Impact of Weather and Climate on Diarrhea Incidence: A review

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Abstract. Globally, diarrhea has become the cause of death for more than 1.31 million people worldwide. Likewise for developing countries, diarrhea is a cause of mortality and morbidity. Direct or indirect incidence of diarrhea can be caused by climate change itself. With diarrheal disease itself as a health problem that must be watched out, because every incidence of diarrhea will be a cause of morbidity and mortality not only in developing countries but throughout the world, with such cultivation, climate change also increases the likelihood of an increase in the incidence of diarrhea disease. The method used is a systematic review. This article includes a combination of the terms and keywords "climate and diarrhea", "Weather and diarrhea". The review results from the available journals show that there is a significant relationship between weather and climate with the distribution of diarrheal disease. The results of tracing through journal reviews show that weather or climate change is a triggering factor in the incidence of diarrhea, the role of climate change on the distribution and transmission of diarrheal disease provides insight into this relationship as well as interventions that can be taken to take preventive measures. The conclusion presented is that countries in the world, especially developing countries, must prepare measures to prevent diarrhea that occurs seasonally as a result of climate change and prepare health information to control the incidence of diarrhea around the world.

1. Introduction

Data from the World Health Organization (WHO) explains that diarrhea is the frequency of defecation with a frequency of more than three times a day and a liquid consistency. Diarrhea can be said to occur in all age groups. Through this, diarrhea is stated as the cause of morbidity and mortality in children under five, which can be seen from the increasing incidence of diarrhea worldwide from 2015 to 2017. Where, in 2015, diarrhea was the cause of 499,000 children dying and 688 million children experiencing pain.

Data World Health Organization (WHO) per 2012 mentions 1, 5 million or 2.7 percent of all deaths worldwide are caused by diarrhea. The number is the same as the death from HIV / AIDS. The large number of deaths from diarrhea is due to the fact that many people in the world live below the poverty line and in poor sanitary conditions. Diarrhea death cases are found in Africa and South Asia.
WHO also said that the increasing incidence of diarrheal diseases is one of the health problems that result right by climate change. Based on several studies, there is a significant relationship between climate change and the effect of temperature on the incidence of diarrhea, it is estimated that there are 5.6 episodes per year in toddlers and 7.0 episodes per year for toddlers in toddlers. period between 1978 and 1979. Diarrhea was the second most common disease after upper respiratory tract disease, with the highest prevalence in children aged 6-11 months.

Diarrhea, according to data from UNICEF and WHO, states that it is the second most common determinant of mortality among children under five in the world with a percentage of up to 16% of deaths. while the morbidity rate around the world shows an increase every year. The target set to control disease incidence around the world has been initiated by WHO and UNICEF in the form of a target prevalence of deaths from diarrheal diseases to 1 per 1,000 live births.

Empirically, many studies have explained that changes in weather, be it temperature, rainfall, etc. have an influence on the incidence of diarrhea. This systematic review is to explain current knowledge about diarrhea and its correlation with weather and climatic factors. This information can be useful for developing and implementing an efficient health information system with public interventions to control the incidence of diarrhea worldwide.

2. Method

2.1 Strategi search

Google and google scholar were used as the main sources, from a database accessed in November 2020 to extract research published in English that addresses the context of Diarrhea worldwide. The search strategy was carried out with the keywords "climate and diarrhea", "Weather and diarrhea", which were used to search for articles. I looked at research articles published during 2020. Titles, abstracts and keywords were filtered for the first step on relevant articles as well as articles that met the inclusion criteria to serve as articles to be reviewed.

2.2 Inclusion Criteria

1. Articles evaluating the effects of climate change and weather on the incidence of diarrheal disease.
2. Article discussing the impact of weather on diarrhea incidence published 2010-2020.

3. Result

3.1 Literature search

The initial search identified 15 articles collected from google and google scholar. Research studies took place in (Africa, Hong Kong, Taiwan, and Japan, Indonesia, India, Peru, Bangladesh, United States). All articles were included to study the relationship between weather and climate impacts on diarrhea incidence. Several methods are used to determine the variable impact of temperature on the spread of diarrhea. o ne article used d binomial regression, two articles used general linear model analysis, o article used ne series regression analysis, two articles used Poisson regression analysis model, one article usedautoregressiveanalysisANOVA covariance model, onearticle used linear log regression analysis, o ne article used statistical analysis, one article used d analysis or used correlation test
Table 1. Characteristics of the Study Discussing the Relationship of Climate and Weather Impacts on the Incidence of diarrhea

| Author                  | Area and Research          | Data collection         | Risk Factors                                      | Disease / Vector | Statistical Methods                                                                 | Main Findings                                                                                                                                                                                                 |
|-------------------------|----------------------------|-------------------------|--------------------------------------------------|------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Andrew Mertens, (2019)  | India                      | High temperature, high rainfall | Diarrhea                                         |                   | Fecal contamination indicator, tested in all households. Estimates the relationship between temperature, rainfall exposure, and diarrhea using binomial regression | The main finding was that there was an increase in the incidence of diarrhea during the week as a result of heavy rainfall and poor climate change in rural India of Tamil Nadu. |
| Chien-Chou Chen (2019)  | Hong Kong, Japan, Taiwan   | Temperature, acute diarrhea | Diarrhea                                         |                   | Using meta-analysis of non-linear lag models to see the relationship between the effect of temperature on the incidence of acute diarrhea | The findings showed that there was no relationship between temperature and the incidence of acute diarrhea in Hong Kong, Taiwan and Japan |
| James Manley (2019)     | Peru                       | Weather effects, Geospatial Investigation | Diarrhea                                         |                   | Using health demographic survey data where data was collected from 2004-2007         | The results showed that there was a small but significant effect between temperature and rainfall on the incidence of diarrhea |
| Lindsay M.Horn (2018)   | Mozambique (Africa)         | Temperature, climate change | Diarrhea                                         |                   | Time series regression uses the Poisson lag model                                   | The results showed that rainfall has a relationship with the incidence of diarrhea |
| Masahiro Hashizume      | bangladesh                 | Climate                 | Diarrhea                                         |                   | Linear regression                                                                    | Based on time series analysis using clinical and environmental data (water temperature, air temperature, rainfall, water depth, water samples etc.) collected for two weeks in four rural locations in Bangladesh, there was no relationship between rainfall and diarrhea incidence. |
| Gentille Musengima (2016) | south Africa              | temperature, diarrhea, climate | Diarrhea                                         |                   | Poisson regression model                                                             | The findings indicated that an increase in temperature of 5°C at the minimum and maximum temperatures within a week could lead to an increase in diarrhea cases by 40% and 31% in each season, respectively. |
| Kathleen A. Alexander (201) | United States of America | Climate change, infectious | Diarrhea                                         |                   | Autoregressive analysis of                                                           | The results showed that the prediction of an increase in |
### 3) 

| Study                                      | Location | Climate Variables | Disease | Analysis Method                     | Temperature and Rainfall Impact |
|--------------------------------------------|----------|-------------------|---------|-------------------------------------|---------------------------------|
| Hasnawati Amqam (2019)                     | Indonesia| Temperature, rainfall, humidity, disease. | Diarrhea | Data analysis using correlation test | Increase of 1°C increases diarrhea cases by 40,944 and an R² value (0.128) means that the variation in air temperature of 12.8% can explain the incidence of diarrhea. |
| Eddy Moors (2013)                          | India    | Climate change, diarrhea | Diarrhea | Using climate model simulation (RCM) | The increase in the incidence of diarrhea is thought to come from an increase in temperature. The temperature rise shows a uniform pattern ranging from 1.5 to 2°C across India in 2004 |
| Simon J. Lloyd (2007)                      | English  | Diarrhea, Climate Weather, Temperature, Rainfall | Diarrhea | Linear regression analysis          | There is no relationship between rainfall and the incidence of diarrhea |

### 4. Discussion

The relationship between the effect of temperature and the incidence of diarrhea.

Climate change is known to affect the transmission of the disease diarrhea, where the case shows the close relationship between climate, temperature and weather with the incidence of diarrhea in some parts of the world. One of the diseases associated with climate change is diarrhea. Climate elements, namely rainfall, temperature, humidity, and wind speed affect the incidence of diarrhea. Where the increase in temperature can accelerate the incubation period of microorganisms so that transmission becomes fast and widespread. Any change in temperature will result in population dynamics of vector species and pathogenic organisms such as protozoa, bacteria and viruses. In the rainy season, low temperatures can make disease vectors develop faster, such as cockroaches, flies and mice. High temperatures will increase and expand the development and growth of infective parasites and can also have a direct effect on the growth of organisms in the environment. Increased temperature is associated with increased diarrheal disease, because warmer temperatures can lead to increased proliferation of pathogens in food and water sources.

While all of the studies included in the data set were conducted over a period of 1 year or more, many were not conducted over a full year period. As a result, the average rate of diarrhea, rainfall, and temperature may rise or fall, depending on seasonal patterns over the partial year period. We performed a sensitivity analysis that excluded the partial year period studies to explain this. Analysis
was performed using Stata software. A positive relationship between diarrhea and increased environmental temperature. Research shows that temperature and rainfall have a small but significant effect on children's health. In particular, the higher temperature difference in a given month (i.e. lower minimum temperature and higher maximum temperature) is protective. We also looked at the protective effect of rain in this month and the negative effect of rain in the previous month. This is consistent with the rainfall in the previous month which increased the incidence of disease, while the less rainfall this month was also the same.

Based on the findings, all articles indicate that climate, weather and temperature have an effect on the incidence of diarrhea besides that rainfall also affects the incidence of diarrhea, this is evidenced by previous research finding evidence that higher rainfall is associated with a higher risk of diarrhea. It is known that diarrheal disease or gastroenteritis is caused not only by one particular factor, but from many factors. The availability of clean water is one of the contributing factors. Rainfall is either directly or indirectly will affect water quality and quantity of water on the surface. This is because heavy rains can introduce disease agents carried by rainwater from poor sanitation which can contaminate water supplies. Environmental factors are also a cause if the rainfall increases which results in flooding, then bacterial or viral contamination from a bad environment with flooding will increase. Rainfall patterns can affect the spread of organisms that can spread the disease, the rain can contaminate the water with ways to move human and animal waste into the groundwater. Organisms found in feces include Kriptosporidium, Giardia and E. coli. These organisms can cause diseases such as diarrhea. During dry conditions there will be a decrease in rainfall or even no rain at all, this can reduce the availability of clean water, thereby increasing the risk of hygiene-related diseases such as diarrhea. A person's behavior, especially the cleanliness of eating utensils or washing hands before eating, will be reduced, so that the transmission of microorganisms that cause diarrhea from eating utensils or unclean hands can contaminate a person's body and diarrhea will occur.

5. Conclusion

There is a relationship between temperature, climate and weather with the incidence of diarrheal diseases, but temperature, climate and weather alone are not the main causes of diarrhea. The observed associations may not be due to climate, weather and temperature, but due to related factors such as rainfall, or human behavior during cold weather, insufficient water availability, human immunity, socioeconomic and cultural factors can directly influence the occurrence of diarrhea.

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