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Spatial Analysis of Pulmonary Tuberculosis in Gowa Regency, South Sulawesi Province, Indonesia

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Abstract: The number of pulmonary tuberculosis (PTB) cases in Indonesia is second ranks in the world. South Sulawesi contributes significantly to the increase of PTB cases in Indonesia. This study explored the spatial dynamics of PTB cases in the highlands and lowlands of Gowa regency, South Sulawesi. This study aimed to present spatial patterns of TB spread in highland and lowland areas in gowa district based on environmental health parameters that will assist in formulating prevention policies and regional-based control strategies.This study used quantitative with spatial analysis approach. The respondents of this study were all registered PTB patients on medical records in the PTB control unit at Health Center in the highlands and lowlands of Gowa regency. Total sample of this research was 156 respondents, derived from 57 in highland and 99 in lowland. Territorial analysis was applied to detect PTB spatial patterns in two regions with different elevation. The variables in this study focused on environmental characteristics in each region.PTB Prevalence in lowland was relatively higher than highland. Temperature and density of occupancy were the determinants of the high prevalence of PTB in the lowlands. At the highland, humidity factor, ventilation area, floor and wall condition were high contributing to PTB incidence (more than 60%). meanwhile, on the lowland, those factors were not significant.This study identified the PTB spatial distribution of highland and lowland by analyzing cases per 100,000 peoples and could be used to develop effective strategies for PTB prevention and control by exploring environmental health factors of public health.

Keywords: tuberculosis, spatial analysis, lowlands, highlands, environmental health factors

Background

Tuberculosis is a disease of global concern and a public health burden in many countries (Wang L., 2012; Addis Z, Adem E, Alemu A, Birhan W, Mathewos B, &Tachebele B, 2015; World Health Organization, 2016). With various control measures, incidence and death from

tuberculosis have decreased, but tuberculosis is estimated to still affect 9.6 million people and cause 1.2 million deaths by 2014. India, Indonesia and China are the countries with the highest number of tuberculosis patients, respectively 23%, 10% and 10% of all patients in the world. By 2015, there are 20.4 million new cases of tuberculosis worldwide consisting of 5.9 million (56%) men, 3.5 million (34%) females, and 1.0 million (10%) children (World Health Organization, 2016). Many factors can make people more vulnerable to TB infection. The most important risk factor globally is HIV. In sub-Saharan Africa, the rate of HIV is very high and people with HIV account for 13% of all people infected with TB. While people without HIV infected with TB accounted for about 5-10% (Fenta, 2016).

In Indonesia, in 2015 found the number of cases of tuberculosis as much as 330,910 cases, increased when compared to all cases of tuberculosis found in 2014 which amounted to 324,539 cases. The highest number of reported cases is found in provinces with large populations of West Java, East Java and Central Java. Tuberculosis cases in these three provinces accounted for 38% of all new cases in Indonesia. According to gender, the number of cases in men is higher than that of women is 1.5 times than in women. In each province throughout Indonesia tuberculosis cases are more prevalent in males than females. According to the age group, tuberculosis cases in 2015 are mostly found in the age group of 25-34 years, which is 18.65% followed by the age group of 45-54 years of 17.33% and in the age group 35-44 years of 17.18% (Health Minister of Indonesian Republic, 2015)

South Sulawesi Province is one of the regency / city provinces that contributes to the high incidence of tuberculosis. The prevalence of pulmonary tuberculosis is based on Riskesdas 2010 results nationally with a diagnosis of 0.7% (D) and symptoms (DG) of 3.3%. while for South Sulawesi in 2010 with the diagnosis (D) 0.6%, and (DG) 5.2%. For 2011, the incidence rate of positive pulmonary TB AFB of 9162 per 100,000 population is 5,367 male and 3,795 women, 107 lung tuberculosis prevalence per 100,000 population that is 127 men and 87 women and death from positive smear positive TB of 322 (3 , 7%) per 100,000 population, the rate of detection of positive TB AFB case detection rate (CDR) was 55.13% while the success rate (Success Rate) was 89.18% when compared to 2010 decreased (Health Department of South Sulawesi Province, 2015).

In Gowa district, in 2014 the number of tuberculosis cases is 1,016 cases, rising by 2015 by 1,229 cases, and by 2016 there are 1,021 cases (Health Department of Gowa regency, 2014; Health Department of Gowa regency, 2016). Although in 2016 has decreased cases as much

as 208 cases, but the number of cases of tuberculosis in Gowa is still very high. In 2015 it is still apparent that the population distribution of Gowa Regency still rests in the sub-districts of lowland such as Somba Opu sub-district with 194 cases, followed by Palangga sub-district as many as 134 cases and in Bajeng sub-district with 94 cases (Health Department of Gowa regency, 2016).

The use of GIS applications and spatial analytical methods has been widely applied to solve problems in the health sector (Makanga, et al., 2017; Luis & Cabral, 2016; Salehi & Ahmadian, 2017; Molla, et al., 2017). Geographic Information System (GIS) is one of the instruments that can be done in assisting the process of prevention and eradication of tuberculosis disease by taking into account the number of patients in a region at a certain time by paying attention to variable rainfall, humidity, density, ventilation area, age, pengantahuan, stasus nutrition as well as various other variables (Achmadi, 2013). Several studies have demonstrated the use of GIS in assisting policy-making processes for tuberculosis prevention and eradication (Huang, et al., 2017; Rao, et al., 2016; Silva, Oliveira, Neto, & Camargos, 2016; Dominkovics, Granell, Navarro, Casals, Orcau, & Cayla, 2011; Onozuka & Hagihara, 2007; Tiwari, Adhikari, Tewari, & Kandpal, 2006).

The administrative area of Gowa Regency consists of 18 districts and 167 villages with an area of 1,883.33 square kilometers or equal to 3.01 percent of the total area of South Sulawesi Province. Region of Gowa Regency is mostly located in the mainland is about 72.26% (BPS - Statistics of Gowa Regency, 2017). Upland areas have potential as an environment that supports the incidence of tuberculosis. This is because, low temperatures can cause high air humidity so that pathogenic bacteria such as Mycobacterium tuberculosis can multiply well. Geographical conditions on the plains are not flat as in the lowlands.

The lowlands have very different temperatures with the highlands, if the high temperature and humidity terat can be one factor of Tuberculosis bacteria can multiply very easily because it has oxygen density, in contrast to the lowlands whose temperature and humidity have compressed oxygen that should make Tuberculosis bacteria are difficult to breed, but the fact that the number of tuberculosis patients in lowland areas is higher than in high altitude, because this is so that researchers focus on observing the spread of tuberculosis in lowland areas and comparing it with the highlands in Gowa regency.

The fundamental difference of this study with research using the previous GIS approach is the researchers tried to see the environmental health characteristics of individual homes of patients with PTB in the highlands and low. In addition, the number of lowland cases is much higher than the highlands in Gowa district of South Sulawesi province. Based on the description above, this research will see how the incidence of Tuberculosis disease with spatial analysis in lowland and high gowa district.

Methods

Types of research

The type of research to be used is a quantitative research type that aims to map the incidence of tuberculosis in low and high altitudes. The research design used is descriptive observational design using Geographic Information System (GIS) approach.

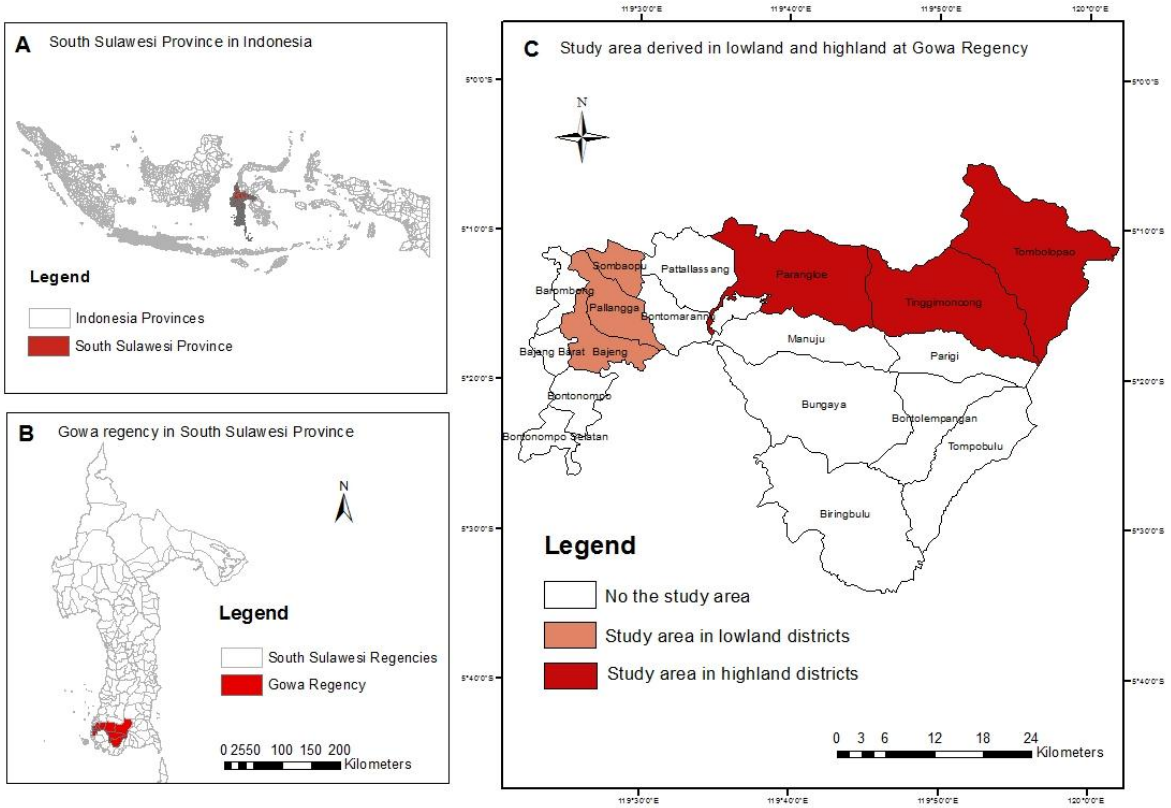
To avoid bias in understanding the terms that will be used in this study, it will be formulated and described these terms.

a. Spatial analysis is a spatial data processing process obtained by determining the coordinate point at the research location using GPS aids and ArcGIS 10.1 software for mapping.
b. Global position system (GPS) is a tool used to determine the coordinate point of home tuberculosis patients in highland area of Gowa regency.
c. Temperature is a state of heat or cold within a home measured using thermo-hygrometer in degrees Celsius (oC) and measured in a family room or a family gathering place based on Ministerial Health Decree No. 829, 1999.
d. Humidity is the wetness of the dryness of the air within the respondent's house as measured using thermo-hygrometer and expressed in% units based on Ministerial Health Decree No. 829, 1999.
e. The density of the dwelling is the ratio of the floor area of the house to the number of people living in a house declared in units of m2 / person based on Minister of Health Decree No. 829, 1999.
f. Ventilation area is the number of outlet or air entry in the form of windows or vent on the respondent's house. Measurement of venting area by meter and compared with floor area based on Minister of Health Decree No. 829, 1999.

g. The condition of the floor is the condition of the floor inside the house as measured by the watertight condition (coated with cement or tiles / tile / ceramic / terrazzo), not waterproof if the widest floor of the house is still in the form of soil or other waterless material based on Ministerial Decree Health No. 829, 1999.
h. The condition of the wall is the state of the protector or the outside of the house, whether made of wood, walls and others based on Ministerial Decree No. 829, 1999.

Location and Time of Study

This research was conducted on three working areas of sub-district puskesmas in lowland areas, namely Somba Opu Puskesmas, Palangga Pukesmas, and Puskesmas Bajeng. As for the highland Puskesmas Gowa Puskesmas Parangloe located in District Parangloe, Tamaona Health Center located in District Tombolopao, and Puskesmas Tinggimoncong located in District Tinggimoncong. The six Puskesmas are puskesmas that have the highest tuberculosis cases in low and high areas of Gowa regency. Research Time in April - July 2019



Population and Sample

The population in this study was all tuberculosis patients who visited and recorded in the medical record in the TB Disease (P2) TB. On the plateau of Puskesmas Parangloe, Puskesmas Tinggimoncong and Tamaona Health Center. And for the lowlands of Somba Opu Puskesmas, Pangga Palangga, Puskesmas Bajeng.

The population in this study amounted to 480 people from Opu Puskesmas as much as 195, Pallkes Puskesmas as much 134, Bajeng Public Health Center as many as 94 people, Puskesmas Parangloe as many as 20 people, Tinggimoncong Puskesmas as many as 8 people, and Tamaona Health Center as many as 29 people. This research was conducted for one month ie in April - July 2019.

The study sample is part of the whole object under study and is considered to represent the population. The samples for the highlands in this study were all visiting tuberculosis patients and recorded on the medical record in the TB Disease (P2) room. The total sample size is 57 people. Sampling technique in this research is total sampling.

Samples for the lowlands in this study were 99 tuberculosis patients taken from 3 Puskesmas namely Somba Opu Puskesmas as many as 40 people, Puskesmas Palangga as many as 31 people, and Bajeng Community Health Center as many as 28 people. Sampling in this study by using simple random sampling technique is a sampling technique in which each member of the population has the same opportunity selected to be a sample. This technique involves taking a random (shuffled) from a population.

Collecting data

Primary data were obtained by tuberculosis patients in the work area of Puskesmas Parangloe, Puskesmas Tinggimoncong, Tamaona Health Center, Somba Opu Public Health Center, Palangga Puskesmas, and Bajeng Community Health Center.

Data collection is done by direct interview to respondent and place at respondent's house by using observation sheet that will be done to obtain general data of respondent or patient.

Observation was done by direct observation on respondent's house by using observation sheet to obtain data about temperature, humidity, ventilation area, floor condition and occupancy density. The observations were then recorded on the observation sheet.

Measurements were made using a roll meter to obtain data on the area of ventilation and density while the thermo-hygrometer was used to measure the temperature and humidity in the respondent's house.

Spatial data is done by collecting the coordinate points of houses of tuberculosis patients living in the highland and lowland clinics. Using GPS type Garmin Etrex 10 and then transferred to the map sources to obtain information and mapping spatial / region based on data collected.

Secondary data were obtained from data from Health Department of Gowa Regency and medical record of Puskesmas Parangloe, Puskesmas Tinggimoncong and Tamaona Health Center, Gowa Regency.

The tools used in this research are observation sheet, roll meter, thermo-hygrometer, Global Positioning System (GPS), map source, ArcGIS 10.1, and Google Earth. GPS is a tool used to map the condition of the area around the sample house while map source, ArcGIS 10.1, and Google Earth is the program used to map the results.

Processing and Data Analysis

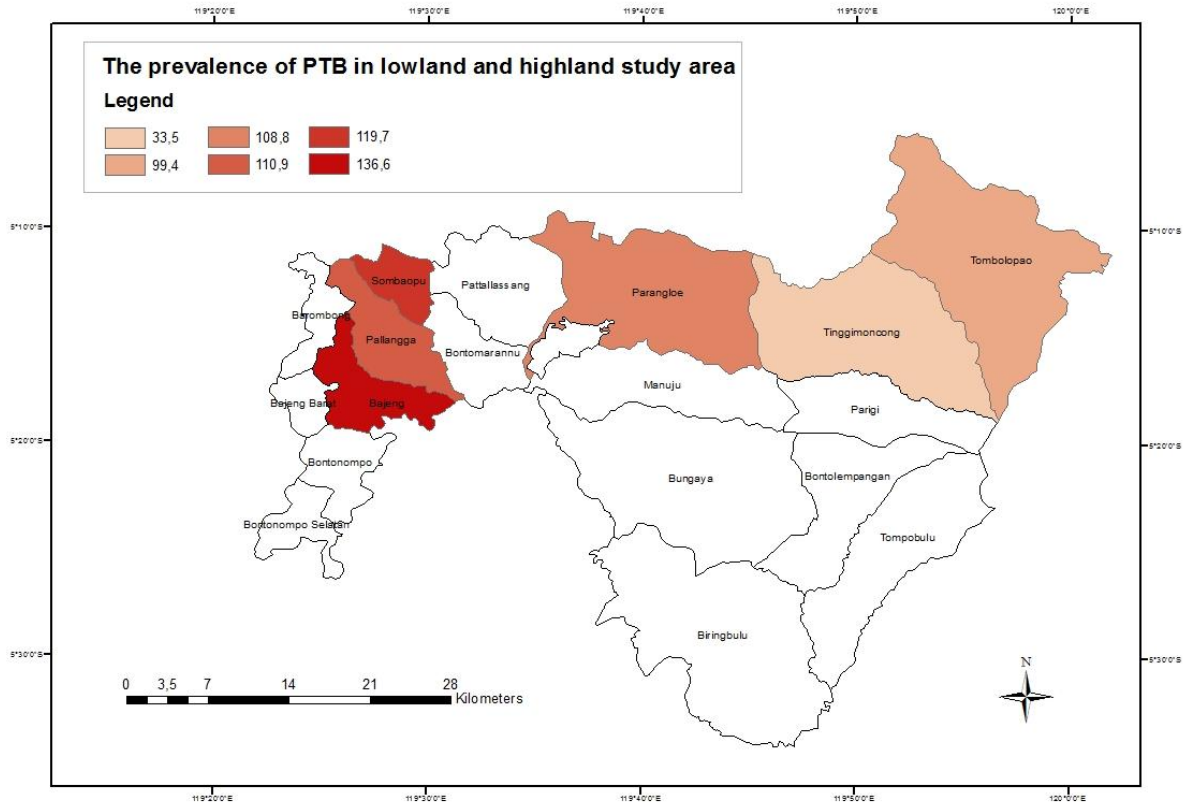
Spatial data analysis process is done by using ArcGIS 10.1. Coordinate point data of tuberculosis patients were collected using GPS, then transferred to the source folder. Further analysis with ArcGIS 10.1 in mapping and displaying spatial information / wilyah based on data collected. The data distribution of tuberculosis patients who have been filled through the observation sheet then performed the examination or validation of data and then inputted and analyzed using statistical methods. Univariate analysis with descriptive approach made in the form of tables accompanied by narrative as an explanation.

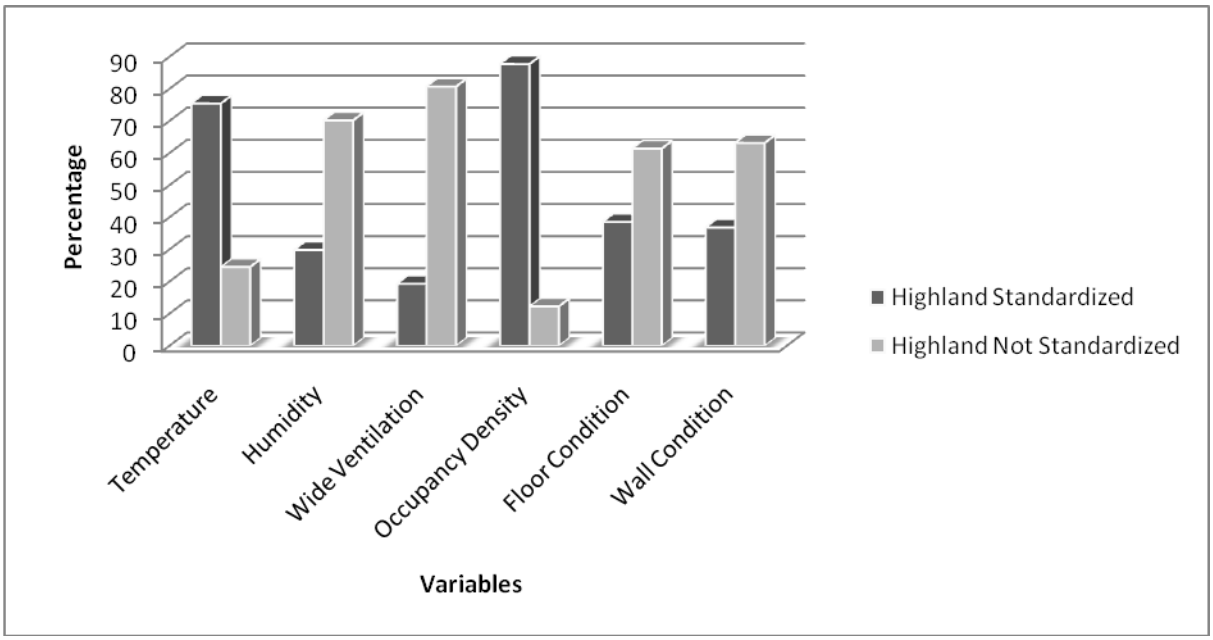
Result

Table 1. Respondent Characteristics

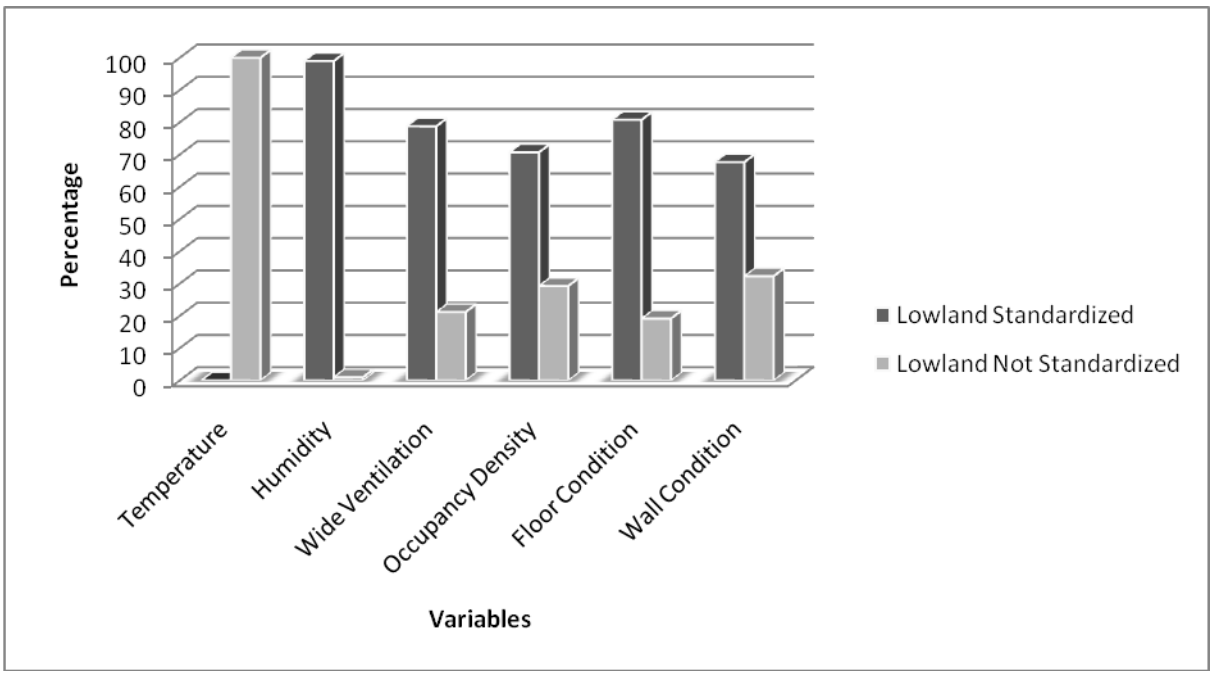
Karakteristik Responden		Lowland		Highland	
		n	%	n	%
Jenis Kelamin	Laki-Laki	55	55,6	33	57,9
	Perempuan	44	44,4	24	42,1
Kelompok Umur	11-20	3	3,0	9	15,8
	21-30	12	12,1	8	14,0
	31-40	26	26,3	9	15,8
	41-50	29	29,3	13	22,8
	> 50	29	29,3	18	31,6
Pendidikan Terakhir	Tidak Sekolah	2	2,0	13	22,8
	Tidak Tamat SD	0	0,0	11	19,3
	SD	36	36,4	17	29,8
	SMP	16	16,2	6	10,5
	SMA	35	35,4	9	15,8
	Strata 1	10	10,1	1	1,8
Pekerjaan	Tidak Bekerja	4	4,0	11	19,3
	Wiraswasta	20	20,2		
	IRT	34	34,3	14	24,6
	Sopir	5	5,1	3	5,3
	Petani	11	11,1	18	31,6
	Pedagang	6	6,1		
	Tukang becak	1	1,0		
	PNS	2	2,0	3	5,3
	Guru	2	2,0		
	Karyawan	4	4,0	1	1,8
	Pelajar	6	6,1	6	10,5
	Buruh	2	2,0	1	1,8
	Tukang Kayu	1	1,0		
	Satpol	1	1,0		

In this research, the analysis of tuberculosis incidence is differentiated to the high and lowland areas and based on the environmental health variables. The following analysis of the prevalence of regional prevalence of tuberculosis in both areas.

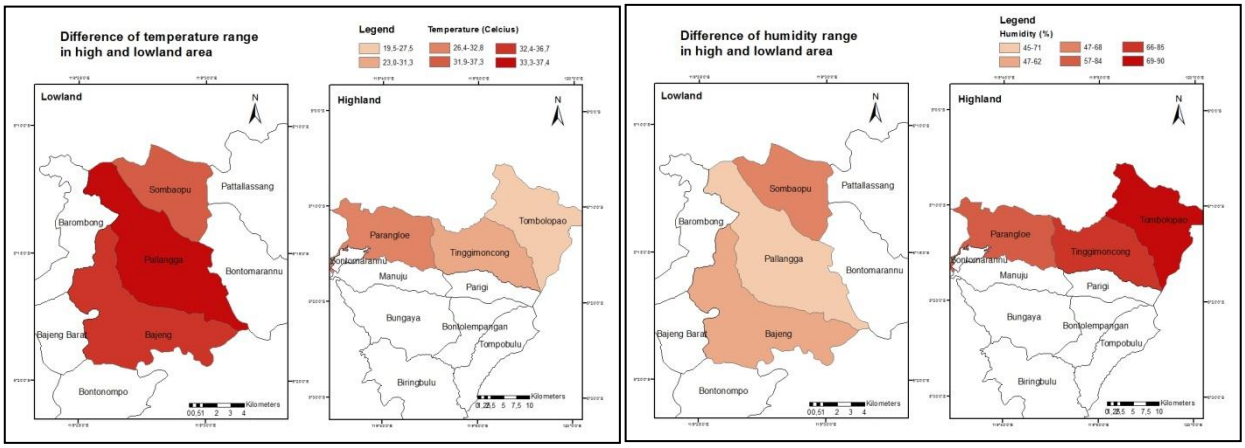


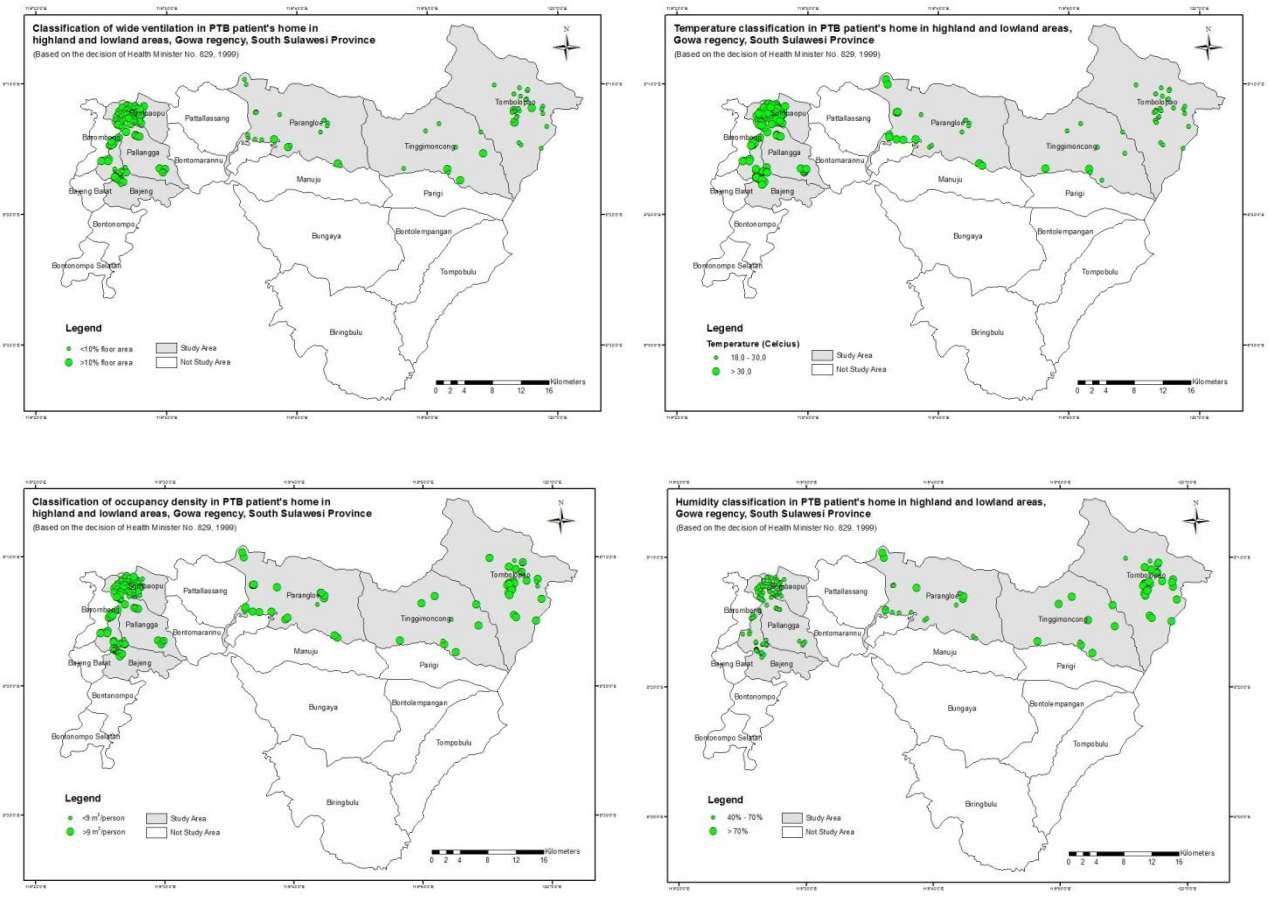


Graph 1. Percentage of environmental health variable condition in highland region of gowa regency based on Minister of Health Regulation no. 829.



Graph 2. Percentage of environmental health variable condition in lowland area of gowa district based on Minister of Health Regulation no. 829.





Discussion

Temperature

The comfort of a room in addition to being determined by the concentrations of air pollutants also depends on the temperature of the air. According to the Decree of the Minister of Health of the Republic of Indonesia No. 829 / Menkes / SK / VII / 1999 on housing health requirements, the temperature is eligible if the inside temperature is 18-30 ° C. The temperature is affected by outside air temperature, air movement and indoor air humidity. Based on the result of the research, the respondent's house temperature was fulfilled as many as 43 houses (75.4%) and unqualified as many as 14 houses (24.6%). The highest temperature measurement result is 32.8 oC while the lowest temperature is 19.5 oC. Temperature is influenced by the type of house occupied by the respondent. The high temperature of the respondent's house is influenced by the geographical condition of the respondent's house. Where all the respondents live in the highlands so that the temperature is relatively low even from the measurement of the temperature inside the respondent's house no less than 18oC.

Upland areas have lower temperatures because the plateau is closer to the atmospheric layer causing high air pressure. The closer to the sea surface the air will get closer and farther from the sea surface density is increasingly tenuous because the air mass is affected by the earth's gravity. The high-density air will absorb more solar heat than the fewer ones. Most of the solar radiation is more absorbed for plant growth and is used for transport (the release of water molecules by plants to the atmosphere). It can also cause the air temperature to be lower as the energy transfer used to increase the temperature is more widely used for transportation and evaporation of water from soil and water bodies such as lakes and rivers.

Bacteria Mycobacterium tuberculosis has the preferred temperature range, but within this range there is an optimum temperature as they grow rapidly. Mycobacterium tuberculosis is a mesophilic bacteria that grows in the temperature range 25-40 º C, but will grow optimally at 31-37 º C. The optimal temperature of bacterial growth varies greatly, some grow at low temperatures (15oC - 20oC), and some even grow at elevated temperatures. Mycobacterium tuberculosis grows optimally at a temperature of about 37oC which happens to coincide with human body temperature (Gould D & Brooker, 2003).

Humidity

One of the requirements of the indoor air condition is the humidity condition. Air humidity is the concentration of water vapor in the air. Humidity in the home can facilitate the breeding of microorganisms. These microorganisms can enter the body through the air. In addition, high humidity can cause the nasal mucous membranes to become dry so less effective in blocking microorganisms (Notoatmodjo, 2007).

According to the Minister of Health Decree No. 829 / Menkes / SK / VII / 1999 on housing health requirements, it is stated that the moisture that meets health requirements is 40-70%. The location of respondents house in the highland area with the lowest humidity is 57% and the highest 90%. The high humidity in the upland areas strongly supports the proliferation of Mycobacterium tuberculosis bacteria.

The high humidity of the air in a place depends on several factors, namely temperature, air pressure, wind movement, quantity and quality of irradiation, vegetation and water availability at the site. Areas with high air temperatures have low air humidity because high temperatures can speed up the evaporation of water somewhere so that the moisture

contained in the site is very small, as well as in areas with low temperatures must have high humidity. The more vegetation an area the higher the humidity of the place.

Mycobacterium tuberculosis bacteria like any other bacteria, will flourish in environments with high moisture because water forms more than 80% of the volume of bacterial cells and is essential for growth and survival of bacterial cells (Gould D & Brooker, 2003). In addition, increased air humidity is a good medium for pathogenic bacteria including tuberculosis bacteria (Notoatmodjo, 2007).

High humidity is also influenced by the number of floors of respondent's house that is not water-resistant. The humidity of the house can be caused by rising damp and then seeping into the wall (percolating damp), and leaking through the roof (roof leaks), too high humidity can cause the floor and wall to always get wet. Uncooled house humidity 5,636 times higher risk than eligible moisture. The less house floors with in-house moisture conditions are not eligible, will cause bacteria to be easy to multiply and viability longer. Humidity in the house will make it easier to breed microorganisms such as bacteria, spirochetes, rickets and viruses. These microorganisms can enter the body through the air, other than that high humidity can cause the nasal mucous membranes become dry so less effective in blocking microorganisms. High humidity of the room will be a good medium for growing and breeding pathogenic bacteria including tuberculosis (Budi & Tuntun, 2014).

Ventilation Area

In general, the assessment of home ventilation by comparing the ventilation area and the floor area of the house, using a role meter. Based on the Decree of the Minister of Health of the Republic of Indonesia No. 829 / Menkes / SK / VII / 1999 on housing health requirements, the area of eligible ventilation is ≥ 10% of the floor area of the house. Home ventilation is the entrance and exit of air for air in a room is always fresh.

A house ventilation area that is <10% of the floor area (not eligible for health) will result in reduced oxygen concentration and increased concentration of toxic carbon dioxide for the inhabitants. In addition, insufficient ventilation will cause increased humidity of the room due to the evaporation of liquid from the skin. High humidity of the room will be a good medium for growing and breeding pathogenic bacteria including tuberculosis (Susanti, 2016).

One of the ventilation functions is to free the air from bacteria, especially pathogenic bacteria such as Mycobacterium tuberculosis. Continuous airflow causes bacteria carried by air to

flow (Notoatmodjo, 2007). In addition, the area of ventilation that does not meet the health requirements will result in blocking the process of airflow and sunlight that enter into the house, as a result of tuberculosis germs in the house can not come out and participate inhaled with air respiration. Ventilation can also be a place to enter ultra violet light, this will be better if home construction using glass tile, then this is a good combination. Sun exposure for 5 minutes can kill Mycobacterium tuberculosis. These bacteria can survive in dark places, and breed more bacteria in dark homes (Ruswanto, 2010).

According to Sujana, Patra and Mahayana (2014) studies indicating that house ventilation has an influence on the incidence of tuberculosis and an unqualified home ventilator has a risk of incidence of tuberculosis 9.048 times higher than for those who have eligible home ventilation (Sujana, Patra, & Mahayana, 2014).

Occupation Density

Occupation/Residential density is the ratio of the floor area of the house to the number of family members in a single dwelling. The occupancy density requirements for the whole house are usually expressed in m2 / person. Where occupancy density is the ratio of the number of occupants to the building area, with the requirements of ≥ 9 m2 / person (Health Minister of Indonesian Republic). Based on the result of the research, the density of respondent house that fulfill the requirement is 50 house (87.7%) and unqualified 7 houses (12.3%). Most of the respondents have a house that is large enough so that there is no density of housing in the house.

According to research conducted by Hamidah, Kandau, and Posangi (2015) stated that respondents who live in homes with occupancy density <9m2 or unqualified have a 3.5 times risk for pulmonary tuberculosis compared with home-dwelling respondents eligible (> 9 m2) (Hamidah, Kandau, & Posangi, 2015). In another study, people living in homes with high occupancy densities were 4.2 times more likely to develop TB disease (Wanti & Djapawiwi, 2015).

Density of occupants in addition can cause privacy problems for residents in terms of health, density of residents will be able to accelerate the occurrence of disease transmission, especially contagious diseases by droplet infection such as pulmonary tuberculosis disease. The more solid, then the transfer of diseases, especially infectious diseases through the air will be easier and faster (Achmadi, 2013).

Floor Condition

Floor is a wall covering the bottom of the room, the floor construction of the house must be densely water and always dry to be easily cleaned of dirt and dust, but it can avoid soil rise that can cause increased indoor humidity. Therefore it needs to be coated with a waterproof (cemented, mounted tiles, terrazzo and others) (Notoatmodjo, 2007).

Based on the result of the research, the condition of the house floor of the respondent who fulfilled the requirements were 22 houses (38.6%) and the unqualified were 35 houses (61.4%). The number of homes that have a floor that does not qualify due to the number of floors of respondents' houses made of boards. Types of floorboards or stilts can cause a rise in house humidity because the boards are not waterproof and the effects of soil moisture. To prevent the occurrence of moisture in the house with the type of floor boards, need to be coated with rubber mats that serve as waterproof mats so as to protect from water seepage and moisture (Susanti, 2016). In addition, there are several floors of the respondent's house lined with cement but most of the floor of the house is damaged and hollow so that the soil can rise to the surface of the floor. Floors that are not water-resistant cause higher humidity in the house so that supports Mycobacterium tuberculosis environment to breed in the house.

According to research Kurniasih, Triyantoro, and Widyanto (2016) showed that there is a relationship between the condition of the floor of the house with the incidence of pulmonary tuberculosis in the work area of Kalibagor Puskesmas Banyumas Regency Year 2016. OR value of 4,840 means that people who live at home with the condition of the floor does not meet risk suffered from Pulmonary TB 4.840 times bigger than those living at home with condition of eligible home floor (Kurniasih, Triyantoro, & Widyanto, 2016).

Wall Condition

The walls serve as a protector, both from rain and wind disturbances and protect from the effects of heat. Some of the wall-making materials are wood, bamboo, brick or stone pairs and so on, but from some of the best materials are brick or non-flammable, waterproof (permanent) pairs that are easy to clean.

Based on the result of the research, the condition of the house wall of respondents who fulfilled the requirements were 21 houses (36.8%) and unqualified were 36 houses (63.2%). Number of condition of respondent's wall that does not fulfill requirement caused by the

number of respondent's house wall made of wood, bamboo, zinc and wall that have not been coated with cement.

Based on research conducted by Dawile, Sondakh, and Maramis (2013) shows that there is no correlation between wall condition and pulmonary tuberculosis ($p < 0.05$) (Dawile, Sondakh, & Maramis, 2013). This study is in accordance with research conducted by Nuraini (2015) which states that there is no significant relationship between the types of walls that are not eligible with the incidence of Pulmonary TB (Nuraini, 2010).

The wall of the bedroom, the living room must be equipped with ventilation means for the regulation of air, because the walls can contribute to the creation of moisture and temperature that allow a seedling of the disease to die or reproduce, as Mycobacterium tuberculosis grows at certain moisture and temperature (Health Minister of Indonesian Republic).

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