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Measles Surveillance in Pekanbaru, Indonesia: An Evaluation Study (2022–2025)

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ABSTRACT

Background: Measles cases in Pekanbaru City fluctuated and increased during 2022–2025, with an outbreak occurring in 2025. This situation is associated with low immunization coverage and suboptimal implementation of Case-Based Measles Surveillance (CBMS). This study aimed to identify gaps in measles surveillance implementation, prioritize problems, and formulate recommendations using fishbone analysis and a Plan of Action (POA).
Methods: This exploratory qualitative study was conducted in October 2025. Informants were selected using purposive sampling, consisting of 4 informants: 2 main informants, namely VPD surveillance officers and Early Warning and Response System (EWRS) officers, as well as 2 supporting informants, namely an epidemiologist and an immunization program manager. Data were collected through in-depth interviews, observation, and document review, with data validity ensured through triangulation (source, data, and method triangulation). Qualitative analysis was followed by fishbone analysis and the development of a Plan of Action (POA).
Result: CBMS implementation reached only 48%, indicating suboptimal surveillance performance despite adequate data quality and relevance. Barriers to CBMS implementation involved human resources, funding, methods, infrastructure, and environmental factors. Proposed solutions included strengthening workforce capacity and numbers, optimizing budgets through activity integration, improving supervision and reporting systems, enhancing laboratory facilities, increasing immunization coverage, and reinforcing community-based surveillance.
Conclusion: A targeted POA is required to strengthen human resources, ensure budget availability, improve data recording and reporting quality, fulfill CBMS supporting facilities, and increase measles–rubella immunization coverage to enhance measles surveillance effectiveness and interrupt transmission in Pekanbaru City.

Keywords: CBMS; Fishbone Analysis; Immunization; Outbreak Measles; Plan of Action.

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Introduction

Measles is a highly contagious acute infectious disease that can cause severe complications and death, particularly due to diarrhea, pneumonia, and encephalitis.[1] Indonesia is among the ten countries with the highest number of measles cases worldwide. In recent years, the incidence of measles outbreaks (*Kejadian Luar Biasa/KLB*) has continued to increase, alongside measles–rubella (MR) immunization coverage for both the first and second doses that has not yet reached the 95% target required to achieve herd immunity.[2] This situation was further exacerbated by the COVID-19 pandemic, which disrupted routine immunization services and measles–rubella surveillance activities.[3]

Riau Province, particularly Pekanbaru City, experienced notable fluctuations and increases in suspected and confirmed measles cases during the 2022–2025 period.[4] As a center of economic growth with high urbanization and population mobility, Pekanbaru City faces an increased risk of measles transmission. Surveillance data indicate 1,336 suspected cases with 210 confirmed cases in 2022; 142 suspected and 6 confirmed cases in 2023; 73 suspected cases with no confirmed cases in 2024; and 650 suspected cases with 88 confirmed cases from January to October 2025. Meanwhile, MR immunization coverage during 2022–October 2025 remained below the target, at 87,3%, 62,0%, 78,0%, and 49,2%, respectively[5]. Although the discarded rate indicator met the national standard, the increase in confirmed cases in 2025 suggests ongoing transmission potential in the community.

Epidemiological surveillance is defined as the systematic and continuous collection, analysis, and interpretation of health-related data to monitor disease trends and guide public health action.[6] Effective measles surveillance is essential for early outbreak detection, trend monitoring, and evidence-based decision-making in measles prevention and control efforts.[7] However, the implementation of measles surveillance in Pekanbaru City faces several challenges, including limited surveillance personnel, reporting delays, and suboptimal utilization of surveillance data for program management. These constraints may delay outbreak detection and response.

Therefore, an in-depth assessment of the application of epidemiological surveillance principles and methods in measles surveillance in Pekanbaru City during 2022–2025 is necessary to strengthen the surveillance system and support sustainable measles control efforts. This study aims to identify key problems in measles surveillance implementation, determine problem priorities, and formulate alternative solutions using fishbone analysis and a Plan of Action (POA). Fishbone analysis was applied to identify key problems and their underlying causes, categorized into human resources, funding, methods, infrastructure, and environmental factors.

Methods

This study employed an exploratory qualitative design and was conducted from 13 to 30 October 2025 at the Pekanbaru City Health Office. Informants were purposively selected based on relevance and adequacy and included key informants. There were 4 informants consisting of 2 main informants: a Vaccine-Preventable Disease (VPD) surveillance officers, an Early Warning and Response System (EWRS) officers and 2 supporting informants: an epidemiologist, and an immunization program manager.

Data were collected through in-depth interviews, direct observations, and document reviews. Data credibility was ensured through triangulation of sources, methods, and data. Qualitative analysis was performed by comparing and synthesizing findings from interviews, observations, and documents to obtain a comprehensive understanding of measles surveillance implementation. Data is entered into a matrix and coded according to theme, then analyzed based on theme and conclusions are drawn.

Fishbone analysis was applied to identify key problems and their underlying causes, categorized into human resources, funding, methods, infrastructure, and environmental factors.[8] Based on the identified problems, a Plan of Action (POA) was systematically developed to formulate feasible and targeted

recommendations for improving measles surveillance.

Results

Pekanbaru City, the capital of Riau Province, covers an area of 632.26 km² and had an estimated population of 1,036,563 in 2025, distributed across 15 sub-districts and 83 urban villages. The three most populous sub-districts are Tuah Madani (147,441 residents), Marpoyan Damai (134,503 residents), and Tenayan Raya (107,064 residents). Health services are supported by 21 primary health centers, 34 auxiliary health centers, and 31 hospitals. Vaccine-preventable disease (VPD) surveillance is managed by the Disease Prevention and Control Division of the Pekanbaru City Health Office.

Situation analysis indicates that measles–rubella (MR) immunization coverage in Pekanbaru City has remained below the national target and declined following the COVID-19 pandemic. As of October 2025, MR1, MR2, and MR3 coverage levels were 49,2%, 14,6%, and 27,4%, respectively. This decline was accompanied by an increase in measles cases, with 650 suspected cases, 88 laboratory-confirmed cases, and one reported death.

Measles surveillance in Pekanbaru City (2022-2024) met the national discarded rate indicator; however, the implementation of Case-Based Measles Surveillance (CBMS) remained suboptimal (Table 1).

Table 1. Measles Surveillance Indicators in Pekanbaru City, 2022–2025

Indicator	2022	2023	2024
Suspected cases reported (n)	1,336	142	73
Incidence rate (per 100,000 pop)	119	13	6
Specimens collected (n)	210	52	48
Specimen collection rate (%)	15,7%	36,6%	65,7%

Continued Table 1. Measles Surveillance Indicators in Pekanbaru City, 2022–2025

Indicator	2022	2023	2024
Confirmed cases (n)	145	6	0
Discarded rate (per 100,000 pop)	5,8	6,0	4,2

In 2025 (January–October), specimens were collected from 312 of 650 suspected cases (48,0%).

Key challenges identified included limited surveillance personnel, multiple responsibilities assigned to surveillance officers, insufficient budget allocation for epidemiological investigations, and incomplete recording of MR01 forms.

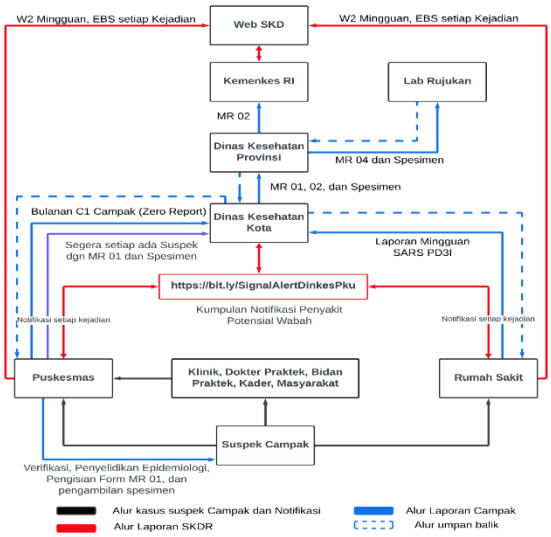

Figure 1. Measles surveillance pipeline in Pekanbaru city

Figure 1 illustrates the measles surveillance process in Pekanbaru City. Suspected measles cases presenting at health centers and hospitals are recorded using the MR-01 form and reported to the City Health Office. The data are then compiled into the MR-02 form and routinely reported through the Early Warning and Response System (EWRS) and the Vaccine-Preventable Disease (VPD) surveillance system. Each suspected measles case undergoes epidemiological investigation within 48 hours, and serum specimens are collected for laboratory confirmation. Feedback on laboratory results is subsequently reported to the Health Office, with an average turnaround time of 2–4 weeks.

Monitoring and evaluation of the VPD surveillance program at the City Health Office are essential to ensure the effectiveness, efficiency, and sustainability of program implementation. Through systematic monitoring and evaluation, program progress can be assessed, constraints identified, and strategies optimized to support measles elimination targets at both national and global levels. Supervision of health centers focuses on ensuring compliance with national surveillance standards, improving the accuracy of case investigation and reporting, and strengthening epidemiological investigation capacity. This process enables timely case detection, appropriate case management, isolation of patients, and quarantine of close contacts to prevent further transmission. In addition, surveillance officers are expected to collect, process, analyze, and interpret data and communicate findings to relevant stakeholders to inform disease prevention and control measures. The epidemiological situation of measles in Pekanbaru City is described below.

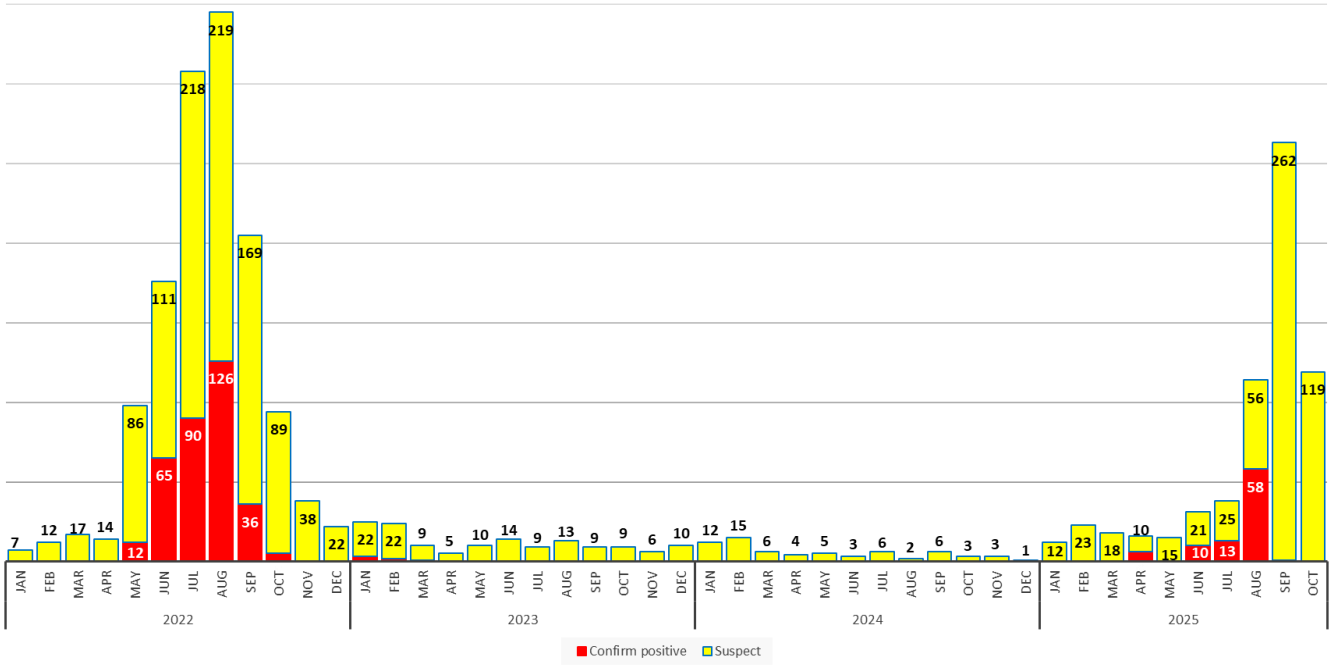

Figure 2. Measles epidemic curve in Pekanbaru city, 2022–October 2025

Figure 2 shows the epidemic curve of measles in Pekanbaru City, with suspected cases shown in blue and laboratory-confirmed cases in red. In 2022, a sharp increase in cases began in May, peaking in August, followed by a gradual decline toward the end of the year, indicating intensified measles transmission during mid-2022. In contrast, measles incidence in 2023 and 2024 remained relatively low and stable, with no notable peaks, suggesting improved epidemiological control during these periods.

Figure 3 illustrates a similar trend pattern, with cases increasing from June and peaking in September. This pattern suggests seasonality, likely associated with increased contact among at-risk groups, particularly children, during school holidays and the start of the academic year.

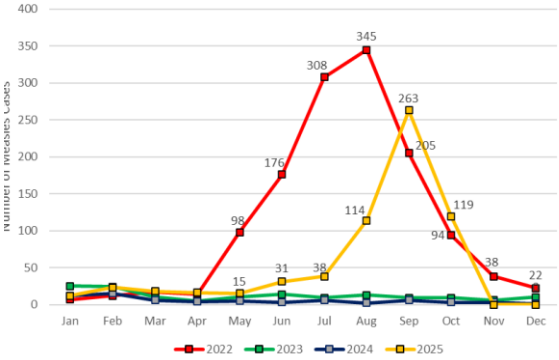

Figure 3. Monthly trends in measles cases in Pekanbaru city, January 2022–October 2025

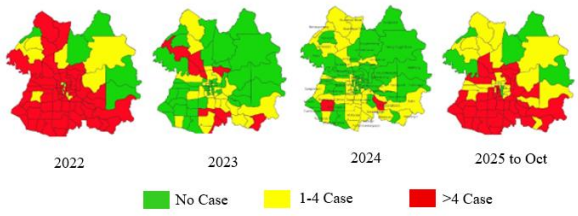

Figure 4. Spatial distribution of measles cases by village in Pekanbaru city, 2022–October 2025

Figure 4 illustrates changes in the spatial distribution of measles cases in Pekanbaru City from 2022 to 2025, in relation to population density. In 2022, most areas were classified as high-incidence (>4 cases; red), indicating widespread and non-localized measles transmission. In 2023, a marked decline was observed, characterized by an increase in areas with no cases or low incidence (1–4 cases; yellow), although several high-incidence clusters persisted. By 2024, the majority of areas reported zero cases (green), suggesting a relatively stable and controlled epidemiological situation. However, from January to October 2025, an increase in high-incidence areas re-emerged, concentrated in several locations and accompanied by an expansion of low-incidence areas.

The surveillance system assessment indicated that data relevance and quality were rated as adequate, while data validity and reliability were considered relatively good[9]. Three of the eight assessment indicators met the "adequate" category, as presented in Table 2.

Table 2. Assessment results of the measles surveillance system in Pekanbaru city, 2023–2025

No.	Surveillance system evaluation	Assessment results	Rating categories	Score
1	Purpose of the surveillance system	From the results of interviews with program holders, 3 out of 6 general objectives were known, namely knowing the epidemiological picture, early warning, risk factors and monitoring the risk of disease. Therefore, the result is $\frac{4}{6}$ x 100% = 66,7%.	Enough	2
2	Data processing and analysis	From the results of data processing and analysis, 3 objectives can be achieved out of the 4 set surveillance objectives. Therefore, the results is $\frac{3}{4}$ x 100% = 75%.	Enough	2
3	Accuracy of diagnosis	From the results of interviews with program holders, it was said that every case of suspected measles was with symptoms of fever and maculopapular rash.	Good	3
4	Data completeness	There is 21 Health Centers, with 28 hospitals in the city of Pekanbaru. From the results of interviews with officers, it is known that every measles report is obtained from the Health Center and Hospital every week. For 52 weeks in 2023, 52 weeks in 2024 and 41 weeks in 2025. All reports are complete, meaning 145 weeks/145 full reports x 100 = 100%.	Good	3
5	Data accuracy	From the results of interviews with the person in charge of the program, it is known that measles reports are sent to the Health Office at the beginning of the following week (every Monday and Tuesday), so that all reports are on time (100%).	Good	3

6	Participation of health facilities	From the results of the interview, it was known that measles reports came from 21 health centers and 28 hospitals throughout the Pekanbaru city.	Good	3
7	Access to health services	Measles cases are treated at health centers, independent clinics/practices, and hospitals. However, there were cases of measles that did not go to health facilities for treatment, they only bought medicine independently at pharmacies. This means that not all measles cases are reported.	Enough	2
8	Data consistency	Judging from the MR-02 (List of Measles Cases) report at the Health Office. The data is consistent with the data of the complete filled table.	Good	3

Notes: Good = 80% > assessment result; Enough = 60-80% assessment result; Less = harvest result <60%

To determine priority problems among the identified issues in the Vaccine-Preventable Disease (VPD) surveillance system at the Pekanbaru City Health Office, each problem was systematically weighted. Problem prioritization was conducted using the USG (Urgency/U, Seriousness/S, and Growth/G) method (Table 3). Urgency reflects the immediacy of the problem and the need for timely resolution. Seriousness refers to the severity of the problem, assessed based on its impact on program performance, achievement of surveillance objectives, and potential risk to the health system. Growth indicates the likelihood that the problem will escalate or become more difficult to control if not addressed promptly. Each criterion was scored on a five-point scale: 1 = very small, 2 = small, 3 = moderate, 4 = large, and 5 = very large (Table 3).

Before formulating alternative solutions, a fishbone analysis was conducted to identify the underlying causes of the priority problem. Each branch of the fishbone represents a contributing factor. The results of the fishbone analysis are presented in Figure 5.

Figure 5 shows the underlying causes of priority problems in measles surveillance using a fishbone diagram. Contributing factors were categorized as follows: Man (poorly trained officers, insufficient surveillance personnel, and dual duties); Method (lack of continuous supervision and suboptimal recording and reporting); Money (inadequate budget); Machine (long specimen processing times and limited equipment); and Environment (high measles transmission). Based on this fishbone analysis, alternative solutions were formulated and are presented in Table 3.

Table 3. Priority matrix for measles surveillance problems in Pekanbaru city, 2025

Problem	U	S	G	Quantity	Rating
Discarded rate campak-rubela ≥2/100.000	3	3	4	10	III
CBMS 48% of the target 100%	5	5	4	14	I
Surveillance data processing and analysis 75%	4	4	4	12	II
Assessment of surveillance systems: data relevance is sufficient, and data quality is sufficient	3	3	3	9	IV

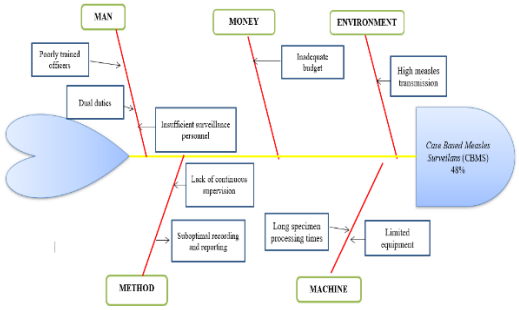

Figure 5. Fishbone analysis of measles surveillance problems

Table 4. Alternative solutions for measles surveillance problems

No.	Problem	Alternative Troubleshooting
1	Man	
	a. Lack of surveillance personnel and dual tasks b. Poorly trained officers	a. Provide recommendations and proposals to the Pekanbaru City Health Office to add epidemiological surveillance in the Health Quarantine Surveillance Team and Immunization Management b. Providing proposals for periodic refreshing/capacity building for the implementation of CBMS
2	Money	
	a. Lack of budget for VPD Surveillance including epidemiological investigation activities	a. Making recommendations so that the budget for the implementation of CBMS is included in the BOK Puskesmas b. Integration of CBMS activities with other activities such as posyandu, immunization sweeping, and other community outreach activities.
3	Method	
	a. Still lack of continuous supervision by the Health Office b. Lack of optimal recording and reporting of measles cases	a. Make proposals for Monitoring, Recording and Reporting activities to Puskesmas and Hospitals b. Make proposals for periodic monitoring and evaluation activities per 3 months offline or online if budget constraints
4	Machine	
	a. Limitations of specimen retrieval tools and consumables b. The result of the old labor came out	a. The Pekanbaru City Health Office proposed the need for tools and consumables to the Riau Provincial Health Office, proposed the procurement of BHP at the BOK Puskesmas, integration with other programs b. Encouraging the Pekanbaru City Health Lab to be able to conduct measles labor inspections
5	Environment	
	a. High measles transmission	a. Increasing routine MR immunization covarege and encouraging the implementation of additional MR immunization b. Start implementing community-based surveillance and integration of CBMS with promotive-preventive activities so that the public is more aware and quickly reports disease cases

Table 5. Plan of action (POA) matrix for measles surveillance

No.	Activities	Purpose	Targets	Time	Budgeting	Location	Implementer	Method	Performance Indicators
1.	**MAN**								
	Regular refreshing/capacity building for the implementation of CBMS	So that all officers know the implementation of CBMS	Puskesmas and Hospital Surveillance Officers	1 Year	APBD/ APBN	The Pekanbaru City Health Office	Head of P2P Division	Capacity building	Increasing the ability of Puskesmas and Hospital Surveillance officers
2.	**MONEY**								
	The budget for the implementation of CBMS is included in the BOK Puskesmas	To make the budget for CBMS activities available	Kepala Dinas Kesehatan Provinsi Riau	1 Year	0	The Pekanbaru City Health Office	Head of Health Office	Advocacy	Budget available
3.	**METHODE**								
	Make proposals for Monitoring, Recording and Reporting activities to Puskesmas and Hospitals	For recording and reporting to be valid	Puskesmas and Hospital Surveillance Officers	1 Year	APBD/ APBN	Health Centers and Hospitals	Measles Surveillance and EWR Surveillance Program Holders	Technical supervision and guidance	Complete and valid recording and reporting
4.	**MACHINE**								
	propose the need for tools and BHP to the Riau Provincial Health Office, proposed procurement of BHP in BOK Puskesmas, integration with other programs	For the fulfillment of CBMS tools and	Provincial Health Office, Head of Health Center	1 Year	0	Provincial Health Office, Head of Health Center	Head of P2P Division	Discussion, Q&A	Tools and Consumables available

5.	**Environment**							
	Increasing routine MR immunization coverage and encouraging the implementation of additional MR immunizations	The formation of herd immunity	Head of the Pekanbaru City Health Office	1 Year	0	Pekanbaru City Health Office	Head of P2P and Head of Health Quarantine Surveillance and Immunization Management	Discussion	Focus on increasing MR immunization achievement to break the chain of measles virus transmission

Table 4 presents alternative solutions for measles surveillance improvement, which include strengthening the capacity and number of officers, optimizing budgets and integrating activities, enhancing supervision and recording/reporting systems, improving laboratory facilities, and increasing immunization coverage and community-based surveillance implementation.

The development of a Plan of Action (POA) is conducted to address public health problems in a specific area. Activity planning follows a structured process: analyzing the situation, prioritizing problems, formulating the problem, and identifying underlying causes, often using a fishbone analysis. Based on this process, a detailed POA or Activity Proposal Plan or Rencana Usulan Kerja (RUK) is presented in Table 4.

Table 5 presents the intervention plan, developed based on situational analysis and problem prioritization using fishbone analysis, with a primary focus on strengthening Case-Based Measles Surveillance (CBMS). The interventions target five key areas: human resources, funding, methods, infrastructure, and the environment.

Discussion

This study evaluated the implementation of Case-Based Measles Surveillance (CBMS) in Pekanbaru City from 2022 to 2025, identifying critical gaps across multiple system components. The findings reveal that despite policy mandates, surveillance performance has been compromised by human resource constraints, funding limitations, weak supervision, logistical barriers, and declining immunization coverage. Each of these findings carries specific implications for measles control and elimination

The finding that CBMS activities relied entirely on Non-Physical Special Allocation Funds, with no dedicated budget for epidemiological investigations, consumables procurement, or monitoring and evaluation, reveals a critical vulnerability. This funding pattern suggests that surveillance is financed at minimum levels sufficient for specimen transport but not for the comprehensive activities that ensure data quality and system responsiveness.[13]

This finding directly contradicts Article 17b of Minister of Health Regulation No. 45 of 2014, which mandates adequate budget and infrastructure for surveillance success. The gap between policy and practice observed in Pekanbaru reflects broader challenges in decentralized health systems, where local budget priorities may not align with national program requirements (World Health Organization, 2018). Evidence from Health Policy and Planning confirms that dedicated funding for routine surveillance activities—including case investigation, supervision, and training—is critical for program success

The practical implication for Pekanbaru is clear: advocacy efforts must reframe surveillance financing from a cost to an investment. When epidemiological investigations are unfunded, cases are incompletely investigated; when monitoring and evaluation are unbudgeted, system weaknesses persist uncorrected. Integrating CBMS financing into health operational expenditures at the municipal level would provide predictable, sustainable funding and enable comprehensive program implementation.

The finding of suboptimal continuous supervision, resulting in incomplete MR01 forms and delayed data verification, identifies a critical process failure. Incomplete forms at the point of data collection create downstream consequences: delayed analysis, inaccurate epidemiological assessments, and ultimately, delayed response. This finding is consistent with Hayu (2019), who documented that absence of regular data audits contributes to inconsistent surveillance reports and increased workload at service levels.[14]

The supervision gap in Pekanbaru likely reflects both the human resource constraints previously identified—supervisors themselves are overburdened—and the absence of structured quality assurance mechanisms. Permenkes No. 45 of 2014 explicitly requires monitoring to ensure activities progress according to planned objectives, yet the finding suggests that monitoring is not occurring at the frequency or intensity

required. This has implications for system design: strengthening supervision requires not merely exhortation but institutionalized mechanisms, including regular supervisory visits, structured feedback loops, and performance dashboards that allow rapid identification of reporting gaps.

The finding that limited specimen collection consumables and dependence on the national laboratory in Jakarta cause diagnostic delays identifies a structural bottleneck with direct consequences for outbreak control[10]. When specimen collection is hampered by stock-outs of serum cups, syringes, or wing needles, cases go unconfirmed; when results are delayed by geographic distance and laboratory workload, response measures are delayed.[15]

This finding is particularly concerning given the established importance of timely laboratory confirmation for accurate case classification, contact tracing, and decision-making.[16] The distance from Pekanbaru to Jakarta—approximately 1,000 kilometers—introduces unavoidable transport delays, and the national laboratory's role serving multiple provinces creates competition for testing capacity. For Pekanbaru, this suggests that during outbreak conditions, public health decisions may need to proceed based on epidemiological linkage and clinical criteria while awaiting laboratory confirmation, rather than waiting for definitive laboratory results before initiating response.

The finding that declining MR immunization coverage from 2022 to 2025 coincided with increased measles cases, including 88 laboratory-confirmed cases in 2025, empirically demonstrates the interdependence of surveillance and immunization. Measles' high basic reproduction number (R_0 = 12–18) means that even small declines in population immunity can precipitate outbreaks.[17,18]

This finding carries profound implications for Pekanbaru. The 2025 outbreak does not represent surveillance failure alone but immunity failure. Surveillance detected the outbreak—indeed, it detected 88 confirmed cases—but could not prevent it. Only high population immunity can prevent transmission, and the ≥95% coverage required for herd immunity leaves no margin for error. The decline in coverage observed in Pekanbaru suggests that routine immunization services may have been disrupted or that population immunity has eroded, creating conditions favorable for sustained transmission.

The role of Outbreak Response Immunization (ORI) as identified in the literature, becomes critical in this context. However, ORI is reactive, not preventive. The Pekanbaru experience underscores that maintaining high routine immunization coverage is the primary strategy; ORI addresses coverage gaps after outbreaks have already begun.[19]

Taken together, these findings confirm that surveillance and immunization are complementary functions requiring integrated strengthening.[10,20] Surveillance identifies risks and detects outbreaks; immunization eliminates sources of transmission. Weakness in either domain undermines the other. In Pekanbaru, resource constraints across human resources, funding, supervision, and laboratory capacity have compromised surveillance sensitivity, while declining immunization coverage has created population susceptibility. The 2025 outbreak was the predictable result.

The practical implication is that vertical interventions focused solely on surveillance procedures will fail. Strengthening CBMS in Pekanbaru requires simultaneous investment in surveillance infrastructure and immunization programs. Capacity-building must include continuous training and adequate staffing ratios. Budget advocacy must integrate surveillance costs into routine health expenditures. Supervision must be institutionalized with regular data audits. Laboratory capacity must be enhanced, potentially through exploring options for regional testing to reduce reliance on Jakarta. And critically, MR immunization coverage must be restored and maintained at ≥95%.[21,22]

Without these integrated interventions, Pekanbaru will remain vulnerable to recurrent measles outbreaks, and the goal of measles elimination will remain unattainable.

Conclusions

The implementation of Case-Based Measles Surveillance (CBMS) in Pekanbaru City (2022–2025) faced significant challenges, including limited resources, weak supervision, reporting delays, and declining immunization coverage, leading to continued outbreaks. Strengthening CBMS requires integrated interventions in human resources, funding, infrastructure, and methods. Crucially, improving surveillance sensitivity and laboratory capacity must go hand-in-hand with increasing MR immunization coverage. As surveillance detects risks and immunization prevents transmission, systematically addressing these gaps is essential to reduce measles transmission and achieve elimination in Pekanbaru City.

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