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The Effect of Climate Change on Environmental-Based Diseases in Palu City in 2015-2020

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Abstract

The purpose of this study was to determine the effect of climate change (temperature, humidity, wind speed, rainfall, and rainy days) on environmental-based diseases (DHF and ARI) in Palu City in 2015-2020. This study uses a quantitative method with an ecological study design. The sampling technique used total sampling where the samples were all cases of DHF and ARI from the Palu City Health Office and climate data from the Mutiara Palu Meteorological Station from 2015-2020. Data analysis using multiple linear regression test. The results of the study for the incidence of DHF showed, partially temperature (0.384 > 0.05), wind speed (0.873 > 0.05), rainfall (0.868 > 0.05). 0.05) and rainy days (0.608 > 0.05) had no effect on the incidence of DHF because the significance value was greater than 0.05. Simultaneously the test results obtained are (0.628 > 0.05), meaning that there is no significant effect between climate change and the incidence of DHF in Palu City because the F test results show a significance value greater than 0.05. The incidence of ARI shows that part there is a significant effect of temperature and humidity on the incidence of ARI with the same significant value (0.00 < 0.05) and positive (+) pattern, and there is a significant effect of wind speed and rainfall on the incidence of ARI with the same significant value (0.00 < 0.05) but with a negative pattern. The conclusion is that there is a significant effect of climate change on the incidence of ARI.

Keywords*:* Climate change, Dengue Hemorrhagic Fever (DHF), Acute Respiratory Infection (ARI)

Key Messages:

- Climate change can affect the incidence of ARI for toddlers.

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1. Introduction

Nowadays the world is experiencing the problem of climate change globally. The impacts of climate change are very complex, covering various aspects of human life, rainfall, and extreme climate change. Climate change will influence human health both directly and indirectly. Climate change will directly harm human health, especially those related to disease incidence, especially diseases transmitted by vectors (insects) or those caused by disease agents (viruses, bacteria, or other parasites) that are sensitive to climate change (1). In Indonesia, the

number of dengue hemorrhagic fever (DHF) in 2019 was recorded at 138,127 cases. This number increased compared to 2018 at 65,602 cases, and in 2020 the number of DHF was recorded as 95,893 cases with a total death toll of 661 cases(2). Respiratory cases in Indonesia reached 28% with 533,187 cases found in 2016 with 18 provinces that had a prevalence above the national figure, besides that pneumonia was also the cause of 16% of deaths in children under five, namely 920,136 cases (3).

The number of DHFs in Palu City fluctuated from 2015 to 2020. In 2015 there were 653 cases of DHF and 3 deaths, in 2016 it fell to 637 cases and 3 cases died, in 2017 and 2018 it fell to 401 cases (2 cases died) and 398 cases (2 cases died), but in 2019 it increased again to 599 cases and 9 died. And the latest data in 2020 has recorded 307 cases of DHF and 2 died (4). For the number of respiratory cases based on data from the Palu City Health Office, the last 5 years tended to decrease and in 2020 there was an increase, where the coverage of patient discovery (38.94%) cases of Toddlers in 2015. In 2016 the number of cases found was 2,508 (25.08%).) of the target of 1,869. In 2017, cases decreased to 2,174 (21.74%) under five cases. Meanwhile, in 2018 the number of patients found was 1,781 (17.81%) cases from the target of 1,903. In 2019 cases continued to decline to 636 (6.36%) under-five cases. And in 2020 the number of patients found was 785 (7.85%) cases (4).

Many factors contribute to the incidence of disease. Dengue Hemorrhagic Fever (DHF) and respiratory are still major public health problems. The number of sufferers and the area of distribution is increasing along with increasing mobility, population density, or due to climate change. Where climate change can trigger the proliferation of vector-borne diseases or disease agents (viruses, bacteria, or other parasites) because vectors or disease agents are sensitive to temperature, humidity, and other ambient environmental conditions(5).

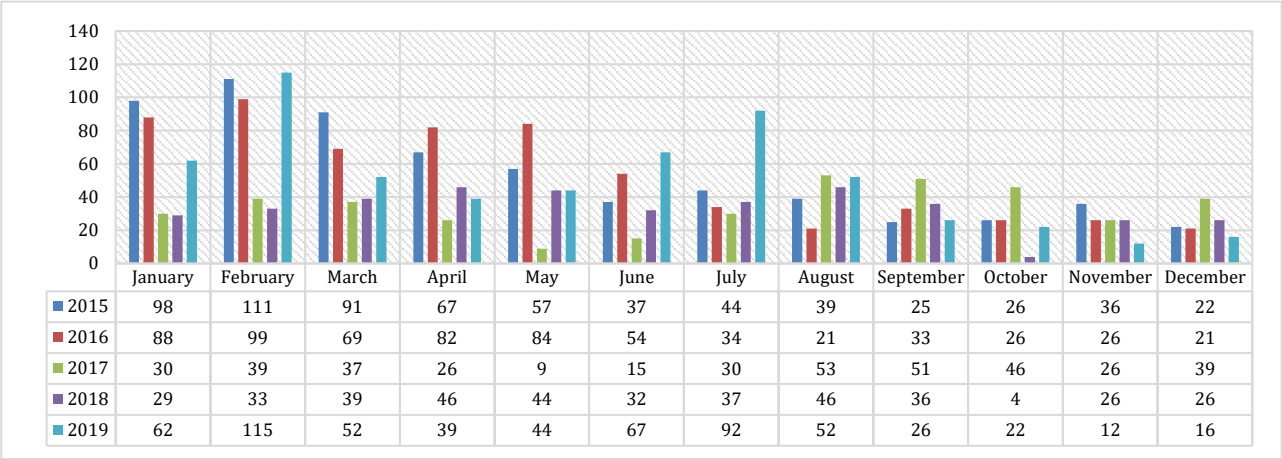
Based on this, the authors are interested in conducting more research related to the influence of climate change on environmental-based diseases in Palu City in 2015-2020. The purpose of this study was to determine the influence of climate change on environmental-based diseases in Palu City in 2015-2020.

2. Methods

This type of research is quantitative and uses an ecological study design. In this case, an ecological study was used to see the relationship between climatic factors and cases of dengue hemorrhagic fever and respiratory disease. This research was conducted in Palu City, and this research was carried out from January-March 2021. The study population was the total number of DHF and respiratory patients in Palu City who were recorded at the Palu City Health Office from January 2015-December 2020. The study used the total sampling techniques. Total sampling is a sampling technique where the number of samples with the population. The data was collected in the form of secondary data, namely data on the incidence of monthly DHF and Respiratory in Palu City which came from the Palu City Health Office report, and temperature climate data. humidity, wind speed, precipitation, and monthly rainy days from the 2015-2020 Sis Al-jufri Palu Meteorological Station report. The data were processed by univariate and bivariate. Univariate analysis was performed to describe the frequency distribution of each variable. Bivariate analysis was used to see the influence of the independent variable, namely the climate factor and the dependent variable.

3. Results

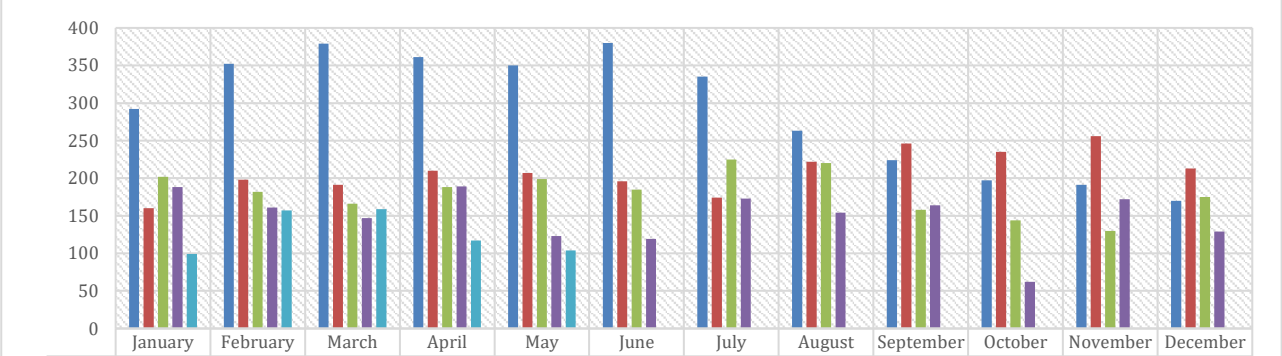
Figure 1 shows the incidence of DHF in Palu City in 2015-2020 experienced a fluctuating number with a maximum number of 115 cases and a minimum of 4 cases. In December as many as 22 cases. In 2016 where the highest incidence occurred in February as many as 99 cases while the lowest occurred in December as many as 21 cases. In 2017, the highest incidence occurred in August with 53 cases, while the lowest occurred in May with 9 cases. In 2018, the highest incidence occurred in April and August with 46 cases, while the lowest occurred in October with 4 cases. In 2019, the highest incidence occurred in February with 115 cases, while the lowest occurred in November with 12 cases.



	January	February	March	April	May	June	July	August	September	October	November	December
2015	98	111	91	67	57	37	44	39	25	26	36	22
2016	88	99	69	82	84	54	34	21	33	26	26	21
2017	30	39	37	26	9	15	30	53	51	46	26	39
2018	29	33	39	46	44	32	37	46	36	4	26	26
2019	62	115	52	39	44	67	92	52	26	22	12	16

Figure 1 Figure 1 Distribution of DHF incidence in Palu City in 2015-2020

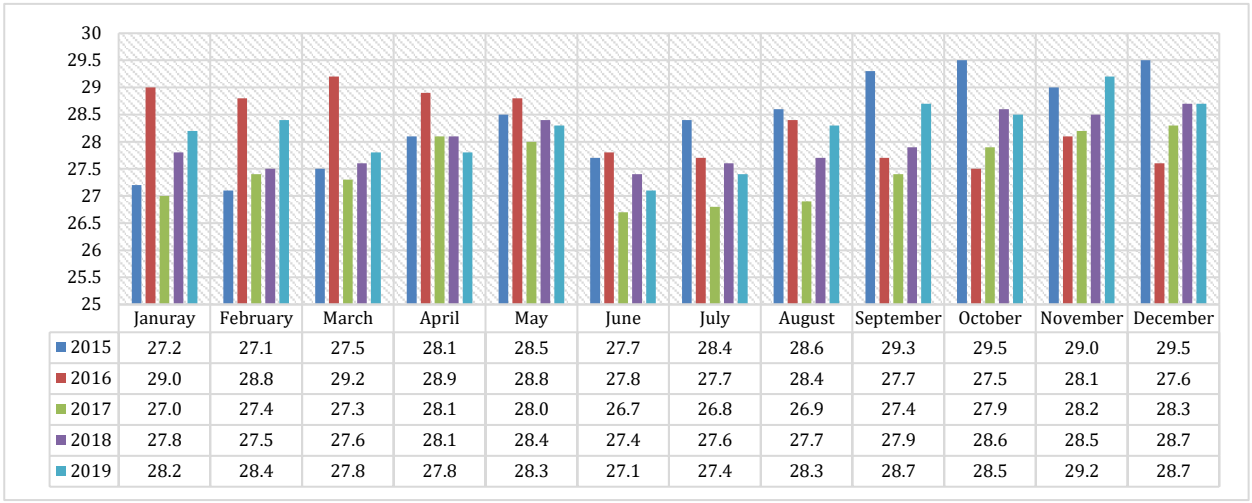
Figure 2. shows that the incidence of Respiratory for toddlers in Palu City in 2015-2020 continues to decline. The data distribution of the highest incidence of Respiratory for toddlers in Palu City in 2015 occurred in June with 380 cases, while the lowest was in December with 170 cases. In 2016 the highest incidence occurred in September as many as 246 cases while the lowest in January as many as 160 cases. In 2017 the highest incidence occurred in July as many as 225 cases while the lowest occurred in November as many as 130 cases. In 2018 the highest incidence occurred in April as many as 189 cases while the lowest was in October as many as 62 cases. In 2019, the highest incidence occurred in September with 171 cases, while the lowest occurred in December with 85 cases. Figure 3. Shows the average air temperature over five years (2015-2020) is 28.02^{o}C. The highest air temperature during 2015-2020 is 29.5 ^{o}C which occurred in October and December 2015 and the lowest air humidity was 26.7 ^{o}C occurred in June 2017.



	January	February	March	April	May	June	July	August	September	October	November	December
2015	292	352	379	361	350	380	335	263	224	197	191	170
2016	160	198	191	210	207	196	174	222	246	235	256	213
2017	202	182	166	188	199	185	225	220	158	144	130	175
2018	188	161	147	189	123	119	173	154	164	62	172	129
2019	99	157	159	117	104	0	0	0	0	0	0	0

Figure 2 Distribution of ARI incidence in children under five in Palu City in 2015-2020

Figure 4 shows that during the 2015-2020 period the average air humidity in Palu City was 75.8%. Air humidity during the five years (2015-2020), fluctuated. Based on monthly data, the highest humidity of 85.9% occurred in June 2019 and the lowest of 64.7% occurred in September 2015. Figure 5 shows throughout 2015-2020 the average wind speed of 4.5 knots. The highest wind speed conditions during the five years (2015-2020) were 6 knots in June 2015 and the lowest was 3 knots in September 2015. Figure 6. This shows the average rainfall over the five years (2015-2020) is 58.58mm. The highest rainfall conditions of 359.2 mm occurred in 2019 in June and the lowest was 0 mm in 2015 in December. Figure 7. Shows the average rainy day for five years (2015-2020) is 15.9 days which fluctuates with a maximum range of 25 rainy days in June 2019 and a minimum of 2 days in September 2015.

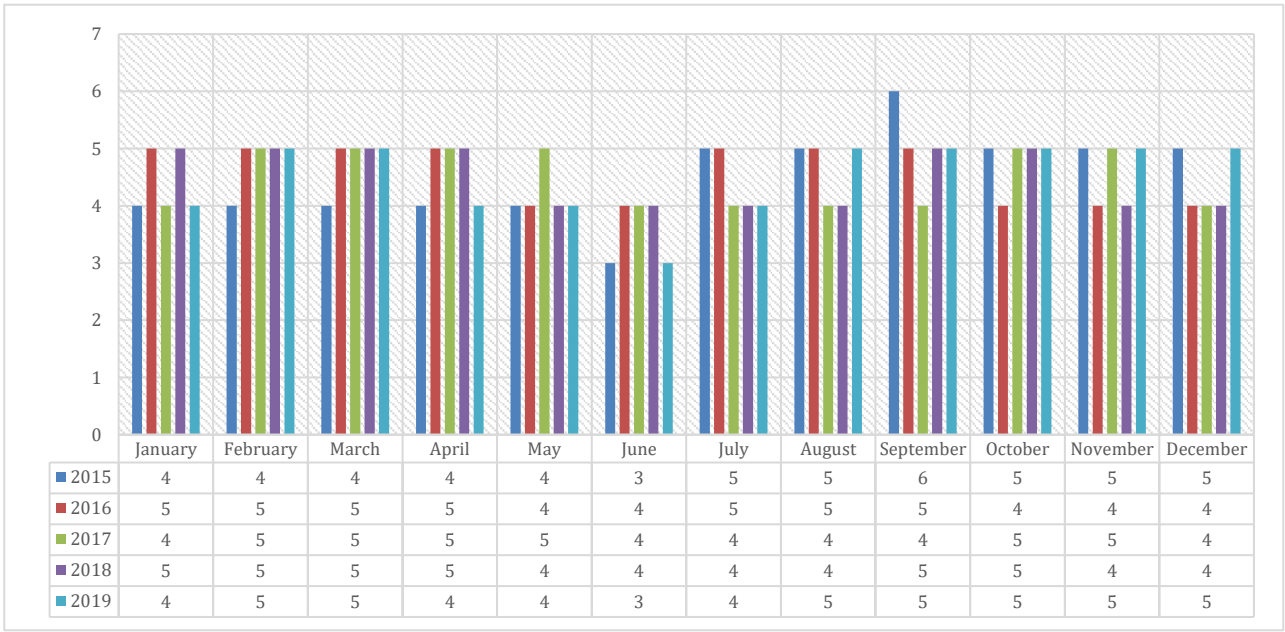


	Januray	February	March	April	May	June	July	August	September	October	November	December
2015	27.2	27.1	27.5	28.1	28.5	27.7	28.4	28.6	29.3	29.5	29.0	29.5
2016	29.0	28.8	29.2	28.9	28.8	27.8	27.7	28.4	27.7	27.5	28.1	27.6
2017	27.0	27.4	27.3	28.1	28.0	26.7	26.8	26.9	27.4	27.9	28.2	28.3
2018	27.8	27.5	27.6	28.1	28.4	27.4	27.6	27.7	27.9	28.6	28.5	28.7
2019	28.2	28.4	27.8	27.8	28.3	27.1	27.4	28.3	28.7	28.5	29.2	28.7

Figure 3 Distribution of Air Temperature in Palu City in 2015-2020

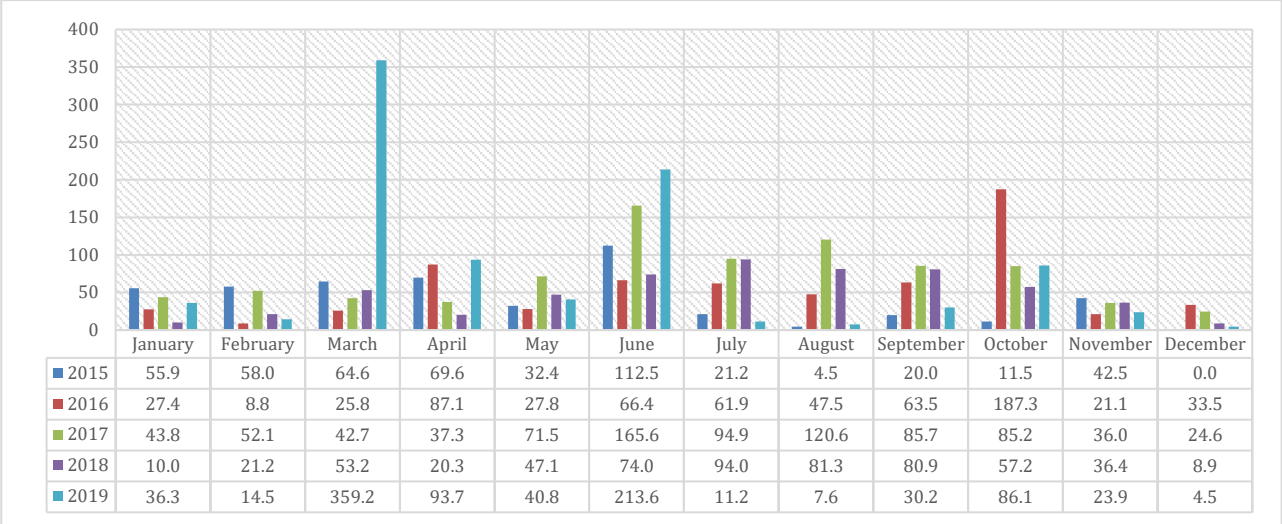
	January	February	March	April	May	June	July	August	September	October	November	December
2015	78.8	77.9	77.9	75.2	74.0	78.8	69.6	67.2	64.7	65.0	72.6	68.4
2016	71.5	72.4	72.7	74.0	76.8	78.4	77.7	74.1	76.1	79.0	75.2	76.0
2017	79.4	78.8	78.2	75.5	80.1	84.0	82.6	82.3	80.1	78.8	77.1	74.9
2018	75.0	78.3	76.4	76.4	77.8	80.5	78.9	76.3	74.4	75.7	74.9	72.7
2019	76.2	71.5	74.2	77.8	78.6	85.9	79.6	73.7	71.6	73.0	70.7	74.0

Figure 4 Air Humidity Distribution in Palu City 2015-2020



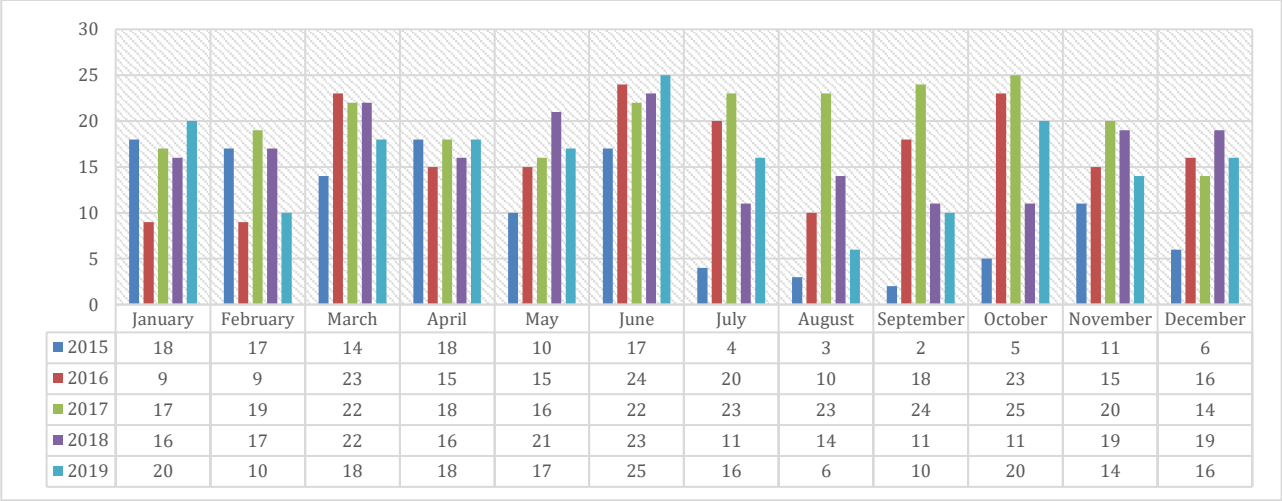
	January	February	March	April	May	June	July	August	September	October	November	December
2015	4	4	4	4	4	3	5	5	6	5	5	5
2016	5	5	5	5	4	4	5	5	5	4	4	4
2017	4	5	5	5	5	4	4	4	4	5	5	4
2018	5	5	5	5	4	4	4	4	5	5	4	4
2019	4	5	5	4	4	3	4	5	5	5	5	5

Figure 5 Wind Speed Distribution in Palu City 2015-2020



	January	February	March	April	May	June	July	August	September	October	November	December
2015	55.9	58.0	64.6	69.6	32.4	112.5	21.2	4.5	20.0	11.5	42.5	0.0
2016	27.4	8.8	25.8	87.1	27.8	66.4	61.9	47.5	63.5	187.3	21.1	33.5
2017	43.8	52.1	42.7	37.3	71.5	165.6	94.9	120.6	85.7	85.2	36.0	24.6
2018	10.0	21.2	53.2	20.3	47.1	74.0	94.0	81.3	80.9	57.2	36.4	8.9
2019	36.3	14.5	359.2	93.7	40.8	213.6	11.2	7.6	30.2	86.1	23.9	4.5

Figure 6 Rainfall Distribution in Palu City 2015-2020



	January	February	March	April	May	June	July	August	September	October	November	December
2015	18	17	14	18	10	17	4	3	2	5	11	6
2016	9	9	23	15	15	24	20	10	18	23	15	16
2017	17	19	22	18	16	22	23	23	24	25	20	14
2018	16	17	22	16	21	23	11	14	11	11	19	19
2019	20	10	18	18	17	25	16	6	10	20	14	16

Figure 7 Rainy Day Distribution in Palu City 2015-2020

Table 1 The results of multiple linear regression analysis using the t test

	Dengue Hemorrhagic Fever (Sig)	ARI (Sig)
Air Temperature	0.384	4.341
Air humidity	-	4.099
Wind Speed	0.873	-3.785
Rainfall	0.868	-4.703
Rainy day	0.608	-

Table 1 show that there is no significant influence between air temperature, humidity, wind speed, rainfall, and rainy days on the incidence of dengue hemorrhagic fever in Palu City in 2015-2020. There is a significant influence between air temperature and humidity on the incidence of Respiratory for toddlers in Palu City in 2015-2020 but has a positive pattern which means that the higher the temperature and humidity, the incidence of Respiratory for toddlers will increase. There is a significant influence between wind speed and rainfall on the incidence of Respiratory for toddlers in Palu City in 2015-2020 but has a negative pattern which means that the higher the wind speed and rainfall, the incidence of respiratory for toddlers will decrease.

Table 2 The results of multiple linear regression analysis using the F test

	Dengue Hemorrhagic Fever (Sig)	ARI (Sig)
F *test*	0,628	8.644

Table 2 show that simultaneously the test results obtained are (17.801 > 2.523) and a significant value (0.00 < 0,05) this means that there is an influence between climate change on the incidence of ARI.

4. Discussion

The Influence of Air Temperature on the Incidence of DHF and Respiratory for Toddlers in Palu City in 2015-2020

Based on table 1, the results of hypothesis testing using the partial t-test showed that air temperature (X_1) did not have a significant influence on the incidence of DHF (Y). This can be shown from the significant value in the t-test of the air temperature variable (X_1) of 0.384 or greater than the significance level (α) of 0.05 and it can be concluded that air temperature does not influence the incidence of DHF.

This is in line with research conducted by Rau et al (2019), Gandawari et al (2018), Bangkele and Safriyanti (2016), which showed that there was no significant relationship between air temperature and the incidence of DHF. It is caused by temperature variations that do not fluctuate much or are constant. Unlike the temperature in the sub-tropics and deserts which have a temperature difference of up to 20^{o}C(6–8).

Based on the partial test results using the t-test, the sig value of the air temperature variable on the incidence of Respiratory for toddlers is 0.00 <0.05, which means that the air temperature variable has a significant effect on the incidence of Respiratory for toddlers in Palu City in 2015-2020. Based on table 1, the results of SPSS output using the *t-test* obtained t value of 4,341 which indicates that air temperature has a positive effect on the incidence of Respiratory for toddlers, which means that the higher the air temperature, the higher the incidence of Respiratory for toddlers. This is in line with research conducted by Khairiyati L et al (2016) shows that there is a similar pattern between temperature and the incidence of Respiratory, meaning that if the air temperature is high, the incidence of Respiratory will be high and vice versa if the air temperature drops, the incidence of Respiratory will decrease (9). The temperature situation does not have a significant relationship with the incidence of Respiratory in an area is the different types and abilities of pathogenic organisms in causing the incidence of Respiratory. The decrease in air temperature tends to be followed by a decrease in the incidence of pneumonia in children under five. This can be caused because the temperature in the house does not meet the requirements. High air temperature in the house is influenced by occupancy density, high house position, ventilation, and lighting area.

The Influence of Air Humidity on the Incidence of DHF and Respiratory for Toddlers in Palu City in 2015-2020

Based on the partial test results using the t-test, it shows that the humidity variable is considered to be excluded, namely the variable that is *excluded* from the analysis model because the data range is too far from other variables and does not fulfill the test requirements for the next test. However, Bangkele and Safriyanti (2016) with the same place/location in this study stated that there is no relationship between the incidence of *dengue* hemorrhagic fever and humidity in Palu City where Palu City has optimal humidity for mosquito breeding, but the incidence of DHF cannot be determined. occurs because health services are already good, therefore humidity is not one of the things that can influence the occurrence of DHF(6).

Based on the partial test results using the t-test, the sig value of the air humidity variable on the incidence of Respiratory for toddlers is 0.00 <0.05, which means that the air humidity variable has a significant influence on the incidence of Respiratory for toddlers in Palu City in 2015-2020. Based on table 1, the results of SPSS output using the t-test obtained t value of 4,099 which indicates that air humidity has a positive influence on the incidence of Respiratory for toddlers, which means that the higher the humidity, the incidence of Respiratory for toddlers will increase. This is in line with research conducted by Halimah Utami Tri et al (2018) the coefficient value of air humidity is 0.250 (positive correlation direction), which means that the number of pneumonia cases will increase when air humidity increases. The p-value (significance) was 0.043 (p<0.05). Thus it can be concluded that there is a significant relationship between air humidity during the period 2013-2018 with the

incidence of pneumonia. Pneumonia is more common at 75% to 90% humidity than at 60% to 70% humidity (10). This is following research conducted by Onozuka D (2009) which explains that the bacteria causing pneumonia can grow optimally at humidity <25% and >80%, but will die at the humidity of 60% (11).

The Influence of Wind Speed on the Occurrence of DHF and Respiratory Toddlers in Palu City in 2015-2020

Based on table 1, the results of hypothesis testing using a partial t-test showed that wind speed (X_3) did not have a significant effect on the incidence of DHF (Y). This can be shown from the significant value in the t-test of the wind speed variable (X_3) of 0.873 or greater than the significance level (α) of 0.05 and it can be concluded that wind speed in Palu City does not influence the incidence of DHF. This is in line with several previous studies which stated that there was no significant relationship between wind speed and the incidence of DHF. It can be expected to have a relatively constant wind speed and still not meet the wind speed limit in inhibiting the spread of mosquitoes(8,12,13).

Based on the partial test results using the *t-test*, the sig value of the wind speed variable on the incidence of Respiratory for toddlers is 0.00 <0.05, which means that the wind speed variable has a significant influence on the incidence of Respiratory for toddlers in Palu City (2015-2020). Based on table 1, the results of the SPSS output using the t-test statistical test obtained a t value of -3,785 which indicates wind speed harms the incidence of Respiratory for toddlers, which means that the higher the wind speed, the lower the incidence of Respiratory for toddlers. This is in line with research conducted by Halimah Utami tri et al (2018) which states that there is a negative patterned relationship (-) which means that the number of Respiratory events will increase if the wind speed decreases (10). This is because when the wind speed increases the pollutant will increase thus during the dry season when the pollutants are drier and lighter, they will be more easily carried away by the wind. During the rainy season, the pollutants in the air will decrease when exposed to rainwater.

Although theoretically wind speed is a risk factor for acute respiratory infections. The spread of microorganisms and pollutants in the air is strongly influenced by wind speed. At low wind speeds, microorganisms tend to stay in certain locations for a longer time. On the other hand, the faster the wind blows, the wider the distribution, thus the air pollutant is not only collected at one point in the area. It can be caused by different climate changes in each place.

The Influence of Rainfall on the Incidence of DHF and ARI for Toddlers in Palu City in 2015-2020

Based on table 1, the results of hypothesis testing using a partial t-test showed that rainfall (X_4) did not have a significant influence on the incidence of DHF (Y). It can be shown from the significant value in the t-test of the rainfall variable (X_4) of 0.868 or greater than the significance level (α) of 0.05 and it can be concluded that rainfall does not affect the incidence of DHF. This is in line with several previous studies, namely that there is no significant relationship between rainfall and the incidence of DHF. This is because the rainfall data obtained is global data in a certain area only. This means that rainfall measurements are only carried out in one area to represent all sub-districts thus the data is not representative enough to cover all existing sub-districts and also due to community residents eradicating mosquito nests before the rainy season is coming (7,14–16).

Based on the partial test results using the *t-test*, the sig value of the rainfall variable on the incidence of Respiratory for toddlers is 0.00 <0.05, which means that the rainfall variable has a significant influence on the incidence of Respiratory for toddlers in Palu City, 2015-2020. Based on table 1, the results of the SPSS output using the *t-test* obtained t value of -4.703 which indicates that rainfall harms the incidence of Respiratory for toddlers, which means that the higher the rainfall, the lower the incidence of Respiratory in children under five. The results of this study are in line with the research conducted by Ernyasih E et al (2018). It was found that there was a significant relationship between rainfall (p = 0.013) and cases of Respiratory in Jakarta in 2011-2015 (2018) (17). This possibility is due to extreme rainfall that can increase cases of upper respiratory tract infections (ARI) because the area becomes cold and humid. Excessive rainfall will make the house humid, most sufferers live in densely populated areas because poor circulation and sanitation are the causes of respiratory diseases (18). Based on the population density in Palu City per sub-district, it looks different, where in 2019 it was recorded at 35.59 people/km^2, with an area of 395.06 km^2 Palu City. It can be shown by the different densities of

occupancy which can reduce the incidence of Respiratory cases in toddlers because an increase in rainfall will cause people to tend to stay in one room for a longer time.

The Influence of Rainy Days on the Incidence of DHF and Respiratory for Toddlers in Palu City in 2015-2020

Based on table 1, the results of hypothesis testing using the partial t-test showed that rainy days (X_5) did not have a significant influence on the incidence of DHF (Y). It can be shown from the significant value in the t-test of the rainy-day variable (X_5) of 0.608 or greater than the significance level (α) of 0.05 and it can be concluded that rainy days do not influence the incidence of DHF. This is in line with the research conducted by Majidah et al (2010), and Febriasari (2011) which stated that there was no significant relationship between rainy days and the incidence of DHF. This can happen because there are too many rainy days accompanied by too much rainfall, this can occur in flooding that washes away the mosquito breeding grounds thus the mosquito population will decrease and be followed by a decrease in the Aedes aegypti (19,20).

5. Conclusion

The conclusion is climate change can affect the incidence of ARI for toddlers but has no significant effect on dengue hemorrhagic fever.

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Conflicts of Interest: The authors declare no conflict of interest

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