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Air Quality Study in Patient Isolation Room Buildings Tuberculosis West Sulawesi Province Regional General Hospital as an Effort Prevention of Sick Building Syndrome (SBS)

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ABSTRACT

The provision of service facilities is driven by increased attention to infections in hospitals, primarily related to patient safety and accreditation assessments, including the design of isolation rooms that reduce the risk of infection. Descriptive study method of air quality in isolated buildings. This method explains phenomena in the form of language and words. To prevent Sick Building Syndrome (SBS), this study investigated the air quality in isolation rooms for tuberculosis patients in public hospitals in West Sulawesi. The results show that hospitals have a relatively high risk of infection because various disease-causing microorganisms or pathogens spread through droplets and air in every hospital room. Therefore, to prevent clinical and non-clinical workers from contracting infections, it is essential to have an isolation room with excellent and comfortable air quality and comply with thermal comfort standards.

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1. INTRODUCTION

Air quality is influenced by abiotic agents such as temperature, light, humidity, and dust particles. Meanwhile, biotic agents such as microorganisms are found indoors, usually in ventilation, doormats, or other places (Wahyutomo et al., 2022). Indoor air quality dramatically affects humans because most spend 85-90% of their time indoors (Damara et al., 2017). A poor ventilation system can result in the accumulation of indoor pollutants. Pollutants can be found in rooms from various sources, both from the outside air and from equipment and activities in the room itself (Anita Camelia, 2011), one of which is that air quality isolation for patients needs to be considered (Aurora, 2021). The isolation room in question is specifically designed to treat patients with infectious diseases to separate them from other patients (Mishra et al., 2016). Hospitals have isolation rooms to prevent the spread of contagious diseases that can become endemic, such as tuberculosis (TB), because this room is a particular one, and not many people can enter there. Admission procedures must also be carried out correctly, and nurses, doctors, hospital staff, and the patient's family must comply with them (Dr. Meva, Nareza, 2020).

Thermal comfort level is the most critical isolation space because it is a condition where a person psychologically, physiologically, and in behavioral patterns feels comfortable carrying out activities at a specific temperature, which means the air temperature is not too hot or cold. (Sudirman & Wahyuningsih, 2020). In research by Sudirman et al. (20200), there are two categories of adaptation to temperature changes that humans can make: behavioral pattern adaptation and physiological adaptation (Sudirman & Wahyuningsih, 2020).

As the EPA (American Environmental Protection Agency) announced, indoor air quality is considered one of the top five environmental problems affecting public health. Natural heat sources include solar heat, geothermal heat, and biological heat sources such as humans and animals. Nurses and other hospital staff spend an average of 40 hours indoors indoors. As a result, experts conclude that more people experience air pollution indoors than outdoors. Failure to address indoor air quality issues can hurt human health (Norhidayah *et al*., 2013). In the last twenty years or two decades, multi-story and tightly closed buildings have used artificial air ventilation systems with air conditioning. Air pollution produced by air conditioning can affect indoor air quality (Stamp et al., 2022). This is used to prevent Sick Building Syndrome (SBS). Sick Building Syndrome (SBS) is when building or building occupants experience health problems and discomfort due to time spent in the building with symptoms such as mucous membrane symptoms, fatigue, headaches, and skin symptoms (Anita Camelia, 2011).

From the results of this study, this research aims to examine the quality of air in the isolation room building for tuberculosis patients at the regional general hospital in West Sulawesi province as an effort to prevent Sick Building Syndrome (SBS). Sick Building Syndrome (SBS) is when building or building occupants experience health problems and discomfort due to time spent in the building with several symptoms, such as mucous membrane symptoms, fatigue, headaches, and skin symptoms (Anita Camelia, 2011).

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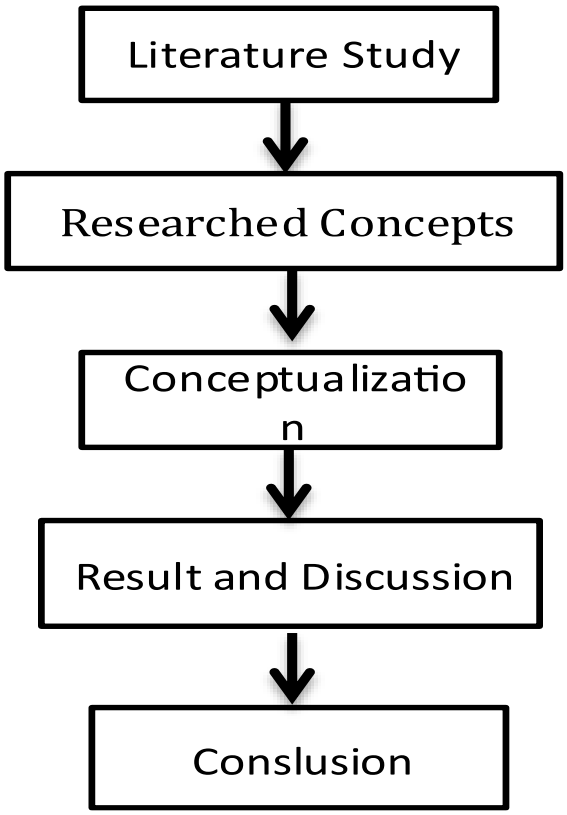
2. RESEARCH METHODS

This research uses a conceptualization method for descriptive air quality studies in isolated buildings. This method is used to describe phenomena in the form of words and language (Simorangkir et al., 2018). The concept of air quality in isolation buildings in public hospitals in West Sulawesi province was studied.



Graph 1. Flow of Research Methods
Source: Author's Analysis Results, 2024

3. RESULTS AND DISCUSSION

3.1 Air Pollution

Air pollution is the presence of foreign materials or substances in the air in specific amounts that change the composition of the air from its normal state. The presence of foreign materials or substances in the air in particular quantities and their presence in the air for an extended period can disrupt human life. If this happens, the air is considered polluted (et al., 2023).

Air pollution is the entry or mixing of hazardous substances into the air, which can cause damage and decrease the quality of the environment (Oktaviani & Prasasti, 2016). Therefore, human health problems will occur. Air pollution comes from two types of sources. The first comes from natural sources, such as volcanic eruptions. The second comes from human sources (anthropogenic sources), such as emissions from transportation, factories, etc. Air pollution can occur everywhere, such as at home, school, and office. Indoor pollution is usually referred to as indoor pollution. Outdoor pollution comes from industry, shipping, motorized vehicles, and natural processes by living things. Sources of air pollution are classified into mobile sources and stationary sources. Mobile sources include land and sea transportation, power plants, industry, and households (Yusrianti, 2015).

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3.2 Sick Building Syndrome

Sick-building syndrome is the leading cause of lung disease (Wang, 2000). According to the American Environmental Protection Bureau (EPA), using an air conditioner as an air ventilation system can introduce the pathogenic bacteria legionella, which causes legionellosis and building syndrome (SBS). Since 1970, the term sick building syndrome, or SBS, has been known. In 1980, the idea of SBS was recognized as an occupational health problem in the workplace by occupational health science, also known as occupational medicine. Air pollution, poor building ventilation, and IAQ (indoor air quality) have all been linked to these health problems (Spengler et al., 2000). Sick building syndrome (SBS) can be defined in two ways: as a person or group of people experiencing a collection of symptoms (syndrome) that is considered non-specific, which can be detrimental to health and is related to the condition of a particular building; or it can be defined as a sick building condition, where residents experience non-specific complaints or health problems (Anita Camelia, 2011). (Anita Camelia, 2011).

Also, sick building syndrome can be defined as symptoms associated with time spent inside a building. However, these symptoms cannot indicate an identifiable disease or cause. The occupants' fatigue may spread throughout the building (Ruth, 2009). Complaints and symptoms of sick building syndrome include nose irritation, eye irritation, disturbed concentration, skin and throat irritation, and respiratory problems of unknown cause. (Tritama et al., 2017)**.**

Based on Muniarti's research, the physical factors of temperature and humidity correlate with sick building syndrome with p-values of 0.036 and 0.539 (Muniarti, 2018). In addition, research by Saffanah and Pulungan shows that airspeed is associated with sick building syndrome with a p-value of 0.037 (Saffanah, 2019). Fauzi's (2015) study demonstrated that physical lighting factors correlate with sick building syndrome, with a p-value of 0.040.

According to research, individual characteristic variables such as age, gender, length of service, smoking habits, and psychosocial correlate with sick building syndrome with a p-value of 0.037 for the age variable, gender variable, length of service variable, 0.50, and psychosocial variables, 0.018, respectively (Zaelani, 2015). The identified and classifiable risk factors will be used to determine how the risk factors interact with the parameters. It can also prevent and control SBS (Rizqiyah & Putri, 2018).

Preventing and controlling health hazards in a healthy and comfortable environment is essential. Energy-efficient buildings are currently a significant concern for solving energy-related problems, such as the Use of energy-efficient ventilation systems and increased temperature and vacuum insulation, which often cause unhealthy and uncomfortable conditions and allow the occurrence of Sick Building Syndrome (SBS)(Susanti & Aulia, 2016).

The main aim of the isolation room design is to protect patients, hospital visitors, and medical staff from spreading microorganisms through the air (Nurochman & Widiastuti, 2022). According to Aditama, complaints or symptoms are divided into seven categories as follows (Ridwan et al., 2018):

1. Irritation of mucous membranes, such as eye irritation, pain, redness, and watering.
2. Nasal irritation, such as throat irritation, painful swallowing, itching, sneezing, and dry cough.
3. Neurotoxic disorders (nervous disorders/general health problems), such as headaches, weakness, fatigue, irritability, and difficulty concentrating.
4. Lung and breathing disorders include coughing, wheezing, shortness of breath, and a feeling of heaviness.

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Factors Causing Sick Building Syndrome: Although it is currently challenging to find a single cause for Sick Building Syndrome, the majority of complaints caused by Sick Building Syndrome originate from indoor air pollution. This air pollution can be caused by free radicals (chemicals) originating from inside or outside the room, such as contamination by microbes or improper ventilation. (Yoshimura & Ohara, 1977). The results of research conducted by the National Institute of Occupational Safety and Health (NIOSH) found that six significant sources of air pollution were found in 466 buildings across the United States:

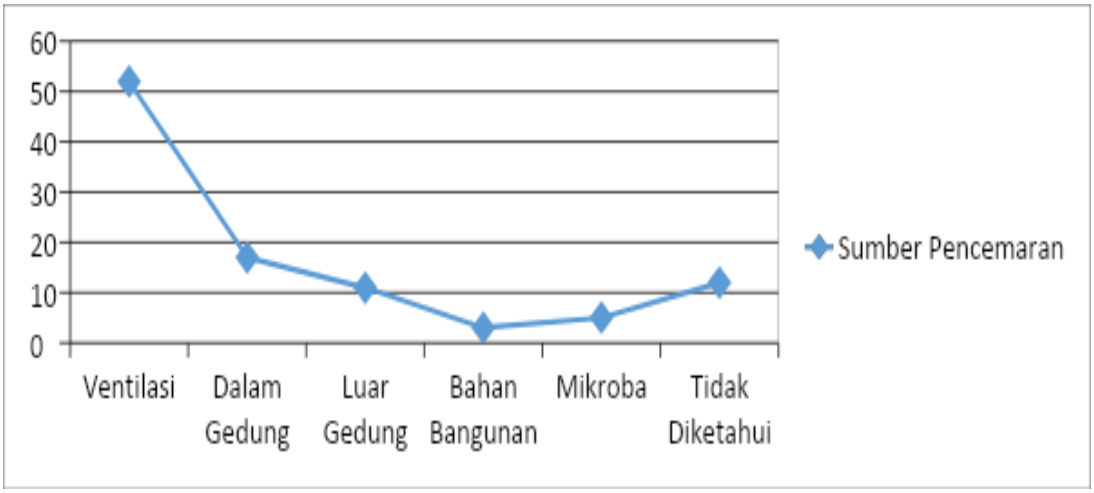

Figure 1. Graphic diagram of sources of air pollution
Source: United States Occupational Health and Safety Administration or NIOSH

Based on the graphic image above, the sources of air pollution are explained as follows:

1. The following factors are responsible for 52% of pollution due to inadequate ventilation: lack of fresh air entering the building, uneven air distribution, and lack of maintenance of ventilation facilities.
2. 17% of air pollution comes from equipment inside buildings, such as photocopiers, tissue paper, paper and wallpaper glue, dyes from printed materials, floor cleaners, and air fresheners. 3.11% of pollution comes from outside the building, caused by improper placement of indoor fresh air sources.
3. 3% of pollution comes from building materials such as formaldehyde, glue, asbestos, fiberglass, and other materials that make up buildings.
4. 5% of microbial pollution comes from bacteria, fungi, protozoa, and other microbial products in air ducts and cooling devices and throughout the system.
5. 12% of sources are unclear (Ridwan et al., 2018).

In terms of buildings, humans are considered thermally comfortable when they cannot determine whether they want a hotter or cooler change in air temperature in space (Kamaruddin, 2023). Two factors, natural factors and human factors, influence thermal comfort. Air temperature (Ta), air humidity (Rh), wind speed (v), and radiation (Ra) are natural factors that dominantly influence thermal comfort. The human factors that dominantly influence thermal comfort are activity and type of clothing (Clo). Other factors that affect thermal comfort are wind tunnels (movement or circulation), the presence and arrangement of vegetation, and selection (Adelia et al., 2023). Thermal comfort is calculated based on the resulting index. One uses the PMV index (*Predicted mean vote*) and the Fanger model. Considering these factors, initial observations were conducted in the isolation room for TB and COVID patients at the West Sulawesi Provincial General Hospital. This one-story (30-meter) building was inaugurated in 2021 and is the only building designed explicitly for isolation rooms. The West Sulawesi Provincial General Hospital has an isolation room for

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tuberculosis and COVID-19 patients, enabling more effective patient care. Office space layout 12 x 30 m with an area of 360 m2.

Initial research results show that several nurses and doctors. In addition, initial observations show a 1 PK (9,000 BTU) AC with three units in the north, three in the south, and two in the middle. Activities carried out in this place are categorized as non-moving activities (nursing). It can be dangerous for doctors, nurses, and other healthcare employees because gaps in the sides of the room prevent optimal air distribution.

Both natural and artificial ventilation systems are essential components in architectural planning. During the activity of electronic equipment, solar radiation produces heat in the room, which must be removed by the ventilation system. Natural and artificial ventilation systems (HVAC) and fan mechanical ventilation systems that function as air movers are included in this category. Due to the role of air in the spread of microorganisms, air flow regulation, also known as draft flow, is very important in isolation rooms. There are more microorganisms in the air than on the floor. When building an isolation room, four things that must be considered are sources of contamination; arrangement and operational design of cooling, ventilation, and air conditioning systems; access between the isolation room and the identified source of contamination; human traffic; and the condition of the room occupants (Ridha Wahyutomo & Purwanto, 2024)

Those who work or use buildings with closed strictures, minimal natural ventilation, and use mechanical ventilation and air conditioning systems without windows are most at risk of sick building syndrome. Workers regularly using screen devices such as computers, laptops, tablets, and others are the most vulnerable. In general, the cause of *sick building Syndrome,* what happened to the building, and the problems experienced were as follows (Ridwan et al., 2018):

1. Headache symptoms that appear indoors can be caused by noise, office lighting, Use of display coatings, harmful substances from organic materials, stress levels, and boredom at work.
2. The symptoms of sneezing, runny nose, and nasal congestion are dust pollutants, biological pollutants, unstable organic chemicals, dirty ventilation systems, and improper maintenance measures.
3. Carbon dioxide, NO2, and SO2 gases produced from the air are the cause of symptoms of eye, nose, and throat irritation, such as:
    a) Heating equipment that is damaged or not functioning correctly. Use fax machines, photocopiers, printers, and scanners that produce ozone.
    b) *Volatile Organic Compounds (VOCs)* are substances found in many things, such as perfume, carpets, and human breath. VOCs contain various organic chemical components that can evaporate and pollute the air.
    c) Poor air conditions that enter the mucous membranes detected by human receptors, which irritate the eyes, nose, and throat
    d) Biological pollution, namely bacteria, fungi, pollen, and viruses, can reproduce in stagnant water that collects in pipes, AC water reservoirs, or places where water collects, such as ceilings (leaks), carpets, or insulation.
4. Biological pollution (microorganisms) such as bacteria, fungi, pollen, and viruses can cause coughing and hoarseness. Mold and bacteria usually appear in heating, ventilation, and air conditioning (HVAC) systems. This indicates that the HVAC system is damp and not being cleaned regularly.
5. The cause of the symptoms of dizziness is when a person uses their eyes to concentrate or accommodate for an extended period. The Use of display screen equipment, such as

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computers, that require the eyes to receive radiation and a lack of light in the workspace causes these symptoms. If the symptoms of dizziness are left for too long, it will affect other parts of the body, especially the head, causing the person to complain of headaches.

6. The cause of symptoms of itching and red spots on the skin can come from biological pollutants, namely bacteria brought in by employees from outside, such as Staphylococcus and Micrococcus, which are found on human skin, as well as Streptococcus, which are inhaled from the nose and pharynx when talking. Dust in the workspace comes from dust collected on carpets, AC holes, and open surfaces such as shelves, cupboards, and office desks.
7. The causes of nausea symptoms occur due to various factors as follows:
   a) Persistent noise;
   b) Inadequate ventilation so that a person does not get enough oxygen to breathe normally.
   c) The smell of volatile organic compounds (VOCs) is found in new carpets and office equipment, such as tables, chairs, and cupboards. The VOC odor emitted from this new equipment can also indicate VOCs (Iskandar, 2019).

4. CONCLUSION

From the study's results in the discussion above, it can be concluded that hospitals have the opposite potential as health facilities, namely being a place to spread pathogenic microorganisms that cause infections. This is because various disease-causing or pathogenic microorganisms spread through droplets and air in each hospital unit. Therefore, an isolation room with good air quality, comfortable air, and compliance with regulations is required.

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