ORIGINAL ARTICLE

# Respirable dust exposure impact on respiratory symptoms among cleaners in a Selangor Public University, Malaysia

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## ABSTRACT

**Introduction: Cleaners perform a vital role in environmental health by keeping the place clean, but they are also exposed to various hazards. Yet, there is a lack of effective and accessible occupational safety standard measures, thus making this to be difficult to monitor the long-term health effects of cleaners. This study aims to determine the respirable dust exposure on respiratory symptoms among cleaners in a public university in Selangor.**

**Materials and Methods: A cross-sectional study was carried out among 51 cleaners. The respondents' background information and respiratory symptoms were gathered using a series of standardised questionnaires validated by the American Thoracic Society (ATS-DLD-78-A). The 8- hour respirable dust exposure to cleaners was measured using an air sampling pump (Gillian & Sensodyne Gil Air 3).**

**Results: The mean of respirable dust was lower than permissible exposure limit with 0.63±0.57mg/m$^3$. The respiratory symptoms among the cleaners showed no significant association between cough, phlegm, and breathing difficulties with working tenure. Meanwhile, wheezing and coughing with phlegm have an almost significant association with working tenure among cleaners with ($\chi^2$=1.00, p=0.08) and ($\chi^2$=1.00, p=0.07) respectively. Exposure to respirable dust has exhibited 6 times the prevalence of coughing with phlegm among cleaners (PR=6.28, 95% CI: 0.44, 89.38).**

**Conclusion: The findings of this study demonstrated that the cleaners were significantly affected by the respirable dust. The cleaners' working environment has caused them to be exposed to respirable dust.**

**KEYWORDS:**
*Cleaner, respirable dust, respiratory symptom*

## INTRODUCTION

Maintaining a secure and healthy learning environment through regular campus cleaning is crucial. As the Centers for Disease Control and Prevention noted, the pandemic highlighted the rapid spread of germs and emphasized the importance of keeping facilities clean.[1] The safety and well-being of students and staff are of utmost importance, thus it is necessary to hire a cleaning company to perform professional cleaning in classrooms, offices, common areas, break rooms, restrooms, dorm rooms, clinics, and other locations regularly.[2] Therefore, cleaners play vital roles in ensuring that the environment is clean and hygienic for everyone.

Cleaners are responsible for various tasks and duties, including sweeping, mopping, sanitising, restocking supplies (such as toilet paper), polishing, and collecting garbage, which require them to move from one area to another, both outdoors and indoors.[3] Additionally, garden maintenance, road cleaning, and grass cutting may also fall under the purview of a cleaner's duties. Due to the nature of their work, cleaners at public universities, who typically work for 8 to 9 hours per day for six days a week, are often exposed to particulate matters present in the air throughout their working hours.

Cleaners are mobile workers who work outdoors and indoors, moving from one location to another to perform their cleaning duties. Although they play a crucial role in maintaining environmental health by ensuring that areas are clean, they are also exposed to various hazards. In particular, they are frequently exposed to hazardous particles such as soil, sand, gravel dust particles, vehicle dust, bioaerosols, and plant particles commonly found in the atmosphere.[4] As they move around to clean different areas, cleaners may inhale and exhale respirable dust on the road, mainly due to vehicle emissions and air pollution. Respirable dust refers to particles smaller than 4 micrometres (µm) in size. It can be inhaled into the lung's gas exchange zone, posing significant health risks to workers across various industries.[5]

When cleaners are repeatedly exposed to respirable dust, they are at an increased risk of developing respiratory diseases. Recent research has demonstrated that particulate matter

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harms the respiratory system and can lead to respiratory disorders.[6] Respiratory disease affects the lungs and other components of the respiratory system, with causes including infection, cigarette smoking, second-hand tobacco smoke, radon, asbestos, and other forms of air pollution.[7-8]

Other dust-related disorders, such as cancer, asthma, allergic alveolitis, and irritation, are also associated with it. A bunch of new non-respiratory illnesses can develop at considerably lower levels of exposure.[9] Long-term airborne dust exposure can cause chronic obstructive pulmonary disease (COPD). Peng et al., stated that COPD is a global public health issue and the third most significant cause of death due to cardiovascular and cerebrovascular illnesses. Given these risks, it is critical to assess the relationship between exposure to respirable dust and respiratory disease among cleaners.[10] The mixture of dust can create a massive impact on the lungs of the cleaners as they are categorized as mobilized workers who work indoors but in open spaces. The effects of inhaling dust are indeed well documented, however, studies on the lung function of cleaners are still undertaken. Hence, this study was performed to evaluate the association between respirable dust exposure with respiratory symptoms among cleaners in a public university in Selangor, Malaysia.

## MATERIALS AND METHODS

A cross-sectional study was conducted among the cleaners at the public university in Selangor. The list of 112 workers was obtained from the Human Resources Department of the cleaning consortium company. The cleaners were selected using a simple random sampling technique by considering the inclusion and exclusion criteria to recruit study respondents based on the list given. A group of 51 cleaners were selected aged from 20 to 60 years old and have worked for more than six months. The exclusion criteria considered whether the individuals had any respiratory disease during the sample collection or had received any medical treatment for respiratory diseases within six weeks before the sample collection. The collection of the sample was obtained during the working period. The sample size was determined using the formula from Lemeshow and Hosmer (1990) with reference to Ismail and Jalaludin (2014), specifically for the significant odds ratio related to respiratory health affected by respirable dust exposure.

$$n = \frac{(Z_{1-\frac{\alpha}{2}})^2 \; P(1-P)}{d^2}$$

Where;

$(Z_{1-\frac{\alpha}{2}})^2$ = standard errors associated with confidence intervals

(95% confident interval = 1.96)
P = referral proportion
d = desire precision (0.05)

After considering 80% response rate and 90% eligibility rate, the total sample size obtained was 51 respondents.

*Instrument*

An air pump, Gillian & Sensodyne Gil Air 3, was used to evaluate respirable dust exposure. The measurement procedure took 8 hours, and the flow rate for the pump is 1.7L/ min based on the NIOSH Manual of Analytical Methods for particulates not otherwise regulated, respirable (NMAM 0600).[13] It indicates a healthy human lung flow rate. The pump was calibrated before and after measurement. The 4.0µm PVC filter paper was dried and weighed before and after sampling. The 2-layers filter cassettes for filter paper and the nylon cyclone sampling head were used. The filter paper was dried and weighed before being placed into the filter cassettes. The cassettes were then sealed and stored in a desiccator containing silica gel to prevent moisture while waiting for sampling time.

A questionnaire was used to determine the respiratory symptoms to evaluate respiratory disease. The respiratory symptoms of the respondents were assessed using a validated questionnaire from the American Thoracic Society (ATS-DLD-78-A),[14] which had been translated into Malay. This translated version underwent pre-testing and reliability testing in a previous local study.[15] It consists of four sections: social demographic, past illnesses, symptoms, and tobacco smoking with dual languages, which are Malay and English.

*Sample Collection*

A simple random sampling under probability sampling methods was conducted for cleaners. The respondents who signed the consent were interviewed for data collection on socio-demographic information. The other questions related to lung disease were obtained from the validated questionnaire developed based on the American Thoracic Society (ATS). The questionnaire contains four sections: socio-demographic, history of respiratory disease, symptoms, and smoking exposure. The socio-demographic, history of respiratory disease, and smoking exposure questions were used to control confounding factors that may influence the results of the study. The socio-demographic questions such as age, gender, family income, education, and race of the respondents were identified to ensure no significant difference among study respondents due to the various backgrounds of study respondents. Besides that, according to American Thoracic Society, smoking exposure and history of respiratory disease should be controlled since these factors might influence respiratory symptoms.[16]

The concentration of respirable dust was collected using an air sampling pump (Gillian & Sensodyne Gil Air 3). The pump was hung on the respondent waist while the cyclone with filter cassette was attached to the breathing zone of the respondent which is a 20cm radius from the nose. The duration of personal air sampling took 8 hours of working period by using a 4.0µm PVC filter. All the study respondents work in a similar environment, which involves working indoors with an open ventilation system as in Fig. 1. Air quality parameters were measured to ensure that there were no significant differences in the environmental conditions during this study. This was accomplished using the TSI Q-Trak Indoor Air Quality Monitor, which measured parameters including CO2 levels, temperature, and relative humidity.

The final weight was taken using the same analytical balance during sampling preparation to determine the weight changes from the filter paper. A filter sample's post-sampling weight, W2 (mg), was recorded, including field blanks. The concentration of respirable particulate ($mg/m^3$) was calculated using the following formula:

$$C = \frac{(W_2 - W_1) - (B_2 - B_1)}{V} \quad X\ 10^3, mg/m^3$$

Where;
W1 = tare weight of filter before sampling (mg),
W2 = post-sampling weight of sample-containing filter (mg)
B1 = mean tare weight of sample-containing filter (mg)
B2 = mean post-sampling weight of blank filters (mg)
V = volume as sampled at the nominal flow rate (1.7L/min)

*Statistical Analysis*
Data collected in the study were analysed using SPSS version 28. Descriptive analysis was used to determine the respirable dust exposure and respiratory symptoms among cleaners by stating sample size (N), the centre of data (mean and median), data dispersion (standard deviation and frequency), and shape of data distribution. Kolmogorov-Smirnov statistics were used to test normality for all continuous variables. Univariate testing was used to analyse the socio-demographic data in the questionnaire. The inferential analysis was conducted for each objective. Next, a chi-square analysis was run to determine the respiratory symptoms among cleaners at a public university in Selangor. Lastly, an odd ratio (OR) was used to identify the association between respirable dust exposure and respiratory symptoms among cleaners at a public university in Selangor.

**Ethics Approval And Informed Consent**
The application of ethics and permission letter was approved by the ethics committee of UiTM Puncak Alam. The reference number for ethical approval is FERC/FSK/MR/2022/0292.

## RESULTS

*Demographic Characteristics of Cleaners*
A total of 51 cleaners were included in this study. Most of the cleaners were females (92.2%), with males accounting for only 9.8%. Malay cleaners comprised around 80.4% of the chosen population, followed by Indians with 19.6%. The most significant level of education attained, at 2.0%, was a certificate, while most workers required SPM level education with 70.6%. The majority of the cleaners were 51 to 60 years old at 35.8%, followed by 41 to 50 at 27.5%. The lowest percentage, 9.8%, was among those 60 years old and older. The cleaners' body mass index (BMI) found that 45.1% were overweight and 33.3% were obese, respectively. Only 9.8% of cleaners are single, making marriage the most common demographic (90.2%).

Various concessionaires employ cleaners at public universities, and their typical work days are between 8 and 9 hours. Nine hours comprised most of the respondents' working hours (74.5%), followed by 8 hours (25.5%). Public transport was first among the cleaners' modes of getting to work (43.1%), while motorcycles came in second with 39.2%. The least was by car, with 17.6%. Table I shows most of the cleaners, 49.0%, did not have any pets at home, whereas 37.3% had cats. Last but not least, only 5.9% of cleaners smoked, followed by 94.1% of cleaners who did not smoke. This may be related to the fact that most responses were female.

Table III shows air quality parameters, comprising CO2, temperature, and relative humidity. The mean of CO2 is 500.92±93.75ppm. The mean temperature was 25.82±1.09°C and the mean for relative humidity was 73.38±5.62%. The low standard deviation value indicates that there is little variation in the air quality parameters of the study environment, suggesting that they are relatively consistent and not significantly different.

*Respiratory Symptoms among Cleaners*
The respiratory symptoms of respondents were categorised into cough, phlegm, wheezing, breathing difficulty, and cough with phlegm. There is a clear correlation between increased symptoms and longer work hours as reported by Ratanachina et al.[17] A Pearson chi-square was used to observe respiratory symptoms among cleaners according to their working tenure. Table IV shows the respiratory symptoms among the cleaners have no significant association between cough, phlegm, and breathing difficulty, and working tenure. Meanwhile, wheezing and coughing with phlegm have an almost significant association with working tenure among cleaners ($\chi^2$=1.00, p=0.08) and ($\chi^2$=1.00, p=0.07) respectively.

*Association between Respirable Dust Exposure with Respiratory Symptoms among Cleaners*
Exposure to respirable dust has six times higher odds of coughing with phlegm among cleaners shown in Table V (OR=6.28, 95%CI: 0.44, 89.38). Despite this, the cleaner has almost twice higher odds of getting a cough with exposure to respirable dust while working (OR=1.88, 95%CI: 0.68, 5.20). Cleaners would also have the probability of getting phlegm and breathing difficulty with 1.39 higher odds (OR=1.39, 95%CI: 0.38, 5.17) and (PR=1.39, 95%CI: 0.44, 89.38) respectively. Meanwhile, no respondent had wheezing symptoms that were excessive compared to the standard; thus, no association data was generated.

There was no significant association between respiratory symptoms and factors such as tenure, smoking status, and a history of respiratory disease. Therefore, conducting a multivariate analysis to control for confounding factors was not found to be significant.

## DISCUSSION

An assessment of respirable dust exposure was undertaken to ascertain the employees' exposure using an air pump, considering the workers' exposure to respirable dust. There were 51 responders who have participated in this respirable dust exposure level monitoring. The mean exposure level of respirable dust was 0.63±0.57$mg/m^3$ which is lower than permissible exposure limit.

The presence of occupants and their daily activities had a significant impact on the concentration of respirable dust.[18-19]

**Table I: The sociodemographic among respondents**

| Variables (n=51) | N | % |
|---|---|---|
| Age (years) | | |
| 20 - 30 | 7 | 13.7 |
| 31 - 40 | 7 | 13.7 |
| 41 - 50 | 14 | 27.5 |
| 51 - 60 | 18 | 35.8 |
| > 60 | 5 | 9.8 |
| Gender | | |
| Female | 47 | 92.2 |
| Male | 4 | 7.8 |
| Body Mass Index (BMI) | | |
| Obese | 17 | 33.3 |
| Overweight | 23 | 45.1 |
| Ideal | 10 | 19.6 |
| Underweight | 1 | 2.0 |
| Race | | |
| Malay | 41 | 80.4 |
| Indian | 10 | 19.6 |
| Marital Status | | |
| Married | 46 | 90.2 |
| Single | 5 | 9.8 |
| Level of Education | | |
| Non-Schooling | 2 | 3.9 |
| Primary School | 12 | 23.5 |
| Secondary School | 36 | 70.6 |
| Certificate | 1 | 2.0 |
| Workings Hours | | |
| 8 | 13 | 25.5 |
| 9 | 38 | 74.5 |
| Mode of Transportation | | |
| Motorcycle | 20 | 39.2 |
| Public Transport | 22 | 43.1 |
| Car | 9 | 17.6 |
| Pets | | |
| Cat | 19 | 37.3 |
| Dog | 6 | 11.8 |
| Other | 1 | 2.0 |
| No Pets | 25 | 49.0 |
| Smoking | | |
| Yes | 3 | 5.9 |
| No | 48 | 94.1 |

**Table II: Respirable dust exposure concentration**

| Variable (n = 51) | Mean ± SD ($mg/m^3$) | min ($mg/m^3$) | max ($mg/m^3$) |
|---|---|---|---|
| Respirable Dust | 0.63 ± 0.57 | 0.058 | 2.176 |

**Table III: Air quality Parameters**

| Variable (n = 51) | Mean ± SD | min | max |
|---|---|---|---|
| $CO_2$ (ppm) | 500.92 ± 93.75 | 474.56 | 527.30 |
| Temperature (°C) | 25.82 ± 1.09 | 25.51 | 26.13 |
| Relative Humidity (%) | 73.38 ± 5.62 | 71.80 | 74.96 |

**Table IV: The presence of symptoms with working tenure**

| Symptoms (n=51) | Working Tenure | N (%) | | $\chi^2$ | p-value |
|---|---|---|---|---|---|
| | | Yes | No | | |
| Cough | 6-12 | 4 (30.8) | 17 (44.7) | 0.52 | 0.78 |
| | 1-5 | 9 (69.2) | 21 (55.3) | | |
| Phlegm | 6-12 | 3 (27.3) | 18 (45.0) | 0.49 | 1.12 |
| | 1-5 | 8 (72.7) | 22 (55.0) | | |
| Wheezing | 6-12 | 1 (33.3) | 20 (41.7) | 1.00 | 0.08 |
| | 1-5 | 2 (66.7) | 28 (58.3) | | |
| Breathing difficulty | 6-12 | 5 (45.5) | 16 (40.0) | 0.74 | 0.11 |
| | 1-5 | 6 (54.5) | 24 (60.0) | | |
| Cough with phlegm | 6-12 | 1 (50.0) | 20 (40.8) | 1.00 | 0.07 |
| | 1-5 | 1 (50.0) | 29 (59.2) | | |

Chi-Square test (Fisher Exact Test)
*Significant p-value < 0.05

**Table V: Association between respirable dust exposure with respiratory symptoms**

| Symptoms (n=51) | | Respirable dust | | $\chi^2$ | PR (95% CI) |
|---|---|---|---|---|---|
| | | Exceed | Not exceed | | |
| Cough | Yes | 3 (5.9) | 10 (19.6) | 1.28 | 1.88 |
| | No | 4 (7.8) | 34 (66.7) | | (0.68-5.20) |
| Phlegm | Yes | 2 (3.9) | 9 (17.6) | 0.23 | 1.39 |
| | No | 5 (9.8) | 35 (68.6) | | (0.38-5.17) |
| Wheezing | Yes | 0 (0.0) | 6 (11.8) | 1.08 | 0 |
| | No | 7 (13.7) | 38 (74.5) | | |
| Breathing difficulty | Yes | 2 (3.9) | 9 (17.6) | 0.23 | 1.39 |
| | No | 5 (9.8) | 35 (68.6) | | (0.44-89.38) |
| Cough with phlegm | Yes | 1 (2.0) | 1 (2.0) | 2.31 | 6.28 |
| | No | 6 (11.8) | 43 (84.3) | | (0.38-5.17) |

Chi-Square test (Fisher Exact Test)
Significant OR > 1, 95% CI

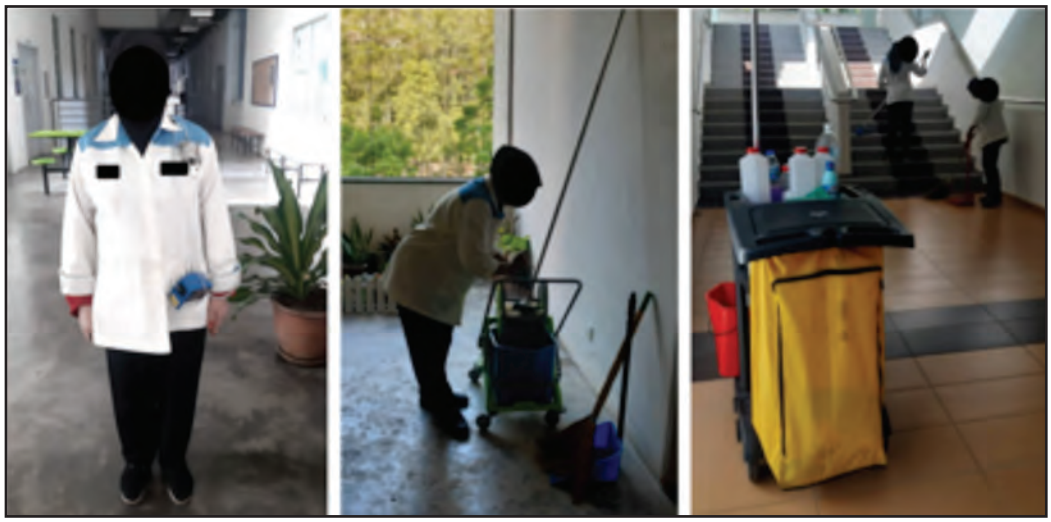

**Fig. 1:** The cleaners wearing an air sampling pump while working

The study was carried out at a library, laboratory and administrative building with a minimal number of occupants and limited daily activities especially during semester break. This study aligns with the research on indoor air quality within a multi-storey central office building at a university in Johor. The study found that the respirable dust levels were within acceptable limits and suitable for occupancy, despite the presence of some observable symptoms of Sick Building Syndrome (SBS) among its occupants.[20]

The cleaners can be categorised as administrative workers because they work outdoors and indoors.[21] Workers in administration occasionally spend time in a building, which did not shield them from the dusty environment.[22] Cleaners usually clean the building and also surrounding areas of the building such as corridors, roadsides around the campus, and others. Although the university did not have traffic congestion like on the main road, but respirable dust was also be present from the smoke emissions of the vehicle. Besides, inside the building, respirable dust is also present

from the cleaning items and others. Both external and indoor factors, including building supplies, cleaning supplies, air fresheners, heating, cooking, and smoking activities can contribute to indoor pollution with particulate matter.[4,23,24]

The air quality parameters measured during the sampling were temperature, $CO_2$, and relative humidity. The rooms where the cleaners were sweeping, wiping, and picking up trash is where the readings of the air quality parameters were taken. Overall, the measurement for $CO_2$ and relative humidity are almost similar with the study from various study in Malaysia.[25-27] Therefore, symptoms such as coughing, wheezing, and phlegm are not associated with extreme temperatures, humidity, or $CO_2$.

According to the results, all of the symptoms were insignificant against the working tenure. Most of the cleaners who worked for 1 to 5 years have a symptom rather than cleaners who worked for more than 6 years. The researchers found that age, personal dust exposure, and the number of years spent working on the landfill were all significantly linked to the presence of cough, chronic cough, and nasal congestion.[22,28,29] In this study, similar protective effects were seen for other measured respiratory symptoms; however, they were not statistically significant.[30]

Most of the respondents claimed that they always wear face masks during cleaning task, even before COVID-19 spread. It can be one of the reasons why the cleaners did not develop any symptom during work.[31] Furthermore, Dugré et al. (2020) stated that limited evidence that the usage of masks may lower the incidence of respiratory infections.[21] However, there may be a decreased risk of influenza-like illness among mask users in the community.

The respirable fraction was associated with all respiratory symptoms, an increased chance of getting a cough and/or phlegm, and shortness of breath.[23] Although this study was significant, the number of PRs in their study corresponds roughly with this study for cough (PR=1.29) and breathing difficulty (PR=1.33).[23,32] This indicates that the cleaners had an elevated risk of experiencing the mentioned symptoms. Even so, there was no relationship found between respirable dust exposure and respiratory symptoms. This could be due to the sample size being too small, hence there was no seasonal change, and no control group.[22,33] Instead, having a minimal number of occupants and limited daily activities results in lower levels of respirable dust. Therefore, there was no association between respirable dust exposure and respiratory symptoms, which could be attributed to the all factors. This study was cross-sectional and was carried out in a relatively constrained amount of time, which could potentially be the reason.

## CONCLUSION

This study has successfully met the objective by examining the impact of respirable dust on cleaners. The results indicated that cleaners were significantly exposed to respirable dust, both indoors and outdoors, likely due to pollution from vehicle exhausts and indoor sources. However, the study found no significant correlation between respiratory symptoms and the duration of employment as a cleaner, with only a few reporting such issues. This could be attributed to the majority of cleaners wearing face masks while working. Although there was no significant association between respirable dust and respiratory symptoms, the potential for such exposure remains high as the OR exceeds 1. Overall, this study underscores the need for greater awareness of the risks posed by respirable dust to cleaners. Building upon the existing findings, a promising avenue for future research involves conducting extended longitudinal investigations to gauge the enduring consequences of prolonged respirable dust exposure on the respiratory health of cleaners. Next, delve into the impact of genetic factors and individual variations in how people respond to dust exposure. Subsequently, assess the efficacy of a range of intervention strategies, including enhanced personal protective equipment (PPE), workplace ventilation enhancements, and revised cleaning techniques, in reducing dust exposure and its effects on respiratory health. Concurrently, this research has the potential to enhance and rigorously implement regulatory guidelines pertaining to permissible exposure limits for respirable dust within cleaning work environments.

## ACKNOWLEDGEMENTS

We would like to express our gratitude to all the respondents from the Centre of Environmental Health & Safety particularly the cleaners who participated in this research.

## CONFLICT OF INTEREST

There were no potential conflicts of interest disclosed by the authors in connection with the research, authorship, and/or publication of this work. The findings of this research have never been published before.

## FUNDING

No funding was received.

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