



Factors Associated with Deaths During A Measles Outbreak in Marromeu, Mozambique, 2025–2026

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Abstract

Introduction: Measles remains a major preventable cause of morbidity and mortality, particularly in populations with low vaccination coverage, limited access to health services, and delayed disease recognition. Maintaining high vaccination coverage is essential to interrupt transmission. Complications of the disease are more frequent among children, malnourished individuals, and those with conditions that compromise immunity.

Methods: A descriptive epidemiological investigation was conducted between February 23 and 26, 2026. Clinical and epidemiological data from five individuals who died between December 2025 and February 2026 and were classified as suspected deaths associated with the outbreak were reviewed. Variables analyzed included age, sex, residence, vaccination status, symptom onset, seeking care, initial diagnosis, and possible transmission chains. The case fatality rate was calculated using the number of suspected deaths divided by the total number of cases reported during the outbreak.

Results: The study identified five deaths among 68 reported cases, corresponding to a case fatality rate of 7.35%. Ages ranged from 10 months to 17 years. Four deaths occurred in the Nhaminhana 1 neighborhood and one in Phandue, all without a documented history of measles vaccination; four deaths occurred at home; three individuals did not seek formal care during the fatal episode, and two were initially diagnosed with malaria. The first two deaths occurred in children aged 5 and 4 years belonging to the same family network. One 10-month-old infant was possibly exposed during a funeral.

Conclusion: The findings demonstrate an epidemiological pattern consistent with community transmission of measles in a context of high susceptibility, associated with the absence of documented vaccination, delays in seeking care, and difficulties in the clinical recognition of the disease. The geographic concentration of deaths and family and community links suggest sustained transmission within a susceptible population, although without laboratory confirmation there is a possibility of association between the deaths and the outbreak.

Keywords: Associated factors, Outbreak, Measles, Mortality, Mozambique

Introduction

Measles is a highly contagious viral disease, transmitted predominantly through the air, and continues to cause serious illness and death despite the availability of a highly effective vaccine. Complications include pneumonia, encephalitis, severe diarrhea, and dehydration, and are more frequent among young children,

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Citation: Edi Fulai, Unicia Nyamula, Caetano Raposo, Maria Vubil, Ana Jeque, Manuel Companhia, Alfredo Carvalho, Luís Fole, Angélica Sotomane, João Manuel. Factors Associated with Deaths During a Measles Outbreak in Marromeu, Mozambique, 2025–2026. Fortune Journal of Health Sciences. 9 (2026): 575-580.

Received: September 10, 2026

Accepted: September 15, 2026

Published: October 27, 2026

malnourished individuals, and those with conditions that compromise immunity [1,2]. Maintaining high vaccination coverage is crucial to interrupting transmission. However, the accumulation of susceptible individuals can favor outbreaks, particularly in communities with low vaccination coverage, limited access to health services, or surveillance systems with insufficient capacity to detect transmission early. WHO recommends case-based surveillance, rapid investigation of suspected cases, and appropriate laboratory or epidemiological confirmation [3–5]. The clinical diagnosis of measles can be hampered by overlap with other febrile illnesses. In contexts where malaria is a frequent cause of fever and seeking care, there is a risk of initially inappropriately attributing symptoms to malaria, particularly when the clinical presentation is incomplete or occurs outside the age group classically associated with measles [6, 9, 10]. In December 2025, suspected cases of measles were identified in the locality of Salone, Marromeu district, Sofala province. Between December 2025 and February 2026, five suspected deaths occurred, predominantly in the Nhaminhana 1 neighborhood. An epidemiological investigation was conducted between February 23 and 26, 2026, to characterize the deaths, reconstruct possible transmission chains, and identify factors associated with the fatal outcomes. In this study, we describe the epidemiological characteristics of the deaths and the possible related factors.

Methods

Study design and location

A descriptive epidemiological investigation was conducted on five suspected deaths associated with a measles outbreak in Salone, Marromeu district, Sofala province, Mozambique. The investigation took place between February 23 and 26, 2026, and included deaths that occurred between December 2025 and February 2026. Data were obtained through verbal autopsies to ascertain the circumstances associated with each death and its contacts, and through document review.

Epidemiological definition

Deaths suspected of being associated with the outbreak were those that presented clinical or epidemiological suspicion of measles and that occurred during the period of transmission identified in the community. According to WHO guidelines, suspected measles includes individuals with fever and maculopapular rash associated with cough, runny nose, or conjunctivitis, or anyone in whom a healthcare professional suspects measles. Definitive confirmation requires laboratory evidence or appropriate epidemiological link to a confirmed case.

Variables

Sociodemographic, temporal, clinical, and epidemiological variables were analyzed, including age, sex, neighborhood of

residence, date of symptom onset, date of death, vaccination status, seeking healthcare, initial diagnosis, epidemiological exposure, family and community contacts, and circumstances of death. The reconstruction of the transmission chains was based on the family, social, and community links identified during the investigation.

Data collection procedure

Data collection was carried out in the community using a standardized electronic form on “**KoboCollect**”. WHO Verbal Autopsy Assessment (VASA) to the closest relative or respondent of each suspected death, allowing for retrospective reconstruction of the clinical history, care seeking, vaccination status, exposures, and circumstances of death. The information obtained was subsequently... triangulated with epidemiological surveillance data, including records of suspected cases, contacts and vaccination, to validate the information, identify epidemiological links and reconstruct the possible chain of transmission of the outbreak.

Data management

The data collected was submitted electronically to the The data were stored and managed on the server of the Sofala Provincial Delegation of the National Institute of Health (INS), in accordance with institutional data management and security procedures. After synchronization, the data were reviewed for completeness and consistency and subsequently prepared for epidemiological analysis.

Epidemiological analysis

The case fatality rate was calculated as:

Case fatality rate (%) = number of suspected deaths / total number of reported cases × 100.

The characteristics of the deaths were presented descriptively, using absolute frequencies, proportions, and median or age range when appropriate.

Ethical considerations

This study was conducted as part of an investigation into a measles outbreak that occurred in the Marromeu district, Sofala province, Mozambique, in 2026. Considering the nature of the evaluation, which did not involve experimental interventions, recruitment of research participants, collection of biological samples, or use of personally identifiable information, submission to and approval by a Research Ethics Committee was not required. However, prior to implementing the evaluation, institutional authorizations were obtained from the Sofala Provincial Health Directorate and the Marromeu District Health, Women and Social Action Service. All data used were anonymized and treated with strict confidentiality, being used exclusively for the purposes of strengthening the outbreak response, programmatic monitoring, and scientific

production. The study was conducted in accordance with the ethical principles established in the Declaration of Helsinki, including the principles of beneficence, non-maleficence, confidentiality, scientific integrity, and respect for the communities involved.

Results

Characteristics of deaths

Five suspected deaths were investigated out of the 68

reported cases of measles that occurred between December 2025 and February 2026 (Table 1). The individuals' ages ranged from 10 months to 17 years. Four of the five deaths occurred in Nhaminhana 1, while one occurred in Phandue. All individuals had documented absence of measles vaccination. Four individuals died at home and one died after seeking care at two health units. Three individuals did not formally seek health care during the episode preceding death, while two had an initial diagnosis of malaria (Figure 1).

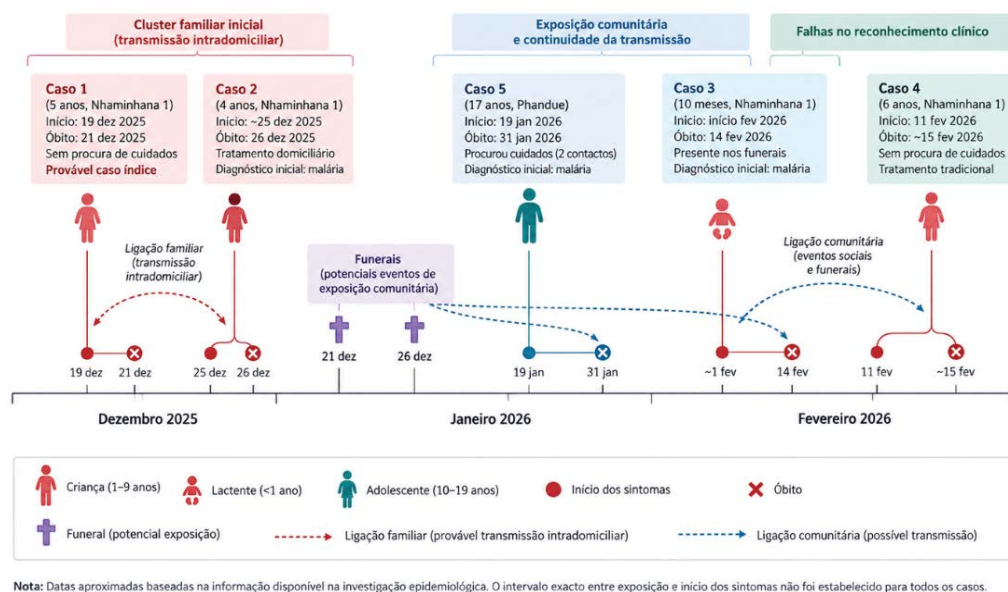


Figure 1: Timeline of the five deaths associated with the measles outbreak, Marromou, Mozambique, 2025-2026

Table 1: Epidemiological and clinical characteristics of the five suspected deaths associated with the measles outbreak, Salone, Marromeu, 2025–2026

No.	Neighborhood	Age	Sex	Onset Symptoms	Date of Death	Vaccination History	Seeking Care	Epidemiological Exposure	Observations
1	Nhaminhana 1	5 years	M	~19/12/2025	21-12-2025	Not vaccinated	He didn't look for it.	Half-brother (MAR-002)	Likely index case; transfer between houses as a cultural practice
2	Nhaminhana 1	4 years	M	~23/12/2025	26-12-2025	Not vaccinated	He didn't look for it.	Half-brother (MAR-002)	Symptoms interpreted as malaria; death at home.
3	Nhaminhana 1	10 months	F	~start Feb 2026	14-02-2026	He did not receive the measles vaccine.	Sought US (malaria diagnosis)	Present at the funerals on December 21st and 26th.	Oral lesions and difficulty eating; likely complication.
4	Nhaminhana 1	6 years	M	11-02-2026	15-02-2026	Not vaccinated	Did not seek (traditional treatment)	Symptomatic twin brother; recreational network linked to funerals.	Home death
5	Phandue	17 years old	F	19-01-2026	31-01-2026	Not vaccinated	Sought medical attention at CS and HR Marromeu (malaria diagnosis).	Indirect social link to the initial cluster	Recurrent diagnosis of malaria; progressive worsening.

Abbreviations: US = health unit; CS = health center; HR = rural hospital; Source: epidemiological investigation of suspected measles deaths, Salone, Marromeu, 2026.

Mortality

Among the 68 cases reported during the outbreak, five suspected deaths were identified, resulting in a case fatality rate of 7.35%. The five deaths presented the following patterns: 5/5 (100%) without documented measles vaccination; 4/5 (80%) residents of Nhaminhana 1; 4/5 (80%) deaths occurred at home; 3/5 (60%) without formal seeking of care during the fatal episode; 2/5 (40%) with initial diagnosis or interpretation as malaria; 1/5 (20%) with documented seeking of care at two levels of attention; 1/5 (20%) under one year of age and 1/5 (20%) adolescent.

Discussion

The study revealed that five suspected deaths associated with a measles outbreak in Salone exhibit three main patterns: High susceptibility associated with lack of documented vaccination, spatial and familial concentration of deaths, and missed opportunities for timely recognition and treatment of the disease. These findings are consistent with the epidemiology of measles, one of the most transmissible human infectious diseases, whose occurrence rapidly highlights gaps in population immunity. An infected person can lead to numerous secondary infections, particularly in communities with insufficient vaccination coverage. Globally, approximately 11 million measles infections and 95,000 measles deaths were estimated in 2024, despite the availability of a highly effective vaccine [1, 2].

The concentration of four of the five deaths in the Nhaminhana 1 neighborhood suggests an important spatial component of transmission. Family links among the first cases and community links identified later are consistent with the spread of the virus in a susceptible population. Although the temporal sequence and epidemiological links support the hypothesis of intrafamilial and community transmission, the absence of molecular characterization prevents definitively establishing the transmission chains. The WHO recommends that outbreak investigations combine clinical, epidemiological, and laboratory data to confirm virus circulation and guide the response [3, 4].

The absence of documented vaccination in the five individuals constitutes the most consistent epidemiological finding. Vaccination is the main intervention to prevent measles cases, outbreaks, and deaths, and the WHO recommends maintaining at least 95% coverage with two doses to interrupt transmission and reduce the risk of outbreaks. Despite global progress, coverage of the first dose of the measles-containing vaccine was 84% in 2025, remaining below the level needed to ensure herd immunity [1, 5]. The persistence of vaccination gaps is particularly relevant in vulnerable contexts, where inequalities in access and fragility of health systems can favor the accumulation of susceptible individuals [2, 5].

The investigation also identified important barriers to seeking care. Four of the five individuals died at home and three had no formal contact with health services during the fatal episode. This pattern suggests that the observed mortality cannot be interpreted solely as a consequence of the biological severity of the infection, and that factors related to community recognition, care-seeking behavior, accessibility, and sociocultural context should be considered. Studies conducted in African contexts demonstrate that measles mortality is influenced by factors related to vaccination coverage, availability and access to care, nutritional status, and socioeconomic conditions [6]. A recent investigation of a prolonged measles outbreak in Somalia also identified limitations in access to care and low vaccination coverage as important factors associated with the persistence of transmission and mortality [7].

The use of traditional treatment identified in one of the cases should be interpreted within the sociocultural context of the community and not exclusively as an individual decision. During outbreaks, risk communication strategies and community engagement can contribute to improving early disease recognition, increasing timely seeking of care, and promoting adherence to vaccination interventions. Evidence from African contexts shows that barriers to vaccination and service utilization can occur simultaneously at the individual, family, community, and health system levels, reinforcing the need for response strategies adapted to the local context [7, 8]. In Mozambique, studies on healthcare-seeking behavior also demonstrate the influence of social norms, interpersonal communication, and community characteristics on the decision to seek care for febrile illnesses [9].

The initial diagnosis of malaria in two individuals is another important finding. In areas where malaria is endemic, the presence of fever may favor an initial attribution to the disease, especially when measles is not routinely included in the differential diagnosis. However, during an active outbreak, the possibility of measles should be systematically considered in the presence of compatible clinical manifestations or known epidemiological exposure. Case-based surveillance and rapid investigation are fundamental to early recognition of transmission and triggering control measures [3, 4]. Recent experience with outbreaks in Africa demonstrates that delays in reporting to services, notification, and the establishment of referral mechanisms can constitute significant bottlenecks in the response [10].

The adolescent case demonstrates that this limitation was not restricted to the pediatric population. The repeated diagnosis of malaria at different levels of care represents a missed opportunity for measles recognition. During periods of community transmission, clinical suspicion should be maintained in all age groups and integrated with the history of exposure, vaccination, and epidemiological context. This aspect is particularly important because the clinical

presentation can vary and because the absence of suspicion can delay investigation, notification, and contact tracing. [3, 4].

The case fatality rate of 7.35% (5/68) It should be interpreted with caution. Although it constitutes an important sign of the severity of the event under investigation, it should not be directly compared with population estimates of case fatality without considering the completeness of case detection, the possibility of underreporting of non-fatal cases, and the classification of deaths. The literature shows that measles case fatality varies substantially according to the epidemiological and socioeconomic context, being associated, among other factors, with vaccination coverage, malnutrition, vitamin A deficiency, access to health care, and the capacity of the health system [6]. The high case fatality observed in this outbreak should therefore be interpreted as a This is an indicator of severity and potential failures in prevention, detection, and care barriers, and not an estimate of the intrinsic lethality of measles.

Furthermore, the classification of the five events as related to measles remains. Epidemiologically probable, but not definitively proven. with the available data. The WHO distinguishes between suspected cases and confirmed cases and recommends laboratory confirmation or appropriate epidemiological linkage [3, 4]. Thus, the most accurate designation for this study is “Suspected deaths associated with the outbreak,” unless laboratory results or additional documentation of epidemiological linkage to confirmed cases are available. This distinction is particularly important to avoid overestimating mortality attributable to measles. The results have direct implications for the response to the outbreak. First, outbreak vaccination should be prioritized. in affected areas and among susceptible populations, complementing the reinforcement of routine vaccination. WHO recommends context-adapted vaccination strategies to rapidly reduce immunity gaps during outbreaks [11]. Second, epidemiological surveillance should be intensified in affected communities and surrounding areas, including active case finding, retrospective investigation and systematic contact tracing. Measles surveillance is essential not only to detect cases, but also to identify transmission chains early and guide vaccination and control measures [3, 4].

Third, laboratory investigation must accompany the epidemiological response. Collecting samples from the first suspected cases allows confirmation of virus circulation and, where appropriate, molecular characterization to support the investigation of transmission chains [3, 4]. Fourth, the capacity of health professionals to recognize and treat measles must be strengthened. There is no specific antiviral treatment; management focuses on preventing and treating complications, hydration, nutritional support, and administering vitamin A to children with measles, in accordance with WHO recommendations [1]. Finally, the

response must incorporate a robust community component , involving local leaders, community health workers and trust structures to promote vaccination, early recognition of warning signs and timely seeking of care. The experience of recent outbreaks in African contexts reinforces the importance of a community-centered approach to reduce barriers to access and improve the response to prolonged outbreaks [7, 8].

This study presents as its main strength the Individual investigation of the five deaths allowed for the reconstruction of temporal, spatial, familial, clinical, and care-seeking characteristics that might not be identified through aggregated surveillance data. The use of verbal autopsy in the community, complemented by cross-referencing with surveillance data, made it possible to retrieve information on deaths that occurred outside of health facilities and to identify possible epidemiological links.

However, there are important limitations. First, individual laboratory results confirming measles virus infection were not available in the five deaths. Second, some exposures and clinical circumstances were reconstructed retrospectively and may be subject to recall bias. Third, the absence of vaccination documentation is not necessarily equivalent to the absolute absence of vaccination. Fourth, transmission chains were inferred from temporal, spatial, and epidemiological links and were not demonstrated by molecular characterization. Finally, the case fatality rate may be influenced by underdetection or underreporting of non-fatal cases, especially since some cases may not have sought care or may not have been reported. WHO recognizes that surveillance systems may underestimate the true occurrence of measles due to non-seeking of care and underreporting [4].

Abbreviations

HR – Rural Hospital

INS – National Institute of Health

WHO – World Health Organization

Health Center

VASA – Verbal Autopsy

Consent for publication

Statement: Not applicable.

Availability of data and materials

The datasets generated and/or analyzed during this study are available upon reasonable request to the corresponding author.

Financing

The authors did not receive specific funding for this work.

Conflicts of interest

The authors declare no conflicts of interest.

Authors' contributions

Edi Fulai - Conceptualization, study design, literature review, methodological review, data analysis and synthesis, interpretation of results, writing and critical revision of the manuscript, and approval.

Unicia Chabale - Methodological review, critical review of the manuscript, and intellectual contribution to the theoretical framework.

Caetano Raposo - Methodological review, critical review of the manuscript, and intellectual contribution to the theoretical framework

Maria Vubil - Literature review, data analysis and synthesis, manuscript writing and revision.

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Alfredo Dias - Literature review, data collection, data analysis and synthesis, manuscript writing and revision.

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Angélica Sotomane - Conceptualization, data collection, study design, literature review, methodological review, critical review, and final manuscript review.

João Manuel - Study conception, methodological review, critical review, and final manuscript review.

Acknowledgments

The authors would like to express their sincere gratitude to Helder Manuel, Alberto Mucauro, and Julieta Maina for their valuable support during the implementation of the study. The authors also thank the Marromeu District Health, Women and Social Action Service, the rapid response team technicians, and the clinicians for their institutional support and collaboration during the data collection process.

Source AI

Epidemiological investigation data. Figure prepared by the authors with AI-assisted graphical refinement (ChatGPT, OpenAI). All epidemiological data and scientific content were verified by the authors.

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