median monthly temperatures range from 23°C-33°C with the lowest in August, and the highest observed in March and April. During the rainy seasons, relative humidity is high on average between 75%-80% and 70%-80% during the dry season. The municipality experiences double cycled rainfall, the primary rainy season runs from March to September with the minor being between October and December. There are six sub-districts in the municipality: Sunyani Central, Abesim, New Dormaa, Ankwi-Krom, Penkwase, and New Town Baakoniaba (Table 1) with 37 health facilities all reporting on malaria morbidity and mortality.

Case definition of malaria

Suspected Uncomplicated Malaria: Any person with fever or history of fever within 24 hours; without signs of severe disease (vital organ dysfunction) is diagnosed clinically as uncomplicated malaria.

Suspected severe malaria: Any patient hospitalized with severe febrile disease with accompanying vital organ dysfunction diagnosed clinically [13].

Confirmed case of malaria: Occurrence of malaria illness/disease in a person in whom the presence of malaria parasites in the blood has been confirmed by parasitological testing [13].

Data collection

A data extraction tool was designed and employed for the extraction of malaria morbidity and mortality data from the DHIMS 2 platform. The variables extracted included: case status, age, sex, time of illness, place of residence, time of report submission and reports submitted.

Data Analysis

We used Microsoft Office Excel 2019 and Stata version 15.1 in analyzing the data. Summary descriptive analysis of the data was done in the form of frequencies, averages, rates, thresholds and percentages. We used tables, charts and graphs to present the data.

In determining the proportion of confirmed malaria cases for all ages from 2015-2019: The malaria morbidity data was grouped by predetermined age groups and sex in the DHIMS 2 platform, that is <28 days, 1-11 months, 1-4 years, 5-9 years, 10-14 years, 15-17 years, 18-19 years, 20-

34 years, 35-49 years, 50-59 years, 60-69 years, and 70+. With the frequencies given for each age category in DHIMS 2, we estimated the relative frequencies or proportions for each age group. We performed the estimation by expressing the number of malaria cases (age-group) divided by the total confirmed cases by 100%.

In describing the distribution of malaria morbidity and mortality by sub-districts in the municipality, cases of malaria on DHIMS 2 were categorized on a sub-district basis. To determine the proportions of malaria cases in the various sub-districts in 2019, we used the 2019 population distribution for the various sub-district as the denominator and the 2019 case count from the sub-district as the numerator, per 10,000 population.

In assessing the trend of malaria morbidity and mortality in the municipality, we categorized the extracted malaria morbidity data based on time of occurrence (month and year) on Microsoft Office Excel. We drew a line graph using the absolute case counts for each of the months from 2015-2019. In determining the threshold levels for malaria in the municipality using the CUSUM-2 approach, we generated the mean number of cases for a preceding 7-month period, leaving a 2-month grace period, for each month. The standard deviations for the same period were derived and multiplied by 2. The sum of the mean and two times the standard deviation gave the threshold level for each month.

In assessing the timeliness and completeness of malaria data reporting, we extracted data on the number of reports submitted by a sub-district on time and the number of reports submitted in total by the same sub-district from the DHIMS 2 platform for timeliness and extracted data on the total number of reports submitted by a sub-district and the number of reports expected from the sub-district for completeness. The proportions resulting from this estimation were compared to the WHO target of 80% for timeliness and completeness of report submission [14].

Ethical considerations

Ghana Field Epidemiology and Laboratory Training Program (GFELTP) of the University of Ghana obtained permission from the Ghana Health Service to conduct malaria surveillance data analysis. The permission was through the National Malaria Elimination Programme (NMEP) as well as the Bono Regional Director of Health Services and the Sunyani Municipal Health Directorate.

Results

Distribution of malaria morbidity and mortality by person

A total of 639361 cases of malaria were suspected from the 2015-2019 period. Of the total cases suspected, 93.5% (597512/639361) were tested using microscopy and Rapid Diagnostic Test (RDT) methods. Over forty-nine per cent (295458/597512) of the people tested were positive. About 5.4% (34737/639361) of the total suspected cases were treated without testing in the municipality.

Females accounted for 55.7% (164436/295458) of confirmed cases. Malaria in children under age of 5 years accounted for 29.9% (88135/295458) of malaria burden. Uncomplicated malaria cases constituted 99.8% (294974/295458) of the confirmed cases. Pregnant women consisted of 1.5% (2387/164436) of the total confirmed malaria cases among females. The case fatality rate among persons diagnosed with severe malaria was 3.7% (18/484) and 1.4% (7/484) for children under age five and over age five years, respectively (Table 2).

Distribution of confirmed cases of malaria by sub-districts in the Sunyani municipality

In 2019, the proportion of malaria was high (6,276.03 per 10,000) among residents of Abesim, and the least (1,890.97 per 10,000) was recorded among residents of the New Dormaa sub-district (Figure 1).

Distribution of confirmed cases of malaria by the time of occurrence in the municipality

Cases of malaria were recorded in all months between January 2015 and December 2019. The highest number of confirmed cases 2.73% (8067/295458) over the period was recorded in October 2018 and the lowest 0.85% (2524/295458) in February 2015 (Figure 2). With the threshold determined, the highest threshold was in July 2019, and the lowest was in September 2017. July 2016 and October 2018, saw the number of malaria cases exceed the threshold level. In May 2018, the number of cases was almost equal to the threshold level (Figure 2).

Timeliness and completeness of malaria report submission in the Sunyani municipality

For the five years under review, the Antwi-krom subdistrict recorded the highest completeness and timeliness of 41.9% and 40.0% respectively. Sunyani Central subdistrict recorded the least completeness and timeliness of 22.1% and 20.1%, respectively (Figure 3).

Discussion

We analyzed five-year malaria morbidity and mortality data of the Sunyani municipality from 2015 to 2019 to identify the distribution of malaria cases by person, place and time and to determine the timeliness and completeness of malaria report submission in the municipality.

The analysis revealed more than half of the confirmed malaria cases in the municipality were females. This could be explained by the higher proportion of females than males in the municipality´s general population [15]. This is consistent with the findings of a study conducted in Manicaland province Zimbabwe, where 52.5% of cases confirmed were females [16]. The similarity in result could likely be explained by the Manicaland province and Sunyani municipality´s similar population structure. Each of them has over 52% of its population being females [15,17]. Despite the higher malaria cases among females in the general population, we found that the prevalence of malaria was higher among male children than female children under five years. This finding was consistent with similar studies in Ghana and Kenyan [18,19]. This observed trend could be explained by female children being less biologically vulnerable to infectious diseases than their male counterparts [18].

About one-third of confirmed cases of malaria were in children under five years. This is similar to what Bajoga et al., (2019) reported in Kaduna, Nigeria [20]. Malaria cases were fewer among children less than one year. This may be partly explained by the increased push to combat malaria through a combination of interventions such as enhanced Insecticide Treated Net (ITN) coverage, improved antenatal care and Intermittent Preventive Treatment of Malaria in pregnancy using Sulphadoxine pyrimethamine (IPTp-SP) uptake [21]. Among the children less than a year old, neonates had the lowest proportion of malaria infections. This may be because, during pregnancy, neonates obtained antibodies from their mothers [18]. Furthermore, a study conducted by Stephens et al., (2017) [22] found that pregnant women exposed to complete IPTp-SP had better protection with reduced placental parasitemia while serving as a buffer for their neonates.

The Sunyani municipality recorded a high malaria case fatality rate of 5.1% with about 3.4% fatality rate among children under five years of age. The high fatality rate among the under five years could be attributed to the delay in getting these children to a health facility for medical care before the onset of complications. However, this finding is inconsistent with the malaria case fatality rate reported by the National Malaria Control Program for the year 2017. The difference in the fatality rate could be attributed to the difference in the population size under surveillance.

The Abesim sub-district registered the highest malaria burden in the municipality from 2015-2019. This could be explained by the Ghana Water Company water treatment plant´s presence in the area that could serve as a breeding ground for mosquitoes and hence the high transmission rate. This finding is similar to a work conducted in Central Ethiopia, where villages with irrigation dams were found to have 3.6 times increased odds of malaria transmission compared to villages without irrigation plants [23]. We ruled out other factors such as high reporting rate by facilities in the area or population proportion compared to the other sub-districts as possible factors accounting for the high transmission in the area.

In the municipality, there was a seasonal variation to the transmissions of malaria over the five years. Cases of malaria were more pronounced between May and October of every year for the period. This could be explained by the municipality´s rainfall pattern, where the major rainfalls occur from March to September and the minor one between October and December each year. This result is consistent with the findings of a study conducted in Limpopo to assess the climatic variables and malaria transmission; they reported that monthly rainfall was the main predictor of malaria transmission [24]. However, this is inconsistent with the findings of a similar study conducted in northeastern rural Benin where the authors´ associated high incidence of malaria with dry or drought seasons of the year [25]. The disparity in this finding could be explained by the difference in the climate of the areas [12,25]. The municipality experienced an excess case count above the threshold levels in May and October 2016 and October of 2018. This could be suggestive of an outbreak of malaria. This is consistent with the findings of Lechthaler et al., (2019) & Ogwang et al., (2018) [26,27]where they detected malaria epidemics from trend analysis of malaria data in Kitgum district Uganda and DR Congo. However, in the case of Sunyani municipality, certain factors needed to be ruled out to confirm the status of the increase, whether it was a true or false increase. These factors include: batch reporting of cases by facilities, changes in reporting practices of surveillance officers, errors in reporting cases and improvements in diagnostic methods for malaria. Also, malaria being an episodic disease could have resulted in over-reporting, which was suggestive of the outbreak.

For the five years under review, the timeliness and completeness of malaria report submission by the sub-districts in the municipality was low with none of the sub-districts meeting the WHO target of 80% for completeness and timeliness of IDSR monthly reports submission. The poor timeliness of report submission is consistent with the findings of a study conducted in Malawi [14]. In contrast to this finding, studies conducted in northern Ghana and

Uganda reported reasonable rates on timeliness and completeness of IDSR monthly report submission [28,29].

There were some limitations to this study. Firstly, malaria is an episodic disease, and the number of cases reported could have been influenced by over-reporting in the municipality. Secondly, some private health facilities in the municipality were not reporting malaria morbidity and mortality data; this could have affected the municipality´s actual burden. However, we made effort to retrieve data from private health facilities and compare hardcopies IDSR forms and hospital registers to the records in the DHIMS 2 to make the findings of this analysis significant and informative. Another limitation of the study was the use of case definition in detecting malaria cases, due to the use of secondary data in this study, we could not ascertain if the health workers properly applied the case definition in all the suspected cases of malaria.

Conclusion

The occurrence of malaria in the municipality varied according to age and sex with children <5 and females recording a higher proportion. Abesim sub-district recorded a high proportion of malaria cases in 2019. There was seasonal variation in the transmission of malaria in the municipality during the period under review. None of the sub-districts met the WHO target for timeliness and completeness of report submission. The Sunyani Municipal Health Directorate should put in measures to ensure completed and timely malaria data is submitted every month. The NMEP should consider interventions such as SMC among children <5 years and indoor residual spraying (IRS) in the Sunyani municipality. The municipal health directorate should strengthen education in the municipality on malaria control and treatment adherence.

What is known about this topic

- Malaria is endemic in Ghana, accounting for about 40% of all OPD diagnosis
- Malaria is the leading cause of morbidity and mortality despite the scale-up of new malaria preventive and control interventions

What this study adds

- The occurrence of malaria in the municipality varied according to age and sex with children <5 years and females recording a higher proportion
- None of the sub-districts met the WHO target for timeliness and completeness of report submission

Competing interests

The authors declare no competing interests.

Authors' contributions

AGM conceptualized the study, implemented data acquisition, performed the analysis, AGM and CT, DB, CLN, MAO and EK drafted the initial manuscript. CT, DB, CLN, MAO and EK edited and reviewed the manuscript. All authors read and approved the final manuscript.

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Table 1: Population of the subdistricts in the Sunyani Municipality, 2019		
No	**Sub-district**	**Population**
1	Abesim	23918
2	Antwikrom	15895
3	New Dormaa	36482
4	New Town/ Baakoniaba	27854
5	Penkwase/	23312
6	Sunyani Central	23917

Table 2: Distribution of confirmed malaria cases in Sunyani municipality, 2015-2019 N=295,458					
Variables	**Under 5 years**		**5 or more years**		**Total**
	Frequency (n)	**Percent (%)**	**Frequency (n)**	**Percent (%)**	
Sex					
Male	45080	15.3	85942	29.1	131,022 (44.4%)
Female	43055	14.6	121381	41.1	164,436 (55.7%)
Classifications					
Uncomplicated	88030	29.8	206944	70.0	294,974 (99.8%)
Severe Malaria	105	.03	379	.13	484 (0.16%)
Severe malaria cases outcome (n=484)					
Died	18	3.7	7	1.4	25 (5.1%)
Recovered	87	18.0	372	76.9	459 (94.9%)
Pregnancy status (Females only n=164,436)					
Pregnant	0	0	2387	1.5	2,387 (1.5%)
Not pregnant	43055	26.2	118994	72.4	162,049 (98.6%)

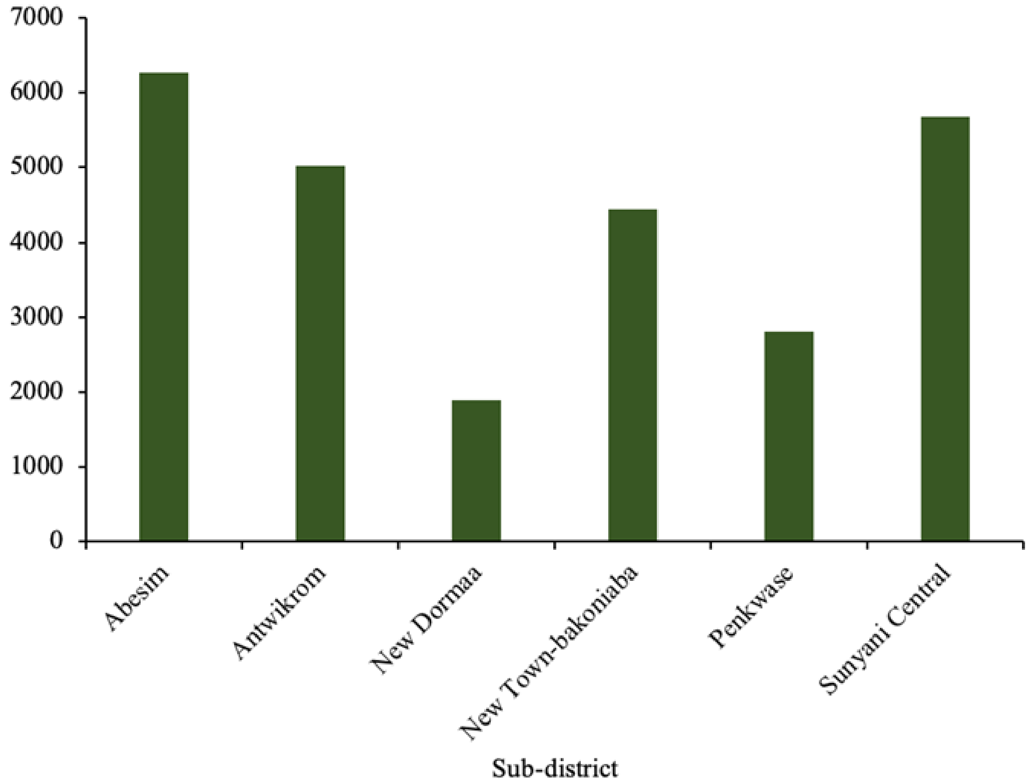

Figure 1: Sub-district distribution of confirmed malaria cases, 2019

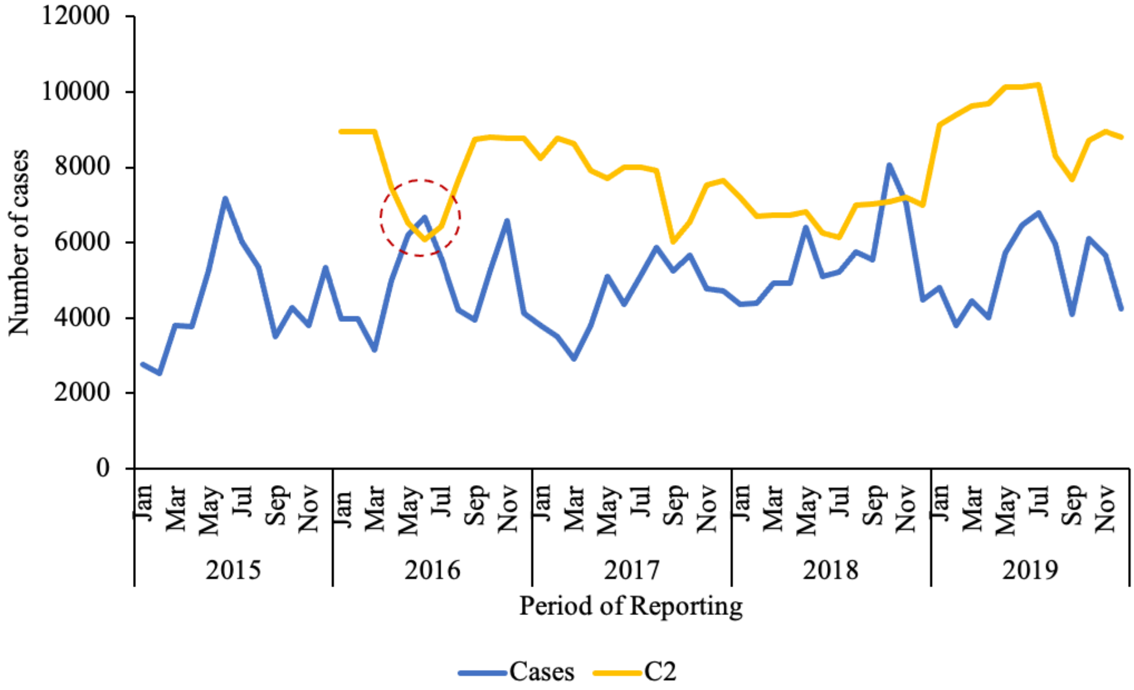

Figure 2: Confirmed malaria cases reported and malaria threshold levels (C2) for Sunyani municipality, January 2015 to December 2019

Figure 3: Timeliness and completeness of malaria data reporting by sub-districts, 2015-2019