doi: 10.5281/BMR.v2i2.24196

Managing Indoor Air Quality for Medical Students in a University

Grace E.H. Voon

1385, Tabuan Heights, Jalan Song, Kuching, Sarawak, MALAYSIA

voonernhui@gmail.com

Received: 30 August 2024
Accepted: 31 October 2024
Published: 30 November 2024

ABSTRACT

This research was done to study Indoor Air Quality (IAQ) and the presence of SBS symptoms among Phase One medical students in a university using a self-administered questionnaire, which was adapted and slightly modified from an established instrument. Four IAQ parameters were used to partially assess the indoor air quality of the two said facilities: parameters temperature, CO level, formaldehyde level, and CO2 level. The respondents' perceptions of the conditions of the teaching facilities were obtained through questionnaire distribution. The findings showed that the respondents' perceptions of the indoor environment were mostly acceptable and poor. The presence of Sick Building Syndrome-related symptoms was relatively insignificant. Based on the findings of the carbon dioxide levels and temperature range in the facilities studied, the air conditioning and ventilation systems should be improved and upgraded for a better learning experience for the students.

Keywords: Indoor air quality, Sick building syndrome

INTRODUCTION

In this era of globalization and modernization, people tend to spend most of their time indoors such as in the office, home, or educational institutions, hence maintaining a healthy indoor air quality is crucial to ensure good quality of life and work performance. Poor indoor air quality will lead to several negative consequences which affect the occupants' health and productivity. Sick building syndrome (SBS) is a medical condition related to poor indoor air quality with symptoms such as headache, fatigue, dizziness, nausea, and other similar symptoms (Vafaeenasab et. al., 2016). According to the United States Environmental Protection Agency, SBS was described as situations where building occupants experience acute health and comfort effects that appear to be related to the duration of time spent in a certain building, but no exact medical illness or cause can be identified (EPA, 2018). Other symptoms of SBS include dry cough, eye, nose, or throat irritation, and difficulty concentrating. SBS has also been reported to be caused, not only by poor indoor air quality but also by the interaction of environmental, occupational, and psychological factors as well as indoor air quality (Gomzi & Bobic, 2009). This paper aims to share relevant information on indoor air quality and SBS among students in a public university.

LITERATURE REVIEW

Environment for Teaching and Learning

The environment of teaching facilities in schools and educational institutions is directly related to the number of SBS cases among students (Takaoka et al., 2015). Studies have shown that indoor fungi's presence will increase the incidence of wheezing and fever in children. In addition, air pollution within the building was proven to lower students' academic performance. Moreover, when there is moisture and mould in the building, the number of asthma and allergy cases is significantly high among students, exacerbating the existing prevalence of the sick building syndrome (Fard et al., 2018). In addition, students tend to spend considerably long hours in the dedicated lecture halls throughout their study period. Ultimately, these students must benefit from a conducive and healthy learning environment including good indoor air quality.

doi: 10.5281/BMR.v2i2.24196

Indoor Air Quality

Indoor Air Quality (IAQ) is the air quality within and around the structures and buildings associated with the occupants' health conditions, comfort, and working ability (EPA, 2018). IAQ parameters include humidity, temperature, mould presence, microorganisms, building ventilation system, exposure to various chemicals or toxins, and many other factors. Poor IAQ can cause discomfort, illnesses, poor attendance, and low work performance whereas good IAQ helps maintain the building occupants' health. Organizations or institutions need to improve the condition of designated working environments, and the Department of Occupational Safety and Health was tasked to work towards reducing healthcare expenses and sick leaves of workers (DOSH, 2016).

Sick building syndrome (SBS)

SBS is frequently without clinical signs and symptoms. Thus, sick building syndrome is difficult to investigate or diagnose. One of the reasons is common people's acceptance of these indications as they are often relatively mild or the result of an assortment of causes (Gomzi & Bobic, 2009). The United States National Institute of Occupational Safety and Health (US NIOSH) identifies improper air quality, insufficient ventilation, outdoor air pollutants, biological agents such as indoor pollutants, building materials, noise, lighting, and other obscure components as conceivable reasons for SBS (Jafari et al., 2015). When more than twenty percent of people working in one building have these symptoms, they disappear or decrease dramatically when employees leave the building, this indicates Sick Building Syndrome (Gomzi & Bobic, 2009). SBS may influence work fulfillment, stress, and productivity (Norhidayah et al., 2013). The adverse indoor air quality, which relates well with poor respiratory and general health effects in the form of SBS (Kumar et al., 2022).

There are many suggested possible causes of SBS which focus on the indoor air quality and the building's ventilation systems. Other possible factors are noise, artificial lighting, workplace hygiene, stress, and psychological effects (Rostron, 2008).

METHODOLOGY

The research was conducted at a public university in Sarawak. The area of research includes the teaching facilities in the building around and inside the Faculty of Medicine and Health Science which are the Tutorial Room (TR) and the Seminar Room (SR). TR used by the Year 1 medical students and SR, utilized by the Year 2 medical students, have been identified as the sampling areas. SR is located inside the Faculty of Medicine and Health Science. Both rooms are used as classrooms for the respective group of students and are open from 7.30 a.m. to 5 p.m. daily.

The research's design is based on a cross-sectional study, where the aim is to compare the presence of Sick Building Syndrome symptoms in TR and SR. Both locations are situated inside the campus compound. The participants of this study were recruited from two groups of medical students in the Faculty of Medicine and Health Sciences. They are categorized into Year 1 and Year 2 medical students. The Year 1 medical students use TR as their classroom while the Year 2 medical students use the SR.

The respondents who participated in this research were 100 students each from Year 1 and Year 2 medical programmes. The sampling method used in this study was the convenient sampling technique. The first stage of the sampling was to randomly approach and request the medical students from Year 1 and Year 2 to join the research voluntarily. For the second stage, questionnaires were distributed to all consented Year 1 and Year 2 medical students, followed by brief information on the questionnaire. The participants were assured of the privacy and confidentiality of the data given.

Both groups of participants were briefed and the significance and aim of the study were clearly explained. The questionnaires were distributed after the briefing and collected the next day. The questionnaire with a slight modification was adapted from the established MM040 NA Office questionnaire, which was validated in a study by Anderson (1998). This questionnaire consisted of a few parts, including the first part which aim to gather information on the personal and general data of the participants. The data was subsequently recorded and analysed.

Air quality sampling was done in TR and SR using the Extech Carbon Monoxide meter, Extech VOC/CH2O meter, and Extech CO2 meter. The three parameters were selected to partially assess the air quality inside both rooms. The indoor air samplings were carried out three times daily in both locations at 8 a.m., 12 p.m., and 4 p.m. to observe any changes in the levels of the tested parameters throughout the day.

FINDINGS AND DISCUSSIONS

Respondents' Profile

A total of 200 students participated in this survey with half of the respondents in Year 1 and the other half in Year 2 of the medical programme. Thus, the participants were equally divided between the two studied locations. The number of female participants was higher than the male participants with 64% of the total participants female and 36% male. The age of the participants varied from 19 – 22 years old, with 48% of them 20 years old and 39% 21 years old. A minority of participants were 19 (8%) and 22 years old (5%). 54% of the students participating in this study were Malay, followed by 20% Iban and 19% Bidayuh. 11.5% of the participants were Chinese while 10% were Iban.

Out of 200 participants, the majority (47.5%) of the students normally spent 4-6 hours per day in the respective teaching facilities. 41.5% of the participants spent 6-8 hours in their respective teaching facilities and only a relatively small percentage (11%) stayed in the room for more than 8 hours. About 22% of 100 participants lingered in the room for 4-6 hours. More than half of the participants (60%) spent 6-8 hours in the room and only 18% hung out more than 8 hours in the room daily. A large percentage (73%) of the participants from SR spent 4-6 hours in the room.

Respondents' perceptions of the indoor environment of teaching facilities

Respondents had to answer whether they had been bothered in their places by the following factors for the past three months. The factors included room temperature, air, odour, room condition, dust, and dirt.

Regarding the room temperature, the questions were asked to see whether the room temperature was too hot or too cold. For 'room temperature too hot', 110 out of 200 respondents claimed it as 'yes, rarely happened' (55.0%). 32.5 % of them chose 'no, never happened' while 12.5 % of respondents selected 'yes, often happened'. Meanwhile for 'room temperature too cold', 47.5% of respondents thought that it rarely happened. About half of the respondents stated 'yes, often happened' and 'no, never happened' (42.0% and 10.5% respectively).

For stuffy "bad" air, above half of the respondents (52.0%) answered 'Yes, rarely happened'. 30.0% of them never experienced "bad" air for the past three months while the remaining 18.0 % claimed to have experienced it often. On the other hand, regarding the 'unpleasant odour', about 51.5% chose 'yes, rarely happened' and 32.0 % thought that unpleasant odour never happened while others (16.5 %) stated it happened often. As for 'noise', the percentage of respondents that regarded it as 'yes, often happened' (44.0 %) and 'yes, rarely happened' (42.5 %) were similar. 13.5 % claimed there was no problem with the noise at the place.

Regarding the room condition, the questions asked were whether the room was too dark or too bright. The majority of the respondents (67.5 %) never encountered the problem of the 'room too dark'. However, 29.5 % of them thought it happened rarely, and a mere 3.5 % thought it happened often. Similarly, most respondents (72.5%) claimed the room was not too bright for the past three months. Meanwhile, the other respondents claimed that they have encountered the problem only rarely or often with the percentage of 24.5 % and 3.0 %, respectively. The last factor asked was 'dust and dirt'. 111 respondents reported it 'rarely happened' but 32 (16.0 %) announced being exposed to dust and dirt. 28.5 % did not have a problem with it at their place. Table 1 summarizes the percentage distribution of respondents' perception of the indoor environment according to teaching facility location.

On the 'Air quality' as described in Table 2, most respondents (56.0%) chose 'Acceptable', followed by 37.0% that selected 'Good'. 6 students (3.0%) regarded the air quality as 'Very good'. Nonetheless, 8 students (4.0%) thought that the air quality was 'Bad' but none of the respondents picked 'Very bad'.

Table 1
The respondents' perception of an indoor environment

			Place		Test Statistics
			TR4	SR	
Temperature too hot	Yes, often happened	n	22	3	Chi-square: 38.447 p-value: 0.00
		%	22.0%	3.0%	
	Yes, rarely happened	n	64	46	
		%	64.0%	46.0%	
	No, never happened	n	14	51	
		%	14.0%	51.0%	
Temperature too cold	Yes, often happened	n	29	55	Chi-square: 16.178 p-value: 0.00
		%	29.0%	55.0%	
	Yes, rarely happened	n	55	40	
		%	55.0%	40.0%	
	No, never happened	n	16	5	
		%	16.0%	5.0%	
Stuffy "bad" air	Yes, often happened	n	23	13	Chi-square: 14.262 p-value: 0.001
		%	23.0%	13.0%	
	Yes, rarely happened	n	59	45	
		%	59.0%	45.0%	
	No, never happened	n	18	42	
		%	18.0%	42.0%	
Unpleasant odour	Yes, often happened	n	20	13	Chi-square: 6.271 p-value: 0.04
		%	20.0%	13.0%	
	Yes, rarely happened	n	56	47	
		%	56.0%	47.0%	
	No, never happened	n	24	40	
		%	24.0%	40.0%	
Noise	Yes, often happened	n	49	39	Chi-square: 4.709 p-value: 0.10
		%	49.0%	39.0%	
	Yes, rarely happened	n	35	50	
		%	35.0%	50.0%	
	No, never happened	n	16	11	
		%	16.0%	11.0%	
Room too dark	Yes, often happened	n	3	4	Chi-square: 5.419 p-value: 0.07
		%	3.0%	4.0%	
	Yes, rarely happened	n	37	22	
		%	37.0%	22.0%	
	No, never happened	n	60	74	
		%	60.0%	74.0%	
Room too bright	Yes, often happened	n	0	6	
		%	0.0%	6.0%	

	Yes, rarely happened	n %	29 29.0%	20 20.0%	Chi-square: 7.715 p-value: 0.02
	No, never happened	n %	71 71.0%	74 74.0%	
Dust and dirt	Yes, often happened	n %	17 17.0%	15 15.0%	Chi-square: 0.152 p-value: 0.93
	Yes, rarely happened	n %	55 55.0%	56 56.0%	
	No, never happened	n %	28 28.0%	29 29.0%	
Total		n %	100 50.0%	100 50.0%	

Table 2
Students' Perception of the indoor air quality

			Place		Test Statistics
			TR4	SR	
Air quality	Very good	n %	0 0.0%	6 6.0%	Chi-square: 7.879 p-value: 0.05
	Good	n %	34 34.0%	40 40.0%	
	Acceptable	n %	61 61.0%	51 51.0%	
	Bad	n %	5 5.0%	3 3.0%	
Air quality is worse in the early morning.	Yes	n %	21 21.0%	7 7.0%	Chi-square: 8.140 p-value: 0.00
	No	n %	79 79.0%	93 93.0%	
Air quality is worse in the afternoon.	Yes	n %	22 22.0%	25 25.0%	Chi-square: 0.250 p-value: 0.62
	No	n %	78 78.0%	75 75.0%	

Next, the respondents were asked if the air quality was worse in the early morning or afternoon and if any bad odour was present. 28 respondents (14.0%) thought the air quality was worse early in the morning, whereas 47 (23.5%) voted that the air quality was worse in the afternoon. Furthermore, almost half of the respondents (43.0%) agreed that bad odour

was present in their teaching facility. For the bad odour, many respondents (17.5%) stated that it was from other students. The percentage of respondents who chose 'carpet dust' and 'food' were almost the same, 6.5% and 7.0% respectively. 3.5% of respondents thought that the bad odour was from air conditioners.

Perceived symptoms of Sick Building Syndrome

People with Sick Building Syndrome experience common symptoms (SBS). Therefore, the respondents were asked if they had any symptoms related to SBS for the past 3 months. They chose 'Yes, often happened', 'Yes, rarely happened', or 'No, never happened'. The symptoms included fatigue, feeling heavy-headed, headache, nausea, difficulty concentrating while working, irritation sensation of the eyes, irritation, runny nose, nose bleeding, hoarse and dry throat, cough, flushed facial skin, itching of the scalp and skin, and stress.

Regarding 'fatigue', most respondents (47.5%) chose 'Yes, rarely happened', followed by 34.0% that selected 'Yes, often happened'. The remaining (18.5%) opted for 'No, never happened'. In the 'feeling heavy-headed' section, 111 respondents (55.5%) chose 'Yes, rarely happened', 51 respondents (25.5%) picked 'No, never happened' and 38 respondents (19.0%) claimed 'Yes, often happened'. Based on the survey, most (67.5%) rarely had headaches, followed by 19.0% who often suffered from headaches and 13.5% who never felt a headache for the last 3 months.

As for 'nausea', the majority of the respondents (66.0%) did not have the symptom, however, it was rarely experienced in 29.0% of respondents. The remaining 5.0% of respondents said that they frequently felt nausea. The next SBS symptom was 'difficulties concentrating while working'. Many (58.0%) chose 'Yes, rarely happened', while another 29.0% opted for 'Yes, often happened' and the least respondents (13.0%) selected 'No, never happened'. In the 'irritation sensation of the eyes' section, half of the respondents (51.5%) said they never felt it. Notwithstanding, 39.0% of them rarely had eye irritation and 9.5% said they often had the symptom.

Furthermore, most respondents (49.5%) rarely had 'irritated, runny noses', whereas 35.5% never experienced the symptom and the remaining respondents (15.0%) said they often had the symptoms. Regarding nose bleeding, the respondents only chose one of the two choices, 'Yes, rarely happened' or 'No, never happened'. Nearly all (91.5%) said they never felt the bleeding and only 17 respondents (8.5%) said that nose bleeding rarely happened to them. As for 'hoarse and dry throat', the respondents who chose 'Yes, rarely happened' (46.5%) and 'No, never happened' (45.0%) were nearly the same, while the remaining 8.5% opted for 'Yes, often happened'.

Apart from that, 120 respondents (60.0%) said they rarely had 'coughing' for the past 3 months, while 63 respondents (31.5%) said they never faced 'coughing' within the duration given and the remaining 17 respondents (8.5%) said they frequently coughed. As for 'flushed facial skin', nearly three-quarters of the respondents (71.0%) never felt the symptom, while 25.5% rarely developed the symptom. This symptom often happened to the remaining 3.5% of the respondents. In the 'itching of the scalp and skin' section, the respondents' famous choices were 'No, never happened' (46.5%) and 'Yes, rarely happened' (45.0%), while only 8.5% of the respondents chose 'Yes, often happened'. Regarding 'suffering from stress', half of the respondents (53.5%) selected 'Yes, rarely happened', followed by 27.5% that claimed 'Yes, often happened' and 19.0% opted for 'No, never happened'.

Indoor Air Quality (IAQ) Assessment

The indoor air quality of the TR and SR was partially assessed using four parameters: temperature, levels of carbon dioxide, formaldehyde, and carbon monoxide. A complete IAQ assessment could not be carried out due to the unavailability of the required equipment. As the sampling was made randomly, no specific patterns of IAQ parameters status were generated.

In general, the temperature that was the measured physical parameter of Indoor Air Quality (IAQ) in this study ranged between 21.2 ^{o} C and 28.4 ^{o}C for the SRoom and from 21.3 ^{o}C to 28.3 ^{o}C for the TR. The acceptable range for indoor temperature specified by DOSH Malaysia was 23 ^{O}C – 26 ^{O}C. In essence, it can be observed that the indoor temperature for both teaching facilities was slightly outside of the acceptable range, on both minimum and maximum values.

The levels of indoor air pollutants, i.e. CO_2, CO, and formaldehyde measured in both locations, were generally below the standard limit set by the DOSH, Malaysia (ICOP, 2010), except for the indoor carbon dioxide levels.

a) Formaldehyde

Table 3 shows the formaldehyde concentration between both teaching facilities occupied by the participants, compared to the level allowed by DOSH Malaysia. Based on the gathered data, the emission of formaldehyde ranged between 0 ppm to 0.2 ppm in the TR. The formaldehyde emission in the SR was in the range of 0 ppm – 0.05 ppm. The formaldehyde emission in TR was relatively higher than the recorded emission in the SR.

Table 3
Assessment using carbon dioxide and formaldehyde levels

Variables	**TR (n=100) Mean (IAQ)**	**SR (n=100) Mean (IAQ)**
CO_2 level (ppm)	1707.83 (SE = 338.59)	931.56 (SE = 119.82)
Formaldehyde level (ppm)	0.06 (SE = 0.02)	0.02 (SE = 0.004)

A descriptive analysis of the accumulated data on formaldehyde emission is shown in Table 3. In TR, the mean level of formaldehyde was 0.06 ppm (standard error 0.02) whereas the mean formaldehyde level in the SR Room was much lower which was 0.02 ppm.

b) Carbon dioxide

A descriptive analysis of the recorded carbon dioxide levels in both locations shows a large difference in the mean CO2 levels in TR and SR. It can be observed that the mean for carbon dioxide levels in the two rooms was 1707.83 ppm (S.E. 338.59). Meanwhile, the mean for carbon dioxide levels in the SR was 931.56 ppm (S.E. 119.82). The CO2 level in TR was higher than those recorded in the seminar room. However, the tolerable limit for CO2 was 1000 ppm (ICOP, 2010). Temperature, ventilation system, and the number of occupants in the specified room affected the level of CO2 in an indoor environment. As the temperature range in both locations was comparatively similar, one possible factor that might have contributed to the

higher CO2 levels in TR was the number of students occupying the teaching facilities.

c) Carbon monoxide

Carbon monoxide readings for both rooms were at 0 ppm throughout the sampling period. This is well below the acceptable limit of 10 ppm for the carbon monoxide levels in indoor air as specified by DOSH Malaysia (ICOP, 2010).

Indoor air quality (IAQ) level is one of the indicators used to determine the air quality and prevalence of SBS symptoms in old or new buildings (Nur Fadilah & Juliana, 2012). In brief, to ensure that the air pollutants are acceptable, the ASHRAE Standard 62 for Natural and Mechanical Ventilation stated that the minimum allowable rate recommended for office was 20 cfm/person. The prevalence of SBS in an old building tends to be higher than in a new building. Levels of indoor carbon dioxide, carbon monoxide, and TVOC were higher in the old building compared to the new building, and these parameters were significantly associated with the prevalence of SBS and indoor air pollutants in the old building. Meanwhile, ultrafine particles (UFP) were associated with the prevalence of SBS in a new building.

In this preliminary research, the IAQ of the two rooms was partially assessed based on one physical parameter, the temperature, and three chemical pollutants parameters, carbon dioxide level, carbon monoxide level, and formaldehyde emission level. According to the Industry Code of Practice on Indoor Air Quality 2010 (ICOP 2010) and Hamdan (2016), the acceptable limit for carbon monoxide is 10 parts per millions (ppm), and for formaldehyde, it is 0.1 ppm. The limits are eight-hour time-weighted average airborne concentrations. In the new buildings, the level of formaldehyde was higher than in old buildings as the concentration of formaldehyde decreases with age (Hamdan, 2016). The formaldehyde emission recorded in TR is comparatively higher (0.06 ppm) than those sampled at the SR (0.02 ppm). This could be due to the higher furniture and interior fittings in the TR compared to those in the SR. Nevertheless, both locations showed the level of formaldehyde below the acceptable level.

The acceptable limit for carbon dioxide level is 1000 ppm. Readings above 1000 ppm indicate inadequate ventilation (Hamdan, 2016). In this study, the carbon dioxide levels measured in TR were higher than in SR. The mean for carbon dioxide levels in TR was above acceptable, displaying the possible inefficient ventilation system. The mean carbon dioxide level in the SR was approximately 932 ppm and within the acceptable level specified by DOSH Malaysia.

Carbon monoxide is a colorless, odorless, tasteless gas produced by burning gasoline, wood, propane, charcoal, or other fuel. Improperly ventilated appliances and engines, particularly in a tightly sealed or enclosed space, may allow carbon monoxide to accumulate to dangerous levels which will cause poisoning in the blood. In this study, the carbon monoxide levels were consistently recorded at 0 ppm in both locations, indicating a healthy level and did not pose any health hazard to the occupants in these teaching not significant as all the readings were 0 ppm.

In this study, the three parameters measured were formaldehyde, carbon monoxide, and carbon dioxide levels in indoor areas. The SI unit used to measure the three parameters was parts per million (ppm). The same SI unit was also used in the study by Jafari et al. (2015) to study the concentration of carbon dioxide in a room. Three instruments used to measure Indoor Air Quality were the CO240 Extech Handheld Air Quality CO2 Meter, VFM200 Extech VOC/Formaldehyde Meter, and CO10 Extech Carbon Monoxide Meter.

Perceiving indoor temperature as cold (42.0%) was a common complaint in both locations. The temperature was perceived as cold even during the hot season. Indoor temperature is correlated with the temperature outside the building and the materials used to build the walls and insulation. In this study, cold temperature correlated with the performance of the ventilation systems. This condition is similar to a previous study by Hellgren et al. (2011), where the room temperature was too low, resulting in poor ventilation. Good ventilation is needed to establish better health for the building occupants. Failure to correct the ventilation will eventually contribute to Sick Building Syndrome (SBS). On top of that, thermal conditions and ventilation have a big role in controlling the effectiveness of learning sessions.

Regarding the reported symptoms by respondents, fatigue (34.0%), difficulties in concentrating (29.0%), and suffering from stress (27.5%) were the most common symptoms experienced by the respondents. The other less significant symptoms were eye irritation sensation, heavy-headed feeling, headache, nausea, nose bleeding, hoarse and dry throat, cough, flushed facial skin, itching of the scalp and skin, and suffering from stress. These results were a bit different from a previous study, where the researchers found out that the commonest symptoms reported by the workers at their target location were irritated, stuffy, or runny nose (Reijula & Sundman-Digert, 2004). This study was supported by Nur Fadilah and Juliana (2012) where a stuffy nose was one of the significant symptoms associated with SBS that was perceived by staff due to poor IAQ. The main reason for the rise of the IAQ problem was related to the ventilation system used (Nur Hanisah et al., 2016). On the other hand, the ventilation system needs to meet the recommended requirements, to prevent health problems including respiratory and other SBS symptoms from being experienced by the building occupants.

CONCLUSION

This research was done to study the presence of SBS symptoms among the Phase One medical students in the University using a self-administered questionnaire, adapted and slightly modified from an established instrument, based on their common teaching facilities, which were the Tutorial Room (TR) and Seminar Room (SR). Therefore, the findings in the research are limited to the two locations sampled and do not apply to all buildings in the University.

Four IAQ parameters: temperature, CO level, formaldehyde level, and CO2 level were used to partially assess the facilities' air quality. Respondents' perceptions of the teaching facilities' conditions were obtained through questionnaire distribution. The findings showed that although the respondents' perception of the two rooms' indoor environment was mostly acceptable and poor, the Sick Building Syndrome-related symptoms were relatively insignificant throughout this research study. Many of the SBS-related symptoms that were registered to be present were reported as only 'rarely happen'. As for the IAQ, the levels of CO and CH2O were also considerably low. Hence, the parameters showed that both

teaching facilities were not considered as the cause of the SBS symptoms faced by the respondents. Nevertheless, the relationship between the symptom presence related to SBS and IAQ parameters could not be shown statistically due to the small number of data acquired.

Based on the findings of the carbon dioxide levels and temperature range in both facilities, it could be deduced that the air conditioning and ventilation systems should be improved and upgraded for a better learning experience for the students. Further work can be done using this preliminary data as the baseline and full IAQ should be performed in all the campus buildings which will yield a more accurate result on the indoor air quality of buildings in the University.

CONTRIBUTION OF AUTHORS

The paper is written by one author.

FUNDING

This work received no specific grant from any funding agency.

CONFLICT OF INTEREST

The author declares that there are no conflicts of interest with any party.

ACKNOWLEDGEMENT

The author would like to thank Muhammad Syafiq Hakim, Wan Ainin Sofia Binti Wan Ahmad, Nurul Amira Binti Mohd Yusof, and Muna Binti Sabri for helping with the research data collection.

REFERENCES

Anderson K. (1998). Epidemiological Approach to Indoor Air Problems. *Indoor Air 1998, Suppl. 4,* 32-39. https://doi:10.1111/j.1600-0668.1998.tb00005

DOSH. (2016). Industry Code of Practice on Indoor Air Quality. *Ministry of Human Resources Department of Occupational Safety and Health.* https://www.dosh.gov.my/index.php/chemical-management-v/indoor-air-quality

EPA. (2018). *Fundamental of indoor air quality in buildings*. https://www.epa.gov/indoor-air-quality-iaq/fundamentals-indoor-air-quality-buildings

Fard, R., Hosseini, M., Faraji, M., & Oskouei, A. (2018). Building characteristics and sick building syndrome among primary school students. *Sri Lanka Journal of Child Health*, *47*(4), 332. https://doi.org/10.4038/sljch.v47i4.8595

Gomzi, M., & Bobic, J. (2009). Sick building syndrome: Do we live and work in an unhealthy environment? *Pericodicum Biologorum*, *111*(1), 79-84. https://core.ac.uk/download/pdf/14408412.pdf

Hamdan, H. (2016). *Indoor air quality inspection report Universiti Malaysia Sarawak.*

Hellgren, U., Hyvärinen, M., Holopainen, R., & Reijula, K. (2011). Perceived indoor air quality, air-related symptoms and ventilation in Finnish hospitals. *International Journal of Occupational Medicine and Environmental Health, 24*(1). https://doi:10.2478/s13382-011-0011-5

Jafari, M.J., Khajevandi, A.A., Mousavi Najarkola, S.A., Yekaninejad, M.S., Pourhoseingholi, M.A., Omidi, L., & Kalantary, S. (2015). Association of sick building syndrome with indoor air parameters. Tanoffos, 14(1), 55-62. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4515331/

Kumar, P., Singh, A. B., & Singh, R. (2022). Comprehensive health risk assessment of microbial indoor air quality in microenvironments. *PLoS ONE, 17*(2): e0264226. https://doi.org/10.1371/journal.pone.0264226

Norhidayah, A., Chia-Kuang, L., Azhar, M., & Nurulwahida, S. (2013). Indoor Air Quality and Sick Building Syndrome in Three Selected Buildings. *Procedia Engineering, 53*, 93-98. https://doi:10.1016/j.proeng.2013.02.014

Nur Fadilah, R., & Juliana, J. (2012). Indoor Air Quality (IAQ) and Sick Buildings Syndrome (SBS) among Office Workers in New and Old Buildings in Universiti Putra Malaysia, Serdang. *Health and the Environment Journal, 3*(2), 98-109. https://www.researchgate.net/publication/231538119_Indoor_Air_Quality_IAQ_and_Sick_Buildings_Syndrome_SBS_among_Office_Workers_in_New_and_Old_Building_in_Universiti_Putra_Malaysia_Serdang

Reijula, K., & Sundman-Digert, C. (2004). Assessment of indoor air problems at work with a questionnaire. *Occupational and Environmental Medicine, 61*(1), 33-38. https://pubmed.ncbi.nlm.nih.gov/14691270/

Nur Hanisah, F., Juliana, J., & Chua, P. (2016). Indoor Air Quality and Sick Building Syndrome (SBS) among Staff in Two Different Private Higher Learning Institution Settings in Kuala Lumpur and Selangor. *International Journal Of Applied Chemistry, 12*(1), 57-61. Retrieved from https://pdfs.semanticscholar.org/0e0e/1ea09936cc896f30eede300f3e1e98b1cfd5.pdf

Rostron, J. (2008). Sick building syndrome: A review of causes, consequences, and remedies. *Journal Of Retail & Leisure Property, 7*(4), 291-303. doi: 10.1057/rlp.2008.20

Takaoka, M., Suzuki, K., & Norback, D. (2015). Sick building syndrome among junior high schools in Japan in relation to the home and school environment. *Global Journal of Health Science, 8*(2), 165-177. https://doi:10.5539/gjhs.v8n2p165

Vafaeenasab, M.R., Morowatisharifabad M.A., Ghaneian M.T., Hajhosseini M., & Ehrampoush M.H. (2016). Assessment of sick building syndrome and its associating factors among nurses in the educational hospitals of Shahid Sadoughi University of Medical Sciences, Yazd, Iran. *Global Journal of Health Science*, *7*(2), 247–253. https://doi:10.5539/gjhs.v7n2p247