Original Article

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Evaluation of Malaria Surveillance System in the Khagrachari District of Bangladesh: An Observational Study

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Abstract

Background: A Malaria surveillance system is essential to achieve "Malaria-free Bangladesh" by 2030. Though the system encountered challenges, including poor data quality, this study evaluated it in Khagrachari and rated its main attributes.

Materials and methods: An observational study was conducted consisting of survey, secondary data analysis, record review and mixed methods of data collection. The surveillance system was examined using the "2001 United States Centers for Disease Control's updated guidelines for Evaluating Public Health Surveillance Systems". A total of 1407 patients' data was collected from previous records (2018-2022). Purposively chosen, 22 stakeholders participated in the study, and 128 case investigation forms were assessed.

Results: 15(68.18%) out of 22 respondents had ≥ 12-year experience on surveillance and 17(77.27%) had formal training. 19(86.36%) respondents reported case definitions were easy-to-use, and 14(63.64%) participants claimed data tools could accommodate changes. 731(51.95%) cases were detected through Passive Case Detection (PCD) and nearly one-fourth (26.15%) cases by Government Organizations. The results of 'Timeliness' against the number of cases investigated within day one was 64.84%. Trends of cases showed significant decline (χ^2trend = 683.03, p = 0.0001).

Conclusion: The system is effective as it meets most of its objectives.

Key words: Attributes; Malaria; Surveillance.

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Introduction

Malaria is an epidemic disease that mainly affects tropical nations like Bangladesh, where it has been a persistent threat due to its favourable climate for the Anopheles mosquito, which acts as a vector of the Plasmodium parasite.[1]

World Malaria Report of 2022 stated that there were an approximately 247 million instances of malaria cases across the globe, accompanied by 619,000 fatalities in the year 2021.[2] Approximately 11.5% of the total population in Bangladesh is living in 72 Upazilas of 13 malaria-endemic districts. The three districts of Chattogram hill tracts are in the accelerated transmission reduction phase (control phase) with API (Annual parasite index) >1 per 1,000 population, and the rest of the ten endemic districts are in the elimination phase with API <1 per 1,000 population.[3] Khagrachari is among the districts with the highest prevalence of malaria, where the disease remains firmly entrenched.[4] According to the 2022 Census of Bangladesh, the Khagrachari District had 169,526 houses and a population of 714,119 people who were considered at a high risk of having malaria.[5]

The majority of malaria cases in Bangladesh are caused by mosquito bite carrying *Plasmodium falciparum,* while the rest of the cases are usually caused by *Plasmodium vivax.*[6] The Plasmodium falciparum is the deadliest species that is responsible for severe malaria.[7] Typical symptoms of malaria include fever, chills, headaches, muscle aches, and fatigue. In severe cases, it can lead to organ failure, anemia and cerebral malaria.[8]

A malaria surveillance is essential for prevention, early diagnosis, and timely treatment to reduce the burden of the disease.[9] The government of Bangladesh has established a comprehensive surveillance system to monitor and track the prevalence of malaria to control the spread of the disease. It has been used for many years to identify areas with high malaria transmission,

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monitor the effectiveness of interventions, and assess the impact of control measures.[10] This surveillance has been conducted with the aim of providing timely information on disease burden and controlling disease outbreaks.[11] In addition, the government has established a malaria control program in Khagrachari, which includes free diagnosis, treatment, and distribution of Long Lasting Insecticidal Nets (LLINs) and the use of indoor residual spraying.[12]

We undertook this study to evaluate the existing malaria surveillance system in the Khagrachari district. Because this type of study has not yet been conducted here or in other districts of our country, but it is crucial to compare the resultsin different regions as well as other countries for proper management of this disease.

Materials and methods

The surveillance system was evaluated using the "2001 United States Centers for Disease Control (US CDC)'s updated guidelines for Evaluating Public Health Surveillance Systems". An observational study was done which comprised a survey, record review and secondary data analysis. The survey was conducted among stakeholders in Khagrachari District, Bangladesh. Retrospective review and analysis of 2018 - 2022 data on malaria cases were collected from BRAC (A Non-Government Organization or NGO) and National Malaria Elimination Program (NMEP) website.

This evaluation was conducted in May-August 2023. A total of 1539 malaria patients had been reported during 2018 - 2022, whereas we found data of 1407 patients. A mixed method of data collection approach was used. A standardized semi-structured questionnaire was administered to 22 purposively selected stakeholders. Information on socio-demographic characteristics, years of experience and attributes of the surveillance system was collected. A Google form and a semi-structured questionnaire were used to collect the data. The Google form consists of 18 variables, and the information was obtained from officials and staff of different levels, e.g. Upazila Manager (UM) District Manager, Upazila Health and Family Planning Officer (UHFPO) Surveillance Medical Officer (SMO) Medical Officer of Disease Control, Statistician and Community Health Care Provider. Besides, data was obtained by using a semi-structured questionnaire with face-to-face interviews with the Civil Surgeon (CS) of Khagrachari, the Medical Officer of Civil Surgeon, and root-level health workers. We also randomly picked 128 Case Investigation Forms (CIF) from all Upazila of Khagrachari for our evaluation purposes.

National malaria elimination program surveillance is a highly secure and active web-based surveillance system. Information is uploaded to a password-protected malaria elimination program database maintained by Communicable Disease Control (CDC) Directorate General of Health Services (DGHS) where data from all over the country are collected, edited, analyzed and stored. With the permission of the legal authority, we collected the needed data for this evaluation only.

Informed consents were taken for the surveillance evaluation. The evaluation process ensures the confidentiality and privacy of the data.

All data was used only for this evaluationwith high security. Data were stored in a password-protected folder on a personal laptop.

Results

Overall, 22 stakeholders were interviewed. The mean age of the stakeholders was 37.19±8.04 years. 15(68.18%) respondents had ≥ 12-year experience in malaria surveillance and 17(77.27%) had formal training in malaria surveillance.

Here, from 2018 to 2022, NMEP data showed 747581 suspected malaria cases, of which 1539 (0.21%) were confirmed malaria cases. Malaria affected almost all age groups, ranging from a 1.5-year-child to a 95-year-old patient. Of these confirmed cases, 918 (65.25%) were men. While analyzingthe available data, we found active working-age (19-60 years) people were more affected (Table I).

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Table I Demographic distribution of confirmed malaria cases (n = 1407)

Variables		Frequency	%
Age	Under 5 years	93	6.61
	06 - 18 years	538	38.24
	19 - 60 years	739	52.52
	Above 60 years	37	2.63
Gender	Male	918	65.25
	Female	489	34.75

Besides, our study found that the highest percentage (49%) of malaria-affected individuals were related to farming. Meanwhile, only 3% were service holders (Figure 1).

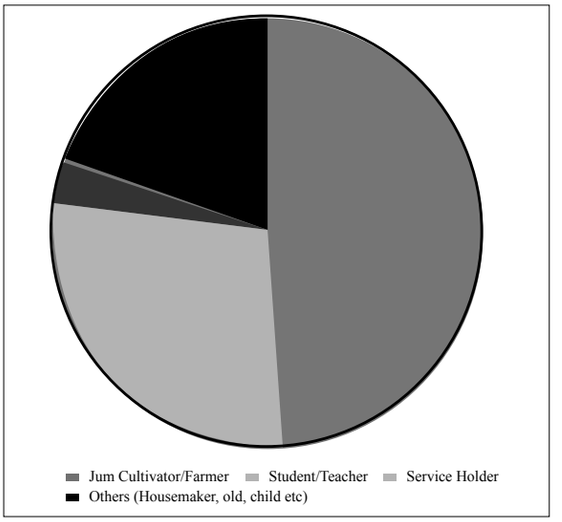

Figure 1 Occupation of malaria affected individuals

Malaria surveillance inKhagrachari is based both on ACD (Active Case Detection) and Passive Case Detection (PCD). ACD comprises a network of health workers and volunteers (NGOs) who are trained to identify and report cases of malaria, screen fever patients for malaria, and provide medication.[13] Additionally, they refer complicated patients to the hospital and report all the incidents to the proper authorities e.g. the UM, DM, UHFPO, SMO who collectively report to the national portal of malaria elimination program website. In PCD, malaria cases are detected through the routine reporting of patients seeking medical care. Rapid Diagnostic Tests (RDT) were done in the suspected patients with symptoms of malaria visiting the Community Clinic, Upazila Health Complex or District Hospital. Furthermore, Blood Slide Examinations (BSE) were also done to check for malaria. If malaria was found, the patient's information was entered into a central database run by the national malaria control program. When the disease spreads, this data is utilized to track its progression and pinpoint the places that require action.[3]

The malaria surveillance system was set up to detect malaria epidemics promptly, especially in areas with seasonal increases in the clustering of malaria cases or with a large population at risk. During our evaluation, we found that malaria surveillance helps to control and reduce the malaria burden. The declining trend in malaria cases has been seen over the period of data review. (Fig. 2). In these evaluation periods there was only one death case reported. After sharp rise from the year 2018 to 2019, there was anintensedeclineof confirmed cases (133) in 2020 and the trend was nearly static up to 2022. The decline in cases was statistically significant (χ^2 trend = 683.03, p= 0.0001. In all, 18 (81.82%) respondents reported that analyzed data were used for decision-making. Moreover, all of our participants said that this surveillance system can detect outbreaks.

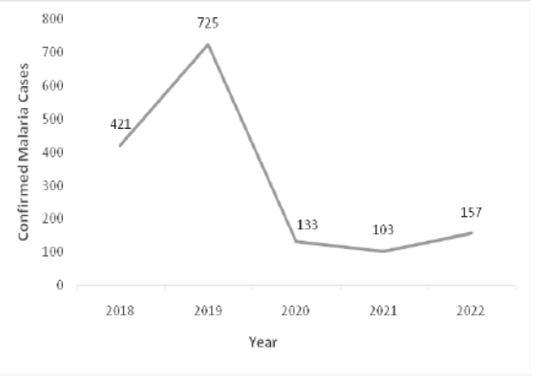

Figure 2 Trendof malaria cases in Khagarchari, 2018-2022

In the malaria surveillance database, we identified that the variables in the CIFwere completed entirely or partially by the NGO healthcare worker. A total of 1539 malaria cases were reported during the surveillance, but only 1407 cases were found during our evaluation. In our analysis, we identified 25 exceptional data points in the "fever to diagnosis" headings. Date of onset

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of fever, nearly 100% were completed with only one data missing. The percentage of invalid data is about 0.43%. We selected 128 CIFs at random, and 100% of the forms were investigated by health workers such as SasthoKormi, Field Officer or UM.

Throughout our evaluation, each Upazila efficiently and consistently submitted their comprehensive reports via the designated website, meeting the deadline without any delays. According to survey data, 1197 (85.07%) were investigated for malaria within three days of the onset of fever. 97.65% of patients' treatment started on the same date of diagnosis of malaria. We noticed a variety of time gaps between the diagnosis of malaria and case investigations in different upazilas in Khagrachari. We randomly picked some CIFs for our evaluation purposes. We saw that Mohalchari, Ramgarh, Matiranga and Manikchari investigated ≥ 90% of cases within one day of diagnosis, whereas Sadar and Dighinala investigation performances were 27.27% and 22.22%, respectively (Table II)

Table II Results of Timeliness against no. of case investigated within day one

Upazila	Year	No. of cases	No. of cases investigated within one day	%
Mohalchari	2018-2022	18	18	100.00
Ramgarh	2018-2020	15	14	93.33
Matiranga	2021-2022	30	27	90.00
Manikchari	2019-2021	10	09	90.00
Panchari	2020-2021	29	23	79.31
Lokhichori	2020-2021	06	04	66.66
Sadar	2021-2022	11	03	27.27
Dighinala	2022	09	02	22.22
Total	128	83	64.84	

Our evaluation shows that the malaria surveillance system maintains timeliness, but there is scope for improvement regarding the case investigation timeline.

In the initial year the data were collected on paper-based forms only and collated into a Microsoft Excel database. Later on, NMEP launched a website (https://nmcp.gov.bd) for data collection, analysis and prompt action. The website regularly updates its features. Starting in May 2021, the website has been updated to incorporate data regarding the distribution of LLINs. NMEP has recently devised a plan to. update the existing online reporting system, which was initially scheduled to be replaced by 2022. KoboCollect, an open-source app for collecting survey data, has been used by BRAC since 2021. The running malaria surveillance system is capable of adapting to outbreaks and the system is flexible. The malaria surveillance system is a web-based database system and has an expert advisory group monitored by the CDCand DGHS. Adequate supplies of RDT kits, antimalarial medication, LLINs and other essential resources were available. The malaria initiative primarily receives assistance from esteemed organizations such as the World Health Organization (WHO) the Global Fund to Fight AIDS, Tuberculosis and Malaria (GFATM) the International Center for Diarrhoeal Disease Research, Bangladesh (icddr, b) BRAC led by Consortium, in collaboration with governmental entities. Working hours are not a problem, and the personnel involved in malaria surveillance are extensively trained and consistently receive remuneration. All these indicate malaria surveillance in Khagrachari is stable.

All participating organizations consistently contribute, ensuring timely completion of report forms. Furthermore, the reporting rate and completeness of reporting via the website achieved a commendable 100%. 10% of the entire number of successful RDT results were consistently forwarded for further analysis to confirm the validity of the RDT procedure at periodic intervals. There was no rejection from patients or patients' attendance.

The occurrence of malaria has been identified in every upazila of Khagrachari (Table II). This disease tends to increase during the monsoon season and reaches its peak in May, and it is nearly similar up to August (Fig 3), which is when the district experiences more rain and warmer temperatures.

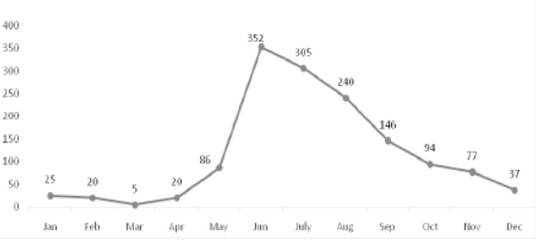

Figure 3 Monthly trend of malaria cases in Khagrachari (2018-2022)

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The RDT kit detected a maximum of 85.85% of cases. 90% of cases were indigenous, though some cases were non-local and imported from the neighboring upazilas. We have observed that almost three-fourths (73.85%) of cases were detected by NGOs. An overwhelming majority of cases (92.96% to be precise) exhibit the Plasmodium falciparum species. The rest were Plasmodium vivax and only 23 cases were positive for both. We found that the majority of cases (92.67%) were uncomplicated, and less than 2% of cases were complicated. Based on our findings, malaria surveillance data shows the representativeness of all demographics. Our data revealed that a significant proportion of cases, specifically 51.95%, were detected through PCD (Table III).

Table III Factors associated with malaria surveillance system (n=1407)

	Variables	Frequency	%
Diagnosed by	RDT	1208	85.85
	BSE	199	14.15
Source	Local	1269	90.19
	Non-local	138	9.81
Organization	GO	368	26.15
	NGO	1039	73.85
Types of parasites	Plasmodium falciparum	1308	92.96
	Plasmodium vivax	76	5.41
	Mixed	23	1.63
Clinical classification	Uncomplicated malaria	1304	92.67
	Vivax malaria	76	5.40
	Severe malaria	27	1.91
Method of Detection	ACD	676	48.05
	PCD	731	51.95

Twenty respondents (90.91%) described the system as simple, mentioned the case definitions were well understood at all levels, standardized electronic and paper-based tools were in use, reporting forms were easy-to-fill, communication channels between all levels were well established, and data flow was clearly defined. Data were collected on both paper and web-based software, so methods of transferring, entering, editing, storing, and backing up data are not difficult to manage. All the respondents indicated that uploading data to the NMEP website was not difficult. We already stated in our above-described result that the malaria surveillance system in Khagrachari is entirely acceptable and maintains timeliness. The review comes to the conclusion that the current system is simple in its design.

Discussion

Malaria stands as a significant concern pertaining to public health in Bangladesh. This country is expected to be malaria-free by 2030, according to the current NSP 2021 - 2025, which aims for a progressive elimination of the disease.[14] In this regard, the malaria surveillance system in Khagrachari district was found to meet most of the attributes of a sound surveillance system.[15]

Khagrachari had a structure in place to ensure quality assurance of data captured in the system. Unfortunately, 132 case investigation reports were missing due to a lack of proper communication channels. Apart from this, all the reporting entity submitted their reports timely via the designated website, meeting the deadline without any exceptions, which was a great achievement. This scenario is similar to the findings from Ebonyi State, Nigeria, in 2014 and in Iran, which showed a high rate of timely reporting.[16,17] However, findings from Kano State and Oyo State, Nigeria, where the target shows timeliness of reporting was not attained.[18,19] The timeliness of surveillance data can affect the ability to respond rapidly and implement control measures.[20] We noticed that the malaria burden decreased once the surveillance system met the deadline.

In order to facilitate and enhance monitoring, it also has a web-based platform. It is simple to handle the process of transferring, inputting, modifying, saving, and backing up data. The government took the initiative to collect data via the DHIS2 platform, which will facilitate data transition. Moreover, the website has been updated to incorporate data regarding the distribution of LLINs. The data collection methods have transitioned from paper-based forms to using the KoboCollect app for data collation. The findings of this study showed that data collection tools were flexible to modification and could accommodate changes in malaria data capturing. These tools have been fully adopted and adequately utilized in the surveillance system. This finding is similar to that of studies conducted in Oyo state, Nigeria, and in Chipinge district, Zimbabwe, where the surveillance systems were adjudged to be simple and flexible.[19,21] The findings of our study showed that data collection is in contrast to studies in Brazil and Zimbabwe, where the systems were complex to operate.[21,22]

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Complicated surveillance systems may not operate well or yield the best results. It is better to be simple as possible, especially in the low-resource country.

To maintain stability, the WHO, the Global Fund to Fight AIDS, Tuberculosis and Malaria (GFATM), the International Center for Diarrhoeal Disease Research, Bangladesh (icddr,b), BRAC funded this initiative along with governmental entities. Similar aids were found in the study of Kano state, Nigeria, whereas Oyo state, Nigeria, received support from partner agencies.[18,19] We found that when it comes to outside assistance, funding shortages may arise, which would compromise the system's stability.

In our study, we found that disease burden was reduced in Khagrachari with the participation of all parties. The reporting rate and completeness of reporting via the website achieved 100% acceptability with no rejection from patients or their attendance.The ease of operation of the system could be a result of the simplified channels of communication and data tools in remote communities where the private sector plays a vital role. On the contrary, the study in Kano and Kaduna state of Nigeria were not representative due to the exclusion of private facilities in the data.[18,23]But representativeness facilitates recognition of possible differences in health outcomes between various demographic groups, enabling focused actions to rectify these disparities.[15]

Furthermore, malaria cases tend to increase during the monsoon season (May-October), with the highest number of cases found in the Dighinala upazila. It corresponds with our country's malaria information, specifically in areas with high malaria transmission.[24] The majority of cases were caused by the *Plasmodium falciparum* species and detected by NGOs, which resembles all demographic similarities to the study conducted in western parts of India.[25] Interestingly we noticed that a significant portion of malaria cases were detected by PCD (Table III) but our national guidelines suggest that ACD should diagnose more than 80%.[3] It was due to the shortage of human resources to collect data from door to door.

Overall, we can say that this was a simple, understandable, standardized electronic and online platform where data were collected on both paper and web-based software. The reporting forms were easy to fill and communication channels between all levels were well established so that the transferring, editing, storing, and backing up of data were not difficult to manage.

Limitations

Our study had a few flaws. Firstly, the sensitivity and predictive positive value attributes could not be ascertained. Besides, randomly chosen CIFs might not reflect the actual scenario. Due to a lack of accessibility, we were incapable of establishing a correlation between the available data and any other data set pertaining to malaria-endemic districts. Moreover, some data points were missing in the databases.

Conclusion

The malaria surveillance system in Khagrachari is effective as it meets most of its objectives. The aim of our study was to evaluate this survey to reduce the spread of infection and lessen the negative effects on health and death rates. Finally, we can conclude that this surveillance is practical, stable, simple, flexible, and acceptable. The timeliness of entering data into the website is generally good, but improvements can be made in the timely conclusion of the case investigation. The system has to improve data quality and representativeness too. On top of that, strong involvement of stakeholders, regular meetings among them, central supervision, and monitoring must be ensured to achieve the objectives properly.

Recommendations

Field investigations should be conducted on malaria patients in the district hospital of Khagrachari. Moreover, as we target to lessen the disease burden, every case should be investigated, and proper linelisting should be maintained. Additionally, the primary focus should be placed on implementing an active surveillance system to ensure that no cases go undetected or unreported.

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Contribution of Authors

MMH-Desing, acquisition of data, data analysis, drafting & final approval.

QAZ-Conception, interpretation of data, critical revision & final approval.

SP- Acquisition, of data, data analysis, drafting & final approval.

SD-Conception, acquisition of data, interpretation of data, critical revision & final approval.

MOQ-Conception, design, critical revision & final approval.

Disclosure

All the authors declared no conflict of interest.

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