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CORRELATION STUDY OF CLIMATOLOGICAL FACTORS WITH THE INCIDENCE OF ACUTE RESPIRATORY INFECTIONS IN TODDLERS IN KENDARI CITY IN 2020-2024

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ABSTRACT

Background: *Acute Respiratory Tract Infection (ARI) is a common infectious disease and can be caused by viruses, bacteria, or fungi. Toddlers are an age group that is vulnerable to ARI. The tropical climate conditions of Kendari City with high temperatures and humidity and seasonal rainfall variations have the potential to affect the incidence of ARI in toddlers.* ***Methods:*** *This study is a descriptive quantitative research with an ecological study design using aggregate population-level data. This study aims to determine the strength and direction of the relationship between climatological factors and the incidence of ARI in toddlers in Kendari City, Southeast Sulawesi Province.* ***Results:*** *Tropical climate stability causes variations in climatological factors to be within the normal range, so that the incidence of ARI in toddlers is more influenced by non-climatological factors such as environmental conditions and children's health status.*

KEYWORDS: *Acute Respiratory Infections (ARI), Climate, Correlations, Regression Analysis.*

INTRODUCTION

Globally, acute respiratory infections (ARI) is still a major health problem that includes upper respiratory infections (URI) and lower respiratory infections (LRI). Based on the Global Burden of Disease Study 2021, it is estimated that there are around 12.8 billion URI

events in all age groups in the world with an incidence rate of 162,484.8 per 100,000 population, indicating the high frequency of mild ARIs in the community (1) Meanwhile, for LRI, around 344 million new incidents were reported globally in 2021 with the number of deaths reaching around 2.18 million people, including more than 500,000 deaths in children under five, so that LRI is the most severe form of ARI and contributes greatly to child deaths. The highest burden of ARIRIA was found in low- and middle-income countries as well as in the age group of toddlers who had a more vulnerable immune system (2).

According to the results of the 2023 Indonesian Health Survey (SKI) from the Ministry of Health of the Republic of Indonesia (Kemenkes RI), the prevalence of Acute Respiratory Infections (ARI) at all ages is 23.5%. This figure shows that almost 1 in 4 Indonesians have experienced ARI. Meanwhile, the highest prevalence of Acute Respiratory Infections (ARI) is found in toddlers at 34.2% (3) The Southeast Sulawesi Health Profile notes that by 2024, acute upper respiratory tract infections will be among the 10 diseases with the highest mortality causing 229 deaths. Kendari City ranks second for non-pneumonia ARI cases in Southeast Sulawesi Province in 2024. The prevalence of non-pneumonia cases of ARI is 17.01% (4)

ARI occurs when a virus or bacteria enters the respiratory tract through droplets, attaches to mucosal epithelial cells, and then multiplies thereby damaging the protective layer of the airways. This process triggers an immune response in the form of the release of inflammatory mediators that cause inflammation, increased mucus production, and narrowing of the airways, resulting in symptoms such as cough, cold, fever, and shortness of breath; In severe conditions it can develop into bronchitis or pneumonia (5).

Acute Respiratory Infections (ARI) that occur repeatedly in toddlers can trigger a continuous inflammatory process in the airways, especially in the anatomically developed bronchial mucosa. This recurrent inflammatory condition causes damage to the bronchial epithelial layer as well as a buildup of secretions that interfere with the pulmonary defense mechanism. As a result, toddlers' lungs become more susceptible to secondary bacterial infections such as Streptococcus pneumoniae and Haemophilus influenzae, which are the leading causes of pneumonia in children (6).

Climate change can impact human health through either directly or indirectly. The direct impact occurs due to exposure to changes in weather patterns, such as changes in air

temperature, rainfall, sea level rise, and increasing frequency of extreme weather events (7) These variations in temperature, humidity, and rainfall have the potential to create an environment that supports the growth of infection-causing microorganisms and reduces the immune system of toddlers, especially because the immune system of early childhood is still not optimally developed. The combination of hot and humid tropical climate factors, plus weather instability between years, can affect air quality and increase the risk of exposure to respiratory infection agents, thus contributing to the high susceptibility of toddlers to the incidence of Acute Respiratory Infections (ARI) in Kendari City (8).

Although several previous studies have described the trend of the incidence of ARI in several areas, studies that examine climatological factors such as air temperature, air humidity and rainfall with the incidence of ARI in toddlers in Kendari City are still limited. The characteristics of the tropical climate of Kendari City with relatively high temperatures, high humidity, and seasonal rainfall variations from year to year have the potential to affect the incidence of ARI in toddlers. ARI often occurs in children, especially toddlers, and has a high mortality rate in developing countries. Therefore, researchers are interested in finding out the correlation between climatological factors including air temperature, air humidity and rainfall with the incidence of ARI in toddlers in Kendari City in 2020-2024.

METHOD

This research is a descriptive quantitative research with an ecological study design with an analysis unit in the form of aggregate population level data. Ecological studies are used to investigate the relationship between exposure at the population level and health outcomes at the population level. This study aims to determine the correlation between climatological factors and the incidence of ARI in toddlers, namely to determine the strength and direction of the relationship in the research variables.

The sample in this study is aggregate data on the incidence of Acute Respiratory Infections (ARI) in toddlers in Kendari City in 2020-2024 which is available at the Kendari City Health Office. The Dependent Variable in this study is the incidence of ARI in toddlers in Kendari City.The Independent Variable in this study is climate factors in the form of air temperature, air humidity, and rainfall. This research began from the collection of secondary data at BMKG Southeast Sulawesi Climatology Station and the Kendari City Health Office.

The data analysis in this study is univariate and bivariate analysis. Bivariate analysis was carried out using linear regression and correlation tests to assess the strength of the relationship between variables, where correlation tests were also used to determine the direction of the relationship between two variables.

RESULT

Table 1. Results of Descriptive Analysis of Research Variables.

Variabel	Mean	SD	Minimum-Maximum
Air Temperature	27, 41	0,87	25,10 – 29,10
Air Humidity	85,45	2,90	79 – 91
Rainfall	181,88	115,27	0 – 499,6
Incidence of ARI in Toddlers	591,48	232,07	158 – 1.195

Based on table 1, the results of descriptive statistical analysis showed that the average air temperature in Kendari City during the study period was 27.41°C with a standard deviation of 0.87°C, indicating a relatively small temperature variation. The air humidity has an average of 85.45% with a standard deviation of 2.90%, which describes air conditions that tend to be humid throughout the year. The average rainfall was recorded at 181.88 mm with a fairly high variation (SD = 115.27 mm), which shows fluctuations in rainfall between months. Meanwhile, the average incidence of ARI in toddlers is 591.48 cases per month, with a minimum value of 158 cases and a maximum of 1,195 cases, which indicates a considerable variation in the incidence of ARI during the observation period.

Classic Assumption Test

Linearity Test

Table 2. Linearity Test Results.

Deviation from Linearity	
	Sig.
Incidence of ARI in toddlers*Air Temperature	0,091
Incidence of ARI in Toddlers*Air Humidity	0,376
Incidence of ARI in toddlers*Rainfall	0,301

Based on table 2, the results of the linearity test showed that the significance value of Deviation from Linearity in the relationship between the incidence of ARI in toddlers with air temperature (0.091), air humidity (0.376), and rainfall (0.301) were all greater than 0.05. This shows that the relationship between independent variables and the incidence of ARI in toddlers is linear, thus meeting the prerequisites for multiple linear regression analysis.

Residual Normality Test

Table 3. Residual Normality Test.

One-Sample Kolmogorov-Smirnov Test	
	Unstandardized Residual
Quantity (n)	60
Asymp. Sig. (2-tailed)	0,200

Based on table 3, the results of the Kolmogorov–Smirnov test show the value of Asymp. Sig. (2-tailed) of 0.200 which is greater than the significance value of 0.05. This shows that the residual is normally distributed, so that the assumption of normality is fulfilled and the multiple linear regression analysis can be continued.

Multicollinearity Test

Table 4. Multicollinearity Test.

Model		**Collinearity Statistics**	
		Tolerance	**VIF**
1	Transform_X1	0,939	1,065
	Transform_X2	0,615	1,626
	Transform_X3	0,630	1,588

Based on table 4, the results of the multicollinearity test showed that all independent variables had a tolerance value of > 0.10 and a VIF value of < 10. The variables of air temperature (VIF 1.065; tolerance 0.939), air humidity (VIF 1.626; tolerance 0.615), and rainfall (VIF 1.588; tolerance 0.630) were declared not to experience multicollinearity. Thus, it can be concluded that there is no multicollinearity between independent variables.

Multicollinearity Test

Table 5. Hetterokedasticity Test.

Model		**Say.**
1	(Constant)	0,106
	Transform_X1	0,477
	Transform_X2	0,119
	Transform_X3	0,297

Based on Table 4.5, the variables of air temperature, air humidity, and precipitation each have a Sig. value of > 0.05, so there is no heteroscedasticity. Thus, the assumption of homoskedasticity is fulfilled.

Multiple Linear Regression Analysis

After all classical assumptions were met, multiple linear regression analysis was carried out to determine the relationship between climatological factors and the incidence of ARI in toddlers to assess the direction of the relationship of each independent variable to the dependent variable and form a regression equation. The results of the analysis are presented in the following regression coefficient table:

Table 6. Multiple Linear Regression Analysis Results.

Coefficients		
del		**B**
1	(Constant)	8102,489
	Transform_X1	64,916
	Transform_X2	-3977,614
	Transform_X3	37,030

Based on table 6, the results of multiple linear regression analysis were obtained from the following regression model:

Y = 8102.489 + 64.916X1 + (-3977.614)X2 + 37.030X3

Where:

Y = Incidence of ARI in Toddlers

X1 = Air Temperature

X2 = Air Humidity

X3 = Rainfall

Based on the multiple linear regression model above, the following information is obtained:

1. The constant is 8102.489 which means that if there is no change in the value of X1 to X3, then the variable of ARI incidence in toddlers is 8102.489.
2. The regression coefficient on the air temperature variable was 64.916 and had a positive value. This shows that every one unit increase in air temperature, assuming other independent variables remain constant, correlates with an increase in the incidence of ARI in toddlers by 64,916 units. This relationship is positive, which means that an increase in air temperature tends to be followed by an increase in the incidence of ARI in toddlers.
3. The regression coefficient in the air humidity variable was –3977.614 and had a negative value. This shows that every one unit increase in air humidity, assuming other independent variables remain constant, correlates with a decrease in the incidence of ARI

in toddlers by 3977,614 units. This relationship is negative, meaning that an increase in air humidity is likely to be followed by a decrease in the incidence of ARI in toddlers.

4. The regression coefficient in the rainfall variable was 37.030 and had a positive value. This shows that each one unit increase in precipitation, assuming other independent variables remain constant, correlates with an increase in the incidence of ARI in toddlers by 37,030 units. This association is positive, which means that increased rainfall is likely to be followed by an increase in the incidence of ARI in toddlers.

Uji Hypothesis

Simultaneous Test (F Test)

Table 7. Simultaneous Test (F Test)

ANOVA						
Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Say.**
1	Regression	148850,566	3	49616,855	0,917	0,438
	Residual	3028860,417	56	54086,793		
	Total	3177710,983	59			

Based on table 7, the results of the F test showed a significance value of 0.438 > 0.05. This shows that simultaneously the climatological factors studied did not have a significant effect on the incidence of ARI in toddlers in Kendari City in 2020-2024.

Partial Test (t-test)

Coefficients		
Model		**Say.**
1	(Constant)	0,207
	Transform_X1	0,977
	Transform_X2	0,134
	Transform_X3	0,648

Source: SPSS Partial Test Results, 2025

Based on table 8, the results of the t-test show that all independent variables have a significance value of > 0.05. Thus, it can be concluded that partially, air temperature, air humidity, and rainfall do not have a significant effect on the incidence of ARI in toddlers in Kendari City in 2020-2024.

Coefficient of Determination Test (R2)

Table 8. Coefficient of Determination Test (R2)

Model Summaryb				
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
1	0,216	0,047	-0,004	232,566

Based on table 9, the results of the determination coefficient test showed an R Square value of 0.047 indicating that the variables of air temperature, air humidity, and rainfall together were only able to explain 4.7% of the variation in the incidence of ARI in toddlers. Given that regression models involve more than one independent variable, the primary interpretation refers to the Adjusted R Square value. The Adjusted R Square value of -0.004 indicates that the multiple linear regression model used has not been able to explain the variation of bound variables, so the relationship between free variables and bound variables is very weak.

DISCUSSION

Correlation of Air Temperature with the Incidence of Childhood Obesity in Toddlers in Kendari City in 2020-2024

Air temperature is a measure of the cold, heat, and conditions of an environment. Temperature can be affected by sunlight, the presence of ventilation, occupancy density, humidity, indoor activities, and more. If the air temperature is right not too cold and not too hot, then the environment will also be comfortable to use for activities (9). The monthly average air temperature in Kendari City during the 2020-2024 period sourced from the BMKG Climatology Station of Southeast Sulawesi Province shows a relatively uniform pattern of fluctuations between years. In general, air temperatures tend to be higher at the beginning of the year (January–March), then decrease in the middle of the year, especially in June–August, before increasing again towards the end of the year (October–December). The drop in temperature in the middle of the year is thought to be related to increased cloud cover and precipitation that can reduce the intensity of solar radiation. Meanwhile, the increase in temperature at the end of the year was influenced by relatively sunnier weather conditions and reduced rainfall. Although there are variations between years, the monthly average temperature range is still relatively stable, reflecting the characteristics of the tropical climate in Kendari City which tends to be warm throughout the year (10).

Air temperature has an important role in human health because changes in temperature that are high enough or low can make the body work harder to adjust to the environment (11) Temperature changes can affect the immunity of toddlers and the survival of microorganisms that cause ARI in the environment. Air temperatures that are too low or too high can affect the condition of the respiratory tract. Cold temperatures can cause the airways to become drier and narrower, reducing the body's ability to filter and fight infection-causing germs (12).

The results of multiple linear regression analysis found that air temperature was not significantly correlated with the incidence of ARI in toddlers in Kendari City during the study period. This indicates that the air temperature variation that occurs is not strong enough to have a direct influence on the increase or decrease in the incidence of ARI in toddlers, especially after controlling with other climatological variables, namely air humidity and rainfall.

Temperatures in Kendari City are in a relatively narrow range and stable throughout the year, without very hot or very cold temperatures. This condition reflects a warm and consistent tropical climate, so the temperature changes that occur are still within the limits that can be tolerated by the body. The impact of temperature on health generally becomes apparent when extreme temperatures occur, whereas in moderate temperature ranges, the effect on health tends to be weakened or even statistically undetectable (13).

Correlation of Air Humidity with the Incidence of ARI in Toddlers in Kendari City in 2020-2024

Air humidity is a measure that expresses the amount of water vapor in the atmosphere. Air humidity is a term used to indicate the amount of water vapor contained in the air at a certain time and place. The more moisture in the air, the wetter the air condition, whereas the less water vapor, the drier the air. Air humidity is one of the important climatic elements because it influences the occurrence of atmospheric phenomena such as the formation of clouds and rain, and plays a major role in the weather characteristics of a region (14).

The monthly average air humidity in Kendari City during the 2020-2024 period sourced from the BMKG Climatology Station of Southeast Sulawesi Province shows a relatively uniform pattern of fluctuations between years. In general, air humidity tends to be higher in the early to mid-year, especially in January-June, then decreases in the middle to the end of the year,

especially in the August-October period, before increasing again towards the end of the year. The decrease in air humidity in that period is thought to be related to reduced rainfall and increased drier air conditions during the dry season. Meanwhile, the increase in humidity at the beginning and end of the year is influenced by high rainfall and the intensity of cloud formation. Although there are variations between years, the monthly average air humidity range is still relatively high, reflecting the characteristics of the humid tropical climate in Kendari City (10).

The results of multiple linear regression analysis showed that air humidity was not significantly correlated with the incidence of ARI in toddlers in Kendari City during the study period. This shows that the variation in air humidity that occurs is not strong enough to directly affect the occurrence of ARI, especially after being controlled with other climatological variables, namely air temperature and precipitation.

The pattern of incidence of ARI in toddlers in Kendari City from 2020–2024 did not show a consistent relationship with monthly air humidity variations. Months with relatively high humidity are not always followed by a consistent spike in ARI cases every year, and on the other hand, periods of declining humidity are also not always followed by a clear decline in ARI cases. High humidity is a relatively normal tropical climate condition and does not always cause a direct spike in ARI cases. At too low humidity, the airway mucus becomes dry so that the body's ability to clean germs decreases, while at stable high humidity such as in the tropics, the airway protection function remains normal. In addition, many respiratory viruses actually survive more easily at low humidity than at high humidity. Therefore, high humidity conditions that have become normal and do not experience extreme spikes are not always followed by an increase in the incidence of ARI. Although air humidity affects respiratory function and symptoms, its impact on the incidence of respiratory diseases is often influenced by other factors such as air pollution, space ventilation, and allergic exposure, so the weak correlation between air humidity and ARI in the Kendari data is consistent with the finding that the relationship between humidity and the risk of respiratory infections is not always simple or significant in general (15).

Correlation of Rainfall with the Incidence of ARI in Toddlers in Kendari City in 2020-2024

Rainfall is the amount of rainwater that falls to the earth's surface over a period of time and is usually expressed in millimeters (mm), where one millimeter of rainfall is equivalent to one

millimeter-high rainwater falling on a flat surface of one square meter. Rainfall data is essential in climate analysis because it helps to understand the precipitation patterns of an area, from the rainy season to the dry season, as well as describe the dynamics of atmospheric changes over a period of time (16).

The monthly average rainfall in Kendari City during the 2020–2024 period sourced from the BMKG Climatology Station of Southeast Sulawesi Province shows a relatively consistent pattern of seasonal fluctuations between years. In general, rainfall tends to increase at the beginning of the year, especially in January–March, which reflects the peak of the rainy season. Furthermore, rainfall decreased in the middle of the year, especially in the June-August period, before increasing again towards the end of the year in November-December. The decrease in rainfall in the middle of the year is related to the dominance of the dry season which is characterized by a reduction in the formation of rain clouds. Meanwhile, the increase in rainfall at the end of the year is influenced by the change of seasons (pancaroba) which triggers an increase in convective activity and the formation of rain clouds. Although there is variation in rainfall intensity between years, the monthly patterns formed are relatively uniform, reflecting the characteristics of the wet tropical climate in Kendari City which is influenced by the monsoon system (10).

High rainfall tends to lead to increased moisture at the ground and air surface, as well as changes in people's daily activity patterns, which in turn affect individual interactions with the microenvironment inside and outside the home. Rainfall is thought to be able to affect the deposition of pollutants from the air and change the condition of aerosols inhaled by toddlers, Rainfall as an environmental variable has the potential to be one of the factors that affect the dynamics of respiratory diseases in young age groups, but the effects are often complex and influenced by other accompanying environmental conditions (17).

The results of multiple linear regression analysis showed that rainfall was not significantly correlated with the incidence of ARI in toddlers in Kendari City during the study period. These findings show that changes in rainfall that occur do not have a direct effect on the increase or decrease in the incidence of ARI in toddlers.

Rainfall in Kendari City tends to fluctuate every month with a relatively normal pattern of ups and downs as a characteristic of the tropical climate. However, the variation in monthly rainfall was not followed by a consistent change in the incidence of ARI in toddlers. Changes

in rainfall from month to month do not necessarily have a direct impact on the health of the respiratory tract of toddlers. Biologically, the incidence of ARI is more influenced by the child's immune system, nutritional status, and daily environmental exposure, so that the body of toddlers does not directly respond to short-term rainfall fluctuations. Rainfall can affect humidity and activity in the house, these influences are often indirect and weak, so in the regression analysis the relationship between rainfall and ARI tends to be not statistically significant (18).

CONCLUSION

Air temperature, air humidity, and precipitation did not show a significant correlation with the incidence of ARI in toddlers in Kendari City during the 2020–2024 period. The stability of the tropical climate causes the variation of climatological factors to be in the normal range, so that the incidence of ARI in toddlers is more influenced by non-climatological factors such as environmental conditions and children's health status.

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