

THE INFLUENCE OF CLIMATE FACTORS ON DIARRHEA CASES IN CHILDREN UNDER FIVE YEARS BEFORE AND AFTER THE COVID-19 PANDEMIC IN BANJARMASIN

Budiyanto¹

¹Division of Gastroenterohepatology, Department of Pediatrics, Faculty of Medicine, University of Lambung Mangkurat / Ulin General Hospital, Banjarmasin
Correspondence Author: budiyantodrpa@gmail.com

Abstract:

Background: Diarrhea still become one of the leading causes of morbidity and mortality in children, especially under 5 years. Anthropogenic climate change, mainly due to global warming process, is expected to change the epidemiological pattern of infectious diseases, including diarrhea. COVID-19 pandemic that has occurred globally since March 2020 may also have an impact. Banjarmasin as a city in a wetland area with tropical savanna climate that also affected by COVID-19 pandemic is also at risk. We conducted a research to study the influence of climate factors on diarrhea cases in children under 5 years before and after the COVID-19 pandemic in Banjarmasin.

Methods: Data of monthly diarrhea cases in children under 5 years at public health centers from Banjarmasin City Health Office and monthly climate data (amount of rainfall, number of rain days, temperature, humidity, sunshine duration, wind speed) from BMKG and BPS between January 2010 to April 2021 were collected. Statistical analysis was carried out to determine the correlation between climate factors and diarrhea cases before and after COVID-19 pandemic.

Results: There was a decrease in the average monthly visits of children under five years with diarrhea before (497 ± 47.4) and after (132 ± 45.8) COVID-19 pandemic. Among climate factors, amount of rainfall ($r=-0.753$; $p=0.005$), number of rain days ($r=-0.774$; $p=0.003$), and humidity ($r=-0.590$; $p=0.044$) were negatively correlated, while sunshine duration ($r=0.674$; $p=0.016$) was positively correlated with diarrhea cases in the period before COVID-19 pandemic. No correlation was found between any climate factor and diarrhea cases in the subsequent period.

Conclusion: Diarrhea cases in children under 5 years in Banjarmasin tend to increase in dry season, however during COVID-19 pandemic there were some changes in society, such as working from home, reluctance to go to health facilities which might affect the usual trend.

Keywords: Anthropogenic climate change; Climate factors; COVID-19 pandemic; Diarrhea under 5 years; Wetland

Introduction

Diarrhea is defined by WHO as the passage of three or more loose or liquid stools per day (or more frequent than is normal for the individual), a symptom that mostly caused by infection of gastrointestinal tract. Diarrhea is one of the leading causes of morbidity and mortality in children under 5 years of age in the world. Every year there are almost 1.7 billion cases of diarrhea in children globally, which results in the death of around 525,000 children under 5 years.¹ Based on Indonesian Health Profile 2019, the prevalence of diarrhea under five years in Indonesia was 11%, and in South Kalimantan was 8.6%, and it causes 12.1% deaths in the age group 29 days to 11 months and 10.7% deaths in the age group 12-59 months.²

Climate is defined as the long-term average weather in a certain period of time, typically over a period of thirty years, in an area or location and affected by its latitude, terrain, altitude, nearby water bodies and their currents, which includes several components of meteorological variables including rainfall, temperature, humidity, wind, and precipitation.³ Weather and climate variability can affect many prevalent human disease, including vector-borne and water-borne infectious disease such as diarrhea. Usually there are typical seasonal patterns in diarrhea disease in which temperature and rainfall has played a role. Extreme weather that cause natural disasters like flood and drought appear to increase its risk, but not always in agreement.⁴

Anthropogenic climate change mainly due to the global warming process, that has been the concern of many experts in the world since more than three decades, has the potential to have catastrophic consequences on human health, and also expected to alter the transmission of infectious diseases,

including diarrhea.^{5,6} Banjarmasin, which is located in a wetland area and has a tropical savanna climate,⁷ also has its own pattern of weather and climate variability that can influence the transmission of infectious diseases, including diarrhea, and is also at risk of being affected by this climate change.

The COVID-19 pandemic that begin in March 11th, 2020 has caused severe social and economic disruption in the society around the world. In Indonesia, the first case was confirmed on March 2nd, 2020 in Jakarta, and by April 2020 it already spread to all 34 provinces in the country, includes South Kalimantan and Banjarmasin as the capital city. As the response of this worldwide ongoing pandemic, the government implementing large scale social restrictions, which was later modified to community activities restrictions enforcement.⁸ This social restriction along with people's phobia of this new disease that might be propagated by some misleading and misconceptions,⁹ also change people's healthcare seeking behaviour, especially during the early pandemic period.¹⁰ There was a decline in primary care visits especially for children and females group, hospital outpatient visits, even in emergency department visits during this period, that might lead to further public health consequences if not countermeasured properly.¹⁰⁻¹³

Both climate change which can cause natural disasters and the ongoing COVID-19 pandemic as a non-natural disaster may affect the epidemiological pattern of infectious diseases, including diarrhea as an important disease with major burden especially for children under five years. It is important to study the correlation between them in each specific area with its own unique characteristics, such as in Banjarmasin, to withstand the uncertainty in the future in order to improve healthcare outcomes.

Research Method

We collected data of monthly diarrhea cases visits in children under five years at public health centers from Banjarmasin City Health Office (*Dinas Kesehatan Kota*) and monthly climate data (amount of rainfall, number of rain days, temperature, humidity, sunshine duration, wind speed) from BMKG (*Badan Meteorologi, Klimatologi, dan Geofisika*) online data and also from BPS (*Badan Pusat Statistik*) Banjarmasin between January 2010 to April 2021. We divided the data into 2 periods: before (January 2010 to February 2020) and after COVID-19 pandemic (March 2020 to April 2021). Statistical analysis was carried out using Pearson correlation or Spearman's rho correlation coefficient (with IBM SPSS™ version 25 software) to determine the correlation between the average monthly data of climate factors and diarrhea cases in children under 5 years before and after the COVID-19 pandemic.

Results

There was a significant decrease in the number of average monthly visits of children under five years with diarrhea before (497 ± 47.4) and after (132 ± 45.8) the COVID-19 pandemic (see figure 1). Among climate factors, amount of rainfall ($r=-0.753$; $p=0.005$) and number of rain days ($r=-0.774$; $p=0.003$) were strong and negatively correlated, while

humidity ($r=-0.590$; $p=0.044$) was moderate and negatively correlated, and sunshine duration ($r=0.674$; $p=0.016$) was strong and positively correlated with diarrhea cases in children under 5 years in the period before the COVID-19 pandemic. We found no significant correlation between any climate factor and diarrhea cases in children under 5 years in the period after the COVID-19 pandemic (see table 1).

Table 1 Correlation between monthly average data of climate factors and diarrhea cases in children under 5 years before and after the COVID-19 pandemic

	Diarrhea under 5 before pandemic		Diarrhea under 5 after pandemic	
	r	p	r	p
Amount of rainfall	- 0.753	0.005	0.545	0.067
Temperature	0.190	0.554	- 0.518	0.084
Humidity	- 0.590	0.044	0.483	0.112
Sunshine duration	0.674	0.016	0.071	0.827
Number of rain days	- 0.774	0.003	0.505	0.094
Wind speed	- 0.372	0.233	0.481	0.113

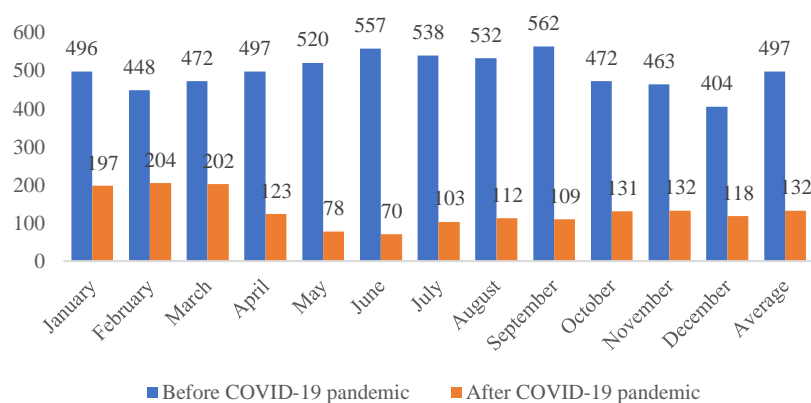


Figure 1 Number of monthly average visits of diarrhea cases under 5 years before COVID-19 pandemic (January 2010 – February 2020) and after COVID-19 pandemic (March 2020 – April 2021)

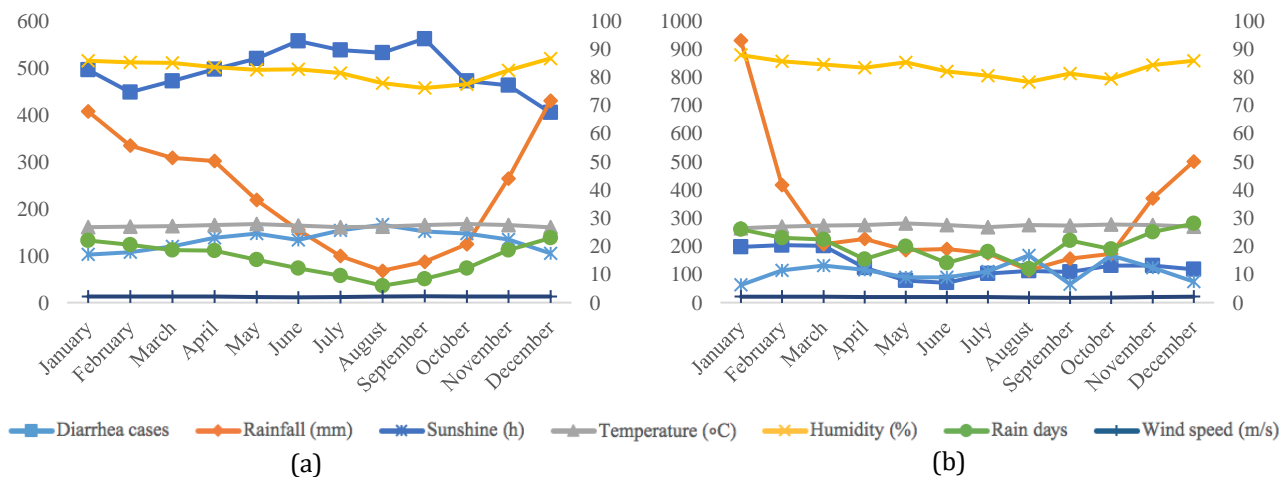


Figure 2 Trend of monthly average diarrhea cases under 5 years and monthly average climate data components: (a) Before COVID-19 pandemic (January 2010 – February 2020); and (b) After COVID-19 pandemic (March 2020 – April 2021)

Discussion

Each region has its own unique characteristics of climate and weather variabilities that may influence the pattern of diseases, especially infectious disease such as diarrhea. Banjarmasin as our research site located in wetland area with tropical savanna climate, with rainy season during November to April and often a long dry period with low humidity and longer sunshine duration during the dry season, especially from August to October. Heavy rainfall occurs from November to June and moderate rainfall from July to October, and the hottest months are between March and September.⁷ This weather pattern can be seen in figure 2. There was extreme rainfall in January 2021 which caused major floods in Banjarmasin.

Diarrhea still a major problem in Banjarmasin, with major burden especially in under 5 years old group. From figure 1 we can see that after the COVID-19 pandemic there was a significant decrease in numbers of monthly visits of diarrhea cases. This trend was similar to another study that compare the

healthcare visits before and after the COVID-19 pandemic in primary health care (Rhatomy, 2020) that found the decline especially in early pandemic period for children aged 0-9 (71%) and females (46%), also in tertiary teaching hospital (Prabowo, 2021) related to people stress and COVID-19 fear, and in pediatric emergency department (Dopfer, 2020) for both communicable and non-communicable diseases.¹⁰⁻¹² One study also found 60.4% reduction in overall hospital emergency and admission department visits, particularly for non-severe illnesses, but a 9% increase of hospitalization rate during pandemic (Muselli, 2021).¹³ This trend apparently also occurred in Banjarmasin after the COVID-19 pandemic, that also might be influenced by the government regulations regarding social restrictions.

In this study, we can see that diarrhea cases in children under 5 years before the COVID-19 pandemic tended to peak between June and September, during the dry season in Banjarmasin. This in accordance with the findings of the climate factors that decreased

in the dry season, i.e. amount of rainfall, number of rain days, and humidity which were found to be negatively correlated with number of diarrhea cases, and the sunshine duration as a climate factor increased during the dry season which was found to be positively correlated. This result is similar with a previous study in Banjarmasin (Cahyadi et al, 2019) that found diarrhea cases of all ages were negatively correlated with amount of rainfall and humidity, and positively correlated with temperature.¹⁴ Another Indonesian study (Fachrin et al, 2020) found humidity as a determinant factor for diarrhea incidence changes on 33 province in Indonesia.¹⁵ Another study in Bangladesh (Chowdhury et al, 2018) as a 4 seasonal countries, found that humidity, temperature, and rainfall correlates with diarrhea cases and other 5 infectious diseases.¹⁶ Regarding the causes, a systematic review and meta-analysis (Kraay et al, 2020) found that rotavirus diarrhea, as the main cause of diarrhea under 5 years, was found to increase in dry season, while bacterial and parasitic diarrhea was more common in rainy season.⁶

In January 2021 during the period after the COVID-19 pandemic there was an extreme amount of rainfall in Banjarmasin, seen in the abnormal distribution of rainfall data (929.3 mm, 303.9 ± 229.76 , $p=0.002$), that brought major flood in this city. Extreme weather is a consequence of climate change, mainly due to global warming process, that was also expected to change the disease pattern including diarrhea. WHO estimates that between 2030 and 2050 climate change will add 48,000 deaths from diarrhea per year related to projected of increased extreme weather events including floods and droughts, both of which are associated with increased incidence of this disease. These conflicting facts were explained by the concentration-dilution hypothesis, suggests that the

background level of rain affects the diarrhea incidence: rainfall following dry periods can flush pathogens into surface water and increasing diarrhea incidence, whereas rainfall following wet periods can dilute pathogen concentrations in surface water, thereby decreasing diarrhea incidence.⁶ A study in South Africa (Ikeda et al, 2019) found that 'wetter than usual' and 'warmer than usual' conditions were anomalously associated with high number of diarrhea cases, although most of diarrhea cases under 5 years was associated with dry condition.⁴ Areas with a tropical climate, such as Banjarmasin, particularly like to experience changes in rainfall intensity and frequency due to climate change, where extreme rainfall following dry periods that causes flooding can increase the diarrhea incidence, seen in trending of positive correlation of rainfall and diarrhea cases during this period (see table 1). The effect of this not

As a limitation of our study, we only analyzed the correlation between monthly average data of climate factors and diarrhea in children under 5 years cases, and did not take into account the spatiotemporal trends that could influence the disease pattern, and we only included the cases from primary healthcare visits. We also only observed a very short period of diarrheal disease pattern, about 14 months, after the COVID-19 pandemic.

Conclusions

Diarrhea cases in children under 5 years in Banjarmasin tend to increase in the dry season between June and September, where the amount of rainfall, number of rain days, and humidity are lower while the sunshine duration is longer. The ongoing COVID-19 pandemic is bringing some changes in society, such as working and studying from home due to social restrictions regulations, and

decreasing healthcare visits due to reluctance to go to health facilities, which may affect the usual trend. Lastly, the extreme weather during the COVID-19 pandemic period that might be caused by climate change such as in January 2021 can also have an impact.

Further study with a more comprehensive analysis, a wider range of subjects, and a longer period of time is necessary to better understand the correlation between climate factors, the COVID-19 pandemic, and cases of diarrhea in children under 5 years, to prepare for the uncertainty in the future in order to improve the public health outcomes.

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