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Analysis of Factors Influencing Measles Incidence Among Children Under Five in Tangerang City in 2023

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ABSTRACT

Background: Tangerang City experienced a significant increase in measles cases in 2023, with 114 laboratory-confirmed cases out of 484 suspected cases, despite achieving a complete basic immunization coverage of 106.4%. This phenomenon suggests that additional factors may have contributed to the occurrence of measles and warrant further investigation. This study aimed to analyze the factors influencing measles incidence among children under five years of age in Tangerang City in 2023.
Methods: This study employed a cross-sectional design with a total sample of 137 children under five who underwent laboratory examination. Bivariate analysis was conducted using the Chi-square test to identify associations between independent variables—namely immunization status, nutritional status, history of contact, parental education, parental occupation, and family income—and measles incidence.
Result: Factors significantly associated with measles incidence were immunization status (PR = 1.62; *p-value* = 0.045 for unvaccinated children and PR = 2.22; *p-value* = 0.021 for children with incomplete immunization) and a history of contact with measles cases (PR = 4.17; *p-value* < 0.001). Other factors, including nutritional status, parental education, parental occupation, sex, and family income, were not statistically significant.
Conclusion: Incomplete immunization status and a history of close contact with measles patients are the primary risk factors for measles incidence in Tangerang City. Recommended measures include strengthening immunization coverage, enhancing surveillance, and improving community education to prevent measles transmission.

Keywords: Measles ; Immunization ; Risk Factors ; Children Under Five ; Tangerang City

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Introduction

Measles, caused by a virus belonging to the Paramyxovirus family, is a highly contagious infection transmitted through respiratory droplets from coughing, sneezing, or nasal secretions. Despite being well recognized and extensively studied, measles remains a significant global public health concern, particularly due to its potential for severe and sometimes fatal complications, especially among children under five years of age (WHO, 2023a). The incubation period of measles ranges from 10 to 14 days, with transmission typically occurring approximately 14–15 days after contact with an infected individual. Children living in densely populated areas or refugee settings are particularly vulnerable to measles outbreaks. A study by Mujiati (2015) reported that children with a history of contact with measles patients had a 3.7-fold higher risk of infection.[1]

Globally, the WHO reported a fourfold increase in measles cases during the first three months of 2019 compared with the same period in the previous year. Measles-related mortality remains high, with an estimated 145,700 deaths in 2015—equivalent to approximately 400 deaths per day or 16 deaths per hour—most of which occurred among children under five years of age.[2] Data from 2022 indicated a further rise, with 17,338 measles cases reported during January and February, compared with 9,665 cases during the same period the previous year. It is estimated that 95% of measles-related deaths occur in developing countries.[2]

In Indonesia, the upward trend in measles cases is also alarming. In 2023, the Ministry of Health of the Republic of Indonesia reported measles outbreaks in 12 provinces, totaling 3,341 cases across 223 districts/cities—representing a 32-fold increase compared with 2021.[3] Banten Province demonstrated a similar trend, with confirmed cases rising from 6 in 2021 to 225 in 2022, and surging to 689 cases in 2023 (Banten Provincial Health Office, 2024). Most cases occurred among children aged 1–4 years (65%) and 5–9 years (52%) who had not received immunization, underscoring the critical importance of comprehensive and equitable immunization coverage.[4]

Tangerang City, a major urban center in Banten Province with high population density and mobility, faces substantial challenges in controlling communicable diseases such as measles. Surveillance data from the Tangerang City Health Office indicate a significant surge in cases. In 2022, 188 suspected measles cases were recorded, with 14 laboratory-confirmed cases based on serological testing. This number increased sharply in 2023 to 484 suspected cases, with 114 laboratory-confirmed measles cases identified through serological examinations conducted by 39 primary health centers (Puskesmas). Consequently, the measles incidence rate in Tangerang City rose markedly from 5.92 per 1,000,000 population in 2022 to 48.59 per 1,000,000 population in 2023.[5]

Surveillance data also reported measles outbreaks in 2023 in the districts of Cipondoh, Periuk, and Cibodas, with a total of 79 cases recorded between January and May. This situation is particularly concerning given that the coverage of Complete Basic Immunization in Tangerang City is relatively high—94.63% in 2022 and even reaching 106.4% in 2023.[5] The occurrence of measles outbreaks despite high immunization coverage suggests the presence of additional risk factors that require in-depth analysis.This phenomenon highlights the need for a more comprehensive approach to understanding the determinants of measles transmission, especially in areas with high immunization coverage that nevertheless continue to report substantial numbers of cases.

Several studies have identified various risk factors contributing to measles incidence and outbreaks. Nurlaila et al. (2020)[6] reported that low immunization coverage, high population density, malnutrition, and limited access to health services are major risk factors for measles outbreaks. Prasetyoputra et al. (2021) further noted that socioeconomic and environmental factors also influence measles transmission in urban areas. Children under five years of age constitute the most vulnerable group, particularly those with vitamin A deficiency, which can exacerbate measles

complications such as blindness or severe skin infections.[7]

Although numerous similar studies have been conducted in Indonesia, Tangerang City lacks a comprehensive investigation specifically examining measles risk factors among children under five. Therefore, this study aims to analyze the specific factors associated with measles incidence among children under five in Tangerang City in 2023, as a basis for developing more effective and targeted measles prevention and control strategies in the area.

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

Table 1 presents information on the characteristics of the respondents. Regarding measles status, out of the total population of 244,067 individuals, 83 cases (60.58%) were laboratory - confirmed measles cases, corresponding to an incidence rate of 34 per 100,000 population. Meanwhile, the remaining 54 cases (39.42%) were classified as discarded measles cases, meaning they were not confirmed as measles, with a rate of 22.1 per 100,000 population.

In terms of age distribution, the highest number of measles cases occurred in the 12–35 months age group, with 58 cases (42.33%) and an incidence rate of 36.2 per 100,000 population. The >36 months age group ranked second with 43 cases (31.39%) and had the highest incidence rate at 98.3 per 100,000 population. Meanwhile, 36 cases (26.28%) were reported among children aged 0–11 months, with an incidence rate of 89.9 per 100,000 population. Based on sex, measles cases were more common among females, accounting for 75 cases (54.74%) with an incidence rate of 7.88 per 100,000 population, compared with males, who accounted for 62 cases (45.26%) with an incidence rate of 6.44 per 100,000 population.

Table 1. Characteristics of Respondents

Variable	Total	Population	Percentage (%)	Rate (per 100.000)
Measles Status				
a. Confirmed Measles	83	244.067	60,58%	34
b. Discarded Measles	54	244.067	39,42%	22,1

Continued Table 1. Characteristics of Respondents

Variable	Total	Population	Percentage (%)	Rate (per 100.000)
Measles Status				
a. Confirmed Measles	83	244.067	60,58%	34
b. Discarded Measles	54	244.067	39,42%	22,1
Age				
a. 0-11 months	36	40.030	26,28	89,9
b. 12-35 months	58	160.315	42,33	36,2
c. 36-59 months	43	43.722	31,39	98,3
Sex				
a. Male	62	122.646	45,26%	6,44
b. Female	75	121.420	54,74%	7,88
Immunization Status				
a. Complete Immunization	45		32,85%	
c. Incomplete Immunization	28		20,44%	
d. Unimmunized	64		46,72%	
Nutritional Status				
a. Normal	104		75,91%	
b. Undernutrition	33		24,09%	
History of Contact with Measles Patients				
a. No Contact	110		80,29%	
c. Contact	27		19,71%	

Respondents' immunization status showed that most cases occurred among children who were not immunized, totaling 64 cases (46.72%). Meanwhile, 45 cases (32.85%) were reported among children with complete immunization, and 28 cases (20.44%) among those with incomplete immunization. The study data also indicate that confirmed measles cases outnumbered discarded cases. Based on nutritional status, most respondents had normal nutritional status, accounting for 104 cases (75.91%), while 33 respondents (24.09%) were classified as undernourished. In terms of history of contact with measles patients, the majority of respondents had no such contact history, totaling 110 cases (80.29%), whereas 27 respondents (19.71%) reported a history of contact with measles cases.

Table 2 presents the characteristics of the parents. The variables include maternal education, paternal education, maternal occupation, paternal occupation, and family income. The highest proportion of maternal education was senior high school (65.69%), while the lowest was primary school (2.19%). Regarding maternal occupation, the majority of mothers were not employed (housewives), accounting for 82.61%. For paternal education, the largest proportion was also senior high school (65.69%), while the smallest proportion was primary school (2.92%). All fathers were reported to be employed; therefore, paternal occupation in this study was categorized into formal and informal sectors. The majority of fathers worked in the formal sector, accounting for 84.67%.

Table 2. Characteristics of Parents

Variable	F	Percentage (%)
Maternal Education Level		
a. Primary School	3	2,19%
b. Junior High School	23	16,79%
c. Senior High School	90	65,69%

Variable	F	Percentage (%)
d. Diploma III	6	4,38%
e. Bachelor's Degree (D-IV/S1)	15	10,95%
Maternal Occupation		
a. Employed	23	17,39%
b. Unemployed	114	82,61%
Paternal Education Level		
a. Primary School	4	2,92%
b. Junior High School	8	5,84%
c. Senior High School	90	65,69%
d. Diploma III	7	5,11%
e. Bachelor's Degree (D-IV/S1)	28	20,44%
Paternal Occupation		
Formal	116	84,67%
Non-Formal	21	15,33%
Family Income		
Sufficient	77	56,20%
Low	60	43,80%

Table 3. Association of Maternal Factors (Education and Occupation) with Measles Incidence among Children Under Five in Tangerang City, 2023

Maternal Education Level	Measles Incidence		Total (%)	PR	*p-value*	95% CI
	Positive (%)	Negative (%)				
Low	14 (53,85%)	12 (46,15%)	26 (100%)	1,22	0,58	0,76-1,97
High	69 (62,16%)	42 (37,84%)	111 (100%)			
Maternal Occupation	Measles Incidence		Total (%)	PR	P-Value	95% CI
	Positive (%)	Negative (%)				
Unemployed	70 (61,40%)	44 (38,60)	114 (100%)	1,13	0,84	0,67-1,90
Employed	13 (56,52%)	10 (43,485)	23 (100%)			

Based on Table 3, the results of the bivariate analysis examining the association between maternal factors (education and occupation) and measles incidence among children under five in Tangerang City in 2024 indicate that, in terms of maternal education level, mothers with lower education had children with confirmed measles in 53.85% of cases, whereas among mothers with higher education the proportion was 62.16%. The analysis showed that the prevalence of measles among respondents with higher maternal education was 1.22 times greater than among those with lower maternal education (PR = 1.22; 95% CI: 0.76–1.97; p-value = 0.58). However, this difference was not statistically significant (p = 0.58). These findings indicate that there was no significant association between maternal education level and measles incidence in Tangerang City in 2023.

Regarding maternal employment status, the proportion of confirmed measles cases among children of non-working mothers was 61.40%, whereas among children of working mothers it was 56.52%. The analysis indicated that the prevalence of measles among children of non-working mothers was 1.13 times higher than among those of working mothers (PR = 1.13; 95% CI: 0.67–1.90; p-value = 0.84). This finding suggests that there was no statistically significant association between maternal employment status and measles incidence in Tangerang City in 2024.

Table 4. Association of Paternal Factors (Education and Occupation) with Measles Incidence among Children Under Five in Tangerang City, 2023

Paternal Education Level	Measles Incidence		Total (%)	PR	*p-value*	95% CI
	Positive (%)	Negative (%)				
Low	8 (66,67%)	4 (33,33%)	12 (100%)	0,83	0,76	0,36-1,91
High	75 (60%)	50 (40%)	125 (100%)			
Paternal Occupation	Measles Incidence		Total (%)	PR	*p-value*	95% CI
	Positive (%)	Negative (%)				
Non-Formal	12 (57,14%)	9 (42,86%)	21 (100%)	0,91	0,91	0,53-1,56
Formal	71(61,21%)	45 (38,79%)	116 (100%)			

Based on Table 4, regarding paternal education, the study results show that among fathers with lower education, the proportion of confirmed measles cases in their children was 66.67%, whereas among fathers with higher education it was 60%. The analysis indicated that the prevalence of measles among respondents with lower paternal education was 0.83 times that of those with higher paternal education (PR = 0.83; 95% CI: 0.36–1.91). However, this difference was not statistically significant (p-value = 0.76). These findings indicate that there was no significant association between paternal education level and measles incidence among children under five in Tangerang City in 2023.

Regarding paternal employment status, the proportion of confirmed measles cases among children of fathers working in the informal sector was 57.14%, while among children of fathers employed in the formal sector it was 61.21%. The analysis indicated that the prevalence of measles among children of fathers working in the formal sector was 0.91 times that of those whose fathers worked in the informal sector (PR = 0.91; 95% CI: 0.53–1.56; p-value = 0.91). However, this difference was not statistically significant (p-value = 0.91). These findings indicate that there was no significant association between paternal employment status and measles incidence among children under five in Tangerang City in 2023.

Based on Table 5, the relationship between sex and measles incidence shows that the proportion of measles cases among females (62.67%) was higher than among males (58.06%). The prevalence of measles among females was 1.12 times that of males (PR = 1.12; 95% CI: 0.74–1.70). However, this difference was not statistically significant (p-value = 0.71). These findings indicate that there was no significant association between sex and measles incidence in Tangerang City in 2023.

The relationship between nutritional status and measles incidence, as shown in the table, indicates that the proportion of measles cases among undernourished children (69.70%) was higher than among children with normal nutritional status (57.69%). The prevalence of measles among undernourished children was 0.71 times that of children with normal nutritional status (PR = 0.71; 95% CI: 0.41–1.26). However, this difference was not statistically significant (p-value = 0.31). These findings indicate that there was no significant association between nutritional status and measles incidence in Tangerang City in 2023.

Based on Table 6, the relationship between history of contact and measles incidence shows that children with a history of contact with measles patients had a markedly higher proportion of confirmed cases (88.89%) compared with those without such contact (53.64%). The analysis indicated that the prevalence of measles among respondents with a history of contact was 4.17 times higher than among those without contact (PR = 4.17; 95% CI: 1.41–12.36). This difference was statistically significant (p-value = 0.00). These findings indicate a significant association between

the history of contact with measles patients and measles incidence in Tangerang City in 2023.

Table 5. Association of Child Factors (Sex and Nutritional Status) with Measles Incidence among Children Under Five in Tangerang City, 2023

Sex	Measles Incidence		Total (%)	PR	p-value	95% CI
	Positive (%)	Negative (%)				
Male	36 (58,06%)	26 (41,94%)	62 (100%)	1,12	0,71	0,74-1,70
Female	47 (62,67%)	28 (37,33%)	75 (100%)			
Nutritional Status	Measles Incidence		Total (%)	PR	p-value	95% CI
	Positive (%)	Negative (%)				
Undernutrition	23 (69,70%)	10 (30,30%)	33 (100%)	0,71	0,31	0,41-1,26
Normal	60 (57,69%)	44 (42,31%)	104 (100%)			

Table 6. Association of Child Factors (History of Contact with Measles Patients) with Measles Incidence among Children Under Five in Tangerang City, 2023

History of Contact with Measles Patients	Measles Incidence		Total (%)	PR	p-value	95% CI
	Positive (%)	Positive (%)				
Contact	24 (88,89%)	3 (11,11%)	27 (100%)	4,17	0,00	1,41-12,36
No Contact	59 (53,64%)	51 (46,36%)	110 (100%)			

Based on Table 7, the bivariate analysis demonstrates the relationship between immunization status and measles incidence in Tangerang City. Unimmunized Group: Of the 64 children who had not received immunization, 42 (65.63%) were confirmed measles cases, while 22 (34.38%) were measles negative. The analysis showed that the prevalence of measles among unimmunized respondents was 1.62 times higher than among those with complete immunization (PR = 1.62; 95% CI: 1.05–2.48). This difference was statistically significant (p-value = 0.045), indicating a significant association between lack of immunization and measles incidence. Partially Immunized Group (Incomplete Immunization): Of the 28 children with incomplete immunization, 21 (75%) were confirmed measles cases, while 7 (25%) were measles negative. The prevalence of measles in this group was 2.22 times higher than among children with complete immunization (PR = 2.22; 95% CI: 1.11–4.44). This difference was statistically significant (p-value = 0.021). These findings indicate a significant association between incomplete immunization status and measles incidence, with a higher risk compared with children who were fully immunized. Fully Immunized Group: Among the 45 children who had received complete immunization, 20 (44.44%) were confirmed measles cases and 25 (55.56%) were measles negative. This group served as the reference category and therefore did not have its own PR value. The incidence of measles in this group was lower than in both the unimmunized and partially immunized groups, with the highest risk observed in the partially immunized group (PR = 2.22) compared with the others.

Based on Table 8, regarding family income, it was found that families with lower income had a higher proportion of confirmed measles cases among children (68.33%) compared with families with sufficient income (54.55%). The analysis indicated that the prevalence of measles among respondents from lower-income families was 1.44 times higher than among those from higher-income families (PR = 1.44; 95% CI: 0.92–2.24). However, this difference was not statistically significant (p-value = 0.14). These findings indicate that there was no significant association between family income level and measles incidence in Tangerang City in 2023.

Table 7. Bivariate Data Analysis (Stratified): Association between Immunization Status and Measles Incidence in Tangerang City, 2023

Immunization Status	Measles Incidence		Total (%)	PR	p-value	95% CI
	Positive (%)	Negative (%)				
Unimmunized	42 (65,63%)	22 (34,38%)	64 (100%)	1,62	0,045	1,05-2,48
Incomplete Immunization	21 (75%)	7 (21%)	28 (100%)	2,22	0,021	1,11-4,44
Complete Immunization	20 (44,44%)	25 (55,56%)	45 (100%)	Reff		

Table 8. Association between Family Income and Measles Incidence among Children Under Five in Tangerang City, 2023

Family Income	Measles Incidence		Total (%)	PR	p-value	95% CI
	Positive (%)	Negative (%)				
Low	41 (68,33%)	19 (31,67%)	60 (100%)	1,44	0,14	0,92-2,24
Sufficient	42 (54,55%)	35(45,45%)	77 (100%)			

Discussion

The results of this study identified two main factors that were significantly associated with measles incidence among children under five in Tangerang City, namely immunization status and history of contact with measles patients. These findings provide important insights for the development of measles prevention and control strategies in Tangerang City.

a. Immunization Status

Children under five who did not receive immunization or whose immunization status was incomplete had a higher risk of developing measles. This is supported by the greater proportion of measles cases observed among the unimmunized group (65.63%) and the partially immunized group (75%) compared with the fully immunized group (44.44%). These findings are consistent with fundamental immunological principles, whereby vaccination stimulates the production of specific antibodies, thereby providing active protection against viral infection. The absence or insufficiency of such antibodies in unimmunized or partially immunized individuals makes them highly susceptible to measles virus infection. These findings are supported by several previous studies. A study by Azis and Ramadhani (2019) in South Tangerang City involving 150 respondents also found a significant association between measles immunization status and measles incidence ($p < 0.05$), with 44% of infected respondents having not received immunization[7]. A similar study by Fadilah (2017) reported a significant relationship with a p-value of 0.041[8]. Research conducted by Yani, Yuniastini, and Fitriana (2015) in Sidorahayu Village reported that unimmunized children had a substantially higher risk (proportion ratio 16:1) of developing measles[9]. his is further supported by a study by Falawati et al. (2020) in Muna Regency, which found a significant association between immunization status and measles incidence based on the chi-square test (χ^2 calculated > χ^2 table)[10]. his is further supported by a study by Falawati et al. (2020) in Muna Regency, which found a significant association between immunization status and measles incidence based on the chi-square test (χ^2 calculated > χ^2 table)[2]. The high incidence of measles among unimmunized or partially immunized groups also contributes to low community immunity (herd immunity). Herd immunity is achieved when a large proportion of the population is immunized, thereby reducing disease transmission and protecting individuals who are vulnerable or unable to receive immunization. When immunization coverage declines, herd immunity weakens, increasing the risk of transmission across the

population, particularly among the most vulnerable groups such as children under five. Therefore, immunization is a crucial preventive measure to reduce the risk of measles among infants and young children. The success of vaccination programs in preventing mortality and reducing measles morbidity is not solely the responsibility of the government but requires active participation from all segments of society to achieve optimal measles elimination goals.

b. History of Contact with Measles Patients

In addition to immunization status, a history of close contact with measles patients was also identified as an important risk factor. The results of this study showed that children who had contact with measles patients were 4.17 times more likely to develop measles. This finding is highly relevant given the nature of the measles virus as a highly infectious pathogen. The virus spreads easily through respiratory droplets or direct contact with nasal and throat secretions of infected individuals (WHO, 2023).

Theoretically, the ability of the measles virus to remain airborne and to be transmitted before the onset of rash symptoms makes it particularly difficult to control. The WHO (2022) reported that the measles virus can remain viable in the air for up to two hours and can be transmitted from four days before until four days after the appearance of the rash.[11] The Centers for Disease Control and Prevention (CDC, 2021) further states that a single measles case can infect 12–18 susceptible individuals in a population lacking immunity, indicating a very high basic reproduction number (R_0)[12]. Several other studies also support these findings. A study by Ahmad Musyafa (2017) reported that individuals with a history of contact had a 4.034-fold higher likelihood of contracting measles compared with those without contact ($p = 0.011$)[13]. Similarly, Ramadhani (2016) found that children under five with a history of contact had a 2.991-fold higher risk of developing measles (95% CI = 1.157–7.731). These consistent results confirm that contact history is a strong determinant in measles virus transmission and an important indicator for surveillance and contact-tracing efforts.

c. Factors Not Significantly Associated

Conversely, several other factors—such as sex, nutritional status, parental education and occupation, and family income—did not show a significant association with measles incidence in this study. Regarding sex, this finding is consistent with a study by Linda Andriani (2017), which reported no association between sex and clinical measles incidence ($p = 0.909$). This suggests that measles infection is universal and does not exhibit sex-based predilection but is more strongly influenced by viral exposure and individual immune status[14].

Nutritional status was also not significantly associated with measles incidence in this study, consistent with the findings of Ardiyanto (2016), who reported that nutritional status did not influence measles occurrence ($p = 0.57$)[15]. Although poor nutrition can generally weaken the immune system and exacerbate measles complications (WHO, 2023a), these results may indicate that in Tangerang City, nutritional status is not a primary determinant of measles infection itself but rather may be more closely related to disease severity or prognosis.

Similarly, socioeconomic factors such as maternal education level were not found to influence measles incidence, in line with the findings of Destiyanta (2015), which showed no association between maternal education and measles occurrence[16]. The same pattern was observed for maternal and paternal occupation as well as paternal education. Occupation may not directly affect measles incidence but could exert an indirect influence through its impact on access to immunization, parental availability, and economic capacity. Family income also did not show a significant association. This finding is supported by literature indicating that in countries with well-established health insurance systems and high immunization coverage, the direct correlation between family income and the risk of measles infection tends to weaken, as access to vaccination and healthcare services becomes more universal (WHO, 2023a; World

Economic Forum, 2025)[17]. Furthermore, Darden and Macis (2024) emphasize that health-seeking behavior—such as adherence to immunization schedules and prompt medical consultation when ill—plays a more critical role than income level in contexts where healthcare access is relatively equitable[18].

Overall, although measles can affect anyone regardless of sex, and nutritional status may influence immune resilience, the findings from Tangerang City indicate that these factors—including parental education and occupation as well as family income—are not significant predictors of measles infection risk. This is likely attributable to the relatively equitable and free access to healthcare services and immunization programs in Tangerang City, which reduces disparities that might otherwise arise from socioeconomic differences in the context of vaccine-preventable infectious diseases.

Conclusion

This study confirms that incomplete immunization status and a history of contact with measles patients are the two primary factors significantly associated with measles incidence among children under five in Tangerang City. Children with incomplete immunization have a higher risk of infection, consistent with the principles of vaccine protection and the concept of herd immunity. Likewise, the highly contagious nature of the measles virus makes a history of close contact a strong predictor of disease transmission. In contrast, other factors—such as sex, nutritional status, parental education and occupation, and family income—did not show a significant association with measles incidence in the context of this study. This is likely attributable to the availability of equitable access to healthcare services and immunization programs in Tangerang City.

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