Investigation of a measles outbreak on Phu Quoc Island, Viet Nam, April–June 2024

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Objective: In 2024, following detection of a measles outbreak on Phu Quoc Island, Viet Nam, an investigation was conducted to describe the epidemiological characteristics and assess response timeliness using the 7-1-7 framework.

Methods: Suspected measles cases were identified through syndromic surveillance (those with fever and rash, plus respiratory inflammation and/or conjunctivitis) and confirmed by serological testing. Demographic and epidemiological information was collected with standardized questionnaires. Vaccination status was verified using the National Immunization Information System and personal vaccination records, with full vaccination defined as two doses of measles-containing vaccine. The 7-1-7 framework was used to assess timeliness of detection (7 days), notification (1 day) and response (7 days).

Results: Of 137 suspected measles cases occurring between 7 April and 7 June 2024, 83 (60.6%) were confirmed. Cases occurred mainly among school-aged children (6–10 years, $n = 55$; 40.1%), with schools as the primary exposure setting ($n = 56$; 40.9%). Among the 55 school-aged children, 10 (18.2%) were fully vaccinated. The attack rate was significantly higher among school-aged children who had not received two vaccine doses than among those who were fully vaccinated (0.9% [45/4988] vs 0.1% [10/8917], $P < 0.001$). Outbreak detection was delayed by 15 days, notification occurred within 1 day of identification of the first suspected case, and response was within 5 days of notification.

Discussion: This outbreak was likely caused by gaps in vaccination coverage and delayed recognition of early warning signs. Strengthening immunization, early case detection and reporting systems are essential to prevent future outbreaks.

Measles is an infectious disease caused by a virus that spreads easily through the air when an infected person coughs or sneezes.[1] The disease can lead to serious complications, especially in children younger than 5 years, including pneumonia, encephalitis, ear infections and diarrhoea.[2] Despite effective vaccines, measles remains a major global health problem, accounting for an estimated 10.3 million cases and 107 500 deaths in 2023.[3] Reduced vaccination coverage during the COVID-19 pandemic has contributed to rising measles cases and outbreaks worldwide.[3]

The most effective way to prevent measles is to ensure that children receive two doses of a measles-containing vaccine (MCV). These two doses, usually given as the measles–mumps–rubella vaccine, provide about 97% protection.[2] To prevent outbreaks, the World Health Organization recommends that coverage with two doses should reach at least 95% in every community.[3] In Viet Nam, the measles vaccine has been part of the Expanded Program on Immunization since the mid-1980s, with the first dose (MCV1) given at 9 months of age and the second dose (MCV2) added to routine vaccinations in 2006 and now administered at 18 months of age.[4] Viet Nam maintained strong measles control for many years, but disruptions during the COVID-19 pandemic caused declines in the coverage of routine vaccinations and created immunity gaps during 2021–2022.[5] These gaps have contributed to the resurgence of measles in several areas.

Phu Quoc, Viet Nam's largest island, lies off the coast of An Giang Province in the southwest, covers about 574 km^2 and has a population of more than 150 000 people. As a major tourism and commercial hub, the island welcomed around 5.4 million visitors in 2023. As no confirmed measles cases had been reported in Phu Quoc since the most recent increase in measles cases during 2019–2020, measles was considered non-

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endemic on the island. On 22 April 2024, the An Giang Provincial Center for Disease Control (CDC) recorded a suspected measles case in Phu Quoc, with an elementary school identified as the starting point of the outbreak. This investigation was conducted to describe the characteristics of the outbreak and to evaluate early response actions.

METHODS

A field investigation team of five members, including epidemiologists, clinicians and laboratory staff from the An Giang Provincial CDC, investigated the measles outbreak. The investigation was carried out on Phu Quoc Island from 22 April to 7 June 2024.

Case definitions

This investigation used two case definitions for measles, in accordance with the guidelines of Viet Nam's Ministry of Health.[6] A suspected clinical measles case was defined as a person presenting with fever and rash between 17 March and 7 June 2024, with at least one of the following symptoms: cough, runny nose or conjunctivitis. A laboratory-confirmed measles case was defined as a suspected case who had a positive measles immunoglobulin M (IgM) test result.

Case finding

Records at the Phu Quoc Health Centre were reviewed to identify cases, and additional case finding was conducted in the community. An active syndromic surveillance system was established to detect cases at the health centre, at private clinics and in the community.

Data collection

A standardized questionnaire (**Supplementary Material**) was used to collect demographic, clinical and epidemiological information. To identify the likely exposure setting, patients were asked about contact with individuals who met the suspected measles case definition. Data were collected through interviews with patients, or with caregivers for those younger than 15 years.

Vaccination status was verified using the National Immunization Information System and personal vaccination records. MCV coverage on Phu Quoc Island was estimated using population data from a random survey of 240 children younger than 10 years across eight of the island's nine communes (30 children per commune).

Sample collection and laboratory analysis

A 3-mL blood sample was collected from each suspected case. The serum was extracted, stored at the Provincial CDC and transported to the Pasteur Institute in Ho Chi Minh City within 3 days of collection. Measles IgM antibodies were detected using enzyme-linked immunosorbent assay.

Data analysis

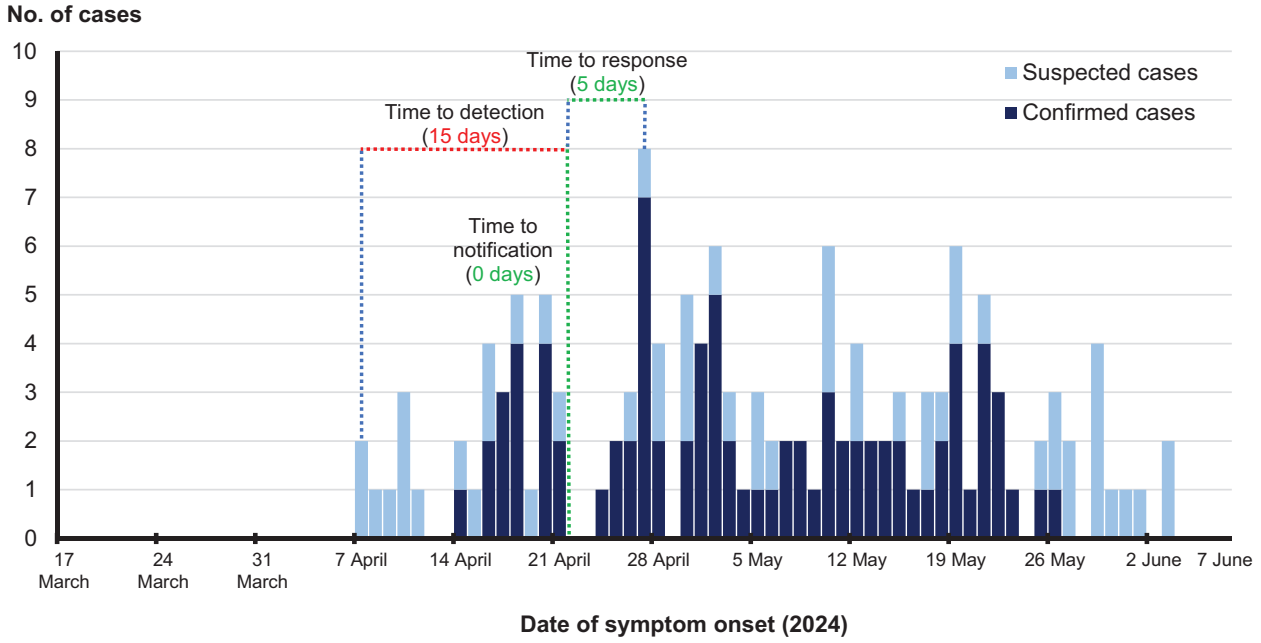
Frequencies and percentages of case characteristics, as well as attack rates overall and by age group, were calculated in Microsoft Excel. Differences in attack rates between undervaccinated and fully vaccinated groups were assessed using Pearson's X^2 test in Open Source Epidemiologic Statistics for Public Health (OpenEpi) software version 3.01.[7] Three age groups (<2, 2–5 and 6–10 years) were selected for attack rate analysis, as they had the highest number of cases and corresponded to the target population for a planned supplementary measles vaccination campaign (1–10 years).

Assessment of outbreak response timeliness

The 7-1-7 Assessment Tool[8] was used to evaluate the timeliness of outbreak detection, notification and response, and to identify bottlenecks and enabling factors for performance improvement. The framework defines targets for detection within 7 days of emergence, notification within 1 day of detection and initiation of response actions within 7 days of notification.

Viet Nam's Ministry of Health defines an outbreak of measles as three epidemiologically linked cases, at least two of whom are laboratory-confirmed. For the purposes of the 7-1-7 assessment, the date of emergence is defined as the symptom onset date of the earliest epidemiologically linked case.

Fig. 1. **Epidemic curve of 137 suspected and laboratory-confirmed measles cases, Phu Quoc Island, Viet Nam, April–June 2024**



RESULTS

Epidemiological characteristics

In total, 137 suspected cases of measles were identified in seven out of nine communes on Phu Quoc Island from 7 April to 7 June 2024. From these cases, 83 blood specimens (60.6%) were collected, and all tested positive for IgM antibodies against measles. The overall incidence of measles was 77 cases/100 000 population. No deaths were reported.

Fig. 1 shows the epidemic curve of the measles outbreak. The earliest case developed symptoms on 7 April. The daily number of cases increased quickly from mid-April and peaked on 27 April at eight cases. The number of cases then gradually declined, with new cases reported until early June.

The first detected case was a 9-month-old female who developed symptoms on 20 April and presented to the provincial obstetric and paediatric hospital on 22 April. The hospital notified the Provincial CDC of the suspected measles case on the same day, and the case was subsequently laboratory-confirmed for measles. The investigation retrospectively identified two earlier suspected cases with symptom onset on 7 April at the same primary school: a 10-year-old household contact of the first detected case and one of her classmates. The household contact had presented to the health centre on the day of symptom onset but was not suspected with measles at the time. No specimens were collected from these two cases, and their sources of infection could not be determined. Another student from the same primary school, with symptom onset around the same time as the first detected case, was also laboratory-confirmed for measles. These four epidemiologically linked cases, of which two were laboratory-confirmed, met the national definition of a measles outbreak.

Table 1 describes the characteristics of the measles cases. Cases were evenly distributed between males and females. Most cases occurred in school-aged children, especially those aged 6–10 years (55/137, 40.1%). Schools were the main exposure setting (56, 40.9%), with additional exposures in health centres (18, 13.2%). More than half of the cases were hospitalized (78, 56.9%). A total of 75 cases (54.7%) had an unknown vaccination history, and 33 (24.1%) were unvaccinated. Seventeen cases (12.4%) had received one dose of an MCV, and 12 (8.8%) had been fully vaccinated.

A community survey on the island found that 52.5% of children had received two doses of MCV, 20.7% had

Table 1. **Characteristics of measles cases and measles attack rates by age group and vaccination status, Phu Quoc Island, Viet Nam, April–June 2024 (*N* = 137)**

Characteristic	No.	%	Population	Attack rate (%)
Sex				
Male	69	51.4	–	
Female	68	48.6	–	
Age group (years)				
<2	**26**	**19.0**	**506**	**5.1**
Undervaccinated	25	18.2	455	5.5
Fully vaccinated	1	0.8	51	2.0
2–5[a]	**36**	**26.3**	**5927**	**0.6**
Undervaccinated	35	25.5	2918	1.2
Fully vaccinated	1	0.8	3009	0.03
6–10[a]	**55**	**40.1**	**13 905**	**0.4**
Undervaccinated	45	32.8	4988	0.9
Fully vaccinated	10	7.2	8917	0.1
11–16[b]	**15**	**10.9**	**–**	
>16[b]	**5**	**3.6**	**–**	
Exposure setting				
School	56	40.9	–	
Community	25	18.2	–	
Health centre	18	13.2	–	
Unknown	38	27.7	–	
Vaccination status				
Unknown	75	54.7	–	
Unvaccinated	33	24.1	–	
1 dose	17	12.4	–	
≥2 doses	12	8.8	–	

[a] Differences in attack rates between undervaccinated and fully vaccinated groups were statistically significant ($P < 0.001$) based on Pearson's X^2 test.

[b] Age groups 11–16 years and >16 years were not included in the analysis of attack rates by vaccination status because the analysis focused on children aged 1–10 years, who accounted for most cases and were the target population for the planned supplementary measles vaccination campaign.

received one dose, and 26.8% were unvaccinated or had unknown vaccination status.

Attack rate

Table 1 shows the measles attack rate by age group and vaccination status. Children younger than 2 years had the highest attack rate (5.1%, 26/506), compared to 0.6% (36/5927) in children 2–5 years and 0.4% (55/13 905) in children 6–10 years. In all age groups, attack rates were higher among undervaccinated children than among fully vaccinated children. Differences between undervaccinated and fully vaccinated children were statistically significant in the 2–5 and 6–10-year age groups ($P < 0.001$).

Public health response

The outbreak was detected late, with a 15-day delay from symptom onset of the earliest case to identification. Notification was timely: it was completed on the same day. Outbreak response measures were fully implemented within 5 days of notification, meeting the 7-1-7 response target (**Fig. 1**).

The investigation and response team was deployed within 1 day of notification (23 April 2024). Risk communication and coordination were established on the same day. Specimens from the first detected case were collected on 22 April, and laboratory confirmation was obtained on 25 April, a turnaround time of 3 days. Public health response measures were implemented between 22 and 25 April, within 3 days. These included distribution of soap, disinfectants and personal protective equipment to communities, schools and health-care facilities, and strengthening MCV availability through the Expanded Programme on Immunization for children aged 9 months to 2 years. Mask use was mandated in schools, and cases were isolated either in health-care facilities or at home, depending on severity. The most time-consuming activity was the epidemiological analysis and initial risk assessment, which required 5 days, from 22 to 27 April. Overall, core response actions were completed within 7 days, meeting the 7-1-7 response target.

Several bottlenecks were identified during the response to the outbreak through the 7-1-7 assessment, review of investigation records and discussions with response team members. These included: (1) limited training of health professionals in surveillance and response, (2) low clinical suspicion among health workers, (3) a lack of coordination across public health units or agencies, and (4) access issues at several exposure locations. Several enablers were also noted: (1) resources were available for response initiation and rapid resource mobilization, (2) laboratory capacity was adequate, and (3) follow-up was carried out in accordance with the initial risk assessment.

DISCUSSION

The measles outbreak on Phu Quoc Island was notable, as it occurred after more than 5 years without reported cases. Most cases had not been fully vaccinated, which facilitated virus transmission, or had an unknown vaccination status. Similar patterns were reported in United States of America in 2025,[9] where 96% of cases were unvaccinated or had unknown vaccination status, and in other countries, including Pakistan in 2017,[10] Botswana in 2023[11] and Bosnia and Herzegovina in 2024.[12] Due to the high transmissibility of measles, at least 95% vaccination coverage is needed to prevent outbreaks,[2] and failure to achieve this level likely contributed to this outbreak.

The age distribution showed that measles risk was not limited to the youngest children, consistent with other outbreaks.[10–12] Measles is very contagious, affecting people of any age who are not vaccinated, highlighting the need to reduce the risk of measles in people of all ages, not only children younger than 5 years. Strengthening routine immunization and implementing supplementary immunization activities for children aged 1–10 years are essential to rapidly control outbreaks and prevent recurrences.

In this outbreak, the high number of hospitalized patients increased the burden on health-care resources. This pattern is consistent with reports from earlier measles epidemics, when hospitals saw a continual increase in hospitalizations of children who had pneumonia or needed special isolation.[13] Measles can cause severe illness, particularly in young, unvaccinated children,[13] and immunity gaps can strain health-care systems. High vaccination coverage and early detection of suspected cases are essential to reduce complications and limit pressure on health-care services.

During this outbreak, measles transmission occurred more frequently in schools than in the community or health-care facilities, consistent with findings from other countries.[14] Close contact among vulnerable children in schools facilitates transmission. This outbreak likely began in a primary school and spread to household contacts and the wider community. These findings highlight the importance of schools in early detection and the need for stronger collaboration between schools and health-care providers to promptly identify suspected cases and limit transmission.

The outbreak was detected late, with a 2-week gap between the first case's symptom onset and confirmation, indicating that the 7-1-7 detection target was not achieved. It was retrospectively found that 10 cases had presented to a health facility before the first detected case but were not accurately diagnosed at the time. Additionally, the cluster at the primary school was not initially reported to the local health station. These represent missed opportunities to have met the detection target. However, notification and responses were timely, with control measures implemented within a few days. Research analysing 41 responses to public health emergencies in Brazil, Ethiopia, Liberia, Nigeria and Uganda between 2018 and 2022 found that only 54% met the 7-day

detection target.[15] This highlights the possibility that early cases may be unreported if medical professionals do not recognize them. This is consistent with previous research that discovered 61% of detection bottlenecks were in health-care facilities.[12] Delayed detection allows for undetected transmission and complicates outbreak control. Strengthening clinical suspicion, improving event-based surveillance and ensuring prompt reporting of suspected cases are essential to improve early detection and outbreak response.

This study had several limitations. Incomplete immunization data necessitated that vaccination coverage be estimated using survey and population data, which may have affected the accuracy of attack rate estimates. Limited clinical outcome data also restricted assessment of the full health burden. However, the use of standardized investigation forms based on national guidelines and comprehensive case identification from health-care facilities and communities strengthened the findings.

The 2024 measles outbreak on Phu Quoc Island, Viet Nam was likely caused by gaps in measles vaccination coverage and delays in recognizing early warning signs, which allowed for transmission before control measures were implemented. Strengthening routine immunization, improving early case detection and enhancing reporting systems are essential to prevent future outbreaks. Applying the results of the 7-1-7 evaluation can also help enhance the effectiveness of recognizing and responding to measles and other infectious diseases.

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Conflicts of interest

The authors have no conflicts of interest to declare.

Ethics statement

This outbreak investigation was conducted as part of routine public health activities for infectious disease prevention and control at the local level. No personal or sensitive patient information was collected. The findings were used exclusively for outbreak detection and response; therefore, ethical review and approval by an institutional review board were not required.

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