ORIGINAL ARTICLE

Indoor Air Quality and Psychosocial Factors Related to Sick Building Syndrome among Office Workers in New and Old Buildings of a Public University in Klang Valley, Malaysia

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ABSTRACT

Introduction: Sick building syndrome (SBS) has been linked to poor indoor air quality (IAQ) and work-related stress. Objective: This research aims to determine the relationship between environmental and psychosocial factors with SBS among office workers in new and old buildings in Universiti Putra Malaysia, Serdang. **Methods:** A cross-sectional comparative study was conducted among 120 office workers in new and old buildings in UPM. SBS symptoms and psychosocial factors were identified using validated questionnaires modified from IAQ and work symptoms survey, and Job Content Questionnaire (JCQ). The IAQ parameters measured using IAQ devices. **Results:** The air velocity, air humidity, temperature and indoor air pollutants level in the new building were significantly higher compared to old building. The prevalence of SBS was significantly higher in the old building compared to the new building (χ^2=31.44, p<0.001). There were significant associations between SBS prevalence with temperature (OR=4.02, 95% CI=1.02-15.85), TVOC (OR=4.55, 95% CI=1.12-18.48); UFP (OR=4.63, 95% CI=1.25-17.21); $PM_{2.5}$ (OR=5.06, 95% CI=1.36-18.89); PM_{10} (OR=4.80, 95% CI=1.33-17.29) and job insecurity (OR=4.08, 95% CI=1.03-16.23). The findings showed that the indoor air pollutants influenced the old building's SBS symptoms and job insecurity influenced SBS in the new building after controlling the confounders. **Conclusion:** The prevalence of SBS among office workers is influenced by indoor air quality and psychosocial factors. Further assessment and preventive steps should be taken to reduce risk factors in the workplace.

Keywords: Indoor air quality, Sick building syndrome, Office workers, Building, $PM_{2.5}$

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INTRODUCTION

Indoor air pollution has been linked to a variety of health problems, including impaired lung function, airway irritation, asthma and allergy symptoms and other respiratory symptoms, whether it comes from the outside or inside sources (1). Sick-building syndrome (SBS), as described by the WHO, causes symptoms associated with the indoor environment which are reported by buildings occupants (2). Symptoms of SBS are related to both personal and environmental influences. (3). Medical history, personal attributes, and type of personality are among the personal factors related with SBS, while building characteristics and the psychosocial work environment are among the environmental factors (4). Indoor air quality (IAQ) problems in a building can also be caused by the inadequate ventilation system, indoor air pollutants, high moisture and dampness, cleaning materials used, and human activities (5).

Old building normally reported to have high concentration of indoor air pollutants which may came from new furniture, newly painted wall, photocopy machine used in open area, wood products and also vaporized chemicals. Inadequate ventilation per occupants and the elevated of indoor chemical pollutants concentrations can lead to SBS prevalence (10). Meanwhile, new building recorded the risk of having SBS symptoms higher if the worker faced psychosocial problem; job insecurity. Disturbed body system affect psychosocial well-being that produce symptoms of headache, dizziness, anxiety and sleeping problems when workers exposed to indoor contaminantsrelated to SBS (13).

SBS is described as symptoms of illnesses experienced by the building occupants, categorized by the complaints of irritation of mucosal membrane and upper respiratory tract. (6). Usually, the building occupants working in the high concentration of indoor contaminants tend to develop SBS symptoms only when in the building. The symptoms disappear when they return home (7). SBS was mostly identified in office buildings with poor ventilation and high concentrations of indoor air pollutants, which triggered the prevalence of SBS among workers. (8). In Malaysia, there are many studies conducted by previous researchers about the relationship between SBS and indoor air quality among office workers in new and old buildings. Poor IAQ in office buildings may affect the workers' health (9).

A previous study showed a significant association between SBS with work stressors and that stress appears from working in a poor indoor environment (11). The prevalence of depression and anxiety among Malaysian adult has increased from 12% in 2011 to 29% in 2015 (12). Factors of chemical exposures, poor physical and psychosocial environments were found to contribute to stress among workers (13) significantly. The workers exposed to chemical contaminants and work stressors were significantly associated with stress among workers. All of the SBS symptoms are influenced by personal, psychosocial and environmental factors (14). Metabolic disorder in the human body happened when workers were exposed to high indoor air pollution that may give rise to headaches, dizziness, anxiousness, and difficulty sleeping (15). Symptoms associated with SBS, are mucous membrane inflammation, allergic reactions and fatigue among stress employees (16).

SBS studies emphasized on indoor air quality without taking into account the job stressor faced by the workers. In order to elucidate the factors related with the prevalence of SBS, this study is conducted to identify the relationship between environmental and psychosocial factors with SBS among office workers in new and old buildings in UPM, Serdang.

MATERIALS AND METHODS

Study location and subject selection

A cross-sectional comparative study was conducted involving 120 office workers who fulfilled the inclusion criteria: full-time male and female office workers, age between 20 to 60 years old and worked for at least four months from the new and old building. The sample size calculation in determining the number of respondents was chosen using the formula from Lemeshow et al., (1990) for group comparison between two buildings (33). The name list of respondents was obtained from the appointed secretary of the administrative office in both buildings. The criteria for building selection were based on its age, using a centralized air conditioning system and the number of occupancies. There were two buildings selected for this study: Faculty of Science building as the old building and the Faculty of Medicine and Health Sciences as the new building. The old building is 48 years old, and the new building is 24 years old. The new and old buildings have an almost similar number of occupants (97 vs 109) and were utterly dependent on the centralized ventilation system to provide sufficient air ventilation.

Questionnaire

The sociodemographic and psychosocial factors were assessed through randomly distributed questionnaires. The SBS symptoms questions were adopted from the Malaysia Industry Code of Practice on Indoor Air Quality (5), and the answers were in the form of binary scoring. Office workers are considered having SBS if they had at least one SBS symptom that occurs at least once in a week (15).

The Job Content Questionnaire (JCQ) was used to assess the psychosocial factors and staff's work tasks (18). JCQ includes 27 questions consisted of job demand, job insecurity, social support and decision latitude.

Indoor air quality measurement

Sampling method was based on the Industry Code of Practice on Indoor Air Quality (5). The number of sampling point was determined based on the estimation of the total floor area of each office. Data collection was conducted for 8-hour continuous measurement started from 8:30 am until 4:30 pm at each sampling point. The measuring devices were placed at 110 cm above from the floor.

Physical parameters which consisted of air velocity, temperature and relative humidity were measured using TSI Model 9565-A Velocicalc Multi-Function Ventilation Meter. For indoor air pollutants parameter, carbon dioxide (CO_2) and (CO) were measured using the TSI Model 7575 Q-Trak. Besides, ppbRAE 3000 was used to measure the level of TVOC contained in the air. TSI Model 8525 P-Trak was used to measure ultrafine particles (UFP) and TSI Model 8532 DustTrak II to measure particulates concentration of $PM_{2.5}$ and $PM_{10.}$ All instruments were calibrated to ensure its sensitivity and to prevent error during data collection. The result from the assessment was compared to the acceptable limits as recommended in the guideline Industry Code of Practice on Indoor Air Quality (5).

Ethical committee approval

Ethical approval was obtained from the Medical Research Ethics Committee, Universiti Putra Malaysia (ref. no: UPM/TNCPI/RMC/JKEUPM/1.4.18.2)

RESULTS

Sociodemographic characteristics

The total respondents involved were 120 office workers with inclusion criteria of full time male and female staff, age between 20 to 60 years old and had been working in the buildings for at least four months and above. Out of the 120 questionnaires returned, 65 respondents from the old building and 55 respondents from the new building participated in this study. Table I shows the sociodemographic characteristics of respondents in new and old buildings. The percentage of male workers (53.8%) was higher compared to female (46.2%) in the old building while the percentage of female (63.6%) was higher than male (36.4%) in the new building. Malay workers made up the highest percentage in the old building (93.8%) and the new building (94.5%). Majority of respondents were non-smokers which recorded 96.9% in the old building and 94.5% in the new building.

Table I. Sociodemographic characteristics of respondents from the new and old buildings

Variables	Study groups n (%)			
	Old building (n=65)	New building (n=55)	χ^2	*p*
Gender				
Male	30 (46.2)	20 (36.4)	3.69	0.055
Female	35 (53.8)	35 (63.6)		
Race				
Malay	61 (93.8)	52 (94.5)	2.10	0.350
Non-Malay	4 (6.2)	3 (5.5)		
Marital Status				
Single	25 (28.5)	10 (18.2)	16.04	0.001**
Married	40 (61.5)	35 (63.6)		
Divorced	0 (0.0)	10 (18.2)		
Smoking Status				
Yes	2 (3.1)	3 (5.5)	0.42	0.516
No	63 (96.9)	52 (94.5)		
Age group				
20-29	6 (9.2)	20 (36.4)	3.12	0.085
30-39	21 (32.4)	12 (21.8)		
40-49	32 (49.2)	19 (34.5)		
50-59	6 (9.2)	4 (7.3)		

The comparison of indoor air pollutants concentration in new and old buildings

Table II has shown the result of comparing all parameters for IAP in the new and old building. The concentration of TVOC, UFP, $PM_{2.5}$ and PM_{10} were significantly higher in the old building compared to the new building. Meanwhile, there was no significant difference between the concentration of CO_2 in both buildings. Based on the result, the median value of TVOC in the old building (median = 15.43 ppm) was significantly higher than the new building (median = 5.69 ppm). The median value for UFP in the old building (median = 6740 pt/cm^3) was significantly higher than the new building (median = 6740 pt/cm^3. The concentration of $PM_{2.5}$ and PM_{10} also were significantly higher in the old building compared to the new building. The air velocity and relative humidity in the new building were significantly higher than the old building. On the other hand, the temperature level was significantly higher in the old building than new building.

Table II. Comparison of the indoor air pollutants concentration in both buildings

Variables	Old building Median (IQR)	New building Median (IQR)	z	*p*
CO_2 (ppm)	288.00 (292.20-301.18)	290.50 (288.48-298.67)	-1.044	0.297
TVOC (ppm)	15.43 (15.46-19.02)	5.69 (5.15-5.94)	-11.969	<0.001**
UFP (pt/cm^3)	6740 (6628-7569)	1250 (1354-1589)	-11.970	<0.001**
$PM_{2.5}$ (µg/m^3)	80 (80-90)	23 (22-27)	-9.579	<0.001**
PM_{10} (µg/m^3)	120 (120-125)	54 (52-57)	-9.498	<0.001**
Air velocity (m/s)	0.06 (0.06-0.07)	0.17 (0.12-0.15)	-2.867	0.004*
Temperature ()	24.7 (24.5-24.6)	23.80 (23.78-23.85)	-12.072	<0.001**
Relative humidity (%)	58.45 (58.31-58.78)	77.55 (77.43-78.23)	-11.983	<0.001**

*Significant at $p < 0.05$ **Significant at $p < 0.001$

The comparison of the psychosocial factors scores in new and old buildings

Table III has shown the comparison of psychosocial factors scores between new and old buildings respondents. By referring to JCQ and score manual, each factor's level was dichotomized based on the median score to obtain high and low values. The Chi-square analysis disclosed no significant difference between psychosocial factors scores. The percentage of psychosocial levels showed slightly higher in the old building and is influenced by gender.

Table III. Comparison of the psychosocial factor score in new and old buildings

Variables	Study groups n (%)		OR (95% CI)	χ^2	p
	Old building (n=65)	New building (n=55)			
Job demand					
High	29 (44.6)	27 (49.1)	1.20		
Low	36 (55.4)	28 (50.9)	(0.58-2.46)	0.24	0.624
Decision latitude					
High	59 (90.8)	45 (81.8)	0.46		
Low	6 (9.2)	10 (18.2)	(0.16-1.35)	2.07	0.151
Social support					
High	56 (86.2)	49 (89.1)	1.31		
Low	9 (13.8)	6 (10.9)	(0.44-3.95)	0.24	0.628
Job insecurity					
High	11(16.9)	10 (18.2)	1.09		
Low	54 (83.1)	45 (81.8)	(0.43-2.80)	0.03	0.857

N=120

The comparison of the prevalence of sick building syndrome in both buildings

The score of the SBS has been analyzed regarding the symptoms experienced by the respondents. One score would be added to the SBS scale if one symptom was reported nearly every day and two points would be given if two symptoms were reported nearly every day, and so on. (15). Table IV has shown the number of respondents who have been categorized as having SBS using the above criteria given; the old building recorded 80% while new building 29.1%. The prevalence of SBS was significantly higher in the old building compared to the new building.

Table IV. Comparison of the prevalence of SBS among office workers between new and old buildings

Variables	Prevalence of SBS N=120 (100%)		OR 95% CI	χ^2	p
	Yes	No			
Old Building N=65	52 (80.0)	13 (20.0)	9.75		
New Building N=55	16 (29.1)	39 (70.9)	(4.20-22.62)	31.44	<0.001**

**Significant at p<0.001

The association between the prevalence of sick building syndrome with physical parameters, indoor air pollutants and psychosocial factors in new and old buildings

Table V and Table VI show the association of the prevalence of SBS with physical parameters level, indoor air pollutants and psychosocial factors in old and new buildings. The chi-square analysis revealed a significant association between the level of physical parameters with the prevalence of SBS in the old building; temperature (OR = 4.02, 95% CI = 1.02-15.85) but there was no significant association between the prevalence of SBS in the new building.

Table V. Associations between the prevalence of sick building syndrome with the level of physical parameters, indoor air pollutants and psychosocial factors in the old building

Variables	Prevalence of SBS N=65 (100%)		OR	95% CI
	Yes (n=52)	No (n=13)		
Physical Parameters				
Air velocity				
High (0.06 m/s)	49 (94.2)	12 (92.3)	1.36	0.13-14.27
Low (< 0.06 m/s)	3 (5.8)	1 (7.7)		
Temperature				
High (24.7)	45 (86.5)	8 (61.5)	**4.02***	**1.02-15.85**
Low (< 24.7)	7 (13.5)	5 (38.5)		
Relative humidity				
High (58.45 %)	16 (30.8)	7 (53.8)	0.38	0.11-1.32
Low (< 58.45 %)	36 (69.2)	6 (46.2)		
Indoor Air Pollutants				
CO_2				
High (288 ppm)	38 (73.1)	5 (38.5)	**4.34***	**1.21-15.53**
Low (< 288 ppm)	14 (26.9)	8 (61.5)		
TVOC				
High (15.43 ppm)	30 (57.7)	3 (23.1)	**4.55***	**1.12-18.48**
Low (< 15.43 ppm)	22 (42.3)	10 (76.9)		
UFP				
High (6740 pt/m^3)	35 (67.3)	4 (30.8)	**4.63***	**1.25-17.21**
Low (< 6740 pt/m^3)	17 (32.7)	9 (69.2)		
$PM_{2.5}$				
High (80 µg/m^3)	36 (69.2)	4 (30.8)	**5.06***	**1.36-18.89**
Low (< 80 µg/m^3)	16 (30.8)	9 (69.2)		
PM_{10}				
High (120 µg/m^3)	39 (75.0)	5 (38.5)	**4.80***	**1.33-17.29**
Low (< 120 µg/m^3)	13 (25.0)	8 (61.5)		
Psychosocial Factors				
Job demand				
High	25 (48.1)	4 (30.8)	2.08	0.57-7.62
Low	27 (51.9)	9 (69.2)		

CONTINUE

Table V. Associations between the prevalence of sick building syndrome with the level of physical parameters, indoor air pollutants and psychosocial factors in the old building (CONT).

Variables	Prevalence of SBS N=65 (100%) Yes (n=52)	No (n=13)	OR	95% CI
Decision latitude				
High	48 (92.3)	11 (84.6)	2.18	0.35-13.46
Low	4 (7.7)	2 (15.4)		
Social support				
High	45 (86.5)	11 (84.6)	1.17	0.21-6.43
Low	7 (13.5)	2 (15.4)		
Job insecurity				
High	10 (19.2)	1 (7.7)	2.86	0.33-14.61
Low	42 (80.8)	12 (92.3)		

* OR significant at 95% CI > 1 (N=120)

There were five parameters in old buildings that showed a significant association between the prevalence of SBS and indoor air pollutants; CO_2 (OR=4.34, 95% CI=1.21-15.53); TVOC (OR=4.55, 95% CI=1.12-18.48); UFP (OR=4.63, 95% CI=1.25-17.21); $PM_{2.5}$ (OR=5.06, 95% CI=1.36-18.89); PM_{10} (OR=4.80, 95% CI=1.33-17.29). Also, there was no significant association between SBS prevalence with indoor air pollutants in the new building.

However, there was no significant association between psychosocial factors with SBS in old buildings. Other than that, there was a significant association between having demand for work and lower respiratory problems; nausea, sore throat, wheeze, or chest pain; and upper respiratory distress was significantly associated with lack social support (14). Based on the results showed in Table VI, the prevalence of SBS was only found to be significantly associated with a psychosocial factor which was job insecurity in the new building (OR:4.08, 95% CI: 1.03-16.23).

Table VI. Associations between the prevalence of sick building syndrome with the level of physical parameters, indoor air pollutants and psychosocial factors in new building

Variables	Prevalence of SBS N=55 (100%) Yes (n=16)	No (n=39)	OR	95% CI
Physical Parameters				
Air velocity				
High (0.17 m/s)	9 (56.3)	22 (56.4)	0.99	0.31-3.21
Low (< 0.17 m/s)	7 (43.7)	17 (43.6)		

CONTINUE

Table VI. Associations between the prevalence of sick building syndrome with the level of physical parameters, indoor air pollutants and psychosocial factors in new building (CONT).

Variables	Prevalence of SBS N=55 (100%) Yes (n=16)	No (n=39)	OR	95% CI
Temperature				
High (23.8)	11 (68.8)	22 (56.4)	1.70	0.50-5.83
Low (< 23.8)	5 (31.2)	17 (43.6)		
Relative humidity				
High (77.5 %)	8 (50.0)	23 (59.0)	0.70	0.22-2.24
Low (< 77.5 %)	8 (50.0)	16 (41.0)		
Indoor Air Pollutants				
CO_2				
High (290.50 ppm)	8 (50.0)	19 (48.7)	1.053	0.33-3.37
Low (< 290.50 ppm)	8 (50.0)	20 (51.3)		
TVOC				
High (5.69 ppm)	5 (31.2)	29 (74.4)	0.157	0.04-0.56
Low (< 5.69 ppm)	11 (68.8)	10 (25.6)		
UFP				
High (1250 pt/m^3)	6 (37.5)	20 (51.3)	0.570	0.17-1.88
Low (< 1250 pt/m^3)	10 (62.5)	19 (48.7)		
$PM_{2.5}$				
High (23 μg/m^3)	14 (87.5)	32 (82.1)	1.531	0.28-8.32
Low (< 23 μg/m^3)	2 (12.5)	7 (17.9)		
PM_{10}				
High (54 μg/m^3)	14 (87.5)	35 (89.7)	0.800	0.13-4.87
Low (54 μg/m^3)	2 (12.5)	4 (10.3)		
Psychosocial Factors				
Job demand				
High	8 (50.0)	19 (48.7)	1.05	0.33-3.37
Low	8 (50.0)	20 (51.3)		
Decision latitude				
High	13 (81.3)	32 (82.1)	0.95	0.21-4.24
Low	3 (18.7)	7 (17.9)		
Social support				
High	13 (81.3)	36 (92.3)	0.36	0.07-2.02
Low	3 (18.7)	3 (7.7)		
Job insecurity				
High	6 (37.5)	5 (12.8)	**4.08***	**1.03-16.23**
Low	10 962.5)	34 (87.2)		

* OR significant at 95% CI > 1 (N=120)

Multiple logistic regressions between physical parameters, indoor air pollutants and psychosocial factors

Multiple logistic regression analysis was performed to determine the main factor influencing the prevalence of sick building syndrome after controlling all confounders in this study (Table VII). The confounders in this study were the age of respondents, medical condition and smoking status. All parameters and confounder mentioned were found to be significantly associated with the prevalence of SBS except for temperature concentration in the old building (OR=3.58, 95% CI=0.82-15.63). Based on the result, the main predictors of the prevalence of SBS was $PM_{2.5}$ with an adjusted odds ratio of 4.51 (95% CI=1.08-15.76). This result indicated that it was five times more likely for office workers in old building develop SBS symptoms if they were exposed to the high concentration of $PM_{2.5}$; 80 μg/m³, compared to those who were not exposed. Besides that, the result also shows the main predictor for the prevalence of SBS which include CO_2, TVOC, UFP, PM_{10} and job insecurity with adjusted OR 3.88(95% CI=1.05-14.39); 4.00(95% CI=1.01-16.61); 4.13(95% CI=1.08-15.76); 4.32(95% CI=1.15-16.15); and 4.35(1.21-22.24) respectively.

Table VII. Multiple logistic regressions between physical parameters, indoor air pollutants and psychosocial factors with the prevalence of SBS in both buildings

Type of building	Parameters Category	Prevalence of SBS N=65 (100%) Yes n=52	No n=13	OR (95% CI)	*OR (95% CI)
Old	**Temperature**				
	High	45	8	4.02	3.58
	Low	7	5	(1.02-15.85)	(0.82-15.63)
	CO_2				
	High	38	5	**4.34**	**3.88**
	Low	14	8	**(1.21-15.53)**	**(1.05-14.39)**
	TVOC				
	High	30	3	**4.55**	**4.00**
	Low	22	10	**(1.12-18.48)**	**(1.01-16.61)**
	UFP				
	High	35	4	**4.63**	**4.13**
	Low	17	9	**(1.25-17.21)**	**(1.08-15.76)**
	$PM_{2.5}$				
	High	36	4	**5.06**	**4.51**
	Low	16	9	**(1.36-18.89)**	**(1.08-15.76)**
	PM_{10}				
	High	39	10	**4.80**	**4.32**
	Low	13	3	**(1.33-17.29)**	**(1.15-16.15)**
New	**Job insecurity**				
	High	6	4	**4.08**	**4.35**
	Low	10	35	**(1.03-16.23)**	**(1.21-22.24)**

*Adjusted OR for age, medical condition and smoking

DISCUSSION

The result showed that the IAQ level for ventilation and temperature were significantly different between new and old building which was consistent with the previous local study (19). Humidity levels have the potential to increase the intensity of chemical pollutants in the surrounding air by changing the level of air circulation and also by the reaction between water and chemicals (20). These findings were similar to many previous studies as they reported the significant differences in physical parameters in new and old buildings (7, 8, 21). The concentration of TVOC, UFP, $PM_{2.5}$ and PM_{10} were significantly higher in the old building compared to the new building. The findings were supported by the local studies (9, 10), as they reported that the chemical pollutants were significantly higher in the old building compared to the new building. Based on observation, the high reading of TVOC came from the newly painted wall, new furniture, cleaning agents, volatile organic chemicals from the chemistry lab, and office partitions made up of wood. Paints, carpets, adhesives, treated wood and wood products are expected to have a significant impact on enclosed concentration levels of TVOC (22). Also, the primary sources of TVOC, which include office furniture, floor finishing, vaporized organic chemicals, and exterior sources such as automobile emissions (23).

The operation of laser printers and photocopiers might also be associated with numerous health impacts from the high concentration of UFP released (24). The $PM_{2.5}$ and PM_{10} levels were found to be significantly higher in the old building compared to the new building. Based on observation, the source of indoor particulates matter came from tobacco smoke and combustion processes at chemistry lab which is located near to the sampling point. Enclosed particulates could be produced from combustion processes, smoking, boiling, and dust resuspension (25).

Based on the data obtained, the percentage of psychosocial stress levels showed slightly higher in the old building and maybe influenced by gender. It can be influenced by the distribution of gender in the old building where female workers (53.8%) were higher than male workers (46.2%). Women employees encountered higher stress levels compared to men employees (26). The finding demonstrated that the prevalence of SBS was significantly higher in the old building compared to the new building. The prevalence of sick building syndrome was significantly higher in the old building compared to the new building and these happen because of high measurement of indoor air contaminants (10).

Based on observation, the source of indoor air contaminants in the old building may came from paint, new furniture, photocopy machine, tobacco smoke and also vaporized chemicals from the chemistry laboratory. It is supported by a previous study where most participants said that they had SBS symptoms when continuing to work in office buildings with insufficient ventilation systems (7). Mucosal symptoms have been significantly associated with poor indoor air quality, including formaldehyde, ultrafine particles and total volatile organic compounds (27). Besides, CO_2, PM and TVOC tended to be positively related to the symptoms of sick building syndrome, and the most commonly reported symptoms were nasal symptoms (28). The result showed that room temperature was found to be positively related to SBS symptoms, and it was found that room temperature above 22°C increased both mucosal irritation and general respiratory symptoms (29).

A significant association was found between the prevalence of SBS and CO_2, TVOC, UFP, $PM_{2.5}$ and PM_{10} in old building. The concentration of CO_2, TVOC, $PM_{2.5}$ and PM_{10} were significantly associated with the prevalence of SBS in the old building (10). Also, there was no significant association between SBS prevalence with indoor air pollutants in the new building. Similar study showed that there was no significant association between level of indoor air pollutants and prevalence of respiratory health symptoms in new buildings for all parameter; Formaldehyde (OR = 2.27, 95%CI = 0.64 - 8.05), VOCs (OR = 3.50, 95%CI = 0.92 - 13.31), UFP (OR =1.12, 95%CI = 0.33 - 3.84) (9).

However, there was no significant association between psychosocial factors with SBS in old buildings. This result against the study conducted that mentioned risk of having SBS symptoms were higher if the workers faced psychosocial problems (high job demand and low social support than environmental factors (30). Other than that, there was a significant association between having demand for work and lower respiratory problems; nausea, sore throat, wheeze, or chest pain; and upper respiratory distress was positively associated with lack social support (14). Based on the results, the prevalence of SBS was only found to be significantly associated with a psychosocial factor which was job insecurity in the new building. The level of psychosocial factors can be influenced by the participants' age (14). Women and young employees are more likely to lose their jobs or firms than men and older employees (31). Gender seems to play an essential role in the reporting of different type of SBS symptoms, and in most studies, SBS symptoms higher among females than males (32).

The result indicated that it was five times more likely for office workers in old building to develop SBS symptoms if they are exposed to the high concentration of $PM_{2.5}$; 80 µg/m^3, compared to those who were not exposed. Besides that, the result also shows that the main predictor for the prevalence of SBS are CO_2, TVOC, UFP, PM_{10} and job insecurity. This result conclude that office workers who are exposed to the high concentration of indoor pollutants and high job insecurity were more likely to develop the symptoms of SBS especially if they are exposed to the high concentration of $PM_{2.5}$ compared to those who were not exposed.

CONCLUSION

Overall, the level of temperature, TVOC, UFP, $PM_{2.5}$ and PM_{10} was significantly higher in the old building compared to the new building. All of these parameters also showed significant association with the prevalence of sick building syndrome in the old building. Meanwhile, job insecurity was significantly associated with the prevalence of sick building syndrome in the new building.

This study also bounded with some limitations. Because the majority of the data is self-reported, there is a risk of misreporting, affect bias (the tendency to consistently score positively or negatively on questionnaire items depending on one's mood), and recall bias. The association between SBS symptom prevalence and ventilation rate, on the other hand, varies depending on the strength of indoor pollutant sources, outdoor air pollution levels, and other factors.

For recommendation, cooperative efforts from management and employees are the best way to improve indoor air quality and psychosocial well-being among workers. Adequate training able to enhance awareness among building occupants on the importance to maintain a healthy working environment. Firstly, the ventilation system should be maintained regularly according to the manufacturer's specification, and HVAC should be kept clean and unobstructed. Besides, increase ventilation rates would dilute the high concentrations of indoor air pollutants, provide strict no-smoking policy, regular housekeeping and prompt clean-up of spills. To improve psychosocial well-being among workers, the management must perform comprehensive interventions such as involving employees in decision-making and conduct programmes for the career development of employees. As a result, it will improve in the reduction of respiratory health complaints among workers.

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