AN ECOLOGICAL STUDY OF CLIMATIC FACTORS AND COVID-19 MAKASSAR

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STUDY PROGRAM INTERNATIONAL CLASS

\DEPARTEMENT OF ENVIRONMENTAL HEALTH

FACULTY OF PUBLIC HEALTH

UNIVERSITAS HASANUDDIN

MAKASSAR 2024

THESIS

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Thesis

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Thesis

The thesis has been examined and defended in front of the Public Health Study Program Undergraduate Examination Committee on 07 February 2024, and was declared to have fulfilled the graduation requirements
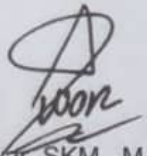
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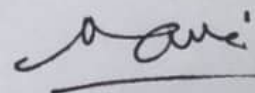Faculty of Public Health
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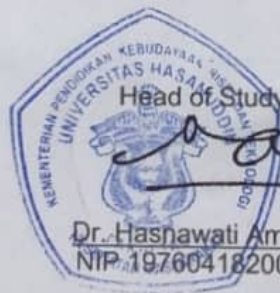Makassar

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Statement of authenticity of the thesis and abundance of COPYRIGHT

I hereby declare that the thesis entitled "An Ecological Study of Climatic Factors and Covid-19 Makassar" is truly my work with direction from the supervisor Prof. Anwar Mallongi, SKM., MSc., Ph. D and title as Main Supervisor and Dr. Hasnawati Amqam, SKM.,M.Sc and title as Co-Supervisor). This scientific work has not been submitted and is not being submitted in any form to any university. Sources of information originating from or quoted from published or unpublished works of other authors have been mentioned in the text and included in the Bibliography of this thesis. If in the future it is proven or can be proven that part or all this thesis is the work of someone else, then I am willing to accept sanctions for this action based on the applicable regulations.

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ABSTRACT

Hasanuddin University Faculty of Public Health, Environmental Health Makassar, 19 January 2024

Shahidul Islam
"AN ECOLOGICAL STUDY OF CLIMATIC FACTORS AND COVID-19 MAKASSAR "

Covid-19 has already spread to about 232 countries and infected about 523,887,351 people worldwide including 6,307,021 deaths. Covid-19 spreads through droplets and is influenced by climatic factors such as wind speed, temperature, and humidity in the transmission process. This study aims to determine the correlation between climatic factors such as temperature, relative humidity, rainfall, duration of sunshine, wind speed, and the number of Covid-19 cases in the city of Makassar 2020-2022.

This research applied ecological research design. Correlations between weekly confirmed Covid-19 cases and climate factors were measured using R software using bivariate analysis Spearman correlation test. Covid-19 cases data were obtained from the Health Ministry of Makassar City from 19 March 2020 to 14 September 2022 and climate factors data were obtained from the Meteorological, Climatological, and Geophysical Agency Makassar, Indonesia.

This analysis shows a significant and weak correlation between average temperature ($R =- 0.36$, $p = 0.001$), average humidity ($R = 0.27$, $p = 0.0023$), duration of sunshine ($R = - 0.25$, $p = 0.0039$), rainfall ($R = 0.19$, $p = 0.029$), average wind speed ($R = 0.28$, $p = 0.0013$) and Covid-19 weekly cases in the city of Makassar.

This research shows that there is a negative-weak correlation between sun exposure and covid-19 cases while rainfall and wind speed has a positive correlation with covid-19 cases

Keywords: **Covid-19 weekly cases, climatic factors, Makassar City**

FOREWORD

Bismillahirrahmanirrahim

Assalamu'alaikum Warahmatullahi Wabarakatuh.

Praise be to Allah *Shubahanahu Wa Ta'ala*, because of His grace and blessing so that the author's final assignment (thesis) can be completed. Don't forget to offer prayers and greetings to His Majesty *Rasulullah Shallallahu 'Alaihi Wa Sallam,* who is the best role model for mankind.

Thank God for all the efforts and hard work as well as support and prayers from family and relatives. and all parties who have participated so that the thesis is entitled **"AN ECOLOGICAL STUDY OF CLIMATIC FACTORS AND COVID-19 MAKASSAR"** can be resolved. This thesis is one of the requirements to obtain a Bachelor of Public Health degree. The author dedicates this thesis to his beloved parents **(Al Marhum Mawlana Saiful Islam and Sahera khatun)** who have provided encouragement and support so that the author can complete this thesis. Parents' love can never be replaced until the end of life, I hope mom and dad are proud of this achievement.

In working on this thesis, of course the writer received help, encouragement, prayers and motivation, so that the writer could overcome

these obstacles and challenges easily. With grace and humility, the author expresses his sincere thanks to:

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The author realizes that this thesis is still far from perfection, therefore the author hopes for suggestions and criticism from readers who are sympathetic to this thesis to improve it. Finally, there are no words that the author should say other than a prayer that Allah Almighty will always bestow His blessings and blessings on our deeds in this world and the hereafter. Amen

Makassar, 19 January 2024

Author

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LIST OF ABBREVIATIONS

WHO   : World Health Organization

COVID-19   : Corona Virus Disease 2019

MERS-CoV   : Middle East Respiratory Syndrome Coronavirus

SARS-COV-2   : Severe Acute Respiratory Syndrome Coronavirus

RISTEKDIKTI   : Riset Teknologi Dan Pendidikan Tinggi

CHAPTER I

INTRODUCTION

A. **Background of The Research**

In December 2019, World Health Organization (WHO) received information about infection by a virus with undetermined etiology in Wuhan, China. In 2020, this epidemic situation was officially named Covid-19 which caused by a virus that seems like SARS and MERS which was occurred a few years back. The difference between Covid-19 (Also called "Sars-Cov-19") and MERS/SARS is in the transmission. Due to the high intensity of the transmission of Covid-19 had been spread to 24 different countries within 3 months after this virus was being reported. From 2020 until 2022 this virus has a high risk for humans with certain diseases (Such as Hypertension, Diabetes, etc.) (Wang et al., 2020) and during that time the virus has become pandemic with multiple variants, clinical Syndrome, and mutation. (Chen et al., 2021).

In February 2020, Covid-19 spread to about 114 countries around the world, and on March 11, 2020, the World Health Organization declared it an epidemic. Thailand is The first country confirmed Covid-19 outside China on January 13th 2020. Thailand confirmed positive for Covid-19 3,135 cases and 58 deaths since January 13, 2020 to June 15, 2020. Covid-19 sufferers are increasing rapidly to 7,734 cases on January 30, 2020 and on the same date confirmed 90 cases Covid- 19 positive patients from various countries

both in Asia, Europe and Australia. As of March 25, 2020, Covid-19 had already infected a total of 414,179 people in Indonesia, and 18,440 people had died from the virus. One of the leading media outlets in Indonesia reported the latest update of Covid-19 on 14 July 2022. Covid-19 has already spread to about 232 countries and infected about 523,887,351 people worldwide including 6,307,021 deaths. In Indonesia, Covid- 19 has already collected 6,057,142 cases and a total of 156,622 deaths have been reported. (Ristedikti, 2022). The spread of the first case of Covid-19 in Indonesia on March 02, 2020 which confirmed as many as 2 patients who come from Jakarta. June 15, 2020, 38,277 confirmed positive cases Covid-19 and confirmed dead as many as 2,134 cases. In East Java, on June 19, 2020 confirmed patient Covid-19 as many as 9,046 +209 new cases, confirmed recovered as many as 2,763 cases, and confirmed death as many as 721 case. In Makassar South Sulawesi untilt 6 august 2022 there are 143.338 positive covid-19 cased total (Ristedikti, 2022)

Humans have an immune system that functions to protect the body from bacterial and viral infections, this immune system is then influenced by several things, one of which is the body's nutritional levels. when the consumption of nutrients is low, the immune system will also have a poor performance which willthen cause infections both viruses and bacteria to be easier (Calder, 2020). Apart from a low immune system which is a risk factor for susceptibility to Covid-19 infection, there are also congenital

diseases that can be one of the risk factors that determine the severity of Covid-19 (Radke et al., 2020)

Virus of Covid-19 was transmitted from air to humans, also known as droplet transmission or airborne transmission (Farinholt et al., 2021). After Covid becomes airborne the viruses enter the respiratory tract, infect humans, and cause the pneumonia-like syndrome. It has also been found that people with certain diseases are at higher risk of being infected with Covid-19. (Shiehzadegan et al., 2021).

This covid-19 transmission process can be roughly influenced by environmental conditions such as temperature, humidity and wind speed, these three variables will then be influenced by atmospheric conditions such as Duration of Sunshine and average rainfall (Islam et al., 2021). For Example In the Northern Hemisphere, many residents and policymakers find relief when their country is in warmer climates and more sunlight reaches Earth in spring and summer. Many viral acute respiratory tracts such as influenza A, influenza B, adenovirus, etc. are dependent on climate. Some viruses have higher durability at lower temperatures, lower humidity, and lower UV radiation. Vitamin D deficiency in humans in winter is seen as a risk factor that increases the rate of infection by the virus, which is caused by a decrease in immunity against the virus (Marajit et al., 2020). Beside that for temperature and humidity were explain on March 9, 2020, by the World Health Organization (WHO) says that the virus (Covid-19) could infect

all regions, including hot and humidity climates. On April 7, 2020, the U.S. National Academy of Sciences stated that there is a correlation between high temperatures and humidity levels and that it also reduces the chances of SARS-Cove-19 surviving. (Bashir et al., 2020). Another research found In the middle of May and November, based on the European Respiratory Society expressed various articles that described the temperature and Covid-19 on the contrary related. (Bashir et al., 2020). The research conducted by (Chen, et, al.) in 2021 under the title "Climate and spread of covid-19" shows that Covid-19 is less prevalent in countries with higher heat and humidity. Another research that had been conducted by Prata, D. under 2021with the title "The correlation between (sub) tropical climates and the incidence of covid-19" found that is an inverse correlation between subtropical and tropical climates for the spread of the novel coronavirus and temperature, suggesting a sensitivity behavior to climates zones.

Rainfall is something unique, because among weather variables such as temperature, humidity, air speed and even exposure to sunlight, rainfall is the factor that affects each of these climate variables which will then increase the transmission of COVID-19. (Shenoy et al., 2022) for example, a city with a high level of rainfall will have an impact on the city's average temperature and if the rainfall is high the temperature in the city will have a low average which is then accompanied by quite high humidity. In addition, rainfall also gives a factor to thehigh air speed. A low average temperature

will then increase the duration of life of covid-19 which will then be one of the risk factors for the spread of this covid-19 virus. high temperatures have a different impact, high temperatures will shorten the life duration of this covid-19 virus and prevent prolonged transmission of this covid-19 virus. (S. Chen et al., 2021)

Simply put, from all the research collected by researchers, it was found that three weather variables such as temperature, humidity, and also air speed had an influence on the transmission of covid-19. High temperatures will then reduce the duration of life of Covid-19 and prevent the spread of Covid-19 (Ma et al., 2020). At a certain humidity level, the Covid-19 virus will survive longer so that it can increase transmission (Wei et al., 2022). High air velocity can carry the virus to a certain space which can then increase the spread of this virus (Bashir et al., 2020). especially exposure to sunlight which contains ultraviolet light which is then emitted to the earth will increase the average temperature of the earth at a certain location. which will then inhibit the growth and spread of this covid-19 (Asyary & Veruswati, 2020)

The description above then became the basis for researchers in conducting this research by using an ecological study design to see the corelation of each weather variable to the spread of covid-19 in the city of Makassar.

B. Problem Research Question

Based on the introduction page, the author raises the following questions "The Correlation between Climate Factors (Duration of Sunshine, Average of the Temperature, Relatively Humidity, Rainfall, And Wind Speed) and the Spread Covid-19?"

C. Objective of the Research

1. Main Objective

Based on the problem, the purpose of this study was to know the correlation between climate factors and the spread covid-19 cases in Makassar.

2. Objective

a. To describe the covid-19 cases in Makassar based on the cumulative frequency

b. To Analyze the correlation between the temperature and covid-19 cases in Makassar

c. To Analyze the correlation between the Humidity and covid-19 case in Makassar

d. To Analyze the correlation between the Rainfall and covid-19 cases in Makassar

e. To Analyze the correlation between the Duration of Sunshine and covid-19 cases in Makassar

f. To Analyze the correlation between the Wind Speed and covid-19 cases in Makassar

D. Benefit of the Research

1. Theoretically

The significance of this research is a justification of the importance of the research carried out by the writer and its impact on the field of research being carried out, as well as the impact on newly acquired knowledge and how others benefit from the research.

2. Practically

a. Student

This research is useful for myself since this research can improve the acknowledgment about climatic condition and its impact on covid-19 cases in Makassar.

b. Reader

In this study, readers can read this Thesis to improve their knowledge about the spread of covid-19

c. Institution

It is expected that this research can contribute to additional knowledge, especially for Public Health students, as well as become reading lesson in the University library and can provide a reference for other students.

CHAPTER II

THEORITICAL OF LITERATURE

A. Literature Review of Covid-19

1. Definition of Covid-19

The Covid-19 virus has a glycoprotein structure that is shaped like a crown in the Latin language commonly called the corona. The majority of the Covid-19 group gave mild symptoms but there were also those who gave severe and life-threatening infections, such as SARS and MERS. (K

Figure 2.1 Structure of Covid-19

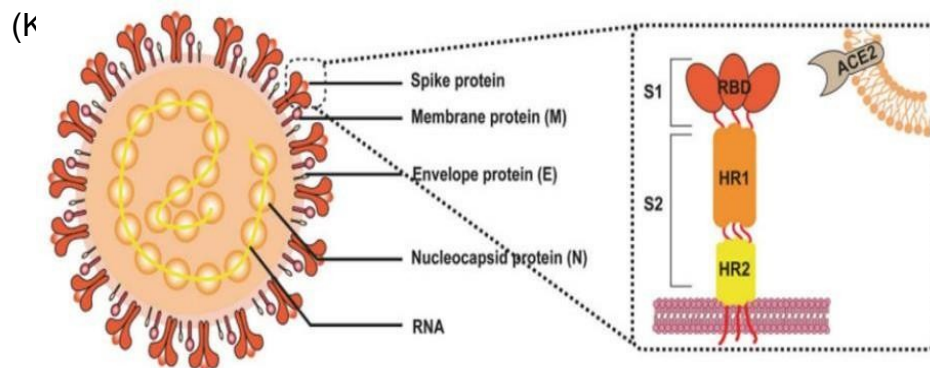SARS-CoV-2 is a spherical virion with a genome of 29,700 nucleotides long. Two-thirds of the genome and long polyprotein ORF1ab belong to the 5´ end. The 3´ end encodes four major structural proteins, namely spike protein (S), nucleocapsid protein (N), membrane protein (M), and envelope protein (E). The S protein consists of two functional subunits, namely the S1 and S2 subunits. (Kumar et al., 2021)

2. **Pathophysiology of Covid-19**

Covid-19 infects through the respiratory tract or body mucosa. The receptor responsible for the entry of the virus is the Angiotensin Converting Enzyme 2 receptor (ACE2), the pathogenicity of which is played by the envelope (Mariz et al., 2020).

Covid-19 Also had four structural proteins S,N,M,E that enable the viruses to gain the acces to the host cell. The S protein is heavily N-glycosylated, the M protein is present as a dimer in the virion, which maintains its shape and the E protein, a transmembrane protein with an Ion channel activity plays an important role in viral pathogenesis. This promotes the assembly and release of the virus from the host cell (Ochani et al., 2021) The N protein is only present in the nucleocapsid, which helps bind the viral genome with the NSP3 protein of the RTC and packages the RNA species produced during infection into the viral particles. It also serves as an antagonist of interferon (IFN), which appears to be beneficial for viral replication (Hurst et al., 2013).

Human with low immune sytem or even low nutrition can easily get infected by the covid-19 viruses It is well acknowledged that a low protein status also can increase the risk of an infection, related to, for example, low antibody production (Iddir et al., 2020). An optimal nutritional status was also fundamental to modulate inflammatory and oxidative stress processes, which are all interrelated with the immune system. The

important notion of the relationship between dietary constituents, nutrition, inflammation, and oxidative stress is well-regarded, and has been emphasized, for example, in the development of the anti- inflammatory dietary index. Dietary and nutritional constituents known to exert anti-inflammatory and antioxidant properties include omega-3 fatty acids, vitamin A, vitamin C, as well as a variety of phytochemicals, such as polyphenols and carotenoids that are widely present in plant-based foods (Rodríguez et al., 2021).

3. **Clinical Manifestation of Covid-19**

This Covid-19 virus infection can cause mild, moderate to severe symptoms. The main clinical symptoms given can be fever with a temperature above 38 degrees (C) and accompanied by cough and shortness of breath. In addition, it can be accompanied by severe symptoms such as myalgia, gastrointestinal symptoms and fatigue. In severe cases rapid and progressive worsening such as ARDS, septic shock, metabolic acidosis, and bleeding. (Mariz et al., 2020).

4. **Treatment of Covid-19**

There is no specific therapy for Covid-19, the main therapy is in the form of symptomatic therapy and oxygen therapy in case of respiratory disorders which can be in the form of invasive or invasive mechanical ventilation. Pharmacological therapies that can be given are

corticosteroids, antivirals, immunomodulators, anticoagulants, inflammatory inhibitors, and serotherapy. (Qing et al., 2020).

5. **Vaccine of Covid-19**

On August 2020 researcher from around the world are aggressively working to develop a total of more than 200 vaccines candidates in various stages of development. There is total 30 vaccines currently on clinical trials on that date such as AstraZeneca and also Moderna that now on 2022 were already being used to prevent the spread of Covid-19. In order to develop a safe and effective vaccine, it is critical that pre-clinical and clinical trials are done with vigilance to avoid severe adverse effects. (Sharma et al., 2020).

Precise recognition mechanisms between viral surface proteins and host receptors are important for understanding how trans-species and host tropics are transmitted as well as for the formation of animal models for vaccine development. The coronavirus spike (S) protein is an important target for vaccine development as it mediates infection mechanisms via binding to cell receptors host. There are a couple of vaccine kinds that being analyzed to prevent the covid such as:

a. Killed and attenuated vaccines. Inactivated whole cell vaccines or live attenuated vaccines present several antigenic components to the host and thus can potentially cause various immunological effects against

pathogens (Ahn et al., 2020). They are traditional vaccines with well-prepared technology, and can become vaccines SARS-CoV-2 was the first to be put into clinical application.6 Currently, several research institutes have initiated this research. The Chinese Center for Disease Control and Prevention, the Wuhan Institute of Virology, the Chinese Academy of Sciences, Zhejiang University, and several other institutions have successfully isolated the SARS-CoV-2 virus strain and started the development of the relevant vaccine. (J. Zhang et al., 2020).

b. Subunit Vaccines. A subunit vaccine includes one or more antigens with strong immunogenicity capable of efficiently stimulating the host immune system. In general, these types of vaccines are safer and easier to manufacture, but often require the addition of adjuvants to elicit a strong protective immune response. So far, several agencies have initiated SARS-CoV-2 subunit vaccine programs, and almost all of them use protein S. as antigens. For example, the University of Queensland is developing a subunit vaccine that base on molecular (L. Zhang & Liu, 2020).

6. **Transmission of Covid-19**

The Covid-19 was transmitted via airborne or droplets, that were being affected by the flow of the air condition. Transmission through the air will cause an extraordinary rate of spread, especially in enclosed spaces with recirculating air conditioning systems because Covid-19 is a

highly contagious pathogen. One route of transmission that has only been discussed in passing is the transport of virus-laden particles in the air. When the liquid splash from a patient becomes small in size due to evaporation, the airflow transports more influence than the gravitational force. These small particles will freely fly in the air and can survive up to a distance of tens of meters from their place of origin, so it is recommended that in addition to washing hands and social restrictions, wearing masks when leaving the house is effective prevention of Covid-19 transmission. (Araf et al., 2022).

B. Literature Review of Climates

1. Definition of Climates

Climate refers to atmospheric conditions over a long period time over a large area. It can also be defined as the long-term average of the weather. The Weather itself is defined simply as the state of the surrounding atmospheric system that describes conditions such as sunny or cloudy, rainy or not, hot or cold, humidity, visibility, and so on. Weather can also be defined as the state or condition of the atmosphere at a certain time and place. Weather can change from day to day even hourly. Weather varies from day to day and from place to place. Furthermore, the weather and climate themselves can vary because it is influenced by the following factors such as: The Latitude and Altitude Of A Places, Land and water

surfaces, Mountains, Vegetation, Air Pressure, and Wind And Storm (Schimel, 2019).

2. **Climates Factors**

Climate change is a change in the physical conditions of the Earth's atmosphere, including temperature and distribution of rainfall that has a wide impact on various sectors of human life (Ministry of Environment, 2001 in LAPAN). This change does not only occur at any time but can occur over a while longer. Climate change is something that is difficult to avoid and can impact various aspects of life. The extreme impact that occurred is an increase in temperature and also a shift in seasons. Season pattern it has been happening irregularly since 1991 which at the time was disturbing national food self-sufficiency which until now still depends on imports food. There is some element that controls the climates which are given below: (Jacobson, 2006).

a. Duration of Sunshine Duration of shunshine

The duration of shunshine can be seen from duration of sunshine from the burning heat of the sun for a duration of 8 hours, from 08.00 WIB to 16.00 WIB (BMKG, 2020) The most important element in climate. This solar radiation produces solar radiation (short wave radiation). Solar radiation encourages evaporation on the surface of the water. This radiation also produces heat energy which can increase the temperature in the air. The occurrence of heating in the air that interacts

with the vapor in the air can form clouds and when it is saturated it can produce precipitation. When unbalanced heating occurs at the Earth's surface it can create a pressure gradient that produces wind. The amount of sunlight received in an area is determined by geographic location, time of day, season, landscape, and local weather. The duration of solar radiation and radiation shrinkage can be affected by pollutant gases such as greenhouse gases, the lack of land with plants and trees, massive housing, and industry. Pollutants that gather in the atmosphere can block the rate of sunlight from reaching the earth's surface. If there is a reduction in the amount of irradiation in one year, it can indicate that there has been an increase in air pollution. The duration of solar irradiation during a given period is defined as the number of sub-periods in which direct solar irradiance exceeds 120 W m-2. The unit used to indicate the quantity of irradiation duration is hours. The measurement period in addition to the unit can be done in the form of days, months, years, decades, and so on.

b. Temperatures

Air temperature can be defined as the degree of hot or cold air in the atmosphere. The temperature from one location to another can be different, this is due to differences in geographical location such as lowlands and highlands. This is due to the curvature of the earth, so the amount of solar energy received varies according to latitude. As a result,

the air temperature generally decreases from the equator towards the poles. When you are on high land the atmosphere becomes less dense and the temperature drops. Therefore, the hills are cooler than the lowlands. The temperature measuring device is a thermometer. Meanwhile, temperature units can be expressed on three different scales, namely Celsius, Fahrenheit, or Kelvin. The three scales in Indonesia usually use units of degrees Celsius (ºC). (Jacobson, 2006)

c. Humidity

Thermal energy radiates from the sun which converts water into water vapor. This invisible water vapor is present as a gas in the atmosphere at all times and is referred to as moisture. In simple terms, humidity is defined as a measure of the water vapor content in the air. Air flowing over the sea will absorb water vapor through evaporation to become moist, while air flowing over dry land is expected to remain dry. In weather parameters, generally, the ideal measure of humidity is expressed by relative humidity. Relative humidity (RH) can be defined as the ratio of the actual vapor pressure to the saturated vapor pressure at a certain air temperature; the result is expressed as a percentage. Since the saturated vapor pressure is temperature dependent, for a certain value of relative humidity, warm air has more water vapor than cold air. This shows that relative humidity does not provide information on how much water vapor is in the air, but rather what percentage of the

maximum vapor pressure has been reached. An instrument for measuring air humidity is called a hygrometer.

d. Rain Weather

Precipitation can be defined as the liquid or solid product of the condensation of water vapor that falls from clouds or is deposited from the air to the earth's surface. The rain process is a combination of atmospheric dynamics and thermodynamics through latent heat released and absorbed during the water change phase. The instrument used to measure rainfall is the observatory rain gauge. The way this tool works is by measuring the amount of rainfall that enters the rainfall gauge for 1 day or in 24-hours period. Rainfall intensity can be distinguished by four criteria which are given below:

Table 2.1 Criteria Of Rain Weather

Criteria	Rainfall/Day	Rainfall/Hours
Very Thick	>100 mm	>20 mm
Thick	50 – 100 mm	10 – 20 mm
Moderate	20 – 50 mm	5 – 10 mm
Heavy	5 – 20 mm	1 – 5 mm

e. Wind Speed

Wind was made by the differentiations of the atmosphere pressure which force the air in high pressure zone to the lowest pressure zone. Zone with low temperature air has a high pressure and the zone with high temperature air has a lower pressure. At noon air temperature is higher on the mainland because the seas is more

absorbable to the heat that's why in mainland the air temperature is higher. After that the air in mainland will go up and their places will be change by the air from the sea, so that the wind blows from land to seas. At night the temperature in mainland is lower than the seas, so the temperature in seas is more higher than the mainland. So the wind travel from mainland to seas. Wind Speed is Measured by anemometer, and wind direction is measured by the weather vane. (Ali et al., 2021)

3. **Climate Conditions**

Climatic conditions vary in each region. Climatic classifications are based on properties such as temperature, rainfall, types of air masses, and seasonal variations of an area. Climate classification is based on the Köppen system (The Köppen System), climates are classified into five namely (Kottek et al., 2006)

a. Tropical (tropical), where the average temperature for all months is greater than 18ºC. The tropical climate is divided into three categories, including tropical rain forest (tropical rainforest/wet tropical), tropical monsoon (tropical monsoon), and tropical savanna (tropical savanna/tropical wet and dry). According to the three categories, the State of Indonesia is included in the category of tropical rainforest climate which is characterized by: High humidity, Rain throughout the year (also known as the wet tropical climate), Areas near the ocean

are associated with high rainfall, Produce a true rainforest canopy, Have good climate stability, and Rich in biodiversity.

b. Dry: the dry climate classification has a higher evaporation potential than rainfall

c. Mild midlatitude: the coldest month of the year has an average temperature higher than -3°C (or 0°C) but below 18°C. Summer can be hot.

d. Severe midlatitude: Winter is at least occasionally covered in snow, with the coldest month having an average temperature below -3°C (or 0°C). Summers are usually mild.

e. Polar: All months have an average temperature below 10°C.

4. **Climates Changes**

In the last few decades, the climate has had a significant to life on earth This is due to the phenomenon of climate change. Climate change is a statistically significant variation of the state average climate and/or variability of its properties, usually persisting over time a long time (usually decades or more) (M. R. Allen et al., 2014). Climate from time to time always changes and is normal. It's different if it changes on weather variables that often change in a relative time short (on a geological scale). This change can be said as an event least likely in a statistical sense. Produced natural activities by nature and human activities contribute to climate change. However, from these two sources, human activity is

considered to be the most important factor dominant in recent changes. Since the last three centuries were expected to be a significant start for human activities contribute to the increase in global air temperature (Rabbani et al., 2022). Human activity is considered to be a driving factor that causes various damage to the environment caused by increased greenhouse gases (mostly there is a significant increase in CO_2 concentration) and changes in land use, has an impact on the increase in air temperature which is one of the important variables on weather and climate . Change is said to be extreme when potentially harmful to human life and other living things (WHO, 2015).

C. Literature Reviews of Covid-19 and Climate

So far there has been no conclusion regarding the spread of COVID-19 through the air. But in several studies, it was found that covid-19 spreads through droplets and is influenced by wind speed, temperature, and humidity in the transmission process. In research conducted in China, data showed that temperature was proven to be one of the environmental factors that helped the spread of covid 19. At high temperatures, data showed that there was an increase in cases of infection by covid-19 (S. Chen et al., 2021) the following is a further explanation regarding the relationship between each variable from weather and covid-19:

1. **Covid-19 And Temperature**

Based on research conducted in India which is a country adjacent to China which is also trying to fight against the coronavirus. At the beginning of March 2020, India only reported a total of 3 Covid cases which then increased drastically to thousands in just one month. Till now India reported a total of 32.3 million cases and 434,074 deaths (COVID-19 India, 2021).

In recent years there have been so many natural phenomena, one of which is the depletion of the ozone layer from the earth which causes daily temperatures in several countries in the world. India is a country with a fairly large population and also vehicle transportation is quite often used so that air pollution is a risk factor for ozone depletion. Based on this research conducted in India which aims to see the association between the spread of COVID-19 with temperature. In this study, it was found that in 3 states in India, where testing was carried out, there were positive results between the spread of Covid-19 and the daily average temperature (Irfan et al., 2022).

The temperature has a critical function in regulating the pandemic dilemma, as COVID-19 cases increase with low temperature, while decrease as the temperature goes up. This finding was corelated with (Ma et al., 2020) that also discovered a positive correlation between daily temperatures and Covid-19 Spread in Chinese city of Wuhan.

Dadbakhsh, M (2022) says that low temperature increases the mortality rate of respiratory illnesses. Another study discovered that both cold and heat impacts may have a detrimental effect on respiratory morbidity (Irfan et al., 2022).

2. **Covid-19 and Humidity**

The stability of SARS-CoV-2 in aerosols: One precondition to support the airborne transmission of SARS-CoV-2 is that the virus can remain infectious in droplets generally longer than the time it takes for the droplets to travel from person to person (Tang et al., 2020) there ar study pointed out that SARS-CoV-2 could remain viable in respirable-sized aerosols for more than 16 hours (Wang & Deng, 2021). The SARS-CoV-2 variant in England was found to remain infectious for at least 1.5 hours in experimental aerosols from artificial saliva and tissue culture mediums (Smither et al., 2020). This study further illustrated that the SARS-CoV-2 was more susceptible at a higher relative humidity in tissue culture mediums, with the decay rate increasing from 0.91% per minutes (medium relative humidity: 40%-60%) to 2.27% per minutes (high relative humidity: 68%-88%). (Wei et al., 2022)

3. **Covid-19 and Wind Speed**

In a study conducted by Nazrul Islam which examined related factors such as weather, humidity, and air speed related to the spread of the Covid-19 virus, this study was analyzed data on total 310 regions

across 116 countries that reported confirmed cases of covid-19 by march 12, 2020 and this study also found that wind speed and also another variable such as temperature and humidity were inversely associated with the incidence of Covid-19 (Islam et al., 2020).

In a study conducted by Mario Coccia with the title that the effect of low wind speed on the dynamic transmission of covid-19 found that that atmospheric stability, based on low wind speed, reduces the dispersion of gaseous and particulate matters (air pollution), which can act as carrier of the SARS-CoV-2 in the air to sustain the diffusion of COVID-19 in environment, generating problems of public health in society. (Coccia, 2021)

4. **Covid-19 and Duration of Sunshine**

The city of Jakarta, which is the capital of the Unitary State of the Republic of Indonesia, has the highest prevalence of COVID-19 among 32 provinces. Jakarta has an average spread of 45.25 new cases per day. This research was conducted by Al Asyary by using the analysis method using Spearman correlation and obtaining data that high Duration of Sunshine has a relationship with cases of recovery from COVID-19. Simply put, patients who are more frequently exposed to the sun have a higher prevalence of recovery. Exposure to sunlight can improve the quality of the human immune system so that it can cause obstacles to the development of the Covid-19 virus. (Asyary & Veruswati,

2020). Prolonged exposure to sunlight can stimulate vitamin D which can improve the function of the immune system. (Slusky & Zeckhauser, 2021) Apart from that, many studies have found that exposure to sunlight can cure many respiratory diseases, one of which is tuberculosis (John F Aloia, 2007)

5. **Covid-19 and Rainfall**

Based on several studies that have been obtained above, it is known that several variables such as temperature, humidity, and also wind speed to Duration of Sunshine have a relationship with the spread or transmission of COVID-19. rainfall itself is one of the factors on the condition of each of these variables. for example, hot temperatures then get the influence of Duration of Sunshine, the duration of Duration of Sunshine will give the earth a fairly hot temperature, rainfall with a long enough duration will provide cold temperatures with relatively high humidity. this then becomes the basis that rainfall can be one of the risk factors that affect the environment and increase the transmission rate of covid-19 (Shenoy et al., 2022).

D. Theoretical Concept


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                 ┌─────────────────────────┐
                 │   Duration of sunshine  │
                 └────────────┬────────────┘
                              │
                              ▼
                 ┌─────────────────────────┐
                 │          Rain           │
                 └────────────┬────────────┘
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```

	Air	Pathway

Virus
Sars Cov-2 → **Air** -Temperature -Wind Speed -Humidity → **Pathway** -Inhalation -airborne -droplet

infection
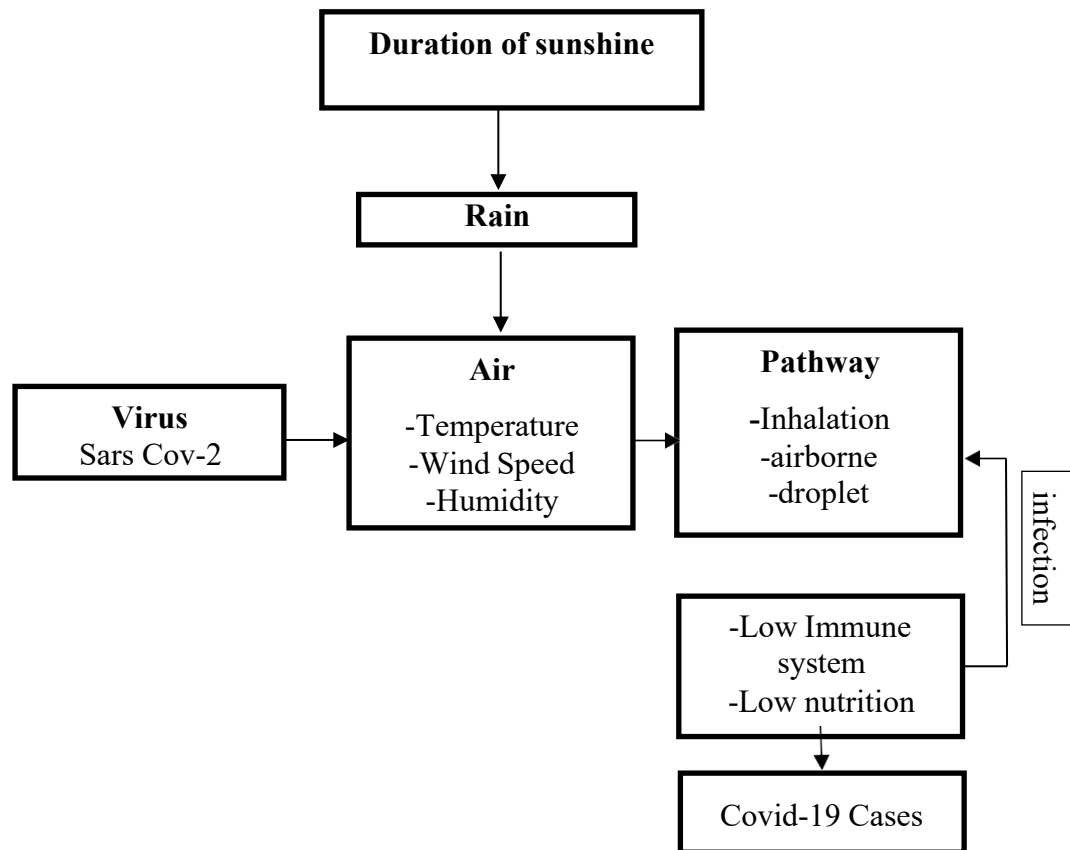
-Low Immune system
-Low nutrition

Covid-19 Cases

Figure 2.2 Theoretical Concept

The COVID-19 virus, namely Sars Cov-2, will be affected by weather conditions such as temperature, humidity, and air speed. These three weather variables get influence factors from atmospheric conditions such as rainfall and exposure to sunlight, such as exposure to sunlight with a long duration of time on the earth which will then increase the temperature on the earth's surface, and reduce the percentage of humidity. affect the temperature and humidity of the earth which will then determine whether the transmission of covid-19 increases or decreases, infection then occurs

through inhalation by humans with two routes, either airborne or droplet. Humans with low nutritional levels will have a low immune system performance which then has a greater chance of being infected with the covid- 19 virus.