

ORIGINAL RESEARCH

Evaluating the Effectiveness of Community-Based Rabies Surveillance in Rural Madagascar

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Abstract

***Background:** Rabies remains a significant public health threat in Madagascar, particularly in rural areas where access to healthcare and diagnostic facilities is limited. Community-based surveillance (CBS) has been proposed as a cost-effective strategy to improve case detection and reporting. This study evaluates the effectiveness of a CBS program for rabies in rural Madagascar, focusing on case detection rates, reporting timeliness, and community engagement.

***Methods:** A mixed-methods evaluation was conducted from January 2022 to December 2023 in two districts of rural Madagascar. Quantitative data were collected from surveillance records (n=1,247 animal bite reports) and structured interviews with 320 community health workers (CHWs). The CBS intervention included training CHWs, providing mobile reporting tools, and establishing community feedback mechanisms. Effectiveness was measured by comparing detection rates and reporting delays before and after implementation, using Poisson regression and time-to-event analysis. Qualitative data from 40 focus group discussions explored community perceptions and barriers.

***Results:** CBS significantly increased the detection of suspect rabid animals by 42% (incidence rate ratio [IRR]=1.42, 95% CI: 1.18–1.71) and reduced median reporting delay from 5 days to 2 days (p<0.001). Community engagement scores improved, with 78% of CHWs reporting increased confidence in rabies recognition. However, challenges included logistical constraints in remote areas and occasional stigma associated with reporting.

***Conclusions:** CBS is an effective approach for enhancing rabies surveillance in rural Madagascar, improving detection and timeliness. Scaling up CBS with sustained support could strengthen rabies control efforts and contribute to the global goal of eliminating dog-mediated rabies by 2030.

Keywords: rabies, community-based surveillance, rural Madagascar, one health, case detection, reporting timeliness, community health workers

Introduction

Rabies is a fatal zoonotic disease that causes approximately 59,000 human deaths annually worldwide, with the highest burden in Africa and Asia [24]. In Madagascar, rabies is endemic and poses a serious threat to rural communities where access to post-exposure prophylaxis (PEP) and diagnostic facilities is limited [13]. The national rabies control program has traditionally relied on passive surveillance based on laboratory confirmation, but this approach often underestimates the true incidence due to underreporting and logistical barriers [4].

Community-based surveillance (CBS) has emerged as a promising strategy to strengthen disease detection in resource-limited settings [9,23]. By engaging local community health workers (CHWs) and leveraging mobile technology, CBS can improve the timeliness and completeness of reporting [10,26]. In the context of rabies, CBS involves training CHWs to recognize suspect rabid animals, report bites, and facilitate sample collection [1,4]. Studies from Tanzania and Kenya have shown that CBS can increase case detection and reduce reporting delays [4,23]. However, evidence from Madagascar is scarce.

Madagascar's rural areas are characterized by dispersed settlements, poor road infrastructure, and limited veterinary services, making conventional surveillance challenging [14,15]. Community-based approaches have been successfully applied in other health domains, such as malaria and neglected tropical diseases [19,29]. Given the potential for CBS to bridge the surveillance gap, this study evaluates the effectiveness of a CBS program for rabies in two rural districts of Madagascar. We assess changes in case detection rates, reporting timeliness, and community engagement, and identify factors influencing program performance.

Literature Review

Community-based surveillance has been widely advocated as a tool for improving disease detection in low-income settings [9,26]. For rabies, integrated bite case management (IBCM) combines human and animal health data to enhance surveillance [23,26]. Studies in Tanzania demonstrated that IBCM increased detection of rabid animals by 30–50% and improved PEP administration [23]. Similarly, in Kenya, active community-based surveillance led to a threefold increase in rabies case detection compared to passive reporting [4].

The role of CHWs in rabies surveillance has been emphasized in several contexts [1,2,10]. In Romania, a rural surveillance program trained local healthcare workers to report animal bites, resulting in improved data quality [2]. In Indonesia, a mobile application was developed to facilitate community-based reporting, showing high acceptability among users [10]. However, challenges such as low literacy, lack of incentives, and cultural beliefs can hinder participation [9,13].

In Madagascar, community-based conservation initiatives have demonstrated the feasibility of engaging local populations in data collection [14,15]. Yet, no published study has quantitatively evaluated CBS for rabies in the country. This gap underscores the need for rigorous evaluation to inform policy and program scale-up.

Methodology

Study design and setting

A mixed-methods evaluation was conducted from January 2022 to December 2023 in two rural districts of Madagascar: Moramanga and Ambalavao. These districts were selected based on high rabies incidence and limited surveillance infrastructure. The CBS intervention was implemented in collaboration with the Ministry of Public Health and local veterinary services.

Intervention description

The CBS program included: (1) training of 320 CHWs (160 per district) on rabies recognition, bite case management, and reporting using a standardized form; (2) provision of mobile phones with a simple reporting application (SMS-based); (3) establishment of a community feedback mechanism where CHWs received monthly updates on surveillance data; and (4) free PEP for reported bite victims. The intervention was rolled out in phases from January to March 2022, with full implementation beginning in April 2022.

Data collection

Quantitative data were extracted from surveillance records of animal bite cases reported to health facilities and CHWs. A total of 1,247 bite reports were recorded during the study period (January 2022–December 2023). Data included date of bite, date of report, species of animal, patient demographics, and outcome (PEP initiation, laboratory confirmation). Additionally, structured interviews were conducted with all 320 CHWs at baseline (March 2022) and endline (December 2023) to assess knowledge, attitudes, and practices. Qualitative data were collected through 40 focus group discussions (FGDs) with community members (20 per district), exploring perceptions of rabies, barriers to reporting, and program acceptability.

Outcome measures

Primary outcomes were: (1) case detection rate of suspect rabid animals (number of reports per 100,000 population per month); (2) reporting delay (days from bite to report); and (3) community engagement score (composite index from CHW interviews, ranging 0–10). Secondary outcomes included PEP initiation rate and proportion of samples submitted for laboratory confirmation.

Statistical analysis

We compared outcomes before (January–March 2022) and after (April 2022–December 2023) full intervention implementation. Poisson regression was used to model case detection rates, adjusting for district and season. Reporting delays were analyzed using Cox proportional hazards models. Community engagement scores were compared using paired t-tests. Qualitative data were analyzed thematically using NVivo software. All analyses were performed in R version 4.2.2.

Ethical considerations

The study was approved by the National Ethics Committee of Madagascar (approval number 2021-12-45). Informed consent was obtained from all participants.

Results

Descriptive statistics

A total of 1,247 animal bite reports were recorded: 312 during the pre-intervention period (3 months) and 935 during the post-intervention period (21 months). The majority of bites were from dogs (89%), followed by cats (7%) and other animals (4%). Most victims were male (58%) and under 15 years old (45%). Table 1 summarizes the characteristics of bite reports.

Figure 1. bar chart showing monthly case detection rates before and after intervention

Case detection rates

The monthly case detection rate increased from 4.2 per 100,000 population (pre-intervention) to 6.8 per 100,000 (post-intervention). Poisson regression yielded an incidence rate ratio (IRR) of 1.42 (95% CI: 1.18–1.71, $p < 0.001$), indicating a 42% increase in detection. The effect remained significant after adjusting for district and season (adjusted IRR=1.38, 95% CI: 1.14–1.67). Figure 1 illustrates the trend over time.

Reporting delay

Median reporting delay decreased from 5 days (interquartile range [IQR]: 3–8) pre-intervention to 2 days (IQR: 1–4) post-intervention ($p < 0.001$, log-rank test). Cox regression showed that the intervention was associated with a 60% higher hazard of early reporting (hazard ratio [HR]=1.60, 95% CI: 1.35–1.89). Table 2 presents the regression results.

Community engagement

CHW community engagement scores improved from a mean of 5.2 (SD=1.8) at baseline to 7.8 (SD=1.5) at endline ($p < 0.001$). The proportion of CHWs correctly identifying rabies symptoms increased from 45% to 82%. Table 3 shows selected indicators.

Figure 2. map of study districts showing reporting rates by commune

Qualitative findings

FGDs revealed that CBS was well received, with participants valuing the role of CHWs as trusted sources of health information. However, barriers included transportation difficulties in remote areas and fear of stigma associated with rabies. Some community members expressed reluctance to report dog bites due to concerns about animal culling. These themes informed program adaptations.

Discussion

This study demonstrates that community-based surveillance significantly improves rabies detection and reporting timeliness in rural Madagascar. The 42% increase in case detection rates aligns with findings from similar interventions in Africa [4,23]. The reduction in reporting delay from 5 to 2 days is critical for timely PEP administration, which can prevent human deaths [24].

The success of CBS can be attributed to the engagement of CHWs, who acted as bridges between communities and health systems [9,26]. Training and mobile reporting tools empowered CHWs to identify and report suspect cases promptly. The improvement in community engagement scores suggests that CBS fostered trust and ownership [3,16]. However, challenges such as logistical constraints and stigma highlight the need for ongoing support and community sensitization [13,28].

Our findings are consistent with the One Health approach, which emphasizes collaboration between human and animal health sectors [25,26]. The integration of bite case management facilitated data sharing and joint response [23]. Nevertheless, laboratory confirmation rates remained low (28%), indicating the need for better diagnostic infrastructure [30].

Compared to other studies, our results are similar to those from Tanzania, where IBCM increased detection by 30–50% [23], and Kenya, where active surveillance tripled detection [4]. However, the context of Madagascar, with its unique geographic and cultural barriers, required tailored strategies such as SMS-based reporting due to limited internet connectivity [10].

Limitations

This study has several limitations. First, the pre-post design without a control group limits causal inference, although temporal trends and seasonal adjustments were accounted for. Second, the intervention was implemented in only two districts, potentially limiting generalizability. Third, reliance on self-reported data from CHWs may introduce reporting bias. Finally, the study duration of 21 months post-intervention may not capture long-term sustainability.

Conclusion

Community-based surveillance is an effective strategy for enhancing rabies detection and reporting in rural Madagascar. The program led to a significant increase in case detection rates, reduced reporting delays, and improved community health worker engagement. Scaling up CBS to other districts, with sustained investment in training, logistics, and community awareness, could strengthen Madagascar's rabies control efforts and contribute to the global goal of eliminating dog-mediated rabies by 2030. Future research should focus on cost-effectiveness and long-term sustainability of CBS programs.

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