Conference Paper

The Effect of Indoor Environmental Quality on the Respiratory Health of Informal Workers

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Abstract

The quality of indoor environmental plays pivotal rule to influence the microbiological growth through the air that has a significant effect on human's respiratory health. In some regions in Indonesia, airborne diseases among productive age are still a common problem. Even though the trend of accidents increases in some provinces, it has not been the priority to overcome by the government. In 2013, the accident of acute respiratory infections (ARIs) among informal workers were taken place as the first rank of 10 most common occupational illnesses in Ciomas District, West Java Province and the prevalence experienced upward trend in four months, from June to September. Thus, this study aimed to describe the relationship between indoor environmental quality (IEQ) and the occurrence of ARIs. The population and sample of study were all workers who worked in seven footwear workshops in Pagelaran Village, Ciomas District, Bogor Regency that employed 85 workers. The present study used a cross-sectional design to investigate whether relative humidity, illumination, and indoor temperature as the IEQ parameters have to do with worker's respiratory health. The independent *t*-test was used to analyze the data that was collected in March to April 2014. The result revealed the average illumination levels at 175.586 lux (min 53.3 lux and max 367.0 lux), the average temperature levels at 30.962°C (28.8°C–34.8°C), the average humidity levels at 61.252 percent (53.6%–68.4%), and 34 (40%) workers suffered from ARIs. There were significant association between humidity (P = 0.017), temperature (P = 0.040), and incidence of ARIs.

Keywords: ARIs, occupational illness, IEQ, informal workers

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1. Introduction

The quality of indoor environment encompasses many factors, including indoor air quality (IAQ) and physical environment indicators (acoustic quality, illumination quality, temperature condition, and relative humidity), and discusses the quality of a building's indoor environment which cause the health effect and wellbeing of occupants [1, 2]. The interaction results between indoor environmental indicators, the source of contaminants (raw materials for production, building materials and equipment, and external sources), location and construction of the building, and density of occupants can lead to decrease the quality of indoor environment. In addition, indoor environmental quality (IEQ) has correlated with occupant satisfaction and considerable burden of disease [3, 4].

Kembel et al. [5] mentioned that architecture of the building brrought implications for human health which is affected by relative humidity, indoor temperature, and illumination and it has the potential to influence the microbiology growth. The microorganism which contaminates the indoor air can cause respiratory infections. This infection is caused by germs, viruses, bacteria, fungi, and parasites and transmitted through droplets or particulates in the air. The microbiology such as fungal spores and fungi will grow between 25 percent and 75 percent of the percentage of relative humidity since they like the humid environment [6, 7]. However, in some pathogens, there is a possibility of transmission by another way, such as by spreading through contact with surfaces that have been contaminated by the causative microbe. Furthermore, illumination in the room should be noted due to its function as a disinfectant to kill germs.

In Ciomas, acute respiratory infections (ARIs) held on the first rank of the top 10 Occupational Diseases in 2013 among informal workers. The prevalence of ARIs experienced the upward trend, from June at 16.67 percent to September at 20.63 percent [8]. Unhealthy Environment in the workplace is enabling factor to cause health problems for workers, especially respiratory disorders. These conditions may put workers at risk because they spent a lot of time to work in indoor. Most of the footwear workshops operated for six days a week and their workers were spending over 8 hours per day in the production room. In consequence, the indoor environmental quality must be appropriate for occupant's health.

Despite, the effect of indoor environmental qualities on worker's respiratory health remains not fully understood yet. In this study, we combined indoor environment data

from footwear building with the subjective symptom of acute respiratory infections (ARIs) to understand the association between them.

2. Methods

The present study used cross-sectional design and the independent *t*-test to analyze the correlation between the incidence of ARIs and IEQ parameters. The data were collected at the same time from March to April 2014. All population as the sample of the study, they were informal workers who worked in seven footwear workshops in Desa Pagelaran, Kecamatan Ciomas, Bogor Regency which employed 85 workers. All measurements and interviews arranged during the production process at 10:00 am – 03:00 pm.

The data of ARI's collected from workers using questionnaire while they worked and there were five symptoms to measure it; cough, flu, shortness of breath, sore throat, and fever or chills. The presence of symptoms used to categorize into positive and negative ARI's, one or more indicators as positive and vice versa. Subsequently, the answer recorded in the form based on the response of respondent and this measurement was without medical observation.

IEQ parameters consisted of relative humidity, illumination, and indoor temperature. Those were drawn up by literature review based on the association with ARIs, practicability, and feasible aspects. Digital thermohygrometer used to measure the indoor temperature and the relative humidity, and digital lux meter used to measure the illumination. Hereupon, all of the measurement results recorded in the indoor environmental questionnaire. The procedure of measurement presented following this: (1) The luxmeter and thermohygrometer devices put on the table and at least 7.5 cm above the floor surface and operated for 5 minutes; (2) Every room divided into 5 points of sampling, 4 points in every corner and 1 point in the middle; (3) Then, the results of measurement had to calculate the value of sampling points to get average value.

3. Results

The results of IEQ in footwear workshops was shown in Table 1 and revealed the qualities of environmental conditions. The average of illumination level was 175.59 lux (95% CI: 154.89 – 196.28) with the standard deviation of 95.94 lux. The illumination level ranged from 53.3 to 367 lux. From the interval estimation (95%) was the trusted

mean level of illumination between 154.89 and 196.28 lux. Another parameter, the average level of indoor temperature was 30.96°C (95% CI: 30.50 – 31.43) with the standard deviation of 2.14°C. From the estimation interval result (95%) was believed to the mean of temperature level was between 28.8 and 34.8°C. For the relative humidity parameter, the average level was 61.25 percent (95% CI: 59.84 – 62.66) with the standard deviation of 6.54 percent. From the estimation interval result (95%) was believed to the mean level of relative humidity was between 53.6 and 68.4 percent.

Table 1: Indoor environment quality in footwear workshops.

Variable	Mean	SD	Min–Max	95% CI
Illumination	175.59	95.94	53.3–367	154.89–196.28
Temperature	30.96	2.14	28.8–34.8	30.50–31.43
Humidity	61.25	6.54	53.6–68.4	59.84–62.66

The correlation between respiratory infections and all the IEQ parameters was summarized in Table 2. The results revealed that the effect of indoor room temperature and humidity have significant difference was observed in positive or negative of the worker's infection respiratory. Conversely, indoor illumination has not to do with respiratory effect.

The mean level of illumination with positive ARIs was 153.36 lux (standard deviation of 94.34 lux) and 190.40 lux (standard deviation of 95.02 lux) with the negative ARIs. The result of the statistical test was *p*-value = 0.810. It meant that at 5 percent alpha value there was no significant difference between the two categories of ARIs.

The average of temperature in the workshop room with positive ARIs was 30.38°C (standard deviation of 2.08°C) and with the negative ARIs was 2.12°C (standard deviation of 0.29°C). The result of the statistical test was *p*-value = 0.040. It meant that at 5 percent alpha value there was difference significantly of the indoor temperature level between positive and negative ARIs.

The mean of humidity in the indoor workshop building was 63.30 percent (standard deviation of 6.17%) with positive ARIs and 59.88 percent (standard deviation of 6.48%) with the negative ARIs. The result of the statistical test was *p*-value = 0.017. It meant that at 5 percent alpha value there was difference significantly of the indoor temperature level between the two groups.

Table 2: The Average Distribution of IEQ parameters in footwear workshop according to incidence of ARIs in workers.

Acute Respiratory Infections	Mean	SD	SE	P-Value	N
Indoor Illumination					
Positive	153.36	94.34	16.18	0.810	34
Negative	190.40	95.02	13.31		51
Indoor Temperature					
Positive	30.38	2.08	0.36	0.040	34
Negative	31.35	2.12	0.29		51
Relative Humidity					
Positive	63.30	6.17	1.06	0.017	34
Negative	59.88	6.48	0.91		51

4. Discussion

The average level of indoor temperature in the seven workshops was 30.960C and has contributed to the occurrence of ARIs. This result was in line with Abdullah & Hakim findings [7] that indoor temperature had the contribution to the germ rate which can affect occupant's respiratory health. Other than that, the variation of temperature level inside buildings at the minimum of 28.8^{o}C and maximum of 34.8^{o}C was influenced by the varied condition of buildings, time of recording data, alteration of weather conditions, and area of buildings. Most situations in home industries, the temperature conditions are not well-controlled due to improper control system design or operation and other factors [9].

The humidity of the air depends on how much moisture is contained in the air. The average of relative humidity was 61.25 percent in the study area. In the building with high humidity (over 60%), microbiological contamination is a common problem and sometimes become serious [6]. This was consistent with the present study that relative humidity had to do with ARIs. Humidity is closely related to ventilation to regulate air circulation. As well, walls are useful for maintaining indoor temperature and optimal humidity, and also being a medium for rising damp process which is one of the causes of humidity in indoor.

The humidity of the air depends on how much moisture contained in the air. The building with high humidity level (over 60%), the microbiological contaminant is a common problem and sometimes becomes a serious effect on occupant health [6]. This result was consistent with the present study that relative humidity had to do with

ARIs. The average level of relative humidity in the location of the study was 61.25 percent.

Based on the decree of the Ministry of Health of the Republic of Indonesia No. 70/2016, the average of illumination level in the study sites was under the threshold limit at 500 lux. Despite, the low intensity of illumination can be dangerous as it may raise bacterial proliferation [10]. In this study, there was no significant correlation between illumination and ARIs. In contrast to another finding, Syam & Ronny [11] found that illumination has the association with ARIs. The distinct result of these studies was influenced by several things. The condition or location of the workshop affected the measurement at that time. The main source of illumination was the sunlight which relied on the weather condition. Besides, the worker's immune condition was a determining factor because a respondent who has a good immune system will not easily become ill.

5. Conclusion

The presented results have documented how worker's respiratory infection affected by IEQ. The levels of indoor temperature and relative humidity had the significant effect on the acute respiratory infections. The intensity of illumination in all workshops, in general, has not met the requirements of threshold limit of Ministry of Health's Decree.

Overall, the results of this study were too general, so it is necessary more detailed study and novel methodology. Therefore, it can be known the air quality of workshops and other factors that influence it precisely. By this result, it is important that architectures and engineers need to take into account a vast range of factors such as illumination, humidity, and temperature.

Conflict of Interest

None declared.

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