Mumps Spread in School Cluster: Risk Factors Behind the Surge of Mumps Cases at Elementary School 4 Magelang

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Abstract

Mumps is a viral infectious disease that primarily affects children and spreads easily among susceptible individuals and can be prevented through MMR vaccination, although it is not yet included in Indonesia's national immunization program. Magelang City Health Office received a report of an increase in mumps cases on November 4, 2024, through the Early Warning and Response System (SKDR). Mumps transmission occurred within the Elementary School 4 Magelang cluster. An outbreak investigation was important to determine the magnitude of the problem and the factors that contributed to the occurrence of mumps. The research design employed a 1:4 case-control study involving all 12 identified mumps cases and 48 controls from a total population of 114. Cases were defined as students experiencing clinical symptoms of mumps, specifically posterior jaw pain and/or parotid gland swelling, or who were diagnosed by medical personnel. Data collection was conducted using interviews with the students and parents, observations, and case report data. The data were analyzed using bivariate analysis with the chi-square test. Twelve cases were reported in total, beginning with the first case on September 25, 2024, and peaking between November 5–11. The highest attack rate was observed among male students (14.06%), students aged 6–7 years (19.23%), and first-grade students (20%). The most common symptom was posterior jaw pain (100%), and the most common risk factors were a history of contact with patients (66.7%) and a history of travel (33.3%). Bivariate analysis revealed that sharing eating and drinking utensils (p-value 0.006) and travel history (OR = 11.5; 95% CI: 1.79–73.58) were significantly associated with mumps occurrence. However, other factors such as MMR vaccination status, history of contact with patients, and current illness status were not statistically significant. Schools should collaborate with healthcare facilities to strengthen infectious disease surveillance and prevent further cases.

Keywords: Mumps, Disease Outbreak, School Health Service, Travel History, Outbreak Investigation, Case-control Studies.

INTRODUCTION

Mumps is endemic worldwide, with outbreaks occurring about every 5 years in unvaccinated areas (Rausc Phung et al., 2024). Mumps is not a notifiable disease to health authorities, making it difficult to estimate global incidence, although it occurs worldwide. The burden of mumps is estimated at 100–1000 cases per 100,000 population, with epidemic peaks occurring every 2–5 years in countries that have not implemented routine mumps vaccination (Twanabasu et al., 2024). In Indonesia, mumps cases increased in 2024, with more than 6,593

suspected cases reported as of November (BB Labkesmas Makassar, 2024). A similar increase was observed in Magelang, where 92 suspected mumps cases were reported between August 1 and November 9, 2024 (Magelang City Health Office, 2024). Mumps (epidemic parotitis) is an infectious disease caused by infection with the *Rubulavirus* of the *Paramyxovirus* family (Tibu et al., 2024). The average incubation period is 16-18 days (Tibu et al., 2024). However, this virus can infect even 2-5 days before symptoms appear and 5 days after symptoms appear (Diversity et al., 2020). The mumps virus spreads through droplets of saliva or mucus released when the sufferer coughs, sneezes, or talks. Direct transmission occurs through touching the face or hands contaminated with the virus. Indirect transmission occurs through contaminated objects, such as shared cutlery or bathing equipment used by the sufferer (Directorate General of Health Services, Ministry of Health 2024; Stefany Palyama et al., 2025). This condition increases students' susceptibility to mumps transmission when cases emerge at school, as various group activities involve close contact, such as sports, playing, using shared transportation, and eating together (Wei Qin et al., 2019).

Symptoms of mumps generally include fever, headache, pain when chewing or swallowing, dry mouth, sore throat, pain and/or swelling at the back of the jaw, and loss of appetite (Bhat et al., 2023). Mumps can cause complications, including mild meningitis, encephalitis, deafness, myocarditis, thyroiditis, pancreatitis, and orchitis in adult males (Wu et al., 2021). Severe complications can also affect the liver, kidneys, and reproductive organs (CDC, 2025; Teferi et al., 2025; Jemail et al., 2020). Diagnosis of mumps is based on clinical symptoms because there is no specific laboratory test, especially when cases increase and a rapid response is needed (Brauer et al., 2016).

Mumps can be prevented with immunization, with two doses of the MMR (measles, mumps, and rubella) vaccine administered at 12 months and 4–6 years of age (Ministry of Health., 2021; Melgar et al. 2025). However, in Indonesia, MMR vaccination is not yet included in the national immunization program and must therefore be accessed independently (Ministry of Health, 2017). However, transmission in schools can still occur among MMR-vaccinated students when MMR vaccination coverage is insufficient to achieve herd immunity (Wei Qin et al., 2019). Therefore, mumps sufferers are advised to isolate themselves at home for five days to prevent transmission (Tibu, 2024).

Based on the epidemiological triangle, the agent (*Rubulavirus*) can be transmitted through exposure facilitated by risky behaviors and environmental conditions. Host factors that increase mumps risk include not receiving the MMR vaccine, being a child aged 2–12 years, reduced immunity due to underlying illnesses, and a history of travel to endemic areas. Environmental

factors that facilitate transmission include activities in crowded settings, contact with infected individuals, and sharing eating and drinking utensils with cases (Huang et al., 2009; Liu et al., 2025; Suparman et al., 2024; Melgar et al. 2025).

On November 4, 2024, the Surveillance and Immunization Section of the Magelang City Health Office received a report from the Early Warning and Response System (SKDR) at the Central Magelang Health Center about an increase in mumps cases at Elementary School 4 Magelang. Initially, the mumps case was found in one student on September 25, 2024, and increased to 12 cases by November 2024. Meanwhile, no mumps cases had occurred at Elementary School 4 Magelang for the past few years. The subsequent increase in cases therefore met the outbreak criteria stipulated in Ministry of Health Regulation No. 1501 of 2010. Therefore, this epidemiological investigation was important to determine the magnitude of the problem, calculate the attack rate (by person, place, and time), and identify the behavioral and risk factors contributing to mumps.

METHOD

Data were collected at Elementary School 4 Magelang on November 11–12, 2024, using a retrospective 1:4 case-control study design to assess the association between selected exposures and disease occurrence (Tenny Steven, Kerndt C. C, 2023). As only 12 mumps cases were identified, all cases were included, and 48 controls were selected to increase the statistical power of the analysis (60 samples) (Iwagami Masao & Shinozaki T, 2022). Data were collected using questionnaires validated by experts through interviews with students and their parents, as well as observations and case reports. Data were statistically analyzed using the chi-square test to estimate odds ratios (OR). The variables investigated included MMR vaccination history, history of contact with sufferers, concurrent illness status, travel history, and history of sharing eating and drinking utensils with cases. The case definition is students who experienced typical mumps clinical symptoms, namely back, jaw pain, and/or parotid gland swelling on one side or both sides, and/or were diagnosed with mumps by a doctor from August to November 12, 2024. Controls are students who are healthy and do not show symptoms of mumps and/or are not diagnosed with mumps by a doctor from August to November 12, 2024, and controls were selected by exact matching, whereby each case was matched with four controls who had the same gender, age, and class as the selected case. This study received data collection approval from the Magelang City Health Office (certificate number 800.1.11.1/31692/220), Elementary School 4 Magelang, and the students' parents.

RESULTS

Chronological Events

The following presents the chronological events of the mumps investigation and the response:

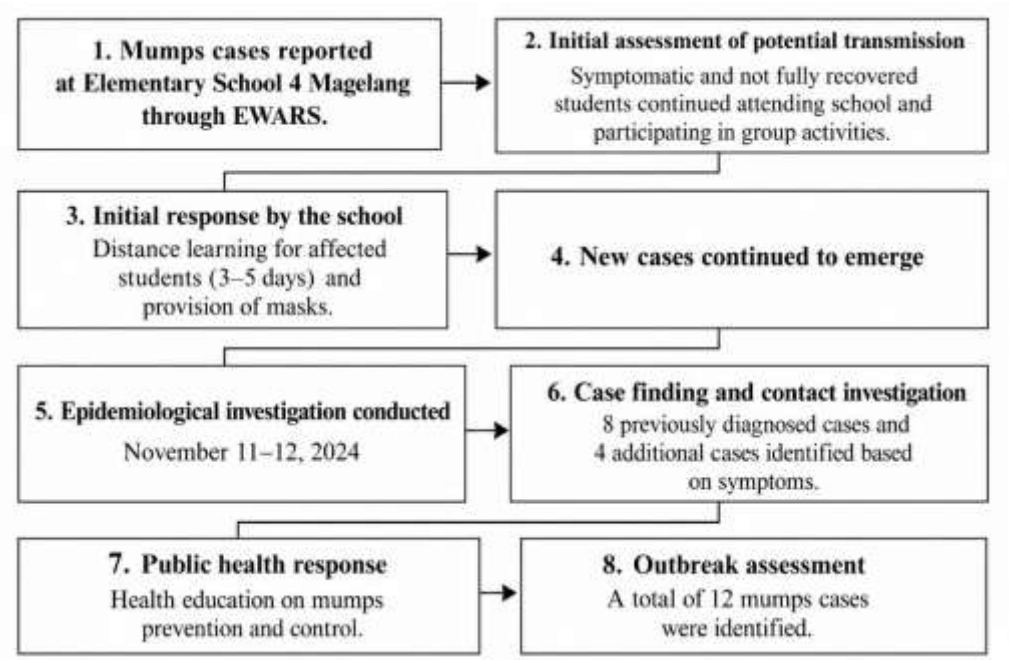

Figure 1. Outbreak Response Flowchart

Observation Results

Observations made during the epidemiological investigation identified several factors that facilitated mumps transmission. The school allowed students with mumps to study from home for approximately 3-5 days. However, several sufferers who still showed symptoms returned to school and continued their activities as usual without wearing masks. Meanwhile, a five-day self-isolation period is recommended after the onset of symptoms, and symptomatic students returning to school before completing the isolation period may increase opportunities for person-to-person transmission, particularly during close-contact activities in the classroom (CDC, 2024). In addition, students often share food and drinks with friends during school breaks. The school observed crowded activities, such as group assignments and playing ball. Neither the school nor the students knew how the mumps virus was transmitted. Mumps is considered a mild and harmless illness, but the school became suspicious because cases did not stop from the first case on September 25 to November 11, 2024. The long incubation period often leaves sufferers unaware that they have been infected. Unconsciously, activities sufferers engage in before symptoms appear can spread the virus to those around them (Tibu et al., 2024).

Univariate Analysis

Establishing a Diagnosis

Mumps diagnosis is based on clinical symptoms because laboratory tests are not specific, especially during periods of increased cases that require a rapid response. Through epidemiological investigations, examinations, and data collection on symptoms and risk factors, all students of Elementary School 4 Magelang were included. Based on the epidemiological investigation results, the most common clinical symptom was posterior jaw pain, experienced by all 12 patients (100%). A Description of the symptoms experienced by mumps sufferers was obtained, including:

Table 1. Distribution of symptoms in mumps cases

Clinical Symptoms of Mumps	Frequency	%
Back Jaw Pain	12	100
Fever	10	83.3
Sore throat	9	75
Parotid Gland Swelling	8	66.7
Weak	5	41.7
Decreased Appetite	5	41.7
Headache	4	33.3

Distribution of Cases by Person and Place

Of the total population of 114 students, 12 students developed mumps. The following presents the attack rates by person and place:

Table 2. Characteristics based on person and place

Characteristics based on person			
Gender	**Case (n=12)**	**Population (N=114)**	**AR (%)**
Male	9	64	14.06
Female	3	50	6
Age			
6 – 7 years	5	26	19.23
8 – 9 years	4	31	12.90
10 - 11 years	2	39	5.13
≥ 12 years	1	18	0.56
Characteristics based on place			
Classroom	**Case (n=12)**	**Population (N=114)**	**AR (%)**
1	5	25	20
2	2	14	14.29
3	1	18	5.56
4	2	14	14.29
6	2	19	10.52

Based on gender, mumps cases are more common in male students, with an attack rate (AR) of 14.06% compared to female students with an AR of 6%. Male students tend to be more involved in group physical activities that involve close contact, such as sports, playing, or sharing food, drinks, or eating and drinking utensils. Female students are often considered to have better compliance with clean and healthy behaviors, are less likely to share eating and

drinking utensils, and generally have less frequent close physical contact than male students (Tian et al., 2024). Moreover, when girls and boys receive the MMR vaccine, girls tend to have a better antibody response because they have much higher titers of neutralizing antibodies to neutralize the virus in their bodies (Kleina et al., 2014; Riggenbach et al., 2022).

According to age group, mumps is most often suffered by students in the youngest age category, namely 6-7 years with AR of 19.23%, followed by those aged 8-9 years (AR 12.90%). This shows that the younger the student, the more likely to get mumps. The mumps virus easily infects people who have weak immune systems. Children have thinner skin and breathe faster than adults, so they are more likely to inhale substances, including harmful microorganisms, through their skin. In addition, children use energy faster than adults and need food and drink more often. This causes children to absorb harmful substances or microorganisms more quickly. So, children do not yet have a developed immune system to fight infection. Most cases of mumps occur among students aged 6-7, the youngest age group among all students. The older the student, the stronger their immune system and the less susceptible they are to disease (CDC, 2022; Yang et al., 2022).

Mumps has spread to almost all classrooms, except in grade 5. The distribution of cases by classroom shows that class 1 had the highest number of cases (5 cases) and the highest AR (20%), with the highest classroom density (largest population) compared with the other classes. Followed by classes 2 and 4, each with 2 cases and an AR of 14.29%.

Distribution of Cases by Time

The epidemiological curve shows that mumps cases occurred over an eight-week period, with the first identified case having an illness onset on September 25, 2024. The number of cases subsequently increased and reached a single major peak of four cases during November 5–11, followed by a decline to one case during November 12–18. Considering the average incubation period of approximately 18 days, the exposure contributing to the peak may have occurred in October 1–7, 2024. The occurrence of a single prominent peak, with cases clustering around the peak period, suggests a possible point-source transmission pattern, indicating that several cases may have been exposed within a relatively short period. However, the occurrence of cases over several weeks and across multiple grade levels also suggests that ongoing person-to-person transmission within the school environment cannot be excluded. The attendance of students who were still symptomatic or had not fully recovered, along with continued group interactions, may have provided opportunities for further transmission (Sridhar et al., 2021)

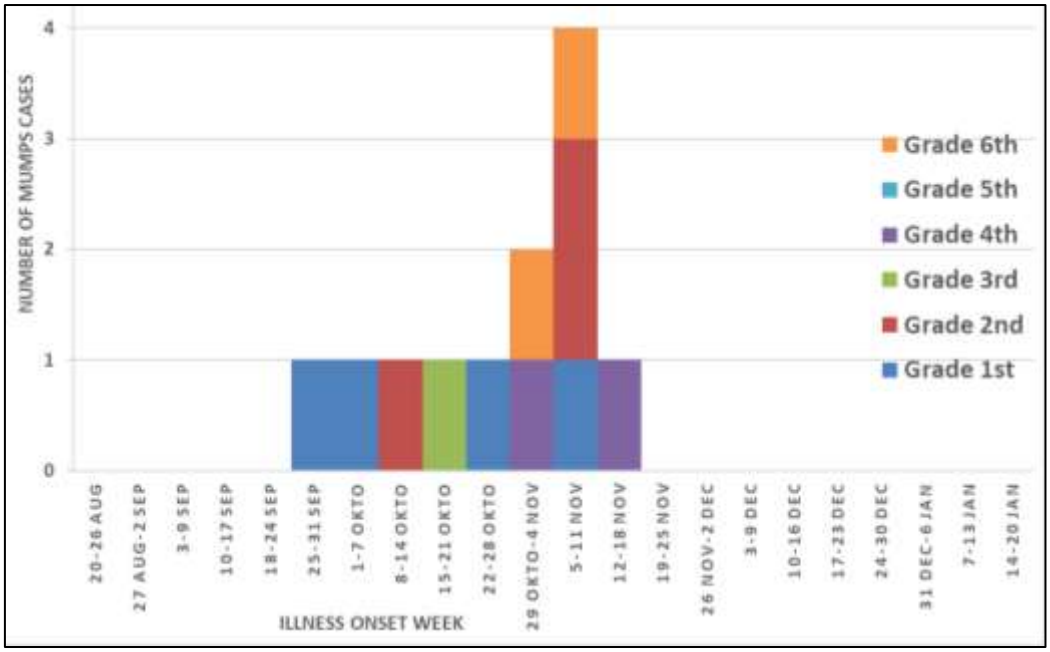

Figure 2. Epidemiology Curve of Mumps Incidence

Distribution of Risk Factors

Table 3. Distribution of Mumps Risk Factors among Students

Risk Factors	Frequency (n=60)	%	Cases (n=12)	%
Host				
Not receiving the MMR vaccination	57	95.0	12	100.0
Travel history	6	10.0	4	33.33
Currently experiencing illness	6	10.0	2	16.67
Environment				
History of contact with sufferers	37	61.67	8	66.67
Sharing eating and drinking utensils with sufferers	3	5.0	3	25.0

According to host factors, 57 students (95.0%) had never received the MMR vaccine, and all cases (100.0%) were unvaccinated. Regarding travel history, six students (10.0%) had a history of travel, and four of them (33.33%) belonged to the case group. In addition, six students (10.0%) had illnesses other than mumps, of whom two students (16.67%) were in the case group. Based on environmental factors, 37 students (61.67%) had a history of contact with mumps cases, of whom eight (66.67%) were in the case group. The presence of cases in close proximity to infected individuals may have facilitated the sharing of eating and drinking utensils; accordingly, three students (5.0%) reported sharing utensils with mumps cases, and three of them (25.0%) were in the case group.

Bivariate Analysis

Bivariate analysis was conducted on a sample of 60 students, consisting of 12 case group students and 48 controls. The following are the results of the bivariate test using the odds ratio method on the observed risk factor variables:

Table 4. Bivariate Test Results

Variable	Mumps Status		OR (95%CI)	*p-value*
	Case (n=12)	Control (n=48)		
Host				
MMR Vaccination Status				
No	12 (100%)	45 (93,75%)	-**	1,000
Yes	0 (0%)	3 (6,25%)		
Travel History				
Yes	4 (33,33%)	2 (4,17%)	11.5 (1.79-73.58)	0.012*
No	8 (66,67%)	46 (95,83%)		
Current Illness Status				
Yes	2 (16,67%)	4 (8,33%)	2.2 (0.35-13.73)	0.590
No	10 (83,33%)	44 (91,67%)		
Environment				
History of Contact with Sufferers				
Yes	8 (66,67%)	29 (60,42%)	1.31 (0.35-4.97)	0.752
No	4 (33,33%)	19 (39,58%)		
Sharing Eating and Drinking Utensils				
Yes	3 (25%)	0 (0%)	- **	0.006*
No	9 (75%)	48 (100%)		

*Note: *p-value* < 0.05 indicates a relationship between risk factors and mumps incidence.
** Note: OR and 95% CI could not be estimated because of a zero cell in the 2×2 table

Travel history was significantly associated with the incidence of mumps, and students with a history of travel had 11.5 times higher odds of developing mumps than those without a travel history (p = 0.012; OR = 11.50; 95% CI: 1.79–73.58). Sharing eating and drinking utensils was also significantly associated with the incidence of mumps (p = 0.006). In contrast, MMR vaccination status (p = 1.000), current illness status (p = 0.590; OR = 2.20; 95% CI: 0.35–13.73), and history of contact with sufferers (p = 0.752; OR = 1.31; 95% CI: 0.35–4.97) were not significantly associated with the incidence of mumps. The odds ratios for MMR vaccination status and sharing eating and drinking utensils could not be calculated because of zero cell counts.

DISCUSSION

MMR (Mumps, Measles, and Rubella) Vaccination Status

The results of the bivariate test on the MMR vaccination status factor obtained a *p-value* of 1,000 (*Fisher's exact test)*, meaning that there is no significant relationship between MMR vaccination status and the incidence of mumps. In the 2x2 table, there is a cell in the table that has a value of 0, so the OR is not defined. The affordability of the MMR vaccine for children is influenced by several factors such as parental concerns, access to health services, and government policies. In Indonesia, the MMR vaccine is not free, but the MR (Measles Rubella) vaccine is the vaccination program in Indonesia (Bureau of Communication and Public Services, Ministry of Health, 2017). The effectiveness of a single dose of the MMR

vaccine is 78%, and two doses can prevent up to 89.4% (Cardemil et al., 2017). A third dose of the MMR vaccine during a mumps outbreak can reduce the attack rate by 61%–88% compared with two doses. However, transmission can still occur in vaccinated populations when herd immunity is insufficient to prevent an outbreak (Wei Qin et al., 2019; Ogbuanu IU et al., 2012). Almost everyone who has never received the MMR vaccine will become ill or experience more severe symptoms when exposed to the virus. However, MMR has not been proven effective at preventing mumps or rubella in people who have been infected. The MMR vaccine can protect children against mumps and help prevent fever, swelling of the parotid glands, pain in the back of the jaw, or severe complications. The first dose of the MMR vaccine is given when the child is 12-23 months old, and the second dose is given at age 4–6 years (Bockelman et al., 2018; Cardemil et al., 2017). The seropositivity rate of a vaccinated person may decrease over time after vaccination, especially in children aged >7 years. However, the absence of cases among students with a history of MMR vaccination suggests a possible protective effect of vaccination against mumps, although this association could not be statistically demonstrated in this study. From a public health perspective, the fact that all cases (100%) had no history of MMR vaccination is an important warning of population susceptibility and the possible lack of herd immunity, which may facilitate transmission when the mumps virus is introduced and circulates within the school environment. (Ngaovithunvong et al., 2016; Zerbo et al., 2020; Wei Qin et al., 2019).

Travel History

Travel history was significantly associated with the incidence of mumps, and students with a history of travel had 11.5 times higher odds of developing mumps than those without a travel history. However, because none of the cases had received the MMR vaccine, the observed association between travel history and mumps may have been subject to confounding, potentially strengthening or weakening the true association. Traveling can increase the risk of health problems, especially in areas endemic to certain diseases (Bockelman et al., 2018). New pathogens encountered during travel are a challenge to the body's immune system, which may not be ready for the new threat (Moncla et al., 2021; Morrone et al., 2020). Travelers must ensure that the destination area is endemic for certain diseases. A study conducted in the United States found that mumps outbreaks can still occur even in areas with high MMR vaccination coverage. The risk of transmitting mumps while traveling can come from food, water, and air, or through social interaction with new people or environments, such as crowded activities, especially when there are infected individuals around or in an ideal environment conducive to spreading the virus (Dr. Soeradji Tirtonegoro General Hospital, 2024; (Melgar, et al. 2025).

Moreover, traveling can cause both physical and psychological effects due to anxiety about travel plans, the length of the trip, and climate changes. This stress can weaken the adaptive immune response, increasing susceptibility to infection (Ali et al., 2025; Alotiby, 2024; Morrone et al., 2020). Furthermore, genomic analyses in the United States identified multiple introductions of the virus from various regions, and once the virus entered an area, outbreaks occurred due to local transmission within the community. (Moncla et al., 2021; Wohl et al., 2020)

Sharing Eating and Drinking Utensils with Sufferers

The results of the bivariate test for the factor of sharing eating and drinking utensils obtained a *p-value* of 0.006 (*Fisher's exact test)*, meaning there is a significant relationship between the factor of sharing eating and drinking utensils and the incidence of mumps. As a result, there are cells with a value of 0, so the OR cannot be defined. One way the mumps virus is transmitted through indirect contact is through eating and drinking utensils used by sufferers. (Bhat et al., 2023; Diversity et al., 2020) Viruses present in saliva can adhere to surfaces when sharing drinking glasses or eating utensils, and subsequently enter the mouth or nose (Franjić, 2024). Furthermore, viruses can survive on inanimate surfaces for several hours to several days, so sharing eating and drinking utensils with sufferers can lead to contamination (Mirambo et al., 2024). The mumps virus can survive longer on plastic and metal surfaces than on porous materials such as fabric and wood (Tiwari et al., 2006; Chatterjee et al., 2022). In addition, cool and humid conditions enhance the stability and persistence of the virus on surfaces compared with hot or dry conditions (Kwon T et al., 2021; Saadat et al., 2023). Maintaining clean and healthy behaviors in school settings, such as regular handwashing before and after meals and routine disinfection, can help eliminate pathogens that adhere to surfaces (Ahmed & Aziz, 2017; CDC, 2025; Nurpuspita Sari et al., 2025).

Limitation

The relatively small sample size may have reduced the statistical power to detect risk factors. In addition, the validity of the odds ratio (OR) for certain variables was limited by the presence of zero cells, which prevented optimal estimation of the OR. Furthermore, information bias, particularly recall bias, may have occurred in this retrospective study. The low MMR vaccination coverage also introduced the potential for confounding in the observed association between travel history and mumps, as all cases were unvaccinated. Future studies should include larger sample sizes and consider using a cohort study design to minimize information bias and strengthen the validity of the findings.

CONCLUSION

A total of 12 students were affected by mumps, with the outbreak peaking during November 5–11, 2024. Mumps cases tended to occur among male students, younger students, and students in the most densely populated classroom. Prevention and control measures at the school had not been effectively implemented, especially given that most students had not received MMR vaccination. Crowding may have facilitated transmission, while sharing eating and drinking utensils and a history of travel contributed to the occurrence of mumps cases at Elementary School 4 Magelang. Surveillance was conducted for two incubation periods after the last reported case (until January 19, 2025) to ensure that no additional cases occurred. The Magelang Tengah Community Health Center should collaborate with the school to strengthen infectious disease surveillance, particularly by monitoring students with a history of travel, to facilitate early case detection. The Magelang City Health Office should strengthen the surveillance network between community health centers and other healthcare facilities and ensure continuous health education, particularly on avoiding the sharing of eating and drinking utensils during mumps outbreaks.

ETHICS APPROVAL

This study has received data collection approval from the Magelang City Health Office and Elementary School 4 Magelang, as documented in the assignment letter (Number: 800.1.11.1/31692/220.

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