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Measles Trends, Immunization Coverage, and Surveillance Performance in Mataram City

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Abstract

This study examined trends in measles cases, immunization coverage, and surveillance performance in Mataram City, Indonesia, during 2023–2024. A descriptive-analytic design was applied using secondary data obtained from the Mataram City Health Office, the Ministry of Health, and the World Health Organization. Data on measles cases, booster immunization coverage, and population density were analyzed descriptively and using Spearman correlation. The results showed that measles cases decreased from 98 cases in 2023 to 50 cases in 2024, accompanied by an increase in booster immunization coverage from 53.8% to 62.1%. However, statistical analysis indicated no significant correlation between booster immunization coverage and measles cases ($r = -0.133$; $p = 0.556$) or between population density and measles cases ($r = -0.253$; $p = 0.257$). These findings suggest that factors beyond immunization coverage, such as surveillance quality and population mobility, may influence measles transmission. Strengthening immunization coverage to reach ≥95% and improving surveillance systems are essential strategies to enhance public health resilience.

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Introduction

Measles remains a major global public health threat despite the availability of safe and effective vaccines. Before the COVID-19 pandemic, global measles vaccination coverage had steadily improved, with first-dose coverage increasing from 72% in 2000 to 86% in 2019; however, this progress declined to 81% in 2021 and only partially recovered to 83% in 2022 (Minta et al., 2023). Similarly,

global two-dose coverage reached only about 65% in 2023, well below the level required for measles elimination (Plans-Rubió, 2025). As a consequence, measles cases and mortality have resurged, with global deaths increasing by 43% between 2021 and 2022 (Minta et al., 2023). These trends demonstrate that disruptions in routine immunization during the pandemic have created significant immunity gaps. Without rapid recovery efforts, these gaps are expected to increase the risk of outbreaks in many regions worldwide.

From a scientific perspective, measles control depends on achieving high levels of population immunity through vaccination and maintaining effective surveillance systems. Due to its high transmissibility, with a basic reproduction number (R_0) often exceeding 10, measles requires at least 95% coverage with two vaccine doses to achieve herd immunity, and in some contexts up to 97% (Plans-Rubió, 2021; Plans-Rubió, 2025; Guerra et al., 2017). However, global immunity levels between 2019 and 2023 were estimated at only 88–89%, which is insufficient to interrupt transmission (Plans-Rubió, 2025). In addition to immunization, case-based surveillance with laboratory confirmation is a core strategy for measles elimination, enabling early detection and rapid response to outbreaks (Masresha et al., 2021; Branda et al., 2024). These two components are complementary: vaccination reduces susceptibility, while surveillance ensures timely intervention. Therefore, an integrated immunization–surveillance approach is essential to sustain measles control.

However, in many settings, including developing regions, both immunization coverage and surveillance performance remain suboptimal. The COVID-19 pandemic disrupted routine immunization services and weakened surveillance systems, resulting in delayed case detection and reduced reporting sensitivity (Masresha et al., 2021; Ota et al., 2021). Globally, only about half of reporting countries met the surveillance sensitivity target of at least two discarded cases per 100,000 population in 2022 (Minta et al., 2023). Furthermore, studies from countries such as Ethiopia, Nigeria, and Kenya show that delayed surveillance response and weak outbreak management contribute to continued measles transmission and higher attack rates (Babure & Tufa, 2021; Ndonye et al., 2024; Seriki et al., 2018). Although increasing immunization coverage is critical, evidence suggests it is insufficient on its own without strong surveillance and rapid response systems. This indicates a gap in understanding how multiple factors interact to influence measles trends, particularly at the local level.

Therefore, this study is important to provide empirical evidence on measles trends by integrating immunization coverage and surveillance performance within a local context. Focusing on Mataram City, this research aims to analyze trends in measles cases, examine the role of booster immunization coverage, and assess the relationships among key determinants of disease transmission. By combining multiple variables into a single analytical framework, this study offers a more comprehensive understanding of measles dynamics than previous research. The findings are expected to support evidence-based strategies to improve immunization programs and strengthen surveillance systems. Ultimately, this research contributes to enhancing public health resilience within the framework of Global Health Security.

Materials and Methods

Research Design/Method of Study

This study employed a descriptive-analytical design using secondary data from the Mataram City Health Office, the WHO, and the Ministry of Health. Reported measles cases (2023-2024), immunization coverage, and population density were analyzed descriptively and using Spearman correlation.

Data Source/Population and Sample

a. Secondary data sources: SKDR Surveillance report data from the Mataram City Health Office, WHO publications, the Indonesian Ministry of Health, and international journals on Global Health Security and measles prevention.
b. Population: all measles cases recorded at Mataram City Health Center in the last two years.
c. Sample: measles case data in SKDR Surveillance of Mataram City Health Office, immunization coverage per year.

Variables and Instruments

a. Variabel
   Dependen (Bound)
   Number of measles cases (Trend of increasing measles cases) Independent (free)
   Percentage (%) Measles immunization (booster)
b. Instrumen:
c. Annual report of Mataram City Health Office, literature, and scientific journals related to GHS.

Data Collection Procedure

Data were collected from official reports of the Mataram City Health Office, measles/rubella immunization data from puskesmas, and SKDR surveillance reports from the Mataram City Health Office. Secondary data were obtained from WHO publications, the Indonesian Ministry of Health, and related journals.

Results and Discussions

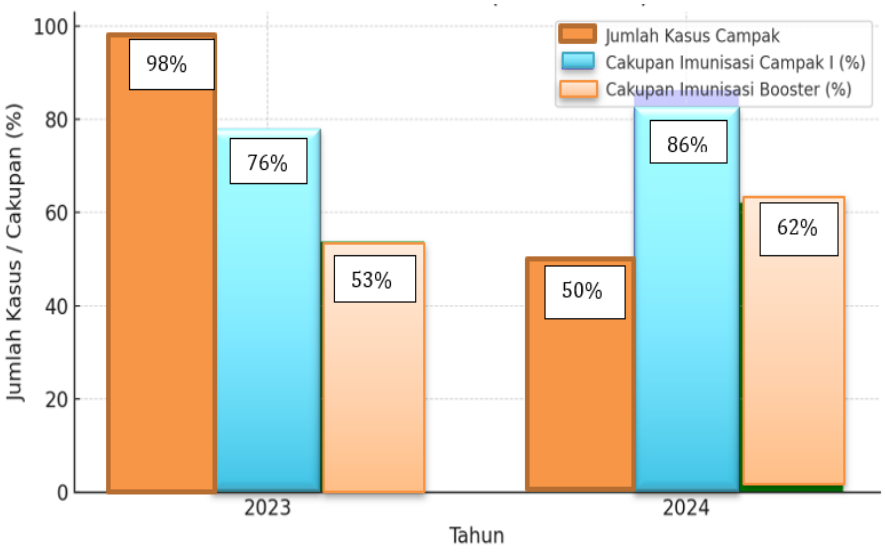
Trends in Measles Cases, Booster Immunization Coverage, and Population Density

This section describes trends in measles cases, booster immunization coverage, and population density based on SKDR reports from health centers in Mataram City during 2023–2024. The data provide an overview of changes in disease incidence alongside improvements in health service indicators. The analysis aims to identify general patterns before further statistical testing is conducted.

Table 1: Measles SKDR Report of Health Center in Mataram City in 2023 and 2024

No	Puskesmas	2023 % Imunisasi Campak I	2023 % Imunisasi Campak Booster	2023 Jumlah Kasus	2023_ Jumlah Penduduk	2023 Luas Wilayah (m2)	2024% Imunisasi Campak I	2024 % Imunisasi Campak Booster	2024 Jumlah Kasus	2024 Jumlah Penduduk	2024 Luas Wilayah (m2)
1	Ampenan	76,5	33	21	44.256	4.400.000	81,5	62	7	39.321	4.400.000
2	Karang Pule	85,6	38,6	19	72.123	6.080.000	103	115,1	1	63.290	6.080.000
3	Pejeruk	93	76,3	10	31.070	2.117.000	86,2	43	8	27.020	2.117.000
4	Pagesangan	104,5	81,9	17	57.165	6.080.000	46,2	41,3	1	42.680	6.080.000
5	Karang Taliwang	74	68,2	3	44.855	4.440.000	54,4	37,2	1	40.402	4.440.000
6	Tanjung Karang	54,2	34,9	4	76.332	2.960.000	76	74,7	7	54.800	2.960.000
7	Mataram	54,8	48,5	9	40.058	10.760.000	47,7	42	9	35.780	10.760.000

8	Selaparang	81,5	28,4	2	31.292	8.700.000	75,1	48,1	2	32.046	8.700.000
9	Dasan Agung	39,3	12,5	2	28.497	3.020.000	61,3	65	1	17.063	3.020.000
10	Cakranegara	66,9	49,9	11	74.792	9.670.000	65,2	48,1	13	59.874	9.670.000
11	Babakan	81,9	79,3	0	38.109	10.760.000	78	71,9	0	32.734	10.760.000
	Puskesmas	76,7	53,8	98	538.549	68.933.000	86,3	62,1	50	445.010	68.933.000



The observed decline in measles cases from 98 cases in 2023 to 50 cases in 2024 occurred alongside an increase in booster immunization coverage from 53.8% to 62.1%, indicating a positive trend in public health performance. From an epidemiological perspective, increased immunization coverage reduces the pool of susceptible individuals, thereby lowering the potential for transmission. However, the achieved coverage remains substantially below the ≥95% threshold required for herd immunity, particularly for highly transmissible diseases such as measles, which has a basic reproduction number (R_0) often exceeding 10 (Plans-Rubió, 2025; Guerra et al., 2017). This implies that although improvements are evident, the population remains at risk of future outbreaks due to persistent immunity gaps.

Furthermore, global evidence indicates that even small declines in vaccination coverage can result in disproportionate increases in measles incidence, particularly following disruptions such as the COVID-19 pandemic (Minta et al., 2023). The relatively sharp decline in cases observed in this study, despite moderate improvements in coverage, suggests that additional factors beyond immunization are at play. These may include improved access to health services, targeted immunization campaigns, behavioral changes in the population, or reduced contact rates. Similar findings have been reported in modeling studies, which show that temporary reductions in population mobility and increased public health interventions can significantly alter transmission dynamics even when vaccination coverage remains suboptimal (Mburu et al., 2020; Ibrahim & Dénes, 2023).

In addition, the improvement in the area per capita ratio (from 128 to 155 m^2/person) may reflect reduced crowding or a better spatial distribution of populations, which could contribute to a decreased transmission risk. However, previous research suggests that structural indicators, such as population density alone, are insufficient to explain measles dynamics without accounting for contact patterns and immunity levels (Delamater et al., 2019). Therefore, the findings of this study reinforce

the concept that measles control is multifactorial, requiring not only increased immunization coverage but also improvements in broader health system performance. The implication is that strengthening routine immunization must be integrated with targeted interventions and improvements in surveillance to achieve sustainable measles control.

Correlation Analysis between Booster Immunization and Measles Cases

Table 2. Spearman Correlation between Booster Immunization and Measles Cases

			campak_pkm	booster_pkm
Spearman's rho	campak_pkm	Correlation Coefficient	1.000	-.133
		Sig. (2-tailed)	.	.556
		N	22	22
	booster_pkm	Correlation Coefficient	-.133	1.000
		Sig. (2-tailed)	.556	.
		N	22	22

The Spearman correlation analysis revealed a weak and non-significant negative relationship (r=–0.133; p=0.556) between booster immunization coverage and measles cases. This finding indicates that, within the observed period and dataset, increased immunization coverage was not statistically associated with a reduction in measles incidence. This result contrasts with extensive global evidence demonstrating a strong inverse relationship between vaccination coverage and measles transmission, particularly when high coverage thresholds are achieved (Plans-Rubió, 2021; Minta et al., 2023). The discrepancy suggests that the protective effect of immunization may not be fully realized when coverage levels remain below the herd immunity threshold.

One possible explanation is heterogeneity in immunization coverage across health centers, which can create localized pockets of susceptibility even as overall coverage appears to improve. Studies have shown that uneven vaccine distribution and delayed administration can significantly reduce the effectiveness of immunization programs in preventing outbreaks (Thompson et al., 2023; Gambrell et al., 2022). In addition, the role of booster immunization may be influenced by timing, vaccine uptake behavior, and population mobility, which are not fully captured in aggregate data.

Another important consideration is the limitation of the study design, including the relatively small sample size (N = 22) and short observation period, which may reduce the statistical power to detect significant associations. Previous studies have emphasized that long-term, multi-year data are often required to observe stable relationships between immunization coverage and measles incidence (Minta et al., 2023). Therefore, the absence of a significant correlation in this study should not be interpreted as evidence that immunization is ineffective, but rather as an indication that its impact is context-dependent and influenced by multiple interacting factors. The implication is that future research should incorporate spatial analysis, longitudinal data, and additional variables to understand the complex dynamics of measles transmission better.

Correlation Analysis between Population Density and Measles Cases

This section analyzes the relationship between population density and measles cases using Spearman correlation. Population density is often associated with increased transmission risk due to higher contact rates. The statistical results are presented below.

Table 3. Spearman Correlation between Population Density and Measles Cases

			campak_pkm	penduduk_pkm
Spearman's rho	campak_pkm	Correlation Coefficient	1.000	-.253
		Sig. (2-tailed)	.	.257
		N	22	22
	penduduk_pkm	Correlation Coefficient	-.253	1.000
		Sig. (2-tailed)	.257	.
		N	22	22

The analysis showed a weak and non-significant negative correlation (r=–0.253; p=0.257) between population density and measles cases, suggesting that population density was not a significant determinant of measles incidence in this study. While higher population density is theoretically associated with increased contact rates and transmission risk, empirical evidence indicates that this relationship is highly context-specific. The basic reproduction number (R_0) of measles can vary with social behavior, contact patterns, and immunity levels, rather than solely with population density (Delamater et al., 2019; Guerra et al., 2017).

Several studies have highlighted that mobility patterns and social mixing are more important predictors of infectious disease spread than static measures such as density (Ibrahim, 2024; Ibrahim & Dénes, 2023). In urban settings, for example, high-density populations may still experience low transmission rates despite high immunization coverage and effective surveillance systems. Conversely, outbreaks can occur in lower-density areas if there are immunity gaps or delays in case detection. This may explain why the expected positive association between density and measles cases was not observed in this study.

Additionally, the improvement in health service indicators, including immunization coverage and possibly surveillance performance, may have mitigated the impact of population density on disease transmission. Studies from African and Asian settings have shown that strong surveillance systems and rapid outbreak response can significantly reduce transmission regardless of demographic conditions (Masresha et al., 2021; Branda et al., 2024). Therefore, the findings suggest that population density should not be considered in isolation but rather as part of a broader system of interacting determinants. The implication is that public health strategies should prioritize strengthening immunization and surveillance systems rather than relying solely on demographic indicators.

Overall, this study's findings highlight the complexity of measles transmission dynamics at the local level. Although improvements in immunization coverage and health service performance were associated with a decline in measles cases, statistical analysis did not reveal significant relationships between the studied variables. This suggests that measles control is influenced by a combination of factors, including immunization coverage, surveillance performance, population behavior, and health system capacity.

These results are consistent with global evidence emphasizing that effective measles control requires an integrated approach combining high immunization coverage, strong surveillance systems, and timely outbreak response (Minta et al., 2023; Branda et al., 2024). The COVID-19 pandemic has further demonstrated how disruptions in these systems can rapidly increase outbreak risk. Therefore, strengthening both immunization and surveillance simultaneously is essential to

achieve sustainable measles control and elimination. This study contributes to the literature by providing local empirical evidence for the need for a comprehensive, context-specific approach within the Global Health Security framework.

Conclusion

This study demonstrated that measles cases in Mataram City declined substantially from 2023 to 2024, alongside improvements in booster immunization coverage and health service indicators. However, statistical analysis revealed no significant relationship between booster immunization coverage and measles incidence, nor between population density and measles cases. These findings indicate that measles transmission is influenced by multiple interacting factors, rather than a single determinant such as immunization coverage alone.

Although the increase in immunization coverage contributed to overall improvements in public health outcomes, the achieved level remains below the threshold for herd immunity. In addition, the absence of significant correlations suggests the important role of other factors, including surveillance performance, population mobility, and health system effectiveness. Therefore, strengthening immunization programs must be complemented by improvements in surveillance systems and integrated public health strategies.

This study highlights the importance of adopting a comprehensive approach within the Global Health Security framework to achieve sustainable measles control. Future research is recommended to incorporate longer observation periods, larger datasets, and additional variables to understand better the complex dynamics of measles transmission at the local level.

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