Episodes of confirmed malaria and associated factors in patients attending selected health facilities, Liberia, 2015-2016: A cross-sectional study.

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ABSTRACT

Introduction: Malaria remains a public health concern and one of the top three causes of morbidities at outpatient department in Liberia. To implement preventive, diagnostic, and malaria treatment measures, the annual malaria episodes is required for planning of interventions and procurement. We determined the median annual malaria episodes and factors associated with more than one episode. **Methods:** A retrospective cross-sectional study; January 2015 to December 2016-confirmed malaria in 15 randomly selected health facilities was conducted. Facilities stratified into three groups based on cases reported per annum; those with > 1,500 malaria cases per annum as high burden facility, 1,000 – 1,500 cases as moderate, and < 1,000 cases as low. One health facility per strata randomly selected from each of the five health divisions. Data extracted from health records were patient's ID(identifier), age, sex, address, visit date and diagnosis. Frequency, proportion, mean, median and interquartile range of episodes' data calculated. **Results:** Of the 35,249 malaria cases reported, 82% (29,236) met the study criteria. Children age ≤ 5 had the highest individual annual episodes. The overall annual median (Interquartile range, IQR) malaria episodes was 1 (IQR, 12). Trends of confirmed malaria increased from 454 cases in January 2015 to 909 in December 2016. Attendance in North Central region, and age less than 5 were significant factors associated with more than one episode of malaria. **Conclusion:** Children under five reported high annual individual episodes of malaria. The overall annual median episode is one. No difference between the WHO estimated annual episode used for malaria programmatic planning.

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Introduction

Globally, 29 countries (95%) of malaria cases were reported in 2019 with an estimated 215 million cases (94%) from the WHO African region [1]. Malaria mortality rate reduced globally from 25 in 2000 to 10 in 2019. About 95% of these deaths worldwide occurred in 31 countries [2] About 229 million cases occurred in 2019 and the African region accounted for 94% of cases and reduced malaria deaths by 44% from 680,000 in the year 2000 to 384,000 in 2019 [1]. Pregnant women and children under the age of five years were more vulnerable [1-3]. In the 2013 health facility survey in Liberia, 42% of out-patient morbidities and 39% of in-patient mortalities were due to malaria [4] and the 2016 Malaria Indicator Survey puts malaria prevalence amongst children under-five using malaria rapid diagnostic test (mRDT) at 45% [5,6].

Gains to reduce the burden of malaria has been made possible through the implementation of targeted policies and high population coverage of effective malaria interventions [4,5]. To drive the achievement of the target set in the sustainable development goals (SDGs) 2030, the National Malaria Control Program (NMCP) of Liberia aims to reduce malaria case incidence by 75%, from 385/1,000 population in 2016 to 95/1,000 population in 2025 [6,7]. In an effort to reduce multiple occurrences of malaria episodes, the NMCP routinely distributes long-lasting insecticide treated nets (LLINs) and increases access to prompt and effective treatment [6,8,9]. However, Liberia´s LLINs ownership has remained low from 2013 to 2019 at 55% while LLINs utilization declined from 42% in 2016 to 40% in 2019 making it a major concern which may influence multiple occurrences of malaria episodes or cases.

Furthermore, over the years, the Liberia NMCP has faced challenges in quantification of malaria commodities for diagnosis and treatment. The challenges are linked to the lack of Liberia´s specific quality data on annual malaria episodes and consumption of malaria commodities. In absence of complete country data, World Health Organization (WHO) recommends the use of country´s specific estimated annual malaria episodes in planning and procurement of malaria commodities [8,10-12]. The projected estimated annual malaria episodes in Liberia for children under-five and pregnant women is two malaria episodes per annum, while procurement projections for anyone at age five years or more one malaria episode per annum is recommended. Although, these recommended projections are used by the Liberia NMCP in procurement planning, there has been a continuous and persistent reporting of malaria commodities stock-out [7] despite low access to health services at 71% [13]. Therefore, there is a need to determine the country specific annual malaria episode for procurement and planning. This study aims to determine the distribution of annual malaria episodes in Liberia geared toward guiding program planning and procurement of malaria commodities.

Methods

Study settings

Liberia with an estimated population of 4,206,701 in 2017, have 15 political subdivisions or counties. The country was grouped into five health regions each having three counties. The five health divisions were North western, North Central, South Central, South Eastern A and South Eastern B. In 2017, there were 831 health facilities reporting malaria cases to the District Health Information System (DHIS2), 37 (4%) hospital, 62 (7%) health centers, and 732 (88%) clinics. At each of these facilities, patients are registrar and assigned a unique ID that is traceable if that patients visit the facility. The patient´s records are physically filed at the health facility for easy reference upon return to the said facility by the patient. The ID is not linked to another health facility rather unique to the facility the patient sought care. The hospitals and health centers provide out- and in-patient services and are operated by specialists, medical doctors, physician assistants and clinical officers, while the clinics are operated by nurses or physician assistants and provide out-patient and referral services.

Study design and Population

We adopted a retrospective cross-sectional study design where we reviewed all records of patients who sought/attended health care services for malaria and was confirmed malaria positive. The study population included all patients who sought care at

the selected health facilities from January 1, 2015 - December 31, 2016. An episode of malaria was defined as a suspected malaria case confirmed as positive using a parasitological test, mRDT and/or microscope irrespective of the plasmodium species and received treatment. For a specific individual, any confirmed malaria case occurred ≥ 14 days after the previous one was considered as a new episode of malaria [14]. We retrieved all records of malaria cases, however, only those with complete clinical and laboratory records were included in the study.

Sample size selection

All eligible individual that met the inclusion criteria were enrolled into the study. Therefore, any individual that presented in the selected health facilities from 2015 to 2016 with a complete record (including identification number, date of visit, age, sex, address, diagnosis, treatment). Also, pregnancy status for women in reproductive age group were enrolled in the study.

Sampling

We selected health facilities based on the number of malaria cases reported per annum in 2016 as follows: High burden malaria health facility > 1,500 malaria cases per annum, moderate burden malaria health facilities > 1000 to 1,500 malaria cases per annum, and low burden malaria health facilities as < 1000 malaria cases per annum. In total, 23 high malaria burden health facilities, 32 moderate malaria burden health facilities, and 203 low malaria burden health facilities met the selection criteria. We randomly selected one health facility per category in each of the five health regions (total of 15 health facilities) All health records of individuals who presented in selected health facilities with an episode of confirmed malaria in 2015 and 2016 were included into the study. For everyone diagnosed (positive) with malaria whose unique ID was traced across the 12 months for the year under review, we determined the number of malaria episode reported in the year.

Data collection tool and method

We developed an electronic Microsoft Access data extraction tool which was used to collect information from patients´ records including case files health facility ledgers, and treatment charts. Facility patients´ identification (ID) number was collected including date of visit at the facility. We used patients´ ID to link individual data from these data sources as well as visiting date in each month. To account for total malaria episodes per annum for an individual, initial episode of malaria was followed up through the course of diagnosis/treatment or 14 days from the initial diagnosis/treatment at the health facility. This was counted as another malaria episode for the year. The age of the individual at presentation was converted to age at mid-year and used for the analysis.

Data analysis

Microsoft access database was imported to STATA 11.0 for analysis. Descriptive analysis was conducted where frequency and proportion for categorical variables, mean, median and Interquartile range (IQR) for quantitative variables were calculated. The age categorization (under-five, five & above including pregnant women) used in program planning by NMCP was adopted for the study. The annual median malaria episodes and IQR was calculated for each age group, sex, region, and pregnant women. We constructed a trend line for confirmed malaria cases with level of significance set at $\alpha \leq 0.05$ and 95% confidence interval.

Availability of data

The data from this study is available for sharing on request aimed at improvement in malaria program implementation.

Ethical considerations

The University of Liberia Ethical Review Board approved the study protocol with reference number 17-04-035. The study objectives, its potential benefits and risks with data confidentiality were explained to health facilities official in charge of the selected health facilities and approval was obtained to use patients´ files or health records after obtaining their permission and waiver for informed consent.

Results

Characteristics and distributions of the participants

Of the 35,249 confirmed malaria from 2015 to 2016, 82.0% (n= 29,236) were included in the study. In Table 1, more malaria cases 59.4% (n=17,354) were reported in 2016. Overall, the mean mid-year age of the participants was 17.9 (± standard deviation (SD) =17.3) years and median mid-year age was 12 (Interquartile range (IQR) = 12) years. Children aged ≤ 5 years were 34.5% (n=10,091), women of reproductive age were 33.3% (n=9,739) with 17.7% (n=1,724) of these pregnant. South Central and South Eastern A regions reported 26.6% (n=7,782) and 23.1% (n=6,737) of all recorded malaria cases, respectively and this increase was not due to chance (p-value < 0.001). There was no significant difference in cases of malaria reported in the two years with regards to age, sex, and pregnancy status. The hospital reported 39.1% (n=11,437) of the overall malaria cases.

Trends of confirmed malaria cases

The trend of confirmed malaria cases is shown in Figure 1. There was an upward trend of confirmed malaria cases from 454 cases in January 2015 to 909 cases in December 2016. Annually, more cases of malaria are reported from March to August with a peak in June.

Annual malaria episodes

The overall annual mean malaria episodes was1.26 (± SD =0.66) and median was 1 with IQR = 12. There was a significant difference in malaria episodes per annum between 2015 and 2016 (p-value < 0.001). In Table 2, the annual median malaria episodes in each age categories, sex, pregnant women, and regions was 1. However, there is a wide IQR of malaria episodes in the population with the highest recorded episodes in different age groups in 2016 ranged between 7 and 12 and children under 5 years more affected.

Bivariate analysis

In Table 3, overall, 82.1% (n=23,996) of the study population had one episode of malaria. In 2016, 18.6% (n=3,231) reported more than one episode of malaria and 16.9% (n=2,009) in 2015 (p-value <0.001). Although, clinics reported a smaller number of malaria cases among the health facilities, they had the highest proportion of those with more than one episode of malaria, 23.5% (n=1,900) with significant associations between age, sex, region, type of health facility, pregnancy, and year of presentation at the health facilities.

Predictors of more than one episode of malaria

In Table 4, Children ≤5yrs were more likely to present with more than one episode of malaria per annum compared to those aged more than five years (Adj Odd ratio (OR) 1.75; 95 Confidence Interval CI: 1.64-1.8; p<0.001).

Among all the regions, the North Central region compared with South Central region was thrice more likely to have people that presented with more than one malaria episode in a year (AOR 2.94, 95% CI: 2.63 - 3.29, p <0.001). Clinics were 3.2 times more likely to have clients that had presented with more than one episode of malaria in a year (AOR 3.18, 95% CI: 2.93 - 3.45, p <0.001).

Discussion

The annual median malaria episodes were similar in all characteristics, i.e., patient age, sex, pregnant women, and region, however, children aged less than five years were more affected and recorded with the highest individual annual episodes of malaria. Among all the regions, the North Central region compared with South Central region was thrice more likely to have people that presented with more than one malaria episode in a year. Age was found to be amongst the main predicator for presenting with more than one episode of malaria. This further strengthened the fact that this age group (under-five) is more vulnerable to malaria in Liberia [3,15] and with the young population of average age 12 years as shown in this study. The highest recorded malaria episodes amongst children under-fives as per our findings is like a study conducted in Mozambique where children younger than three years accounted for almost half of the total malaria cases/episodes [16]. The study also revealed that individual number of annual episodes of malaria is lower in pregnant women compared to non-pregnant women thus, correlating with a systematic review and meta-analysis of prevalence of malaria in pregnant women by Anna M. van Eijk in 2015 [17].

The lack of country specific annual median malaria episode may impede program planning logistically

and economically. The overall annual median malaria episodes in this study population was 1, and contrary to the NMCP gap analysis and WHO recommended projections of annual median malaria episodes of two in under five children and pregnant women [2,18,19] though different methodologies. But our finding was in consonant with a prospective study conducted in Burkina-Faso that reported one annual median malaria episode [20].

It is noteworthy that Liberia post Ebola health system has greatly improved with integrated disease surveillance response (IDSR), the community health assistant program (CHAP) and recently with malaria surveillance as recommended by the Global Technical Strategy (GTS) 2016-2030. The system is now reaching out to more people than ever with a trickledown effect on the health seeking behaviour pattern among the general population. However, the system is still challenged with frequent stock out of malaria commodities in service delivery points (SDP), thus pointing at potential quantifications issues. Therefore, the overall annual median malaria episodes of 1 in this study population needs to be further adjusted to account for the realities. This result validates the need for appropriate quantification, distribution of malaria commodities and make informed decisions on appropriate interventions that would strengthen the Liberia Malaria Program towards the attainment of its goal.

Also, the absent of the integrated community case management of malaria and lack of caregiver´s awareness about malaria may be among several reasons for the high reported individual episodes or cases of malaria in North Central, North Western and South Eastern-A compared to other health regions. This finding was confirmed by the 2016 Malaria Indicator Survey and a report by WHO [5] where these regions were reported having higher prevalence of malaria that may be linked to low utilization of malaria preventive and treatment services [5,21]. Amongst other predicators for a patient to experience multiple occurrences of malaria episodes, age was found to be a major predictor according to our study. This finding is in conformity with a study conducted by Saranath Lawpoolsri in 2019 where they reported sex and young age as significant factor associated with multiple occurrences of malaria infections or episodes [18,22]. This means that the National Malaria Control Program planners are to consider age including other predicators/factors associated with more than one episode of malaria during planning.

Limitations

Although, this study is not without a limitation, it used a retrospective cross-sectional study design to determine the annual median malaria episode. But similar literatures reviewed used a prospective or longitudinal study design. Despite this variation, the findings are reliable because of the population size. But we advised to cautiously generalize the interpretation for Liberia, but the outcome can be used for programmatic decisions. Being a secondary data review, some health records are missing with incomplete information, but efforts made to review various individual data sources to compliment data completion and data linkage was done using patient´s ID and better within the health facility rather than between health facilities.

It was also difficult to document total individual episodes of malaria per annum as most of the malaria episodes may not be reported in either the selected health facilities or any other health facilities, and caregivers may visit patent medicine dealers, community health workers or community volunteers for treatment of probable malaria cases. Also, to consider are possible lack of representativeness of the HFs, a crude random pick of each type per Health regions without consideration of distribution of HFs, the malaria endemicity or population densities including other socio-demo or health service factors such as care seeking within these regions may results to poor estimation of the number of episodes. Also, only confirmed cases were considered; in a case where treatment is issued to presumptively diagnosed malaria cases this approach may lead to underestimation of cases and later quantification of commodities.

Conclusion

The episode of malaria varies across age categories with children aged five years or less recording the highest annual individual episodes of malaria. There are regional differences in those that presented with more than one malaria episode in a year. This implies that specific attention or targeted interventions are to be provided to children under-

five and areas of high recorded malaria episodes. This has quantification and program planning implication that may lead to over or under planning for malaria interventions and procurement of malaria commodities. Therefore, malaria program planners and policy makers should use the burden of malaria across age categories and location when planning or quantifying for malaria commodities.

Recommendations

NMCP should increase its focus to examine the processes related to planning malaria control interventions including the procurement and distribution of malaria commodities. Though the actual annual median malaria episodes for vulnerable group was 1, the 2 used in current programmatic planning should eliminate frequent stock-out reported. Programmatically, the NMCP should consider making adjustment in its strategies for implementation with regards to planning malaria interventions, quantification of antimalarial, distribution, planning and implementation during procurement decision makings as per the observed variation in annual median malaria cases or episodes.

What is known about this topic

- In the context of Liberia, under five children are more vulnerable to malaria with high individual annual malaria episodes. The NMCP gap analysis and WHO report estimated two episodes of malaria in under five years per annum. This estimate was used in the programmatic planning for the procurement of malaria commodities. Stock-out of malaria commodities are still frequently reported.

What this study adds

- The actual annual median malaria episodes in the study population was 1 and lower than the 2 recommended by WHO. There is a need to examine other factors that may account for frequent stock out of malaria commodities in Liberia, such as improvements in the health system and the impact of the CHAP.

Competing interests

The authors declare no competing interests.

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Authors' contributions

VSK, led the designing of the protocol, Training, and field data collection, VSK and OB did the analysis and interpretation while LH, JA, ND, and FS assisted with the technical revision of the protocol, training, and field data collection and ED assisted with the protocol review and data analysis. OB, DB, MA, PA and HW assisted with the technical review/editing of the manuscript for publication. OJP provided oversight on the implementation of the study. All authors read and approved the final manuscript.

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Table 1: Characteristics and distributions of confirmed malaria cases in 15 selected health facilities, Liberia, 2015 – 2016				
Characteristics	**2015, n (%)**	**2016, n (%)**	**Total, n (%)**	**P-value**
Age categories at mid-year				
0 - 11 Months	3490 (29.4)	4931 (28.4)	8421 (28.8)	0.30
1 - 5 years	687 (5.8)	983 (5.7)	1670 (5.7)	
6 - 13 years	1909 (16.1)	2836 (16.3)	4745 (16.2)	
≥ 14 years	5796 (48.8)	8604 (49.6)	14400 (49.3)	
Children aged ≤ 5 years				
Yes	4177 (35.2)	5914 (34.1)	10091 (34.5)	0.06
No	7705 (64.8)	11440 (65.9)	19145 (65.5)	
Gender				
Male	4791 (40.3)	6975 (40.2)	11766 (40.2)	0.83
Female	7091 (59.7)	10379 (59.8)	17470 (59.8)	
Region				
North Central	2053 (17.3)	2452 (14.1)	4505 (15.4)	<0.001
North Western	1607 (13.5)	2812 (16.2)	4419 (15.1)	
South Central	2549 (21.5)	5233 (30.2)	7782 (26.6)	
South Eastern A	2995 (25.2)	3742 (21.6)	6737 (23.1)	
South Eastern B	2678 (22.5)	3115 (17.9)	5793 (19.8)	
More than 1 episode of malaria				
Yes	2009 (16.9)	3231 (18.6)	5240 (17.9)	<0.001
No	9873 (83.1)	14123 (81.4)	23996 (81.4)	
Type of health facility				
Clinic	3128 (26.3)	4967 (28.6)	8095 (27.7)	<0.001
Health Centre	3691 (31.1)	6013 (34.7)	9704 (33.2)	
Hospital	5063 (42.6)	6374 (36.7)	11437 (39.1)	
Women of reproductive age (n = 9739)				
Pregnant	705 (18.3)	1019 (17.3)	1724 (17.7)	0.23
Not Pregnant	3153 (81.7)	4862 (82.7)	8015 (82.3)	
Total	3858 (39.6)	5881 (60.4)	9739 (100.0)	

Table 2: Annual mean and median malaria episode among health facility patients by age, gender, region and pregnancy, Liberia 2015 - 2016				
	Year 2015		**Year 2016**	
Characteristics	**Median (IQR)**	**Mean (std. dev)**	**Median (IQR)**	**Mean (std. dev)**
Age categories at mid-year				
0 - 11 Months	1 (6)	1.3 (±0.7)	1 (7)	1.4 (±0.8)
1 - 5 years	1 (6)	1.3 (±0.7)	1 (12)	1.5 (±1.0)
6 - 13 years	1 (7)	1.3 (±0.7)	1 (7)	1.3 (±0.8)
≥ 14 years	1 (6)	1.2 (±0.5)	1 (7)	1.2 (±0.5)
Children aged ≤ 5 years				
Yes	1 (6)	1.3 (±0.7)	1 (12)	1.4 (±0.8)
No	1 (7)	1.2 (±0.5)	1 (7)	1.2 (±0.6)
Gender				
Male	1 (6)	1.2 (±0.6)	1 (12)	1.3 (±0.7)
Female	1 (7)	1.2 (±0.6)	1 (10	1.3 (±0.7)
Regions				
North Central	1 (6)	1.2 (±0.5)	1 (7)	1.3 (±0.7)
North Western	1 (6)	1.4 (±0.8)	1 (12)	1.4 (±0.9)
South Central	1 (4)	1.1 (±0.4)	1 (6)	1.1 (±0.4)
South Eastern A	1 (7)	1.3 (±0.7)	1 (7)	1.3 (±0.7)
South Eastern B	1 (5)	1.2 (±0.5)	1 (7)	1.3 (±0.8)
Total	1 (8)	1.2 (±0.6)	1 (13)	1.3 (±0.7)
Women of reproductive age				
Pregnant	1 (5)	1.3 (±0.6)	1 (4)	1.3 (±0.6)
Not pregnant	1 (6)	1.2 (±0.5)	1 (7)	1.2 (±0.5)
Total	1 (6)	1.2 (±0.5)	1 (7)	1.2 (±0.5)

Table 3: Associations between participants' age, sex, region, type of health facility and numbers of malaria episode presented in selected health facilities, Liberia, 2015-2016.

	Malaria Episode > 1 per annum			
Characteristics	**Yes**	**No**	**Total**	**P-value**
Age categories at mid-Year				
0 - 11 Months	1938 (23.0)	6483 (77.0)	8421 (28.8)	<0.001
1 - 5 years	413 (24.7)	1257 (75.3)	1670 (5.7)	
6 - 13 years	948 (20.0)	3797 (80.0)	4745 (16.2)	
≥ 14 years	1941 (13.5)	12459 (86.5)	14400 (49.3)	
Sex				
Male	1918 (16.3)	9848 (83.7)	11766 (40.2)	<0.001
Female	3322 (19.0)	14148 (81.0)	17470 (59.8)	
Region				
North Central	860 (19.1)	3645 (80.9)	4505 (15.4)	<0.001
North Western	1015 (23.0)	3404 (77.0)	4419 (15.1)	
South Central	736 (9.5)	7046 (90.5)	7782 (26.6)	
South Eastern A	1515 (22.5)	5222 (77.5)	6737 (23.0)	
South Eastern B	1114 (19.2)	4679 (80.8)	5793 (19.8)	
Type of heath facility				
Clinic	1900 (23.5)	6195 (76.5)	8095 (27.7)	<0.001
Health Center	1794 (18.5)	7910 (81.5)	9704 (33.2)	
Hospital	1546 (13.5)	9891 (86.5)	11437 (39.1)	
Year				
2015	2009 (16.9)	9873 (93.1)	11882 (40.6)	<0.001
2016	3231 (18.6)	14123 (81.4)	17354 (59.4)	
Women of reproductive age				
Yes	378 (21.9)	1346 (78.1)	1724 (17.7)	<0.001
No	1095 (13.7)	6920 (86.3)	8015 (82.3)	

Table 4: Predictors of participants presenting at health facilities with more than one episode of malaria in a year, Liberia, 2015 – 2016.

Terms	**Adj. Odds Ratio**	**95% Conf. Interval**	**P-Value**
Age at mid-year (> 5 years/≤ 5 Years)	1.75	1.64 - 1.86	0,001
Region (North Western/North Central)	0.74	0.67 - 0.82	0.001
Region (South Central/North Central)	2.94	2.63 - 3.29	0.001
Region (South Eastern A/North Central)	0.63	0.57 - 0.70	0.001
Region (South Eastern B/North Central)	0.79	0.72 - 0.88	0.001
Type of Health Facility (Health Center/Clinic)	1.89	1.75 - 2.05	0.001
Type of Health Facility (Hosp/Clinic)	3.18	2.93 - 3.45	0.001
Year (2016/2015)	0.82	0.77 - 0.88	0.001
Sex (Female/Male)	0.76	0.71 - 0.81	0.001
**Regions: South Eastern A/North Central South Eastern B/North Central			

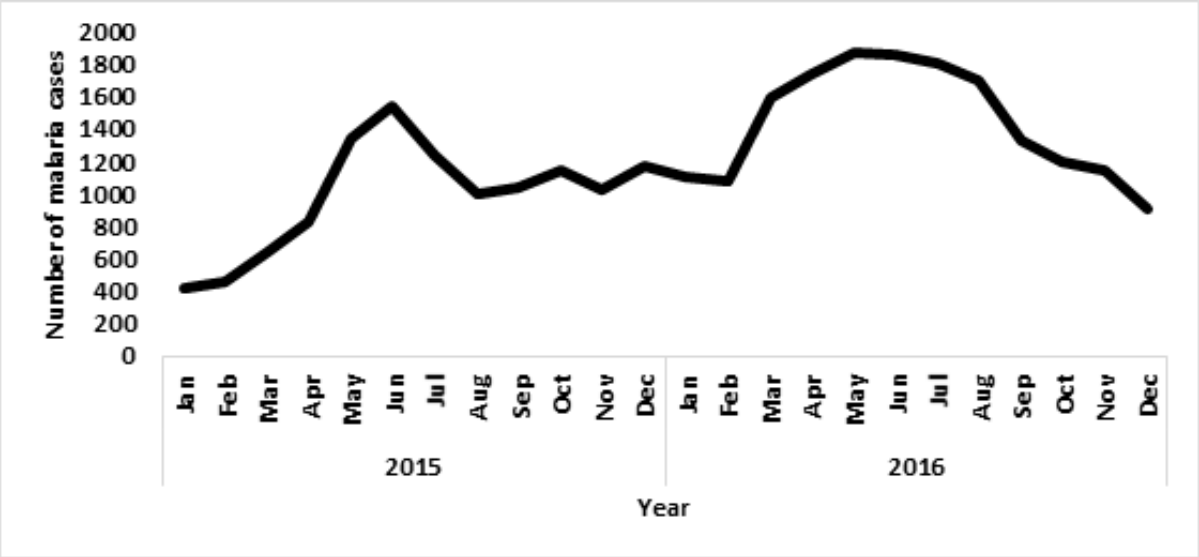

Figure 1: Trends of confirmed malaria cases in 15 selected health facilities, Liberia, 2015 – 2016