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Factors of Measles-Rubella Immunization Resilience of Districts/Municipalities in Indonesia, 2022-2023

Muammar Muslih[1], Tri Yunis Miko[2], Irawan Mangunatmadja[3], Masdalina Pane[4]

[1]Student of Department of Epidemiology, Faculty of Public Health, Universitas Indonesia, Indonesia

[2]Lecturer of Department of Epidemiology, Faculty of Public Health, Universitas Indonesia, Indonesia

[3]Professor Faculty of Medicine, Universitas Indonesia, Indonesia

[4]Researcher BRIN, Indonesia

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Abstract

Measles Rubella immunization resilience is one of the important indicators in supporting the achievement of equitable and sustainable immunization coverage in Indonesia. This study aims to analyze the factors that influence the resilience of Measles Rubella immunization at the district/city level in 2022-2023. This study used a quantitative approach with survey method, involving 286 districts/cities as research sites. Data were obtained from national immunization reports, MR surveillance, and interviews with health workers. Logistic regression was used to evaluate the influence of socioeconomic, geographical, health resources, and community participation on immunization resilience. The results showed that access to health facilities, measles rubella vaccine coverage, and immunization/surveillance program budget had a significant influence on immunization resilience. In addition, geographical differences and urbanization levels were also found to be a challenge in equitable vaccine distribution. This study recommends a collaborative strategy involving local government, health sector, and local communities to improve Measles Rubella immunization coverage across Indonesia.

Keywords: Immunization resilience, Measles Rubella cases, MR vaccine coverage, public health.

INTRODUCTION

The COVID-19 pandemic has had a major impact on measles suspect case finding. There was a significant change in the number of measles suspects found in the field during 2020 compared to 2019. At the beginning of 2020, the number of suspected measles cases was still in the same proportion as in 2019, but since the COVID-19 pandemic hit Indonesia in March 2020, there has been a drastic decrease in the number of suspected measles cases. This is due to the impact of the COVID-19 pandemic which caused the central government and local governments to reallocate resources including

surveillance resources for COVID-19 surveillance activities. In addition, the number of non-COVID-19 patient visits to health facilities also decreased during the COVID-19 pandemic, leading to a decrease in case finding. When accumulated, the decrease in cases in 2020 was 62% when compared to 2019.

Until 2022, there are five (5) countries that have been verified for measles, namely, Maldives, Bhutan, DPR Korea, Timor Leste and Sri Lanka, while the countries that have been verified for rubella are Malvides and Sri Lanka. While Bhutan, DPR Korea and Timor Leste are still waiting for the verification process for rubella. Based on the results of the *Regional Consultation on re-Setting the Target Date for Achieving the Measles and Rubella (MR) Elimination Goal In WHO SEA* in March 2023 in India, Indonesia is set to achieve measles rubella/CRS elimination in 2026 along with other SEAR member countries as a result of the past COVID-19 pandemic (WHO SEAR, 2023). Measles is still a highly contagious and often fatal disease, especially in countries with weak health systems. Measles can cause serious complications such as diarrhea, dehydration, pneumonia and brain inflammation, and even death. Indonesia is among the 10 countries with the highest number of measles cases in the world.

Prior to global measles vaccination in 1980, major measles epidemics occurred every 2 to 3 years. Each year there are an estimated 165 million measles cases and 2.6 million measles-related deaths. In 2017, nearly 110,000 people died from complications of measles. Accelerated immunization activities have shown considerable impact in reducing measles deaths. With the availability of measles vaccination globally, there was a reduction in mortality from 761,000 in 2000 to 128,000 in 2021. During this period, measles vaccination is estimated to have significantly reduced mortality by 83% Due to its infectious nature, measles virus is easily spread throughout the world, so even if a country has achieved elimination of the *indigenous* virus, it is still vulnerable to outbreaks caused by imported viruses. This is the case in the WHO regional areas of the Americas and Europe, where the virus has re-emerged and has caused major outbreaks. As long as measles and rubella immunization coverage is uneven around the world, measles and rubella will remain a threat to the survival of children and families everywhere. Several countries in the Africa, Southeast Asia, Europe, Eastern Mediterranean and Western Pacific regions have experienced measles re-emergence due to neglecting to maintain high and equitable immunization coverage (WHO, 2022).

Unlike measles, rubella infection causes relatively mild illness in children and most patients only experience a mild rash or fever. However, rubella infection in women during young pregnancy can affect the unborn child, resulting in miscarriage, stillbirth or birth with a combination of defects called *Congenital Rubella Syndrome* (CRS), which can include heart disease, blindness and deafness. More than 100,000 babies are born with CRS every year.

The Immunization Program is one of the priority activities of the Ministry of Health and as a tangible form of the government's commitment to achieving *Sustainable Development Goals* (SDGs). The Immunization Target in (National Medium-Term Development Plan) RPJMN 2020-2024 is implemented in order to reduce mortality in children, it is expected that the coverage of Complete Basic Immunization (IDL) in 2021 is 93.6% in infants aged 0-11 months, and 100% of 15 districts / cities reach IDL 80% of children aged 0-11 months.

Research bodies in various countries prove that the more infants and toddlers who are not immunized, the more outbreaks, severe illness, disability or death will occur. In Indonesia, there was a polio outbreak in 2005-2006 (385 children were permanently paralyzed), a measles outbreak in 2009-2010 (5818 children hospitalized, 16 died), a diphtheria outbreak in 2010-2011 (816 children hospitalized, 56 died).

The decline in measles rubella immunization coverage (MR dose 1 and MR dose 2) during the COVID-19 pandemic has increased the risk of measles rubella/CRS cases. In 2022, until the 52nd week, there were 4850 measles cases in 250 urban districts in 32 provinces and 841 rubella cases in 202 urban districts in 33 provinces. 14% of measles cases occurred at age <1 year, 38% of measles cases occurred at age 1-4 years, 33% of measles cases occurred at age 5-9 years, 8% of

measles cases occurred at age 10-14 years. Of the 4850 measles cases, 67% were unimmunized, 26% had unknown and incomplete immunization history (Ministry of Health, 2021).

Tang *et al*., (2016), stated that during an outbreak in Guangxi (China), people who had contact with measles patients or visited the hospital had a chance to get sick with measles 9.84 times compared to people who had no history of contact with sufferers. Risk factors that can cause measles are vaccination history, patient immunity, contact history with measles patients both at home and when visiting the hospital, history of traveling to areas where there is an incidence of measles with a high attack rate, especially in children (Vemula *et al.*, 2016).

The number of city districts with cases in 2019 was 118 city districts, in 2020 72 city districts, in 2021 72 city districts, in 2022 250 city districts. Low immunization coverage leads to an increase in cases in city districts.

Considering the disease burden of measles and rubella, and the potential to reduce incidence to the point of elimination using measles rubella vaccines, in 2019 all WHO/SEAR member countries including Indonesia have set targets to achieve measles elimination and rubella/CRS control by 2023. The ongoing COVID-19 pandemic since 2020 has impacted many essential programs in Indonesia, including measles immunization and surveillance programs. In the last two years, there has been a decrease in measles immunization coverage and a decrease in measles surveillance performance, resulting in an increase in measles cases and the occurrence of measles outbreaks in several regions.

Based on official data from WHO, other countries in Southeast Asia, the United States, Europe, Africa, the Eastern Mediterranean, the Western Pacific during the COVID-19 pandemic experienced a decline in both case finding and reporting, and this should not happen during other new disease pandemics.

Measles rubella surveillance is needed to determine the epidemiology of measles rubella disease in the community. Since 2000, more than one billion children in high-risk countries have been immunized against measles, resulting in a 75% reduction in global measles deaths by 2013, and a very low endemicity by 2013. During the year 2022, the number of measles cases in our country was more than 3,341 reported cases. This number of cases was obtained during the period of 1 year from January to December 2022. When compared to 2021, there is a significant increase of approximately 32 times. The reason is because for 2 consecutive years Indonesia could not reach the target for routine immunization services. So that many children are not routinely immunized due to the COVID-19 pandemic so that it needs early work again to control the pandemic. Although immunization coverage is high, measles outbreaks are still possible and will occur due to enclaves with low immunization coverage.

Health system resilience is defined as "the capacity of health actors, institutions, and populations to prepare for and respond to crises effectively maintaining core functions when crisis strikes and based on lessons learned during the crisis, reorganizing if conditions warrant". Unprepared health systems around the world inadvertently contribute to the transmission of disease during epidemics, and unprepared health systems are also unable to deliver essential services. Many countries have committed resources and efforts towards strengthening health systems based on recent disasters, but actionable plans and approaches to building resilient health systems have yet to reach consensus.

Response to crises, be it disease outbreaks or other disruptions that result in a surge in demand for health services e.g., disease outbreaks, natural disasters or mass events requires a strong public health response and highly proactive health services.

The review of health system strengthening has started in 2018. The 2018 *Health Sector Review* (HSR) is intended to strengthen the National Health System with a focus on strengthening health services in the face of population aging and demographic bonus opportunities, reducing maternal and neonatal mortality, improving nutrition, controlling infectious diseases including immunization-preventable diseases and new infectious diseases and controlling non-communicable

diseases and risk factors. The scope of strengthening includes the fulfillment of human resources as well as pharmaceuticals and medical devices, strengthening food drug supervision, quality and equitable health services, increasing the effectiveness of health financing and JKN, and strengthening governance and health information systems. Kruk *et al*. (2015) describe a resilient health system as one that is integrated with existing efforts to strengthen the health system, able to detect and interpret local warning signs and quickly request support, able to provide services to diverse populations, able to isolate threats and maintain core functions, and able to adapt to health changes.

To date, much of the literature specifically referencing health system resilience has focused on high-level attributes, rather than identifying the specific capacities that health systems need to be resilient to infectious disease outbreaks and natural hazards, for example, Kruk *et al*.'s five attributes of a resilient health system include a self-organizing system, with the ability to quickly identify and isolate threats and prepare resources.

Previous disease outbreaks and humanitarian emergencies have underscored the importance of sustaining health services such as immunization, and effectively engaging communities in service planning and delivery.

Immunization is an integral part of the health system where the basic immunization program is part of the transformation of primary health care. Immunization is also part of the transformation of the health security system, including the production of domestically-made routine vaccine availability.

Measuring the measles rubella immunization resilience index is important because it is part of the calculation of *Human Development Indices* (HDI) found in table 8 with health outcomes where the indicators are infant health (percentage of infants who were exclusively breastfed in the 24 hours before the survey, percentage of infants who were not immunized against measles rubella and DPT, and infant mortality rate) and child health (percentage of children under 5 years of age who are stunted and under-five mortality rate), (UNDP, 2018).

The measles rubella outbreaks that occurred were the result of measles rubella immunization resilience that was not optimal in each district/city in Indonesia, so efforts were needed to improve immunization resilience.

To measure whether the resilience of measles rubella immunization in a district/city is good or not, we need a model that can measure the index value of measles rubella immunization resilience based on variables that affect measles rubella immunization.

Based on the information related to immunization resilience above, if it is related to the outbreak of measles rubella, health resilience, especially the resilience of measles rubella immunization in Indonesia, has not been able to prevent and detect early the occurrence of an increase / spike in measles rubella cases that occurred in almost half of the city districts in Indonesia in 2022-2023 so that researchers feel the need to conduct research related to the factors of district measles rubella immunization resilience in 2022-2023.

RESEARCH METHODOLOGY

This type of research is a quantitative observational design with an ecological study or population correlation, where the research unit is a district / city that is positive for IgM measles rubella cases. The definition of an ecological study or population correlation study is an epidemiological study with the population as the unit of analysis, which aims to describe the correlative relationship between disease and factors of interest to researchers, such as age, immunization coverage, and others. An ecological study is an empirical discovery study of a group that applies the unit of analysis. Such studies include geographical studies, including studies of the conditions of provinces, districts or cities, sub-districts, and so on (H.J, Mukono, 2002).

In ecological studies involving variables that have different levels, multilevel analysis is more appropriate than individual analysis using ordinary logistic regression analysis. Multilevel analysis is the most powerful analysis compared to other analyses for estimating contextual effects and ecological effects to enhance individual-level effects. With multilevel analysis, the relationship between the factors in this study can be seen at various levels simultaneously, at the individual, village and district/city levels.

This study will create a measles rubella immunization resilience model using measles rubella surveillance epidata bulletin data, measles rubella immunization coverage data, district/city health office data. This study is also to determine if there is a relationship between the resilience of measles rubella immunization in city districts and the presence of measles cases and to determine if there is a relationship between measles rubella immunization resilience and measles rubella immunization coverage, trained human resources (immunization and surveillance), percentage of measles alerts responded to in SKDR, immunization service budget, stable funding, measles surveillance sensitivity, completeness and accuracy of reporting, good governance, age, gender and immunization history in cases.

The study was conducted from August to December 2024. This study used secondary data from the Directorate of Immunization Management of the Ministry of Health in 2022-2023, the Directorate of Surveillance and Health Quarantine in 2022-2023, the latest Riskesdas, Data and Information Center in 2022-2023, the Ministry of Home Affairs and the Central Bureau of Statistics.

Secondary data from the Directorate of Immunization Management of the Ministry of Health in 2019-2022, the Directorate of Health Surveillance and Quarantine in 2019-2022, the latest Riskesdas, the Data and Information Center in 2019-2022, and the Central Bureau of Statistics.

Data processing using statistical data processing *software* with steps

a. *Editing* is the activity of clarifying the consistency and completeness of data.

b. *Coding* is the activity of converting data into data in the form of numbers or numbers.

c. *Cleaning* is the process of checking data for consistency and missing *treatments*.

d. *Data entry* is the activity of entering data into computer software (SPSS/Stata, Ms Excel).

RESEARCH RESULTS

Research Implementation

The study was conducted from August to December 2024 using primary data through googleform and secondary data of measles rubella surveillance in 2022-2023. The target population of the study was all districts with positive measles cases in Indonesia in the period 2022-2023, while the source population was the measles rubella cases recorded in the report of districts with measles rubella cases of the Indonesian Ministry of Health during the study period, which was 286 districts.

The total eligible population that met the inclusion and exclusion criteria was 286 respondents. Thus, the final total sample included in the study was 286 city districts.

Univariate Analysis

Measles rubella cases city district

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	138	48,3	48,3	48,3
	Yes	148	51,7	51,7	100,0
	Total	286	100,0	100,0	

Measles rubella cases were found in **148 urban districts (51.7%)**, while the remaining **138 urban districts (48.3%)** did not have measles rubella cases.

District measles rubella immunization coverage

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	<90%	146	51,0	51,0	51,0
	>90%	140	49,0	49,0	100,0
	Total	286	100,0	100,0	

Measles-rubella immunization coverage showed more districts with less than 90% coverage, with **146 districts (51%)** at less than 90% coverage, and **140 districts (49%)** at more than 90% coverage.

Percentage of city district alerts

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	< 80%	163	57,0	57,0	57,0
	> 80%	123	43,0	43,0	100,0
	Total	286	100,0	100,0	

The alert percentage also recorded more districts with **163 districts (57%)** below 80%, while **123 districts (43%)** had an alert percentage above 80%.

District Immunization Program Budget

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Inadequate	130	45,5	45,5	45,5
	Adequate	156	54,5	54,5	100,0
	Total	286	100,0	100,0	

In terms of budget, **156 city districts (54.5%)** reported adequate budgets, while **130 city districts (45.5%)** reported inadequate budgets.

Outbreak Response Funding

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not Available	169	59,1	59,1	59,1
	Available	117	40,9	40,9	100,0
	Total	286	100,0	100,0	

In terms of funding in the event of an outbreak, more city districts, **169 city districts (59.1%)**, stated that funding was not available, while only **117 city districts (40.9%)** stated that funding was available.

City District surveillance sensitivity

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	< 80%	123	43,0	43,0	43,0
	> 80%	163	57,0	57,0	100,0
	Total	286	100,0	100,0	

The surveillance sensitivity with which districts conducted measles suspect case finding was above 80% with **163 districts (57%)**, while **123 districts (43%)** were below 80% surveillance sensitivity.

Completeness and accuracy of City District reports

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	<90%	142	49,7	49,7	49,7
	>90%	144	50,3	50,3	100,0
	Total	286	100,0	100,0	

The completeness and accuracy of the city district reports were similar, with **144 city districts (50.3%)** showing results over 90% and **142 city districts (49.7%)** having completeness and accuracy below 90%.

Good government in support of the Program

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not good	121	42,3	42,3	42,3
	Good	165	57,7	57,7	100,0
	Total	286	100,0	100,0	

From the aspect of good governance where the discarded rate target was achieved and implementation support was provided, **165 districts/municipalities (57.7%)** reported good governance, while **121 districts/municipalities (42.3%)** reported the opposite.

Immunization human resources

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Untrained	171	59,8	59,8	59,8

	Trained	115	40,2	40,2	100,0
	Total	286	100,0	100,0	

Regarding immunization human resources, **171 city districts (59.8%)** stated that immunization personnel were not trained, while **115 (40.2%)** city districts stated that immunization personnel were trained.

Measles surveillance human resources

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Untrained	153	53,5	53,5	53,5
	Trained	133	46,5	46,5	100,0
	Total	286	100,0	100,0	

Similarly, for measles surveillance human resources, **153 districts (53.5%)** reported that their surveillance personnel were not trained, while **133 districts (46.5%)** reported that their surveillance personnel were trained.

Bivariate Analysis

		Measles rubella cases	Measles rubella immunization coverage	Alert percentage	Budget	Funding	Surveillance sensitivity	Completeness and accuracy of the report	Good government	Immunization human resources
Measles rubella cases	Pearson Correlation	1	,232**	,160**	,313**	,277**	-,047	,651**	-,133*	-,036
	Sig. (1-tailed)		,000	,003	,000	,000	,213	,000	,012	,273
	N	286	286	286	286	286	286	286	286	286
Measles rubella immunization	Pearson, Correlation	232**	1	-,045	,121*	,096	-,011	,217**	-,068	-,061

coverage	Sig. (1-tailed)	,000		,222	,020	,053	,425	,000	,128	,151
	N	286	286	286	286	286	286	286	286	286
Alert percentage	Pearson Correlation	,160**	-,045	1	,112*	,082	,213**	,001	-,071	,008
	Sig. (1-tailed)	,003	,222		,029	,084	,000	,493	,116	,448
	N	286	286	286	286	286	286	286	286	286
Budget	Pearson Correlation	,313**	,121*	,112*	1	,303**	-,098*	,189**	,000	,004
	Sig. (1-tailed)	,000	,020	,029		,000	,049	,001	,500	,474
	N	286	286	286	286	286	286	286	286	286
Funding	Pearson Correlation	,277**	,096	,082	,303**	1	-,125*	,115*	-,065	,028
	Sig. (1-tailed)	,000	,053	,084	,000		,018	,026	,137	,317
	N 286		286	286	286	286	286	286	286	286
Surveillance sensitivity	Pearson - Correlation	,047	-,011	,213**	-,098*	-,125*	1	-,072	-,129*	-,123*
	Sig. (1-tailed)	,213	,425	,000	,049	,018		,114	,014	,019
	N	286	286	286	286	286	286	286	286	286
Completeness and accuracy of the report	Pearson Correlation	,651**	,217**	,001	,189**	,115*	-,072	1	-,058	-,141**
	Sig. (1-tailed)	,000	,000	,493	,001	,026	,114		,165	,008

	N	286	286	286	286	286	286	286	286	286
Good government	Pearson - Correlation	,133*	-,068	-,071	,000	-,065	-,129*	-,058	1	-,005
	Sig. (1-tailed)	,012	,128	,116	,500	,137	,014	,165		,466
	N 286		286	286	286	286	286	286	286	286
Immunization human resources	Pearson - Correlation	,036	-,061	,008	,004	,028	-,123*	-,141**	-,005	1
	Sig. (1-tailed)	,273	,151	,448	,474	,317	,019	,008	,466	
	N	286	286	286	286	286	286	286	286	286
Measles surveillance human resources	Pearson Correlation	,073	,041	,125*	,049	,065	,017	,085	,046	-,078
	Sig. (1-tailed)	,110	,247	,018	,206	,135	,387	,077	,217	,093
	N	286	286	286	286	286	286	286	286	286
Measles rubella immunization resistance	Pearson Correlation	,242**	,188**	,088	,239**	,225**	-,102*	,122*	,116*	,121*
	Sig. (1-tailed)	,000	,001	,069	,000	,000	,042	,019	,025	,020
	N	286	286	286	286	286	286	286	286	286

**. Correlation is significant at the 0.01 level (1-tailed).

*. Correlation is significant at the 0.05 level (1-tailed).

Based on correlation analysis, the independent variable *Measles Rubella Cases* has a significant positive relationship with the dependent variable *Measles Rubella Immunization Resilience* (r = 0.242, p = 0.000), which indicates that an increase in measles rubella cases can affect immunization resilience.

The Measles Rubella Immunization Coverage variable also has a significant positive relationship (r = 0.188, p = 0.001), indicating that the higher the measles rubella immunization coverage, the better the immunization resilience, and vice versa if the measles rubella immunization coverage is low, the resilience is also low. Furthermore, the *available budget for immunization* shows a significant positive correlation (r = 0.239, p = 0.000), where the availability of the budget can strengthen immunization resilience. Similarly, *stable Funding*, which has a significant positive relationship (r = 0.225, p = 0.000), indicates that adequate allocation of funds can support immunization resilience.

The Completeness and Timeliness *of Reports* variable had a significant positive correlation (r = 0.122, p = 0.019), indicating that complete and timely reporting contributes to immunization resilience. *Good Governance* also showed a significant positive correlation (r = 0.116, p = 0.025), indicating that good governance can support immunization efforts. In addition, *Immunization HRH* has a significant positive correlation (r = 0.121, p = 0.020), indicating that the quality of health workers trained in immunization affects immunization resilience. The *Measles Surveillance HRH* variable also showed a significant positive relationship (r = 0.158, p = 0.004), confirming the importance of trained and qualified surveillance personnel in supporting immunization resilience.

On the other hand, *Surveillance Sensitivity* had a small significant negative correlation (r = -0.102, p = 0.042), indicating that higher surveillance sensitivity was found in areas with lower immunization resilience.

These results indicate that most of the independent variables have a significant influence on *Measles Rubella Immunization Resilience*, with p-values that are within the range of statistical significance (<0.05). This correlation provides insight that factors such as budget, funding, immunization coverage and reporting quality play an important role in supporting immunization resilience.

Multivariate Analysis
Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I. for EXP(B)	
								Lower	Upper
Step 1[a]	Measles rubella cases	,787	,381	4,264	1	,039	2,196	1,041	4,633
	Measles rubella immunization coverage	,685	,275	6,191	1	,013	1,985	1,157	3,406
	Percentage of alerts(1)	-,262	,285	,849	1	,357	,769	,440	1,344
	Budget	,586	,286	4,200	1	,040	1,797	1,026	3,148
	Funding	,568	,284	4,004	1	,045	1,765	1,012	3,078
	Surveillance sensitivity	-,247	,283	,760	1	,383	,781	,448	1,361
	Completeness and	-,181	,367	,244	1	,621	,834	,406	1,713

	accuracy of the report								
	Good government	,712	,280	6,466	1	,011	2,038	1,177	3,529
	Immunization human resources	,627	,280	5,031	1	,025	1,872	1,082	3,238
	Measles surveillance human resources	,596	,270	4,893	1	,027	1,816	1,070	3,080
	Constant	-2,314	,493	21,994	1	,000	,099		
Step 2[a]	Measles rubella cases	,666	,290	5,268	1	,022	1,946	1,102	3,437
	Measles rubella immunization coverage	,675	,275	6,054	1	,014	1,965	1,147	3,366
	Percentage of alerts(1)	-,280	,282	,988	1	,320	,755	,435	1,313
	Budget	,587	,286	4,225	1	,040	1,799	1,028	3,151
	Funding	,582	,282	4,261	1	,039	1,790	1,030	3,113
	Surveillance sensitivity	-,239	,283	,718	1	,397	,787	,452	1,370
	Good government	,710	,280	6,437	1	,011	2,034	1,175	3,521
	Immunization human resources	,648	,276	5,501	1	,019	1,912	1,112	3,288
	Measles surveillance human resources	,591	,269	4,812	1	,028	1,805	1,065	3,059
	Constant	-2,344	,490	22,876	1	,000	,096		
Step 3[a]	Measles rubella cases	,674	,290	5,406	1	,020	1,962	1,112	3,463
	Measles rubella immunization coverage	,670	,274	5,977	1	,014	1,954	1,142	3,344
	Percentage of alerts(1)	-,219	,272	,647	1	,421	,803	,471	1,370
	Budget	,607	,285	4,538	1	,033	1,835	1,050	3,209

	Funding	,599	,282	4,534	1	,033	1,821	1,049	3,162
	Good government	,731	,278	6,904	1	,009	2,078	1,204	3,584
	Immunization human resources	,678	,274	6,123	1	,013	1,970	1,151	3,371
	Measles surveillance human resources	,590	,269	4,816	1	,028	1,804	1,065	3,056
	Constant	-2,557	,425	36,272	1	,000	,078		
Step 4[a]	Measles rubella cases	,700	,288	5,893	1	,015	2,014	1,144	3,545
	Measles rubella immunization coverage	,650	,273	5,695	1	,017	1,916	1,123	3,269
	Budget	,618	,284	4,727	1	,030	1,856	1,063	3,241
	Funding	,601	,281	4,557	1	,033	1,823	1,050	3,165
	Good government	,718	,278	6,681	1	,010	2,050	1,189	3,532
	Immunization human resources	,677	,274	6,116	1	,013	1,968	1,151	3,365
	Measles surveillance human resources	,610	,268	5,198	1	,023	1,841	1,089	3,110
	Constant	-2,690	,393	46,805	1	,000	,068		

a. Variable(s) entered on step 1: Measles rubella cases, Measles rubella immunization coverage, Percentage of alerts, Budget, Funding, Surveillance sensitivity, Completeness and accuracy of reports, Good governance, Immunization human resources, Measles surveillance human resources.

Based on the results of multivariate analysis using the logistic regression *model* in the table presented, the following interpretation for each research variable:

The following is the interpretation of the table of results of logistic regression analysis on the relationship between independent variables with immunization resistance:

1. Measles Rubella Case The measles rubella case variable has a significant effect on immunization resilience, with a *p-value* of 0.039 and an *Odds Ratio* (OR) of 2.196. This indicates that areas with measles rubella cases are 2.2 times more likely to achieve immunization resilience than areas without cases. This finding indicates that the presence of cases is an important trigger in strengthening immunization efforts.

2. Measles Rubella Immunization Coverage Measles rubella immunization coverage also showed a significant effect on immunization resilience, with a *p-value* of

0.013 and an OR of 1.985. This means that every increase in immunization coverage will almost double the likelihood of immunization resilience. This confirms the importance of extensive coverage to achieve population resilience to measles rubella.

3. Alert Percentage

The percentage of alerts variable did not show a significant effect on immunization resilience, with a *p-value* of 0.357 and an OR of 0.769. This value indicates that an increase or decrease in the percentage of alerts does not necessarily affect immunization resilience directly.

4. Budget

Budget has a significant influence on immunization resilience, with a *p-value of* 0.040 and OR of 1.797. This indicates that an increase in the budget for immunization activities is likely to increase immunization resilience by 1.8 times. Thus, an adequate budget is a key factor in the success of immunization programs.

5. Funding

Funding also had a significant effect, with a *p-value of* 0.045 and an OR of 1.765. This means that regions with better funding are 1.76 times more likely to achieve immunization resilience. This confirms the importance of sufficient financial support to strengthen immunization programs.

6. Surveillance Sensitivity

Surveillance sensitivity did not have a significant effect on immunization resilience, with a *p-value* of 0.383 and OR of 0.781. This value indicates that the level of surveillance sensitivity is not enough to affect immunization resilience, so further evaluation of the role of surveillance in immunization programs is needed.

7. Completeness and Accuracy of Reports Completeness and accuracy of reports also showed no significant effect, with a *p-value* of 0.621 and OR of 0.834. This finding suggests that report quality has not been a major factor in supporting immunization resilience in the study areas.

8. Good Governance

Good governance has a significant effect on immunization resilience, with a *p-value* of 0.011 and an OR of 2.038. This indicates that regions with good governance are twice as likely to achieve immunization resilience. Effective governance can strengthen health systems and immunization program implementation.

9. Human Resource for Immunization Human resources for immunization showed a significant effect, with a *p-value* of 0.025 and an OR of 1.872. This means that the availability of adequate immunization personnel can increase the chance of immunization resilience by 1.87 times. Competent health workers are essential for immunization success.

10. Measles Surveillance HR Human resources for measles surveillance also has a significant influence on immunization resilience, with a *p-value* of

0.027 and an OR of 1.816. This indicates that regions with adequate surveillance personnel have a 1.82 times greater chance of achieving immunization resilience. The presence of reliable surveillance personnel helps early detection and treatment of measles-rubella cases.

Overall, significant variables include measles-rubella cases, immunization coverage, budget, funding, governance, and availability of immunization and surveillance human resources. Meanwhile, the percentage of alerts, surveillance

sensitivity, and completeness of reports do not have a significant effect on immunization resilience, so they need to be further reviewed.

Summary Table of Associations of Independent Variables with measles-rubella immunization resistance (After dropping/step3)

Variables	**P-value**	**OR**	**95% CI**	
			Lower	upper
Measles rubella cases	0,015	2,014	1,144	3,545
Measles rubella immunization coverage	0,017	1,916	1,123	3,269
Budget	0,030	1,856	1,063	3,241
Funding	0,033	1,823	1,05	3,165
Good government	0,010	2,050	1,189	3,532
Immunization human resources	0,013	1,968	1,151	3,365
Measles surveillance human resources	0,023	1,841	1,089	3,11

The following is the interpretation of the results of the table analysis of the relationship between independent variables and measles rubella immunization resistance after simplification (step 3):

1. Measles Rubella Cases The measles rubella case variable has a *p-value* of 0.015, indicating a significant relationship with immunization resilience. *The Odds Ratio* (OR) value of 2.014 with 95% confidence interval (1.144-3.545) indicates that areas with measles rubella cases are 2 times more likely to achieve immunization resilience compared to areas without cases. This confirms that the presence of cases is a trigger to strengthen the implementation of immunization programs.

2. Measles Rubella Immunization Coverage Measles rubella immunization coverage showed a significant effect on immunization resilience, with a *p-value* of 0.017 and an OR of 1.916 (95% CI: 1.123-3.269). This means that every increase in immunization coverage almost doubles the chance of achieving immunization resilience. Good immunization coverage is an important factor in achieving herd immunity.

3. Budget

The budget variable has a significant effect on immunization resilience, with a *p-value* of 0.030 and an OR of 1.856 (95% CI: 1.063-3.241). This indicates that each increase in the budget for immunization programs increases the likelihood of achieving immunization resilience by 1.86 times. Adequate budget is needed to support effective immunization implementation.

4. Funding

Funding had a significant association with immunization resilience, with a *p-value* of 0.033 and an OR of 1.823 (95%

CI: 1.05-3.165). Regions with better funding were 1.82 times more likely to achieve immunization resilience. This emphasizes the importance of allocating sufficient financial resources to support immunization programs.

5. Good Governance

Good governance showed a significant effect on immunization resilience, with a *p-value* of 0.010 and an OR of 2.050 (95% CI: 1.189-3.532). This means that regions with good governance are 2 times more likely to achieve immunization resilience. Good governance includes effective planning, implementation, and supervision of immunization programs.

6. Human Resources for Immunization The availability of immunization human resources has a significant association, with a *p-value* of 0.013 and an OR of 1.968 (95% CI: 1.151-3.365). This indicates that regions with adequate immunization human resources are 1.97 times more likely to achieve immunization resilience. The availability and competency of health workers are critical to the successful implementation of immunization.

7. Measles Surveillance HRH Human resources for measles surveillance showed a significant association with immunization resilience, with a *p-value* of 0.023 and an OR of 1.841 (95% CI: 1.089-3.11). Regions with adequate surveillance personnel were 1.84 times more likely to achieve immunization resilience. Reliable surveillance human resources help early detection and monitoring of immunization implementation.

CONCLUSION

The analysis shows that all remaining independent variables (measles rubella cases, immunization coverage, budget, funding, good governance, immunization human resources, and measles surveillance human resources) have a significant influence on measles rubella immunization resilience. These variables are key factors in supporting the achievement of an effective and sustainable immunization program.

Overall, most of the independent variables showed a significant influence on measles rubella immunization resilience at the district level, except for the variables of percentage of alerts responded and surveillance sensitivity which were not significant. This indicates the importance of factors such as immunization coverage, budget, funding, report completeness, government quality, and human resource capacity in supporting immunization resilience.

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