

Analysis of airborne germ concentrations and Covid 19 transmission at Port Health Office of Semarang

Windy Cintya Dewi^{1*}, and Mursid Raharjo¹

¹Master of Environmental Health Study Program, Faculty of Public Health, Diponegoro University, Indonesia

Abstract. Covid 19 as a new emerging disease has spread all over the world. Covid 19 case also occurred at Port Health Office of Semarang, where the number of Covid 19 cases was 71 of 126 employees (56% percentage) and the airborne germ rate in preliminary study exceeded the standard set by *American Conference of Governmental Industrial Hygienist* (ACGIH) which was 500 CFU/m³. The purpose of analyzing the number of airborne germs with the incidence of Covid 19 cases at KKP Semarang. This study is an observational study by measuring the physical quality of the air in the research location and taking air samples to calculate the number of germs in the air in the room. The results of this study that the number of airborne germs is influenced by factors such as temperature, humidity, and lighting. The use of ventilation systems (using air conditioning or fans) will also affect the development of microorganisms in the room. Efforts have been made to control the development of airborne germs in the room, including the placement of a humidifier, maintenance of air conditioners/fans, and the obligation to use PPE (masks) in the room to minimize the transmission of Covid 19 during activities.

1 Introduction

Covid 19 is a new emerging disease that has become a pandemic in all regions of the world. This virus was first discovered in Wuhan in December 2019. Symptoms of Covid 19 will appear 2-14 days after exposure to the virus. This disease is spread through small particles (droplets) when someone sneezes, coughs, talks, sings or breathes. Transmission of this virus is transmitted to family, close friends who have direct contact with patients infected with Covid 19. And indirect contact with the patient's environment or items such as infected curtains and linen [1]. The current situation in the world today, the case of Covid 19 is still increasing, its spread has also been from human to human in almost all countries in the world. Covid 19 cases at the time the research was conducted from September to October 2021 have spread to 223 countries in the world with 155,665,214 confirmed cases and 3,250,648 of them died. Covid 19 cases have continued to increase in Indonesia since 2020 with a total of 1,703,632 positive cases and 46,663 deaths, 510 affected regencies/cities and 311 of them local transmissions.

* Corresponding author: windycintya@gmail.com

Port Health Office of Semarang (KKP Semarang) as one of the Technical Implementation Units (UPT) of the Ministry of Health which is under and responsible to the Director General of Disease Prevention and Control [2]. KKP Semarang has several duties and functions, one of which is to provide limited services to service users such as the general public, ship passengers, airplane passengers, shipping agents, airlines, airplane crews and ship crews.

An office building has the potential to transmit an airborne disease if the ventilation system of the room is poor. Air exchange is needed in a room because on average 90% of people carry out indoor activities. Poor air quality will have a negative impact on workers/employees in the form of complaints of health problems [3]. As an agency that provides services to the community, it is undeniable that employees will interact with many people in the room without knowing that person's health status. Employees working in a room with a working period of 8 hours/day, of course, need to be supported by a comfortable working environment such as room air quality (temperature, humidity, air circulation, dust, air microbiology, pollutant gases) [3]. Indoor air quality is influenced by, among others, building conditions, interior elements, air conditioning facilities, chemical and biological pollutants [4]. Potential dangers and risks to office employees that come from biological hazards include influenza viruses obtained from co-workers transmission [5].

The Preliminary Study conducted at the Main Office of the KKP Semarang found that the air germ number at one point was 540 CFU/m³ or exceeding the standard set by the *American Conference of Governmental Industrial Hygienist* (ACGIH) which was 500 CFU/m³. During the Covid 19 pandemic, the number of Covid 19 cases at KKP Semarang was quite high, namely 71 cases with a total of 126 employees (a 56 percent percentage). Based on this, it is necessary to analyze the number of airborne germs with the incidence of Covid 19 cases at the KKP Semarang.

2 Method

This research is an observational study, where samples were taken to measure airborne germs at 9 research locations, namely the Semarang KKP Main Office (Main Office), Working Areas General Ahmad Yani Airport Semarang (JAY), Adisoemarmo Airport (SOC), Tegal Sea Port (TGL), Pekalongan Sea Port (PKL), Batang Sea Port (BTG), Jepara Sea Port (JPR), Juwana Sea Port (JWN) and Rembang Sea Port (RBG). Air samples for the number of air germs amounted to 58 samples. The rooms used as targets in this research are service rooms and administration rooms. The selection of the room is based on the room used for activities, both by KKP Semarang employees and service users. Measurement of the physical quality of room air using a temperature gauge, lighting meter and air humidity meter while for air sampling using a *MAS 100 NT* tool then the air germ number at that location is calculated. This tool has a suction capability of 160 liters/minute and the time used for measurement is 1.5 minutes.

3 Result and Discussion

The research was carried out from September to October 2021 at the Main Office and 8 Working Areas of the Port Health Office of Semarang. The results of physical air quality measurements and air samples can be seen in table 1 and table 2 as follows:

Table 1. Condition of research locations at KKP Semarang in 2021.

Locations	Description				
	Large Room (m ²)	Number of Employees (person)	Case of Covid 19 (person)	Number of AC (unit)	Air Germ Number (CFU/m ³)
Induk	508	57	44	10	789.4
SOC	97.5	18	8	5	1021.67
JAY	63.8	18	9	4	992.33
TGL	50.24	9	5	2	1831
PKL	33.07	4	1	2	1244.83
BTG	60.89	4	0	3	1459.17
JPR	69	5	3	2	428.17
JWN	63	6	0	2	1446
RBG	79.5	5	1	2	974.17

Based on table 1 above, it can be concluded that all research sites have airborne germ numbers above the standard set by the *American Conference of Governmental Industrial Hygienists* (ACGIH) which is 500 CFU/m³. Likewise with the standards set by Permenkes No. 1077 in 2011 is <700 CFU/m³ [6]. The density of the occupants also affects the presence of microorganisms in the room in addition to the area of the room and the activities of the occupants [7]. In an office the minimum work space for employees is 2.2 m²/employee [5]. All research sites have implemented a predetermined minimum work area. The spread of bacteria, fungi and viruses usually occurs through the ventilation and reproduction system indoor bioaerosols, especially when the room conditions are too high cramped (crowded) [8]. The highest percentage of Covid 19 cases was at the Main Office at 77.2%, while the 2 Work Area locations at the KKP Semarang, namely Work Ares Batang & Juwana, had a percentage of 0% because there were no Covid 19 cases found in the Work Area.

Several studies have been conducted in relation to indoor ventilation systems, such as the research conducted by Moerdjoko in 2004 which states that natural ventilation systems have a probability of 0.8x greater number of microorganisms than rooms that use air conditioning and air-conditioning rooms have a probability of no air microorganisms by 96% [9] in addition there is also a study that has been done by Vidyautami where it is stated that there is an effect of the use of ventilation (AC and non-AC) on the presence of microorganisms in the room. The humidity factor in this study that affects the presence of microorganisms the most [10].

Table 2. Physical quality of air at KKP Semarang in 2021.

Locations	Service Room			Administration Room		
	Temperature (°C)	Humidity (%)	Lighting (Lux)	Temperature (°C)	Humidity (%)	Lighting (Lux)
Induk	27.1	71.5	102	27.6	61.2	114
JAY	29.4	68.4	48	26.7	72.6	69
SOC	28.3	61.4	370	29.4	63.4	105
TGL	31.5	58.4	117	30.2	57.5	20
PKL	30.7	67.9	44	30.8	62.1	42
BTG	30.1	65.3	413	28.2	60.1	128
JPR	32.5	62.2	14	33.6	61.7	17
JWN	26.1	80.8	90	29.4	69.3	114
RBG	31.1	59.9	714	31.0	66.3	90

Table 2 states that the physical quality of air in the KKP Semarang largely exceeds Permenkes RI Number 48 of 2016 concerning Standards for Occupational Safety and Health in Offices, namely for a temperature of 23-26°C [5] while a comfortable temperature for

working is 18-28°C [3]. In line with the research conducted by Isharyadi in 2008, it was stated that there was a relationship between room air temperature and the total number of microorganisms on health problems [11].

The humidity in the room that is considered comfortable is 40-60%. If the humidity in the room is above 60%, it will cause the proliferation of pathogenic organisms and allergenic organisms, besides that high humidity will increase the growth of microorganisms [7]. Improvements to humidity problems will reduce health problems for the occupants of the room [12].

Workspace lighting according to Permenkes Number 1405 of 2002 is a minimum of 100 lux [3]. The results showed that the room lighting was in the range of 14 - 714 lux. Olivia's research conducted in 2020 stated that the factors that had the most significant relationship with airborne germ numbers were temperature, humidity and lighting [13]. The physical quality of indoor air consisting of temperature, humidity and lighting also supports the growth of bacteria of the genus *Staphylococcus* [9]. The number of air germs in each room has differences according to the level of activity inside and outside [14]. The results of the physical air quality measurement show that the temperature and humidity are above the set standards so that temperature control efforts are needed through the use of air conditioning devices such as Air Conditioners (AC), fans, etc. while efforts to control humidity < 65% can be done through the installation of a humidifier [3].

Some of the conditions that can increase the risk of infection in a person exposed to Covid 19 include being in a room with an inadequate ventilation system, long exposure time, improper use of masks and activities that increase the emission of respiratory fluids such as speaking loudly, singing or exercising [15]. The risk of transmitting Covid 19 in the air cannot be completely eliminated, but control measures can be taken such as the EPA recommendations, namely through increasing ventilation by filtering outdoor and indoor air, doing physical distancing, using masks, washing hands with soap and other efforts [15].

Efforts to reduce the number of microbes can also be done by maintaining the relative humidity below 60% in the building, cleaning the air conditioning system regularly, providing adequate ventilation in the building and cleaning the room with disinfectant [16].

4 Conclusion and Suggestion

The number of airborne germs that exceeds the quality standards set by the American Conference of Governmental Industrial Hygienist (ACGIH) is 500 CFU/m³ and Permenkes No. 1077 in 2011 is <700 CFU/m³. The number of germs can affect the condition of the air in the room so that it can cause health problems, one of which is the case of Covid 19. Control efforts need to be made to control the number of germs in the air in the room by suppressing the risk factors that affect the number of germs in the air in the room, including through the installation of a humidifier to control humidity <65%, installation of air conditioners and fans to control room air temperature, use of PPE (masks) to control droplet transmission when talking, breathing or sneezing.

The authors would like to thank the Port Health Office of Semarang for providing the opportunity to become the object of research and providing secondary data (supporting data) to complement the research results.

References

1. Nugroho WD, C WI, Alanish ST, Istiqomah N, Cahyasari I. *Jurnal of Bionursing Literature Review : Transmisi Covid-19 dari Manusia ke Manusia Di Asia*. 2(2):101–12 (2020)
2. Kemenkes RI. Permenkes No 2348 Tahun 2011. Jakarta. 1–19 p (2011)
3. Kemenkes RI. Kepmenkes RI No. 1405 tentang Persyaratan Kesehatan Lingkungan Kerja Perkantoran Dan Industri Menteri Kesehatan Republik Indonesia. Keputusan Menteri Kesehat Republik Indones Nomor1405/Menkes/Sk/Xi/2002. 1–22 (2002)
4. Pakasi TA, Pakasi LS. Pentingnya Pengendalian Udara Lingkungan Untuk Pencegahan Transmisi SARS CoV2. *CoMPHI J Community Med Public Heal Indones J*. 1(2):109–16 (2020)
5. Kemenkes RI. Permenkes RI No. 48 Tahun 2016 tentang Standar Keselamatan dan Kesehatan Kerja Perkantoran. Jakarta: Kementerian Kesehatan. p. 1–18 (2016)
6. Kemenkes RI. Peraturan Mentri Kesehatan Indonesia No 1077/Menkes/PER/2011. (2011)
7. Handayani E, Raharjo M, Darundiati YH. Microbial Risk Assessment of Indoor Airborne Microbe In The Community Health Center In Semarang City. *Int J Heal Educ Soc*. 3(July):16–26 (2020)
8. Mukono J, Prasasti C, Sudarmaji S. Pengaruh Kualitas Udara dalam Ruangan Ber-ac terhadap Gangguan Kesehatan. *J Kesehat Lingkung Unair*. 1(2):3941 (2005)
9. Moerdjoko. Kaitan Sistem Ventilasi Bangunan dengan Keberadaan Mikroorganisme Udara. *Dimens Tek Arsitek*. 32:89–93 (2004)
10. Vidyautami DN (Devi), Huboyo HS (Haryono), Hadiwidodo M (Mochtar). Pengaruh Penggunaan Ventilasi (Ac Dan Non Ac) Dalam Ruangan Terhadap Keberadaan Mikroorganisme Udara (Studi Kasus: Ruang Kuliah Jurusan Teknik Sipil Universitas Diponegoro). *J Tek Lingkung [Internet]*. 4(1):1–8. Available from: <https://www.neliti.com/publications/143280> (2015)
11. Putra I, Ikhtiar M, Emelda A. Analisis Mikroorganisme Udara terhadap Gangguan Kesehatan dalam Ruangan Administrasi Gedung Menara UMI Makassar. *J Kesehat*. 1(2):68–75 (2018)
12. Qian H, Zheng X. Ventilation control for airborne transmission of human exhaled bio-aerosols in buildings. *J Thorac Dis*. 10(Suppl 19): S2295–304 (2018)
13. Yulianti OA, Cahyono T, Mulyasari TM. Faktor Yang Berhubungan Dengan Angka Kuman Udara Di Sd Negeri Kecamatan Baturraden. *Bul Keslingmas*. 39(1):13– 22 (2020)
14. Pangestika, Rismawati dan Wilti IR. Karakteristik Risiko Kesehatan Non-Karsinogenik Akibat Pajanan PM 2,5. *Kesehat Lingkung Indones*. 20(1):7–14 (2021)
15. EPA. Indoor Air and Coronavirus [Internet]. Available from: <https://www.epa.gov/coronavirus/indoor-air-and-coronavirus-covid-19#:~:text=Spread of COVID-19 occurs,exercise%2C coughing%2C sneezing>.
16. Linda D. Stetzenbach, Harriet Amman, Eckardt Johannung, Gary King RJS. *Microorganisms, Mold, and Indoor Air Quality*.