


BMJ Open Comprehensive evaluation of malaria reactive surveillance and response strategies in Lao People's Democratic Republic: a mixed-methods study

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ABSTRACT

Objectives To achieve malaria elimination by 2030, the Lao People's Democratic Republic (PDR) adopted a reactive surveillance and response (RASR) strategy of malaria case notification within 1 day, case investigation and classification within 3 days and foci investigation and response within 7 days. It is important to evaluate the performance and feasibility of RASR implementation in Lao PDR so that the strategy may be optimised and better contribute towards the goal of malaria elimination.

Design A mixed-methods study comprising of secondary data analysis of routinely collected malaria surveillance data, quantitative surveys and qualitative consultations was conducted in 2022.

Setting Primary data collections for quantitative surveys and qualitative consultations were conducted in Huaphan, Khammouane, Luangprabang and Savannakhet Provinces of Lao PDR.

Participants Quantitative surveys were conducted among malaria programme stakeholders and service providers. Qualitative interviews were conducted with malaria programme stakeholders, and focus group discussions with malaria programme stakeholders, service providers and mobile and migrant populations (MMPs).

Outcome measures Outcomes of interests were awareness and acceptability of current RASR activities by different group of participants, implementation, performance and feasibility of RASR activities including enablers and barriers.

Results In Lao PDR, malaria programme stakeholders and service providers were aware of RASR; however, these activities were not well known in MMPs. Respectively, the timeliness of case notification and case investigation was 0.0% and 15.6% in 2018 but increased to 98.0% and 98.6% in 2022. Implementation of RASR was acceptable to the malaria programme stakeholders and service providers, and continued implementation was perceived as feasible. Nevertheless, issues such as low level of community awareness, high level of migration and limitations in health system capacity were identified.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ This was a mixed-method study that used diverse data collection methods and included different groups of participants ranging from mobile and migrant populations, frontline malaria service providers to higher level malaria programme stakeholders.
- ⇒ Findings from different methods were triangulated to increase the breadth and depth of understanding of performance and operational feasibility of reactive surveillance and response (RASR) strategies and activities in Lao PDR.
- ⇒ Completeness and effectiveness of RASR activities, essential parameters for measuring the success of the RASR strategy, could not be assessed due to limitations in the secondary dataset.
- ⇒ Future evaluations will benefit from the assessment of these essential parameters and their contribution to effective RASR implementation.

Conclusion Overall, the timeliness of case notification and investigation in Lao PDR was high, and malaria programme stakeholders and service providers had positive opinions on RASR. However, some operational and health system-related barriers were identified, which need to be addressed to improve the performance of RASR in Lao PDR.

INTRODUCTION

Over the last decade, the Lao People's Democratic Republic (Lao PDR), a country in the Greater Mekong Subregion (GMS), has made a significant reduction in its malaria burden. Between 2010 and 2021, malaria morbidity and mortality in Lao PDR decreased by 83% and 96%, respectively,¹ and malaria is currently only endemic in the Southern Provinces of Lao PDR. Lao PDR has committed

to eliminate falciparum malaria by 2025 and all malaria species by 2030.²

In the elimination programme, all parasitologically confirmed index malaria cases (a malaria index case is a passively detected malaria case that triggers the reactive surveillance and response (RASR) activities) detected by a malaria service provider must be notified in a timely manner, followed by case and focus investigations. This process seeks to reliably determine the source of infection and classify cases and foci to inform an appropriate response. These activities are interconnected and are referred to as case detection and notification, case investigation and classification and foci investigation and response, or herein collectively referred to as RASR.³ Since 2018, Lao PDR started applying the '1-3-7 strategy' in 17 provinces, a time-bound malaria RASR strategy developed by China in 2012⁴ that entails case notification within 1 day, case investigation and classification within 3 days and focus investigation and response activities within 7 days after a malaria case is diagnosed.⁵

It is vital to evaluate the performance and feasibility of the implementation of RASR strategies to provide recommendations to improve the surveillance system and ultimately contribute towards achieving national and regional malaria elimination targets. This mixed-methods evaluation study is part of a multicountry assessment of RASR strategies in the GMS.^{6,7} It aims to comprehensively review and analyse the RASR strategies that are currently used in Lao PDR with specific objectives, (1) assess the awareness and acceptability of current RASR activities by malaria programme stakeholders, malaria service providers and mobile and migrant populations (MMPs); (2) investigate the implementation and performance of RASR activities in Lao PDR; (3) explore the feasibility of RASR implementation by identifying enablers and barriers and (4) explore how current RASR strategies can be optimised to overcome existing barriers and improve their effectiveness to achieve malaria elimination.

METHODS

Study design and participants

A mixed-methods study was conducted between September and October 2022, and detailed procedures are outlined in online supplemental material 1. Briefly, secondary analysis of an aggregated subset of the routinely collected malaria surveillance data from the provinces in malaria elimination phase, quantitative surveys of malaria programme stakeholders (disease control unit leaders and Vector Borne Disease Control Unit staff from the Provincial and District Health Offices) and malaria service providers (health centre and primary healthcare facility staff and village malaria workers (VMWs)) and qualitative consultations such as focus group discussions (FGDs) with malaria programme stakeholders, malaria service providers and MMPs and semistructured interviews with malaria programme stakeholders, was conducted. Study reporting adhered to the Strengthening the Reporting of

Observational Studies in Epidemiology and Standards for Reporting Qualitative Research checklists (online supplemental materials 2A,B).

Study setting

Primary data collections for quantitative surveys and qualitative consultations were conducted in four provinces of Lao PDR—Huaphan (Sopbao district), Khammouane (Boualapha and Thakhek districts), Luangprabang (Phoukhoun district) and Savannakhet (Vilabouli district) provinces (figure 1). These provinces were purposively selected to capture the different stages of elimination across the regions of Lao PDR, such as provinces where all districts (Huaphan and Luanprabang provinces) or most districts (Khammouane province) reported no malaria cases and provinces with several high-burden districts (Savannakhet province) in 2022.

Data collection, management and analyses

For the purpose of secondary data analysis, the Laos Centre of Malariology, Parasitology and Entomology provided secondary datasets containing aggregated data on malaria testing, treatment and surveillance collected through routine malaria surveillance system and performed by staff from health centres as well as district and provincial disease control teams in all 17 provinces in malaria elimination phase between 01 Jan 2018 and 31 Dec 2022. The raw secondary dataset was stored in Microsoft Excel with separate spreadsheets for malaria testing and treatment, malaria case notification and investigation and foci investigation and responses. The Microsoft Excel spreadsheets were imported to Stata V.17.0 (StataCorp, Texas, USA), where they were merged to form a dataset (online supplemental material 3) and analysed to assess the timeliness of case notification and investigation. Timeliness of foci investigation and response activities could not be assessed due to limitations in the secondary dataset.

Quantitative questionnaires in the Lao language were administered to 28 malaria programme stakeholders (Questionnaire one in online supplemental material 4) and 37 malaria service providers (Questionnaire two in online supplemental material 4) to explore their awareness and practice of current malaria RASR strategies and feasibility of implementing these strategies in Lao PDR (online supplemental material 5: additional table 1). Participants were recruited purposively based on their working experience, malaria burden of their responsible geographical area, operational feasibility to collect data and the implementation of malaria elimination strategies at the time of survey. The quantitative data were collected using Research Electronic Data Capture (REDCap) and exported to Microsoft Excel files. Open responses were translated to English and then exported into Stata V.17.0 (Stata Corp, Texas, USA), where the survey data was cleaned and descriptively analysed.

A subset of surveyed malaria programme stakeholders, malaria service providers and MMPs were recruited



Figure 1 Study areas in Lao PDR*. *Map generated using QGIS application V.3.22.0 using base maps from the Lao PDR Administrative Boundary Common Operational Database developed by the United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA) downloaded from <https://data.laos.opendevlopmentmekong.net/dataset/>.

purposely for qualitative consultations. Four semi-structured interviews with malaria programme stakeholders (male: 3; female: 1), five FGDs with 14 malaria programme stakeholders (male: 11; female: 3) (in groups of 2–4), six FGDs with 24 malaria service providers (male: 11; female: 13) (in groups of 3–5) and four FGDs with 20 MMPs (male: 14; female: 6) (in groups of 3–6) were conducted (online supplemental material 5: additional table 2). Interview and FGD guides (online supplemental material 4) were used to explore the perceptions and practices of current malaria RASR strategies and acceptability and feasibility for successful implementation of these strategies in Lao PDR. Malaria programme stakeholders and malaria service providers were purposively recruited based on their roles and experience implementing malaria RASR strategies in Lao PDR. Study participants at the village level such as VMWs and MMPs were purposively recruited if their villages were in the coverage of the selected primary healthcare facility where RASR strategies have been rolled out. Interviews and FGDs were audio recorded, transcribed verbatim and translated into English. They were then organised, managed and analysed thematically (deductive followed by inductive analysis)⁸ in NVivo (Release 1.7.1) by two researchers who

immersed and coded data and then discussed themes and subthemes to reach a consensus on the interpretation.⁹

Patient and public involvement

This study used non-identified aggregated secondary data extracted from routinely collected national malaria surveillance system database. As such, patients were not engaged nor involved in this research. Village malaria workers and mobile and migrant populations from respective community were involved in data collection. Refer to the Methods section and online supplemental material 1 (Additional methods) for further details.

RESULTS

Awareness and acceptability of RASR activities

All (100%, 28/28) surveyed malaria programme stakeholders reported that the 1-3-7 strategy was the time-bound RASR strategy adopted by the Laos Centre of Malariology, Parasitology and Entomology. However, only 59.5% (22/37) of malaria service providers recalled the 1-3-7 strategy, and 35.1% (13/37) responded that they were not aware of any time-bound RASR strategy. In addition, 5.4% (2/37) of malaria service providers responded

that there was another time-bound RASR strategy adopted by the malaria programme, though they were unable to recall what the time frames were.

Interviewees and FGD participants reported that the 1-3-7 strategy was well accepted by malaria programme stakeholders and service providers. Moreover, participants claimed that the 1-3-7 strategy was appropriate and effective because it provided a timely response to interrupt the onward transmission of malaria in their assigned geographical areas. Participants also believed that the 1-3-7 strategy was effective for malaria elimination given that the number of malaria cases had decreased in areas implementing the 1-3-7 RASR strategy, and no new malaria cases were identified for many years in those areas.

... if we follow the 1-3-7 strategy, we can eliminate malaria on time as planned... (A malaria programme stakeholder and FGD participant)

At the grass-roots level, MMPs were not aware of RASR activities such as malaria case notification, case investigation, focus investigation and response as there were no malaria cases in their villages or worksites, although some of them mentioned in FGD that routine malaria prevention, control and diagnosis services such as distribution of mosquito nets and blood testing for malaria were available in their community.

We used to hear that there were some malaria cases in our area before, but we do not hear about it (malaria) anymore... we don't know what kind of activities are carried out once a malaria patient has been detected. (An MMP and FGD participant)

Implementation and performance of RASR activities

In surveys, malaria programme stakeholders commonly reported electronic reporting system using mobile phones or mobile tablets (89.3%, 25/28) and paper-based reporting (85.7%, 24/28) as methods for reporting malaria cases. Additionally, the majority of malaria service providers reported that they notified malaria cases to the malaria programme stakeholders by direct phone calling (75.7%, 28/37).

After a malaria positive case had been notified, case investigation was mostly led or supervised by the district malaria control unit or district health office (71.4%, 20/28). About half of the surveyed malaria service providers (48.6%, 18/37) responded that they were involved in every case investigation executed within their responsible areas. Among those who were never involved in case investigation before (37.8%, 14/37), almost all of them (92.9%, 13/14) reported that they were willing to be involved in case investigation in the future (online supplemental material 5: additional table 3).

The majority of surveyed malaria programme stakeholders and malaria service providers reported that during a case investigation, the investigator(s) visited the index case (83.1%, 54/65), checked malaria preventive measures used by the index case (84.6%, 55/65),

educated the index case on malaria prevention (84.6%, 55/65) and collected travel history of the index case (83.1%, 54/65). In addition, 58.5% (38/65) of the surveyed malaria programme stakeholders and malaria service providers mentioned that the location of the index case was mapped during a case investigation by taking the Global Positioning System coordinates (online supplemental material 5: additional table 4).

During qualitative consultations, malaria programme stakeholders mentioned that after investigating and classifying malaria cases according to the National Guidelines, the responsible team which was comprised of district disease control team and designated health facility staff conducted reactive case detection (RACD) as part of the foci investigation and responses. In surveys, malaria programme stakeholders and service providers responded that RACD was triggered either by local cases only (40.0%, 26/65) or by both local and imported cases (46.2%, 30/65). The majority of survey participants (86.2%, 56/65) mentioned that household members of the index case were screened during RACD. All malaria programme stakeholders (100%, 28/28) stated that neighbours of the index case need to be screened during RACD; however, only 62.2% (23/37) of the malaria service providers mentioned that they did so (table 1).

Surveyed participants reported that there were no standardised procedures for conducting RACD. Almost all malaria programme stakeholders (92.9%, 26/28) reported that all household members should be screened during RACD whether they had a fever or not. However, about half (51.4%, 19/37) of the malaria service providers reported that they screened all household members regardless of fever, and 35.1% (13/37) mentioned that only the febrile cases were screened. The majority of malaria programme stakeholders (71.4%, 20/28) reported that all neighbours of the index case should be screened regardless of fever, and 28.6% (8/28) mentioned that only the febrile cases should be screened. About half of the surveyed malaria service providers (48.6%, 18/37) reported that all neighbours were screened during RACD regardless of fever, and approximately one-quarter (24.3%, 9/37) mentioned that only febrile cases were screened. Survey respondents also reported variations in the median number of neighbours (13, IQR: 5, 50), households (10, IQR: 5, 24) and geographical parameter (radius in metres; 125, IQR: 50, 500) around the index case screened during an RACD (table 1).

During FGD, malaria service providers mentioned that they did not understand the process of RACD because there were no malaria cases in their geographical areas, or they were not aware of any specific guidelines or instructions for RACD. Malaria programme stakeholders also highlighted during interviews that there were human resource and financial challenges in doing RACD as part of the RASR strategy.

Apart from RACD, other commonly conducted focus response activities as reported in surveys included awareness raising among community members on malaria

Table 1 Reactive case detection in Lao PDR as reported by surveyed participants

| Procedures for reactive case detection | Programme stakeholder (n=28) | Service providers (n=37) | Overall (n=65) |
|---|------------------------------|--------------------------|----------------|
| Triggering factor for reactive case detection in the community, n (%)* | | | |
| Local cases only | 13 (46.4) | 13 (35.1) | 26 (40.0) |
| Both local and imported cases | 15 (53.6) | 15 (40.5) | 30 (46.2) |
| Imported cases only | 0 | 2 (5.4) | 2 (3.1) |
| When local cases reached a minimum threshold | 0 | 2 (5.4) | 2 (3.1) |
| Screening of household members of the index case, n (%)* | | | |
| Yes | 26 (92.9) | 30 (81.1) | 56 (86.2) |
| No | 2 (7.1) | 6 (16.2) | 8 (12.3) |
| Screening of neighbours of the index case, n (%)* | | | |
| Yes | 28 (100.0) | 23 (62.2) | 51 (78.5) |
| No | 0 | 13 (35.1) | 13 (20.0) |
| Number of neighbours screened, median (IQR) | 50 (25, 50) | 8 (4, 17.5) | 13 (5, 50) |
| Screening of households around the index case, n (%) | | | |
| Yes | 18 (64.3) | 22 (59.5) | 40 (61.5) |
| No | 10 (35.7) | 14 (37.8) | 24 (36.9) |
| Number of households screened, median (IQR) | 16 (6.5, 42.5) | 6 (3, 15) | 10 (5, 24) |
| Screening a geographical radius around the index case, n (%) | | | |
| Yes | 20 (71.4) | 22 (59.5) | 42 (64.6) |
| No | 8 (28.6) | 14 (37.8) | 22 (33.8) |
| Radius in metres screened, median (IQR) | 500 (100, 1000) | 50 (20, 500) | 125 (50, 500) |
| Type of household members screened during a reactive case detection, n (%)* | | | |
| Febrile cases only | 2 (7.1) | 13 (35.1) | 15 (23.1) |
| All household members regardless of fever | 26 (92.9) | 19 (51.4) | 45 (69.2) |
| Household members were not screened | 0 | 2 (5.4) | 2 (3.1) |
| Type of neighbours screened during a reactive case detection, n (%)* | | | |
| Febrile cases only | 8 (28.6) | 9 (24.3) | 17 (26.2) |
| All neighbours regardless of fever | 20 (71.4) | 18 (48.6) | 38 (58.5) |
| Neighbours were not screened | 0 | 9 (24.3) | 9 (13.8) |
| Diagnostic methods used in reactive case detection, n (%)† | | | |
| Rapid diagnostic test | 26 (92.9) | 30 (81.1) | 56 (86.2) |
| Microscopy | 13 (46.4) | 4 (10.8) | 17 (26.2) |
| PCR | 8 (28.6) | 0 | 8 (12.3) |
| Clinical diagnosis | 0 | 2 (5.4) | 2 (3.1) |
| Serology | 0 | 0 | 0 |

*Missing values present.
 †Multiple responses were allowed.
 PDR, People's Democratic Republic.

transmission, malaria prevention and vector control measures if needed, entomological surveillance, and spot checks for mosquito breeding places if proper entomological surveillance was not feasible (online supplemental material 5: additional table 5).

Timeliness of RASR activities in Lao PDR

Secondary analysis of malaria data from the districts in the elimination phase revealed that the total number of

malaria cases per year ranged between 77 (in 2019) and 257 (in 2018). Among 17 reporting units, Khammouan province consistently held the largest number of malaria cases every year, making up 54%–88% of total cases except for the year 2022 (online supplemental material 5: additional table 6).

In 2018, none of the included provinces achieved timely case notification within 1 day. Of the total cases,

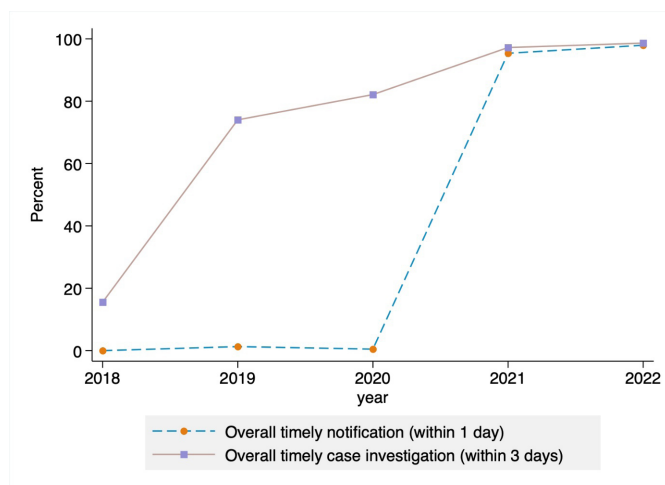


Figure 2 Overall timeliness of case notification and investigation in malaria elimination provinces of Lao PDR during 2018–2022 (source: secondary data analysis).

only 1.3% in 2019 and 0.5% in 2020 achieved timely case notification within 1 day. However, from 2021 onwards, >95% of cases were reported in 1 day, with eight out of 10 provinces achieving 100% timeliness in case notification in 2022. Overall, timely case investigation significantly increased from 15.6% in 2018 to 74.0% (57/77) in 2019, 82.1% (170/207) in 2020 and increasing further to 97.2% (105/108) in 2021 and 98.6% (145/147) in 2022. In 2022, 100% timeliness in case investigation was noted for eight out of 10 provinces (figure 2; online supplemental material 5: additional table 6).

Enablers of RASR activities in Lao PDR

An enabler of RASR activities in Lao PDR was the strong perception of malaria programme stakeholders that the 1-3-7 strategy was an effective approach to achieve malaria elimination if carried out in a timely manner. They also reported that the 1-3-7 strategy was appropriate for their areas, and they already introduced and advocated its use for malaria elimination across all the districts in their provinces.

Malaria service providers reported in FGDs and interviews that the 1-3-7 strategy was feasible to implement in their geographical areas because they believed that the health centre staff and VMWs were knowledgeable about their local context and could approach target populations well. Malaria programme stakeholders also reported that health staff and VMWs could participate in different RASR activities such as case notification, investigation and response. Furthermore, malaria service providers reported that although many community members did not understand the objective and goals of such activities, there was good community participation in RASR activities because they believed in service providers.

Almost all the health staff are from the local community so that they are well familiar with location and context ... they can participate in different activities like giving health education, notifying, reporting and

investigating malaria cases, and assisting response activities. (Interview with a malaria programme stakeholder)

Barriers for RASR activities in Lao PDR

Survey results showed that about half of the participants believed there were no barriers in conducting case notification within 1 day (44.6%, 29/65), case investigation within 3 days (50.8%, 33/65) or foci investigation and response activities within 7 days (40.0%, 26/65) (online supplemental material 5: additional table 7). However, some operational and health system-related barriers were identified during interviews and FGD.

Operational barriers for RASR activities in Lao PDR

Having many MMPs in an area was identified as an operational barrier for the successful implementation of RASR activities in Lao PDR because of their mobility patterns and the nature of their workplaces. MMPs in some villages and districts were travelling from one place to another in a relatively short period of time, which made the completion of all steps of RASR activities difficult for malaria service providers to achieve. Malaria service providers perceived that the completeness of RASR activities was undermined by MMPs working in remote rubber plantation sites, which are not easily accessible. Further, owners of rubber plantation sites did not cooperate well with the health sector in performing RASR activities among MMPs. Malaria service providers suggested that a strategy such as cooperation with relevant authorities from labour offices and business owners should be developed to improve access to MMPs and strengthen RASR strategies.

Data collection (for RASR) among this group of population (MMP) is challenging because almost every migrant comes and sells the goods in the village and district for a short period like one or two days. And then they move on to other places. (A malaria programme stakeholder and FGD participant)

Another operational barrier for the successful implementation of RASR activities in Lao PDR was inaccessibility to at-risk populations in the community. Malaria programme stakeholders and malaria service providers reported that some villages were far away from the health centres and were difficult to access, preventing timely implementation of RASR activities, especially in the rainy season. Additionally, it was reported that some villages at risk of malaria did not have mobile phone network or internet access, resulting in delays to every step of RASR activities. Malaria programme stakeholders and malaria service providers reported that there were telecommunication barriers to conduct case notification within 1 day (36.9%, 24/65) (online supplemental material 5: additional table 8). Consistent with the quantitative finding, malaria programme stakeholders also reported during semistructured interviews and FGDs that the timing of RASR activities was negatively impacted by transportation and telecommunication

difficulties. Suggested approaches to improve timely notification of malaria cases and subsequent RASR activities included the provision of mobile top-up cards and transportation to hospitals and health centres in remote areas.

RASR activities cannot be carried out in some areas according to the 1-3-7. Especially in remote and hard-to-reach areas where the road is cut off and there is no phone signal. It is the main obstacle for implementation (of 1-3-7 strategy). (A malaria programme stakeholder and FGD participant)

Health system-related barriers for RASR activities in Lao PDR

Both the malaria programme stakeholders and the malaria service providers reported challenges related to human resources in conducting RASR activities. They reported that there were not enough staff in the health facilities, that most of the existing staff were overburdened with many assignments and tasks and that they were untrained for RASR activities. Malaria service providers also reported in the FGD that they had to involve VMWs in performing RASR activities.

At the health centre level, the staff is not enough. Existing staff have to do many different tasks, so we have to use volunteer staff. Using volunteer staff is not sustainable and it needs to be changed for good. (A malaria service provider and FGD participant)

During semistructured interviews and FGDs, the participants identified a skilful and cooperative team effort as a necessity for the successful implementation of RASR strategies. Malaria programme stakeholders and malaria service providers suggested that regular training of health centre staff and VMWs was required to improve their knowledge and skills in RASR strategies and activities. Moreover, all stakeholders reported that community involvement was important in conducting RASR activities as the effort from health workers alone was not sufficient.

Another barrier for successful implementation of RASR activities was lack of available funds for RASR at the district health offices, which could only be applied for after a positive case was reported. The process of applying for, approving and withdrawing the necessary budget for RASR activities often took too long and hindered the completion of RASR activities as per the 1-3-7 time schedule. To avoid such delays, malaria service providers used readily available budgets reserved for other administrative purposes in the first place and reimbursed from RASR budget after completing the response activities. However, delays in RASR activities were inevitable when district health offices had no other reserved budget. Malaria programme stakeholders suggested that a reserved fund for RASR activities should be readily available, and budget approval and disbursement processes should be completed in a timely manner to avoid delays in the implementation of RASR activities.

DISCUSSION

Overall, the 1-3-7 strategy is the policy-endorsed RASR strategy in Lao PDR and is well accepted by malaria programme stakeholders and malaria service providers. The implementation of RASR strategy in Lao PDR was satisfactory after 2020 in terms of timeliness of case notification and investigation. However, this study also highlighted some key issues and ways for improving the effectiveness of RASR strategy and accelerating Lao PDR's progress towards malaria elimination.

Even though the RASR strategy was first launched in Lao PDR in 2018, its attributable indicators were only added to the national reporting system the following year. Guidelines and training followed afterwards due to programmatic complexity and financial constraints. As such, complete guidelines and training tools were not fully disseminated until 2020. In 2022, 17 out of 18 provinces in Lao PDR were in the malaria elimination phase except for Attapeu province which was still in the burden reduction phase. Timeliness of case notification and investigation in malaria elimination districts of these 17 provinces improved drastically in 2021 and 2022 compared with earlier years. Such drastic improvement in the timeliness of RASR activities could be attributable to the rolling out of the RASR guidelines and trainings to health facility staff at different levels in 2020 and 2021, programme planning exercises which applied a bottom-up approach considering the resource gaps at different levels of health system, and full integration of RASR data into District Health Information Software 2 (DHIS-2) which is the routine health management and information system in Lao PDR. To maintain the impressive achievement of timely case notification and investigation, refresher trainings for health facility staff at different levels should be continued.

Malaria programme stakeholders and service providers had a common understanding of investigating and classifying malaria cases; however, variations were noted in steps and parameters for subsequent RACD activities. Like in other GMS countries,⁶ even though malaria service providers in Lao PDR screened the household members of the index case and the neighbouring households, there was no specific demarcation for the number of neighbours, households or a geographical radius to be screened during RACD. It is also important to carefully determine which population to test during RACD as this should be based on the case and where the case caught malaria. For example, in Cambodia, cotravellers or coexposed persons were also screened during RACD.^{10 11} In addition to specified and detailed geospatial guidelines for RACD, capacity building and training for RACD should also be carried out at different levels so that all the malaria service providers have a common understanding of the RACD process, which is important for detecting afebrile malaria infections and interrupting the onward transmission of malaria in the community.¹²

Successful implementation of RASR activities requires community engagement and it is important that the



community believes in and commits to malaria elimination strategies.¹³ While awareness of RASR strategies and activities was high among malaria programme stakeholders and malaria service providers, the community was not fully aware of RASR activities nor the goal and objectives of these activities. Awareness raising through mass media and campaigns should be considered to improve the community's knowledge of malaria RASR as it plays a crucial role in sustainability of a malaria elimination programme.¹⁴ It is also crucial to engage the community in planning, implementing and evaluating the different steps of RASR strategies to ensure that the strategies and activities meet the community's behaviour and health needs.¹⁵ In addition, policy makers and programme implementers should take human behaviour and socio-cultural context into account for successful malaria control and elimination at the community level,¹⁶ and it is important to understand the community's perception of malaria since it influences and shapes their attitude and behaviour towards malaria prevention, control and elimination efforts.¹⁷

As in other GMS countries,^{6 18} the malaria elimination programme in Lao PDR is facing challenges posed by MMPs. MMPs are highly mobile due to the nature of their work and have difficulties in accessing malaria and other healthcare services from formal healthcare providers. MMPs are considered vulnerable and at a high risk of

malaria in the GMS due to their workplace environment and shelters which are usually constructed poorly, and the requirement to work or sleep outdoors resulting in increased exposure to malaria vectors.¹⁸ Frequent migration of MMPs to pursue temporary employment also precludes adequate access to malaria prevention and treatment services.¹⁹ Due to MMPs' frequent migration from one place to another compounded by difficult road conditions and remoteness, health service providers reported that it was challenging to do RACD and other necessary response measures within the recommended timeframe (ie, within 7 days of a case diagnosis in Lao PDR). Consequently, onward transmission might not be interrupted among MMPs, and they could reintroduce imported cases into malaria-free areas.^{20–25} Hence, it is critical to formulate MMP-orientated RASR strategies and intervention packages. Currently, the Laos Centre of Malariology, Parasitology and Entomology is trying to implement targeted approaches for MMPs such as distributing long-lasting insecticidal nets (LLINs) and using peer educators in order to interrupt the residual transmission among them and achieve malaria elimination in Lao PDR. In addition, using innovative and attractive approaches to increase MMPs' awareness on malaria through popular social media platforms (eg, TikTok) should also be considered.

Table 2 Recommendations to improve RASR in Lao PDR

| Type of RASR activity | Issue | Recommendation |
|--|--|--|
| Case notification | Telecommunication difficulties | <ul style="list-style-type: none"> ▶ For areas with no mobile network, to provide travel incentive for VMWs to travel to the nearest area where mobile service is available ▶ For areas with accessible mobile coverage, to support top-up charges for VMWs |
| Case investigation, focus investigation and response | Transportation difficulties | ▶ To provide vehicles for the staff from district health offices to conduct case investigation, foci investigation and response activities |
| | Prolonged cash flow mechanism for RASR activities | <ul style="list-style-type: none"> ▶ To keep a reserved fund at the district health offices for RASR activities ▶ To expedite budget approval and disbursement processes for RASR activities |
| | Lack of specific SOP for RACD | ▶ To develop a SOP for RACD |
| Case notification, case investigation, focus investigation and response | Lack of awareness of VMWs and community on RASR activities | <ul style="list-style-type: none"> ▶ To conduct awareness raising through mass media and campaigns ▶ To promote community engagement in RASR activities |
| | Presence of MMPs | <ul style="list-style-type: none"> ▶ To formulate MMPs tailored RASR strategies ▶ To develop and maintain cooperation with labour department and worksite owners/companies in implementing RASR activities |
| | Staff shortage in health facilities | ▶ To consider task shifting to VMWs for RASR activities especially in case investigation, foci investigation and response |
| | Poor technical knowledge on RASR strategies and activities | <ul style="list-style-type: none"> ▶ To allocate more budget for training and capacity building for health centre staff and VMWs ▶ To conduct regular trainings and refresher trainings for health centre staff and VMWs ▶ To ensure job aids and SOPs are available for health centre staff and VMWs |
| MMPs, mobile and migrant populations; PDR, People's Democratic Republic; RACD, reactive case detection; RASR, reactive surveillance and response; SOP, standard operating procedures; VMWs, village malaria workers. | | |

Another challenge reported by participants was telecommunication difficulty in remote areas, which was perceived to pose a threat to the effective implementation of RASR strategies. In surveys with malaria service providers, it was reported that malaria cases were mainly notified through direct phone calling. Timeliness of case notification could be negatively affected by difficult telecommunication, which in turn could cause delays in subsequent RASR activities such as case investigation, focus investigation and response activities. Providing travel incentive and mobile top-up cards to malaria service providers from areas with poor internet or mobile connections could be a practical solution so that they could commute to the nearest place with accessible telecommunication service. Task shifting some of the RASR activities to VMWs could also be a feasible solution to prevent delays in implementation of RASR activities due to difficulties in transportation and telecommunication.

Lao PDR is facing challenges in its health system for the successful implementation of RASR strategy such as prolonged cash flow mechanism and lack of human resources. Many malaria programme stakeholders reported a lack of reserved funds at the district level as well as lengthy and complicated funding modalities which might lead to delayed implementation of RASR activities. Funding mechanisms and cycles were considered important for the successful and timely implementation of malaria elimination activities including RASR, and it is important to harmonise health system funding and the national malaria elimination action plan.²⁶ Limitations in human resources for RASR activities are a common challenge for malaria elimination programmes in the GMS,^{6 7 26} and may contribute to an overburdened workforce assigned various responsibilities beyond their capacity.⁷ Task shifting of some RASR activities such as case investigation and classification and preliminary focus investigation to VMWs could be a reasonable solution for the sustainability of VMWs as well as the successful implementation of RASR activities. While it is important to find solutions to gap-fill human resource problems, the performance of existing health staff could also be significantly improved through regular and refresher trainings that address their operational challenges in the field¹⁷ and by ensuring that job aids and SOPs are readily available for them.

Strengths and limitations of the study

This was the first mixed-method study to comprehensively evaluate the performance and operational feasibility of RASR strategies and activities in Lao PDR. The study has used diverse data collection methods and included participants from different levels ranging from MMPs and frontline malaria service providers to higher-level malaria programme stakeholders. Moreover, findings from different methods were triangulated to increase the breadth and depth of understanding of the study findings.

Completeness and effectiveness, essential parameters for measuring the success of RASR strategy could not be

assessed due to limitations in the secondary dataset, which provided no more than the provincial-level aggregated data with a limited number of variables (online supplemental material 3). Due to this limitation, completeness of each step of RASR strategy and effectiveness of RACD could not be calculated (online supplemental material 1: section 3).

Recommendations and conclusion

Overall, the implementation of RASR strategy for malaria elimination is on the right track in Lao PDR. The timeliness of case notification and investigation was found to be satisfactory after 3 years of implementation, and the opinions and perception of malaria programme stakeholders and malaria service providers towards RASR strategies were encouraging. However, this study highlighted the important barriers to effective implementation of RASR strategies in Lao PDR. To further strengthen RASR strategies in accelerating towards malaria elimination in Lao PDR, this study provides a set of recommendations in table 2. Optimisation of RASR strategy by following these recommendations will accelerate malaria elimination in Lao PDR, which in turn will contribute to the malaria elimination in the GMS by 2030.

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