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The Analysis of Parameter Climate Impact on the Incidence of Pneumonia in Central Kalimantan

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A B S T R A C T

This study analyzes the impact of climate change—specifically temperature, humidity, rainfall, and wind speed—on pneumonia incidence and mortality in Central Kalimantan from 2015 to 2024. Using a retrospective cohort design, the study finds a significant relationship between climate parameters and both pneumonia incidence and mortality rates (p-value 0.000 < 0.05). The findings highlight that climate change poses serious health risks, particularly for vulnerable groups like children, the elderly, and individuals with chronic illnesses, by weakening the immune system and worsening air quality.

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INTRODUCTION

Climate change is the greatest health threat faced by all of humanity, including the increased risk of respiratory system disorders. The instability of temperature, wind direction, and humidity due to climate change also reduces air quality, accelerates the spread of pathogens, and weakens the immune system, thereby increasing susceptibility to respiratory infections. The rise in global temperatures due to climate change creates environmental conditions that support the growth of pneumonia-causing pathogens, such as the bacterium Streptococcus pneumonia and the influenza virus, which more easily attack individuals with weak immune systems, especially children and the elderly, both directly and indirectly, worsening the risk of pneumonia (Ebi & Mills, 2013). Additionally, the unpredictable changes in rainfall patterns, especially the increased intensity of extreme rainfall, heighten the risk of flooding. Floods can create stagnant water that becomes a breeding ground for disease-causing microorganisms, including bacteria and viruses associated with pneumonia (WHO, 2018). High humidity conditions indoors due to flooding also promote the growth of mold and other microorganisms that cause respiratory disorders (Smith et al.,2014).

Extreme temperatures, whether hot or cold, increase the risk of respiratory infections due to a weakened immune system caused by thermal stress (Ruchiraset, et al 2018). High humidity can support the growth of pathogenic microorganisms such as bacteria and viruses that cause pneumonia, while low humidity can dry out the respiratory tract, making it more susceptible to infection. High rainfall intensity is often associated with increased humidity and waterlogging, creating a conducive environment for microorganisms (Oluwatimilehin, et al 2022). Wind speed can affect the dispersion of air pollutants and infectious particles, including bacteria and viruses that cause pneumonia (Wenfang, et al 2020).

Main climate parameters such as air temperature, humidity, rainfall, and wind speed are undergoing significant changes. For example, the rise in temperature causes more frequent and prolonged heatwaves, while humidity in some areas increases due to high evaporation rates. Meanwhile, rainfall patterns have become irregular, with high rainfall intensity in some locations and severe drought in others. Changes in wind speed also affect atmospheric circulation, impacting the distribution of moisture and particles in the air (Kim, et al 2016).

Changes in these climate parameters contribute directly and indirectly to public health, including the increased risk of pneumonia. Air temperature creates a long-term warming trend (global warming). This warming affects the distribution of heat in the atmosphere, accelerates the evaporation process, and influences regional weather dynamics (Keswani, et al 2022). With the increase in temperature, the atmosphere's capacity to hold water vapor also increases. In certain regions, this causes high humidity that contributes to atmospheric instability, while in other areas it can worsen dry conditions (Oluwatimilehin, et al 2022). Changes in rainfall patterns often occur due to rising sea and atmospheric temperatures. Some regions experience heavier rainfall and flooding, while others experience extreme drought (Veenema, et al 2022).

In 2019, pneumonia accounted for 14% of total deaths among children under 5 years old, with the death toll reaching 740,180 (WHO, 2023). In Indonesia, the prevalence of pneumonia increases with age: 2.5% in the 55-64 age group, 3.0% in the 65-74 age group, and 2.9% in those aged 75 and above (Riskesdas, 2018). In Central Kalimantan Province, pneumonia is a public health issue that requires serious attention and more prompt handling. The geographical and climatic conditions of Central Kalimantan, dominated by tropical regions with variations in temperature, humidity, rainfall, and wind speed, have the potential to influence the increase in the incidence of pneumonia. Data from the Central Kalimantan Provincial Health Office for the period from 2015 to 2024 recorded fluctuations in pneumonia cases across all districts and cities. This data shows that several regions experienced spikes in cases in certain years, which are suspected to be related to the dynamics of local climatic factors. The highest number of pneumonia cases came from Kotawaringin Barat Regency with 2,844 cases, Murung Raya Regency with 1,306 cases, and Sukamara Regency with 973 cases.

The Regional General Hospital dr. Doris Sylvanus Palangka Raya is the only referral hospital for 13 districts and 1 city. This hospital not only serves as a referral hospital but is also the first educational hospital owned by the government in Central Kalimantan, providing comprehensive individual health services that include inpatient, outpatient, and emergency care. Data from the Regional General Hospital dr. Doris Sylvanus Palangka Raya from the year 2015 to 2024 shows fluctuations in pneumonia cases from 2015 to 2024. The data indicates that the highest number of pneumonia cases occurred in 2021, with 656 cases, followed by 640 cases in 2024 and 584 cases in 2018.

Pneumonia management in Indonesia has primarily focused on the toddler age group. This focus is based on data from the Indonesian Ministry of Health, which states that pneumonia remains the leading cause of death among children under five in Indonesia (Ministry of Health of the Republic of Indonesia, 2023). National programs such as the provision of pneumococcal immunization and strengthening child health services have been prioritized steps to reduce the morbidity and mortality rates due to pneumonia in this age group.

However, epidemiological data in Central Kalimantan suggests that pneumonia cases are not only prevalent among toddlers but also show high prevalence in other groups such as infants, toddlers, preschoolers, young children, adolescents, young adults, middle-aged adults, pre-elders, and the elderly. These vulnerable groups are affected by various factors, including declining health conditions, the presence of comorbidities, and exposure to extreme climate change, such as rising temperatures and high humidity (Provincial Health Office of Central Kalimantan, 2023). This phenomenon indicates that the distribution pattern of pneumonia cases in Central Kalimantan differs from the national distribution pattern. Given the differing characteristics of vulnerable groups in Central Kalimantan, it is important to develop pneumonia management strategies that do not solely focus on toddlers but also address the needs of infants, toddlers, preschoolers, children, adolescents, young adults, middle-aged adults, pre-elders, and the elderly. Efforts that can be made include improving early detection, providing easily accessible health services, and educating the community about pneumonia risk factors in these various age groups. A locally-based data approach will be key to ensuring that interventions are more targeted and effective in reducing case numbers.

Nationally, pneumonia management policies in Indonesia have not yet optimally involved various stakeholders related to climate data and information, such as the Meteorology, Climatology, and Geophysics Agency (BMKG). Handling pneumonia has largely been centered on medical aspects through health sector interventions, such as increasing immunization coverage, strengthening primary health services, and community education (Ministry of Health of the Republic of Indonesia, 2023). Cross-sectoral involvement, especially agencies responsible for providing climate data, remains very limited. However, research findings in Central Kalimantan show a significant correlation between climate parameters and the increase in pneumonia cases, particularly among vulnerable groups such as the elderly. These findings highlight the important role of climate data in planning prevention programs and mitigating health risks, especially pneumonia in areas vulnerable to climate change. Regular utilization of climate data will assist local governments and health workers in anticipating potential surges in pneumonia cases, particularly during extreme weather periods. Therefore, cross-sectoral cooperation, especially between health authorities and BMKG, is needed to support early warning systems and integrate climate data into health programs. It is hoped that this policy will enhance the effectiveness of pneumonia management to be adaptive and aligned with the environmental conditions of the region.

THEORETICAL REVIEW

Wenfang et al (2020) Research "Assessing the Effects of Meteorological Factors on Daily Children's Respiratory Disease Hospitalizations: A Retrospective Study" This study uses distributed lag non-linear models to analyze the impact of temperature, humidity, wind speed, and net effective temperature (Net Effective Temperature - NET) on the number of children hospitalized due to respiratory diseases, considering differences in age, gender, and type of infection. The research results indicate that meteorological factors such as temperature, humidity, and wind speed have a greater impact on lower respiratory tract infections compared to upper respiratory tract infections. Girls and the age group of 4–7 years are more vulnerable to the effects of temperature and wind speed, while humidity more affects the age group of 0–3 years. In addition, the NET value was found to significantly affect lower respiratory tract infections.

Demoury et al (2022) study titled "Impact of Short-Term Exposure to Extreme Temperatures on Mortality: A Multi-City Study in Belgium. The research shows that exposure to extreme heat is associated with an increase in mortality rates, especially among vulnerable groups such as the elderly and individuals with certain medical conditions. On the other hand, extreme cold temperatures also show a negative impact on mortality, with more pronounced effects during the winter. However, the effects of cold temperatures are not as strong as those of hot temperatures. Extreme temperatures, both hot and cold, have the potential to increase short-term mortality rates in Belgium. This effect is stronger in more vulnerable populations, such as the elderly and people with chronic illnesses. This study emphasizes the importance of mitigation measures to reduce the impact of extreme temperatures on public health, especially in urban areas with more fluctuating temperatures.

The research by Bahrami et al. (2022) explores the impact of climate change on respiratory health, specifically the correlation between climate parameters and the incidence of SARS in Iran. This study uses retrospective data from 2016 to 2018, which includes climate parameters (such as temperature, rainfall, and humidity) as well as the distribution of SARS cases across various climate zones in Iran. Neural Network and Multivariate Poisson Regression models were used to analyze this correlation. The research results indicate that an increase in daily minimum temperature and rainfall significantly raises the risk of SARS, both in men and women. Projections based on the RCP 4.5 (Representative Concentration Pathways) scenario indicate that changes in the geographical distribution of SARS in Iran will occur due to changes in climate parameters, with an estimated increase in cases of 36% between 2020 and 2050.

The research by Samweli et al. (2021) titled "Analysis of Pneumonia Occurrence in Relation to Climate Change in Tanga, Tanzania" explores the correlation between climate indicators and the incidence of pneumonia in the Tanga region, Tanzania. This study used a time-series design based on meteorological and health data from January 2016 to December 2018.The analyzed climate data includes rainfall, temperature, and humidity, which are then correlated with monthly pneumonia case data. Chakraborty et al (2022) identified that seasonal changes, such as increased rainfall and cold temperatures during the rainy or winter seasons, can worsen the incidence of pneumonia. This is related to the decline in the immune system triggered by extreme weather conditions and lifestyle changes during certain seasons.

METHODOLOGY

This study uses quantitative research with an observational analytic design, employing the retrospective cohort study method. Retrospective cohort study is a type of observational study where researchers assess the correlation between exposure or risk factors and outcomes using existing data from the past. Data were collected over a 10-year period from 2015-2024, from January 2015 to December 2024. All data were collected from existing sources, such as climate parameter data, medical records, health databases, or other archives, which recorded risk factors and outcomes that occurred in the past. Data collection from dr. Doris Sylvanus General Regional Hospital in Palangka Raya is the only referral hospital for 13 districts and 1 city.

Climate Data:

1) Maximum Temperature (Tx) °C: Daily, weekly, or monthly air temperature data that can be obtained from the Tjilik Riwut meteorological station.
2) Average Humidity (RH_avg) %: Air humidity data collected simultaneously with temperature data from the Tjilik Riwut meteorological station.
3) Rainfall (RR) mm: Rainfall data measured in millimeters per day or month from the Tjilik Riwut meteorological station.
4) Average Wind Speed (ff_avg) m/s: Wind speed data that can be obtained from the Tjilik Riwut meteorological station weather station.

Pneumonia Incidence Data

1) Pneumonia Case Data: Database of the Provincial Health Office, City Health Office, Medical Record Database of RSUD dr. Doris Sylvanus Palangka Raya because it is the referral hospital for all patients in Central Kalimantan.

Statistical Analysis

Data were entered into SPSS (SPSS Statistic, Version 26, IBM). Multiple Linear Regression is used to analyze the correlation between climate parameters (minimum temperature, maximum temperature, average humidity, rainfall, and average wind speed). The analysis used is descriptive analysis to describe the characteristics of the data, such as: mean, median, standard deviation for temperature, humidity, rainfall, and pneumonia incidence. The frequency distribution of pneumonia cases in various climate categories (for example, summer versus rainy season).

RESEARCH RESULTS

Maximum Temperature (Tx) Year 2015-2024

The highest maximum temperature (Tx) data in October 2019 showed a result of 37.70°C, and the lowest in March 2021 showed a result of 25.50°C, with an average maximum temperature (Tx) over 10 years showing a result of 31.70°C.The highest maximum temperature (Tx) in 2023 was 33.20°C, and the lowest maximum temperature (Tx) in 2018 was 28.70°C.

Table 1. Maximum Temperature Data (Tx) 2015-2024

No	Month	Year										
		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Total
1	January	32,8	32,6	32,5	29,9	31,3	31,4	35,5	32,5	31,3	31,6	32,14
2	February	29,3	32,1	30,5	29,3	31,1	31,3	30,4	31,1	31	32,6	30,87
3	March	30,3	33,2	31,2	28,1	32,6	32,9	22,5	32,7	32,4	32,8	30,87
4	April	29,2	29,9	32,5	29,8	32,5	32,8	33,4	32,5	33,2	33,1	31,89
5	May	29,8	32,1	30,5	28,8	33,5	30,8	32,8	31,8	33,9	33,2	31,72
6	June	31,7	32,3	25,7	30,5	30,2	29,1	31,9	31,1	33,2	32,3	30,8
7	July	33,2	32,2	27,7	24,1	29,9	31,3	32,6	32,5	32,9	32,1	30,85
8	August	28	31,5	30,9	32	31	31,6	32,4	32,3	33,3	32,7	31,57
9	September	26,6	33	27,8	26,6	32,6	32,9	31,9	32,2	34,3	34,6	31,25
10	October	32,5	32,8	33,3	30	37,7	32,8	33,5	32,2	35,4	33,1	33,33
11	November	33,6	32,8	28,9	28,2	32,3	32,8	32	52,6	34,3	33	34,05
12	December	32	30,7	27,1	26,9	31,5	31,4	32,5	32,4	33	33	31,05
Total		30,8	32,1	29,9	28,7	32,2	31,8	31,8	33,8	33,2	32,8	31,7

Source: Primary Data, 2015-2024

Average Humidity (RH_avg) Year 2015-2024

The highest average humidity (RH_avg) data in September 2020 showed a result of 88.8%, and the lowest in November 2019 showed a result of 28.8%, with the average humidity (RH_avg) over 10 years showing a result of 75.8%.The highest Average Humidity (RH_avg) in 2021 showed a result of 83.7%, and the lowest Average Humidity (RH_avg) in 2019 showed a result of 61.0%.

Table 2. Average Humidity Data (RH-avg) for 2015-2024

No	Month	Year										
		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Total
1	January	73,7	75,9	78,4	74,6	73,7	82,8	87,7	86,4	81,1	80,7	79,5
2	February	83,7	84	76	62,7	60,5	84,4	82,2	80,1	71,3	82,2	76,71
3	March	78,8	84,9	84,1	69,8	70,4	80,7	73,1	81,8	81,9	82,5	78,8
4	April	61,5	84,7	83,1	63,2	56	86,7	80,5	80,6	74,3	81,8	75,24
5	May	81,4	75,5	80,7	62,5	67,9	82,7	87,7	80,1	77,4	82,6	77,85
6	June	80,8	77,6	80,2	76,2	54,6	79,3	77,3	78,3	77,2	82,7	76,42
7	July	80,1	76,2	69,8	46,8	59,5	82,5	83,4	81,7	73,6	79,2	73,28
8	August	61,9	73,5	79,4	55,8	73,7	80,7	87,8	81,8	69,9	61,5	72,6
9	September	59,7	79,9	73,5	61,5	49,8	88,8	82,9	82,8	70	80,4	72,93
10	October	77,2	80,1	81,9	61,2	63,5	82,8	87,9	65,1	69,2	79,6	74,85
11	November	79,8	83	79,5	72,9	28,8	81,3	87,3	80,1	80,1	82,3	75,51
12	December	80,6	70,2	54,3	75,2	73,7	85,6	86,8	76,5	82,5	82,8	76,82
Total		74,9	78,8	76,7	65,2	61,0	83,2	83,7	79,6	75,7	79,9	75,9

Source: Primary Data, 2015-2024

Rainfall (RR) Year 2015-2024

The highest rainfall data (RR) in November 2021 showed a result of 1,197 mm, and the lowest in September 2015 showed a result of 0.0 mm, with the 10-year rainfall (RR) showing a result of 313.4 mm. The highest rainfall (RR) in 2020 recorded 516.0 mm, while the lowest rainfall (RR) in 2017 recorded 9.2 mm.

Table 3. Rainfall Data (RR) 2015-2024

No	Month	Year										
		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Total
1	January	1,156	12,8	11,4	875,5	869,2	16,1	10,3	871,4	296,1	7,8	297
2	February	16,1	15,1	5,6	919,7	323,1	621,7	321,7	930,1	620,7	15,7	379
3	March	13,8	581,4	15,3	587,5	299,5	871,1	300	583,2	303,1	15,7	357
4	April	898,2	14,8	7,9	310,3	305,4	309	4,5	602	10,2	7,4	247
5	May	870,5	9,4	15,3	29,1	575,7	296,6	293,5	20,6	250,5	297,3	266
6	June	4,5	12,2	10,7	300,2	1,2	300,6	302,3	8,2	299,4	595,9	184
7	July	287,7	291,5	4,3	291,5	0,2	862,4	291,5	2,299	866,9	289,2	319
8	August	287	6,1	3,9	289,1	1,9	290,6	1,725	1,150	287,7	1,150	117
9	September	0	601,9	2	593,1	1,8	301,7	597,7	305,3	595,6	597,8	360
10	October	300,1	869,6	7,7	291,7	292,5	867,8	865,7	9,8	291,2	866,4	466
11	November	310,1	601,2	13,6	1,193	300,7	589,6	1,197	605,3	305,6	13,9	274
12	December	8,5	860	13	870,6	298,4	865,3	866,9	6	583,7	586	496
Total		249,8	323,0	9,2	446,6	272,5	516,0	321,4	328,8	392,6	274,5	313,4

Source: Primary Data, 2015-2024

Average Wind Speed (ff_avg) 2015-2024

The highest average wind speed (ff_avg) data in August 2017 and September 2019 showed results of 2.6 m/s, while the lowest in July-October 2021 showed results of 1 m/s, with an average wind speed (ff_avg) over 10 years showing results of 1.9 m/s. The highest Average Wind Speed (ff_avg) in 2017 showed a result of 2.1 mm, and the lowest Average Wind Speed (ff_avg) in 2020 showed a result of 1.5 mm.

Table 4. Average Wind Speed Data (ff_avg) for the Years 2015-2024

No	Month	Year										
		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Total
1	January	2,2	1,8	1,8	2	1,7	1,8	1,9	1,8	2	1,7	1,87
2	February	1,7	1,8	2,3	2	1,7	1,9	1,7	1,8	2,1	1,8	1,88
3	March	1,9	1,6	2	1,9	2	1,7	1,8	1,9	2	1,7	1,85
4	April	2,2	1,9	1,9	1,9	1,6	1,7	1,9	1,9	1,9	1,9	1,88
5	May	1,9	1,9	1,9	1,8	1,9	1,6	1,6	1,8	1,8	1,7	1,79
6	June	1,9	1,8	1,9	1,8	1,9	1,7	1,7	1,7	1,8	1,8	1,8
7	July	1,9	1,9	2	2	2,5	1	1,7	1,6	2	2,3	1,89
8	August	2	2,1	2,6	2,2	2,5	1	1,8	2	2,3	2,1	2,06
9	September	1,9	1,9	2,3	2	2,6	1	1,8	2	2,2	2,3	2
10	October	1,6	2,2	2	1,9	2	1	1,8	2,1	1,8	2	1,84
11	November	1,7	2,1	1,8	2	1,9	1,9	1,8	2	1,7	2	1,89
12	December	1,8	2,2	2,4	2,2	1,9	2	1,7	2	1,7	2	1,99
Total		1,9	1,9	2,1	2,0	2,0	1,5	1,8	1,9	1,9	1,9	1,9

Source: Primary Data, 2015-2024

Incidence Rate of Pneumonia Cases from 2015-2024

The incidence data of pneumonia cases from 2015-2024 shows that the lowest number of pneumonia cases occurred in 2015, totaling 414 cases (7.05%), and the highest number in 2024, totaling 735 cases (12.5%), with a total of 5,872 cases (100%) over the 10-year period. The highest number of cases by month occurred in August 2020, with 115 cases (1.9%).

Table 5. Pneumonia Incidence Rate Data for the Years 2015-2024

No	Month	Year										
		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Total
1	January	20	21	30	42	24	66	21	35	27	40	**326**
2	February	22	20	33	59	38	83	42	51	38	55	**441**
3	March	30	31	36	56	51	64	65	74	63	65	**535**
4	April	32	32	38	83	56	43	90	86	70	82	**612**
5	May	36	35	39	54	34	46	65	51	43	52	**455**
6	June	35	37	36	48	28	43	81	54	45	66	**473**
7	July	37	38	41	54	37	43	52	68	63	85	**518**
8	August	36	37	43	50	39	115	67	56	49	53	**545**
9	September	40	41	48	61	44	51	79	61	47	55	**527**
10	October	42	42	54	48	35	25	3	54	43	55	**401**
11	November	40	40	56	60	46	34	79	48	35	60	**498**
12	December	44	46	60	70	51	40	75	52	36	67	**541**
Total		**372**	**379**	**451**	**584**	**421**	**504**	**656**	**604**	**494**	**640**	**5105**

Source: Primary Data, 2015-2024

The data normality test uses Shapiro-Wilk because the sample value N < 30. All variables were normally distributed so the Multiple Linear Regression test was conducted again, namely Collinearity Tolerance and VIF Statistics.

Table 6. Multiple Linear Regression Test Analysis Results the Impact of Climate Parameters on Pneumonia Incidence Rates

No	**Model**	**N**	***Standardized Coefficients***		
			Beta	***t***	***Sig.***
1	Temperature	10	.846	4.491	.002
2	Average Humidity	10	.852	4.600	.002
3	Rainfall	10	.976	12.649	.000
4	Average Wind Speed	10	.999	59.330	.001

Source: Author's Analysis Results, 2025

The climate parameter that has the highest correlation is rainfall with a Beta value of 0.976 and a sig. value of 0.000 and the climate parameter that has the lowest correlation is temperature with a Beta value of 0.846 and a sig. Value of 0.002. It can be concluded from the multiple linear regression test results that there is a correlation between the impact of climate parameters (maximum temperature, average humidity, rainfall and average wind speed) on pneumonia disease with a sig value of 0.000 and a sig value of 0.000 which is smaller than the p value of 0.05 (0.000<0.05), then H0 is rejected and H1 is accepted, indicating a significant correlation between the impact of climate parameters on pneumonia disease incidence rates.

Pneumonia Case Fatality Rate Data 2015-2024

Data on pneumonia case fatality rates from 2015-2024 showed that the lowest number of pneumonia cases in 2015 was 8 cases (1.28%) and the highest number in 2022 was 199 cases (31.89%) with a total of 624 cases (100%) over 10 years. The highest number of cases by month occurred in April 2022 totaling 31 cases (4.9%).

Table 7. Data on Pneumonia Case Fatality Rates 2015-2024

No	Month	Year										
		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Total
1	January	0	0	0	0	0	1	1	11	3	9	**25**
2	February	0	0	0	0	1	1	1	14	2	6	**25**
3	March	1	1	1	2	2	2	4	17	14	17	**61**
4	April	3	3	4	4	5	3	10	31	16	22	**101**
5	May	0	0	0	1	1	2	1	15	9	12	**41**
6	June	0	0	0	1	1	2	2	20	8	12	**46**
7	July	1	1	1	2	2	2	5	16	12	16	**58**
8	August	2	3	4	3	3	3	7	25	17	20	**87**
9	September	0	0	1	2	2	2	4	12	10	14	**47**
10	October	0	0	0	0	0	1	1	12	2	7	**23**
11	November	0	0	1	1	1	2	2	11	9	15	**42**
12	December	1	2	2	2	2	3	7	15	15	19	**68**
Total		**8**	**10**	**14**	**18**	**19**	**22**	**43**	**174**	**112**	**154**	**574**

Source: Primary Data, 2015-2024

Data normality test using Shapiro-Wilk because the sample value N <30. The data normality test found that the average wind speed showed statistical results of 75.0% (sig.0.000 value) and 49.6% (sig.0.000 value), maximum temperature showed statistical results of 75.0% (sig.0.000 value) and 64.0% (sig.0.001 value), average humidity showed statistical results of 75.0% (sig.0.000 value) and 64.0% (sig.0.001 value).) and 64.0% (sig.0.001 value), average humidity showed statistical results of 75.0% (sig.0.000 value) and 64.0% (sig.0.001 value) and rainfall showed statistical results of 75.0% (sig.0.000 value) and 63.4% (sig.0.001 value). All variables are normally distributed so that the Multiple Linear Regression test is carried out again, namely Collinearity Tolerance and VIF Statistics.

Table 7. Multiple Linear Regression Test Analysis Results The Impact of Climate Parameters on Pneumonia Mortality Rates

No	**Model**	**N**	***Standardized Coefficients***		
			Beta	***t***	***Sig.***
1	Temperature	10	.974	12.149	.000
2	Average Humidity	10	.948	8.436	.000
3	Rainfall	10	.940	7.827	.000
4	Average Wind Speed	10	.982	14.817	.000

Source: Author's Analysis Results, 2025

Climate parameters such as rainfall with a Beta value of 0.940 and a sig value of 0.000, climate parameters of average wind speed have a Beta value of 0.982 and a sig value of 0.000, average humidity has a Beta value of 0.948 and a sig value of 0.000, temperature has a Beta value of 0.974 and a sig value of 0.000. It can be concluded from the results of the multiple linear regression test that there is a correlation between the impact of climate parameters (maximum temperature, average humidity, rainfall and average wind speed) on pneumonia mortality rates with a sig value of 0.000 and a sig value of 0.000 which is smaller than the p value of 0.05, namely (0.000<0.05), then H0 is rejected and H1 is accepted which indicates a significant correlation between the impact of climate parameters on pneumonia mortality rates.

DISCUSSION

The Impact of Climate Parameters on the Incidence Rate of Pneumonia

The correlation between the impact of climate parameters (maximum temperature, average humidity, rainfall, and average wind speed) and pneumonia is indicated by a significance value of 0.000, which means it is less than the p-value of 0.05 (0.000 < 0.05). This leads to the rejection of H0 and acceptance of H1, indicating a significant correlation between the impact of climate parameters and the incidence rate of pneumonia. This result reinforces that climate parameters play an essential role in increasing the risk of pneumonia, especially in regions with extreme weather conditions and high climate variability.

High temperatures have been shown to weaken the immune system and worsen the condition of patients with respiratory disorders, while drastic temperature fluctuations increase the risk of pneumonia attacks, particularly for individuals with low immunity (Yousuf et al., 2021). High humidity contributes to poor air quality by creating an ideal environment for the growth of pathogenic bacteria and fungi, thereby increasing the risk of infection (Spector et al., 2019). Additionally, high humidity also extends the survival of viruses and bacteria in the air, further exacerbating the transmission rate of diseases. High rainfall worsens environmental conditions by increasing humidity and supporting the growth of pathogenic microorganisms that cause pneumonia. Furthermore, heavy rainfall can carry pollutants from the atmosphere into lower air layers, increasing the risk of inhaling harmful particles that deteriorate respiratory health (Spector et al., 2019). High wind speeds also play an important role in the spread of air pollutants. The higher the wind speed, the greater the distribution of pollutant particles that can enter the human respiratory system, increasing the risk of respiratory infections and pneumonia (Al-Delaimy et al., 2010).

The findings of this study provide a clear picture of the importance of considering the impact of climate change on public health, particularly in preventing pneumonia. For vulnerable groups such as children, the elderly, and individuals with chronic diseases, climate change can significantly increase health risks. Therefore, it is crucial to incorporate climate factors into public health and climate change policies. Collaboration between the health and meteorology sectors, including the development of climate data-based early warning systems, will be beneficial in mitigating the negative impacts of climate change on health. Furthermore, improving access to healthcare facilities that are prepared to respond to climate impacts can help reduce pneumonia incidence rates, especially in areas exposed to extreme climate change. The integration of climate and health policies will be a strategic step in protecting communities from the increasingly uncertain impacts of climate change.

The Impact of Climate Parameters on the Mortality Rate of Pneumonia

The correlation between the impact of climate parameters (maximum temperature, average humidity, rainfall, and average wind speed) and the mortality rate of pneumonia is indicated by a significance value of 0.000, which is less than the p-value of 0.05 (0.000 < 0.05). Thus, H0 is rejected and H1 is accepted, showing a significant correlation between the impact of climate parameters and the mortality rate of pneumonia.

The research also indicates that high rainfall, which directly affects environmental humidity, supports the spread of pathogens and increases air pollutant levels. This condition leads to an increased burden of respiratory infections, which ultimately impacts pneumonia mortality rates (Spector et al., 2019). High temperatures can exacerbate the condition of patients with respiratory disorders through various mechanisms, such as increased thermal stress and worsening air quality. Extreme temperatures not only disrupt the immune system but can also potentially increase the concentration of air pollutants that worsen patient conditions, especially in vulnerable groups such as children and the elderly. These findings align with studies suggesting that extreme temperatures significantly increase mortality rates from respiratory diseases (Yousuf et al., 2021). High humidity creates an ideal environment for bacteria and fungi, increasing the risk of infection. Strong winds can cause drastic temperature fluctuations, which, in turn, can weaken individuals' immune systems, particularly those already susceptible to pneumonia. The importance of considering climate variables in pneumonia mitigation and response strategies is critical, especially amid the increasingly extreme global climate change (Al-Delaimy et al., 2010).

Related to the above research and linked to the theory, climate parameters are significantly associated with the increased mortality rates due to pneumonia. Analysis shows that climate variables such as maximum temperature, average humidity, rainfall, and wind speed have significant correlations with mortality rates, with significance values below 0.05. High temperatures increase thermal stress and air pollutant concentrations, which can weaken the immune system, especially in vulnerable groups like the elderly and children. On the other hand, high humidity and rainfall create ideal conditions for bacterial and fungal growth, while strong winds cause drastic temperature fluctuations. These conditions, if not anticipated through health policies and data-driven strategies, could worsen respiratory disease exacerbations amid the global challenges of climate change.

CONCLUSIONS AND RECOMMENDATIONS

This study aims to establish a significant correlation between the impact of climate parameters on the incidence and mortality rates of pneumonia in Central Kalimantan. The Central Kalimantan Health Agency, together with the Indonesian Ministry of Health, needs to establish a strong partnership with BMKG (Meteorology, Climatology, and Geophysics Agency) to integrate climate data into disease surveillance systems. This collaboration is essential to strengthen climate-based early warning systems that can help predict spikes in pneumonia cases. This effort aligns with the One Health approach emphasized in the Indonesian Minister of Health Regulation No. 42 of 2023, which mandates cross-sector collaboration to anticipate environmental impacts on public health.

FURTHER STUDY

Data on pneumonia cases based on age and gender has been collected, but the connection between the impact of climate parameters on the age and gender of patients suffering from pneumonia in Central Kalimantan has not yet been explored.

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