Research Journal of Recent Sciences ISSN 2277-2502
Vol. **12(2),** 33-39, July **(2023)** *Res. J. Recent Sci.*

Review Paper

Threats of poor indoor air quality and sick building syndrome in academic institutions: A systematic review

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Available online at: www.isca.in, www.isca.me
Received 16th December 2021, revised 14th December 2022, accepted 6th May 2023

Abstract

Students spend an average of more than five hours a day in school, so it is critical that they have access to healthy and productive indoor environments. This paper, therefore, focuses on the importance of IAQ studies in ensuring the health of educational institutions. Particulate matter, carbon dioxide, and other hazardous elements in the air were evaluated for their impact on the health and well-being of students. Sick building syndrome (SBS) is also examined in this paper, as is poor indoor air quality (IAQ). Techniques and strategies for assessing indoor air quality (IAQ) vary widely in their importance and frequency of use, according to various studies. SBS symptoms have been linked to poor indoor air quality (IAQ) in classrooms due to high levels of carbon dioxide, furnishings, and occupants, according to numerous studies. To gain a better understanding of how indoor air quality affects everything from student health and performance to productivity and cognitive function, more research and studies are needed. These studies and research will lead to better IAQ measurements and assessment and sampling techniques.

Keywords: Indoor air quality, sick building syndrome.

Introduction

The quality of the air in a room or structure is referred to as indoor air quality (IAQ). There appears to be a problem with the health effects of indoor air pollution, as well as the comfort and well-being of the people who live or work in the building or indoor space[1]. There are numerous reasons for poor indoor air quality, which is caused by the infiltration of outdoor and indoor pollutants such as dirt, soil, smoking, and a few other pollutants. As stated in the paper, studies have shown that indoor air quality (IAQ) contributes to human health because most people spend 80 to 90 percent of their time indoors rather than outdoors, whether at home, at work, or elsewhere[2]. Following that, the weather condition in certain countries, such as those with a desert climate, can have an impact on the quality of indoor air. In these countries, people who enter the indoor space through the doors must contend with dust particles that enter the space as they walk through the doors. Another consideration is the fact that educational facilities have a higher occupancy density than other indoor spaces, making them one of the most polluted. Performance of students and educators can also be affected by indoor air quality (IAQ). SBS is a term used to describe situations in which building occupants suffer from acute health and comfort problems. Dry eyes, eye pressure, watering eyes, blocked or stuffy nose, runny nose, dry or sore throat, flu-like symptoms, difficulty breathing, exhaustion, and dry skin were among the symptoms investigated[3,4].

Methodology

This systematic review made use of two major databases, namely Research Gate and Science Direct, to conduct its research. In addition to providing access to over 30,000 journals, Science Direct is a global website that covers more than 250 fields of study. Social science, environmental science, agricultural science, and biological science are just a few of the research topics being investigated. PubMed, on the other hand, provides access to more than 20,000 studies covering a wide range of subject areas such as economics, biology, and educational research. The keywords that were used in the search process, as shown in Table-1, were discovered during the first stage. With the help of prior research and a thesaurus, keywords for academic institutions that were related to indoor air quality and sick building syndrome were identified.

As shown in Table-2, a few inclusion and exclusion criteria have been established. First and foremost, in terms of timeframe, a period of seven years (between 2013 and 2020) is considered sufficient for analysing trends in science and related publications. The only article journals that publish analytical evidence are selected in relation to the literature form, which means that review papers and book collections as well as book and conference proceedings are all excluded from consideration. Only papers written in English are considered for analysis, to avoid any misunderstandings or difficulties in translation during

the process. It conducted a thorough review and analysis of the remaining papers. The study was primarily concerned with research. To categories the relevant themes and sub-themes, the information was first extracted from the abstracts and then from the full-length articles (in-depth).

Table-1: Keyword.

Repository	Search word used
PubMed, Science Direct	Indoor Air Quality in Academic Building OR Sick Building Syndrome in University" OR Indoor Air Quality and Sick Building Syndrome in Academic Institutions

Table-2: Criteria for Inclusion and Exclusion.

Criterion	Eligibility	Exclusion
Literature type	Journal (research articles)	Journals (systematic review, review, meta-analysis, meta synthesis), series of books, books, book chapters, proceedings of conferences.
Language	English	Non-English
Timeline	Between 2013-2020	< 2013
Subject area	Social Science, Environmental Science, Occupational Safety and Health, and Biological Science	Other than Social Science, Environmental Science, Occupational Safety and Health, and Biological Science

Figure-1 presents the flow of data through the various stages of a systematic review. There is a list of the records that were mentioned, included, and excluded, as well as the reasons for exclusions.

Results and discussion

The study identified two major themes and eleven sub-themes related to indoor air quality and sick building syndrome. The two major themes are indoor air quality assessments (4 sub-themes) and sampling techniques (7 sub-themes). The findings provided an in-depth examination of the effects of IAQ and SBS symptoms. The academic building's indoor air quality measurements are detailed in Table-3. Numerous types of research are based on measuring or administering a questionnaire regarding air temperature and relative humidity, as they are significant contributors to indoor air quality (IAQ), which has an effect on the student's happiness, performance, and attention span. According to these papers, a total of seven studies focused on adapting questionnaires to building occupants' perceived indoor air quality and SBS symptoms [1,2,4-8]. Additionally, two studies examined SBS symptoms in occupants primarily through questionnaires[3,9]. Finally, four studies[10-13] obtained results for only indoor air quality measurements. Four studies were adapted from various sources and used as the study's questionnaire. To begin, the questionnaires distributed to occupants by Zainal et al.[8] and Nor Faeiza et al.[6] were adapted from the National Institute of Occupational Safety and Health's Indoor Air Quality and Work Symptoms Survey (NIOSH). Whereas the questionnaire used in the study by Kamaruddin et al.[5] was adapted from the American Thoracic Society's "ATS-DLD-C WHO" questionnaire. Thirdly, the questionnaire was adapted from a Swedish study on health-related exposure and modified to reflect the current situation in China[7]. Finally, a study was conducted in a university setting in Greece to assess the occupants using a structured questionnaire called MM 040 NA for workplaces[3]. Table-4 compares the measured and reported symptoms of SBS indoor air parameters in various studies. In school settings, air quality sampling is used to determine the concentration of numerous indoor air contaminants, such as temperature, relative humidity, CO_2, CO, particulate matter (PM10), and air velocity.

Sampling strategy: Table-4 shows a comparison of the assessed and reported symptoms of SBS indoor air parameters in various studies. A sampling of air quality in a school setting concerns the concentration of many assessed indoor air contaminants, such as temperature, relative humidity, CO_2, CO, particulate matter (PM10), and air velocity. Several studies have primarily focused on indoor quality parameter[2,5,10,11]. As a result, these key elements of the IAQ evaluation are used in academic institutions. Furthermore, researchers conducted an accurate inspection to track and analyse the mechanical ventilation system attached to the facilities to assess fungal or bacterial growth in the buildings[2,6,12]. Thermal comfort and lighting were investigated because they contribute to air pollution and SBS symptoms[9]. Occupants such as students, educators, and office workers were given a questionnaire or survey form, which allowed the researchers to gain a better understanding of how relaxed, happy, and safe the occupants are, as well as how they communicate with the atmosphere and the indoor environment around them[1,2,4-9]. As a result, it indicates whether the IAQ is adequate or if there is a problem. The researchers were also able to recognise the symptoms of Sick Building Syndrome.

Data analysis at various institutional buildings: Data analysis was approached differently in each of the research cases. CO_2, temperature, and relative humidity are some important parameters that have been calculated in most study cases. Furthermore, specific studies measured for any microbial growth in the studied locations. Table-3 revealed two studies on the evaluation of IAQ in offices that sampled office staff[2,8]. First, two papers[5,11] focused on sites with younger occupants (i.e., nurseries and day care centres). Dias Pereira, Raimondo, Corgnati, and Gameiro da Silva[1] conducted their research in high school classrooms, whereas Argunhan and Avci[10]

conducted their research in university classrooms. Finally, in the university library, a study was conducted on people who spent more than 30 minutes in the library[7]. Finally, a study based solely on the sick building syndrome[3,9] was conducted.

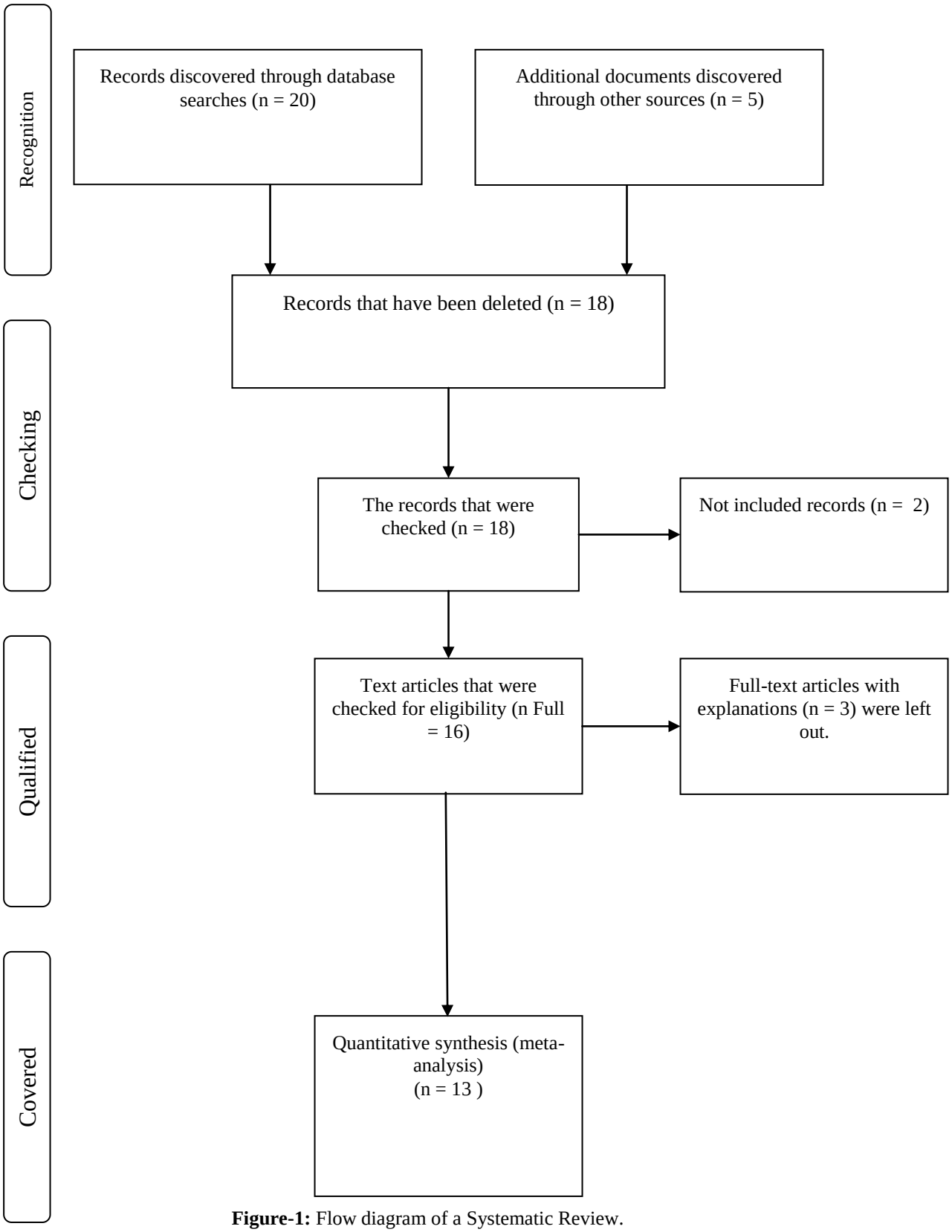

Figure-1: Flow diagram of a Systematic Review.

Table- 3: IAQ Measurement.

Ref.	Study Locations	Parameters Measured	Type of Participants
1	Secondary classrooms	Temperature, RH, CO_2	Secondary students
2	University Offices	Temperature, RH, CO_2, Particulate matters (2.5,10)	101 University office workers
3	University main administration building	-	613 University employees
4	Engineering Laboratories	Temperature, RH, Air Velocity	71 Undergraduate and postgraduate students
5	Preschool	Temperature, RH, CO_2, CO, Particulate Matters (2.5,10), Air Velocity.	111 Malay children who attended preschool
6	Two buildings of a private higher learning institution	Temperature, RH, CO_2, CO	130 students
7	University Library	Temperature, RH, CO_2	270 Occupants >30 mins in the library
8	Office environment at an academic institution	Temperature, RH, CO, CO_2, PM10.	Office workers
9	University	-	40 out of 372 valid returned questionnaires
10	University Classrooms	Temperature, RH, CO_2, Particulate Matters (0.5,1,2.5,5,10)	-
11	Daycare centre	Temperature, RH, CO_2, PM10, CO,	-
12	Prayer room, lecturer room's lobby, Chemical engineering laboratory	Temperature, RH, Air velocity	-
13	Lecture Room	Temperature, RH, CO_2	-

RH: relative humidity, CO: carbon monoxide, CO_2: carbon dioxide, PM10: particulate matter 10.

Table-4: Indoor Air Parameters Measured and Identified SBS

Ref.	Temp. (°C)	RH (%)	CO_2 (ppm)	PM 10 (ppm)	CO (ppm)	Air velocity (ms-1)	Identified SBS
1	✓	✓	✓	-	-	-	-
2	✓	✓	✓	✓	-	-	Findings showed that runny nose (14 %), red eyes (19 %), eye pain (21 %), fatigue (36%), headache (41 %) and itchy skin (15 %) were the most common SBS symptoms.
3	-	-	-	-	-	-	Fatigue was the most frequently reported SBS symptom (34.1 %). The prevalence of General, Mucosal and Dermal symptoms was 40.8 %, 19.8 % and 8.1 % respectively. Several contributing risk factors, such as the IAQ Discomfort Scale, atopy, sleep issues, female, biological and chemical agents, PC-use, psychosocial work scale, and job satisfaction, have been established.
4	✓	✓	-	-	-	✓	Dry skin (40.85 %), accompanied by runny nose (31 %), dry eyes (29.5 %), blocked/stuffy nose (28.17 %), nausea (26.76 %) and flu-like symptoms were the highest proportion of symptoms among laboratory respondents (21.13 %).
5	✓	✓	✓	✓	-	✓	Cough (34.4 %), mucus (4.9 %), wheezing (32.8 %), tightness of the chest (1.6 %)
6	✓	✓	✓	✓	✓		Significantly correlated with the level of indoor air quality was the significant difference between the number of respondents with SBS symptoms and the questionnaires and the chemical test.

7	✓	✓	✓	-	-	-	The highest proportion of symptoms is breathing problems (78 %), accompanied by dizziness (55 %), reduced productivity (11 %), exhaustion (4%) and irritable feelings (3 %)
8	✓	✓	✓	-	✓	-	Mucosal (19.6%) and general (18.7%) symptoms were identified more frequently than skin symptoms (10.2%)
9	-	-	-	-	-	-	Regular feelings of cold, headache and dizziness, confusion, eye, mouth, nose and/or skin pain, nausea, tiredness, and trouble breathing.
10	✓	✓	✓	✓	-	-	-
11	✓	✓	✓	✓	✓	✓	-
12	✓	✓	-	-	-	-	-
13	✓	✓	✓	-	-	-	-

Working or studying in a comfortable environment increases not only well-being, but also happiness, and thus productivity and learning. IAQ are determined physically by relative humidity, carbon dioxide and temperature. It is well established that temperature is proportional to relative humidity. The development of metabolic heat, ambient heat transfer, physiological changes, and body temperatures have all been linked to the sensation of comfort. This is demonstrated in a case study conducted in Portuguese secondary classrooms. The emphasis was on the CO_2 concentration, relative humidity and temperature, as well as the temperature and humidity associated with it. The results were 780 parts per million, 20.7 degrees Celsius, and 49.9 percent, respectively[1]. Throughout each class, doors and windows were locked, resulting in reduced air circulation. Temperature and humidity increases are frequently observed in non-industrial indoor environments in tropical or subtropical climates, particularly during the hot season and during severe heat events. In developing countries such as Malaysia, where air conditioning is not widely available, high temperatures and relative humidity are common[4-6,8]. As a result, symptoms are frequently encountered when temperature and relative humidity levels fluctuate. Mucosal symptoms such as runny nose, stuffy nose, and mucus, for example, have been found to be significantly related to temperature and relative humidity[4,5,8]. According to the literature, increased air temperatures have a detrimental effect on work performance[7]. Additionally, this study demonstrates how temperature affects dust accumulation, which causes occupants to have trouble breathing, stuffy or pungent odours, and dizziness.

Low indoor air quality (IAQ) levels in buildings have an adverse effect on the respiratory systems of people with respiratory illnesses. IAQ research and relationship to respiratory health in Malay pre-school children confirmed this statement, revealing that increased CO and PM levels were associated with wheezing. Exposure to poor IAQ can also cause high risk on participants developing lung and respiratory problems[5]. Additionally, certain months of the year in Saudi Arabia can be dusty due to sand hurricanes, particularly in buildings with no natural ventilation. As a result, inadequate ventilation, when combined with other indoor sources, can contribute to the accumulation of pollutants. Indoor CO_2 concentrations are primarily determined by the level of occupancy and the rate at which outdoor air is supplied.

Several case studies have been conducted to ascertain the concentrations of airborne microorganisms, including one conducted in higher education buildings in Johor, Malaysia to ascertain the count of fungi and bacteria on the surface of the prayer room, the lecture room's lobby, and the chemical laboratory[12]. They discovered that both the overall bacterial and fungal concentrations were significantly greater than the 500 CFU/m^3 maximum exposure limit. The paper's findings indicate that high relative humidity rates are possible because of increased microbial concentrations, emphasising the effect of indoor sources, occupant activity and maintenance, school cleaning practises, and high occupant density. Additionally, the locations have a high concentration of bacteria and fungi due to the area being open to students, lecturers, and visitors.

As a result of the absence of air movement in the areas complained about, it is recommended that microorganism from outside and stored indoors. Additionally, it can be deduced that a variety of factors, including increased occupant density, poor classroom sanitation, and insufficient external air supply, when combined with routinely substandard school building construction and maintenance, can result in a wide variety of high bacterial and fungal loads. Exposure to biological pollutants may pose health risks. Additionally, the study discovered that bacteria are significant indoor air pollutants that can contribute the prevalence of SBS[2]. Allergic reactions, which can range from rhinitis or conjunctivitis to severe asthma, should be regarded with suspicion. Pneumonitis associated with hypersensitivity and allergic reactions is another possibility[2,12].

Surveys and questionnaires are two methods for gathering data on health and domestic exposure. A survey and questionnaire case study were conducted in Kuala Lumpur's dense private higher learning institutions[6].

The surveys and questionnaires were used to ascertain the relationship between IAQ and SBS among students by calculating the temperature, relative humidity, PM10, CO2, and CO levels using the Social Science Statistical Package (SPSS). The mean rank was found to be 29.29, 28.06, 31.39, 37.9, and 37.46, respectively, and they discovered that SBS were correlated significantly with the level of IAQ between the questioners and the chemical test. Pupils frequently face increased workloads and exposure to chemical and biological pollutants on the job. Proper maintenance of the mechanical ventilation system, annual house cleaning procedures, and improved air circulation all contribute to the prevention of human health hazards in enclosed spaces[1-4].

A comprehensive standard protocol is required to enhance and mitigate the effects I indoor contaminants exposure. To maintain a high standard of indoor air quality within their homes, residents must practice good housekeeping. The most realistic method of resolving indoor air quality issues is to monitor the point source[5]. Further epidemiological research is required to ascertain the occupant's potential exposure, at which point the best strategy for minimising indoor emissions can be recommended. Dust and dirt management and cleaning are also critical for maintaining public safety and limiting bacteria and fungi growth[2,6,12].

Commonly reported illnesses and disorders include the following: The conditions of the indoor environment influence human health, efficiency, and comfort. While IAQ measurements in classrooms have been extensively documented, only a few have been linked to student success and well-being. Six variables of indoor environment quality (IEQ) have been identified for beneficial learning, including furniture, sunlight, adaptive capabilities, thermal comfort, and IAQ. Since poor IAQ is frequently associated with Sick Building Syndrome (SBS), indoor contaminants typically have a negative impact on students' performance and productivity. Temperature, humidity, and air quality all contribute to SBS symptoms. Poor indoor air quality (IAQ) in a building increases the risk of Sick Building Syndrome (SBS), which refers to imprecise conditions as well as general symptoms. SBS symptoms and signs include sensory organ aggravation (eyes, nose, mouth, ears, and skin), fatigue, migraine, and respiratory and nausea disorders[2,3,7,9].

To begin, research indicates that high temperatures can contribute to student fatigue in engineering laboratories[4]. Additionally, university employees in Greece have reported experiencing exhaustion as the most common SBS symptom[3]. Two studies confirm this, demonstrating that occupants experience decreased productivity and exhaustion[2,7]. At a university in Saudi Arabia, it was discovered that increased humidity promotes the growth of moulds and mildews in the office setting[2]. Air pollution around schools also influences students' health, increasing their risk of respiratory, neurological, and even cancer problems. The respiratory condition is also exacerbated at school because of air pollution. According to a study on IAQ and its relationship to respiratory health in pre-school, air quality factors such as carbon dioxide (CO_2) can help reduce productivity, lethargy, and respiratory diseases associated with wheezing[5]. Additionally, high CO_2 concentrations have been linked to decreased concentrations and fatigue[2,7,9]. As students are expected to miss school due to respiratory-related health issues, illnesses caused by poor IAQ are constantly investigated and confirmed by evidence. SBS has been identified among students in schools with poor indoor air quality[2,4,7,8]. Poor IAQ is frequently accompanied by a deficient IEQ, which, as demonstrated by a survey conducted at Taylor's University in Malaysia, contributes to SBS among students[9]. The relationship was reinforced in a study conducted among students from Kuala Lumpur and Selangor educational institutions[6].

SBS can significantly impair occupants' psychosocial well-being by causing anxiety, depression, environmental discomfort, and work pressure, as well as impairing occupants' performance[3,9]. A monotonous work environment has been identified as a psychosocial variable associated with the development of SBS[2,3,8]. A tedious job is one in which employees are required to repeatedly perform operations or tasks. Workers such as students, educators, and clerical staff may struggle with work pressures, anxiety, or depression in their current environment. These symptoms are more prevalent in women than men, possibly because more women work in secretarial jobs, are more health conscious, or require a lower dose of contaminants to manifest the effects[3]. SBS symptoms are more prevalent in air-conditioned buildings than in naturally ventilated buildings[8]. Employees' productivity may suffer because of their mental disengagement from their tasks. Additionally[9] substantiates this assertion. They emphasised that the occupational stressor's position is strongly associated with the occurrence of SBS symptoms. Nonetheless, given the significant influence of psychosocial contributors, it should be argued that the amount of current research devoted to analysing its effects is relatively small.

At last, a study was conducted on SBS among office workers at an academic institution in relation to the work environment and indoor air pollutants[8]. Centrally controlled air conditioning systems, prolonged use of photocopiers, printers, or fax machines, and the introduction of a new carpet in the office environment were all identified as significant risk factors for SBS in the following study. They discovered a link between skin symptoms and the use of photocopiers, printers, or fax machines. Indoor contaminants such as ozone, particulate matter, and volatile organic compounds may be generated by office appliances, such as those released during copying and printing processes. Thus, IAQ management in educational buildings should recognise natural ventilation as a supplement to mechanical ventilation as a means of increasing sustainability, while focusing on adequate control of indoor air CO_2 concentrations to reduce the risk of airborne infections.

In general, various studies found that poor indoor air quality and a high prevalence of SBS symptoms such as fatigue and dizziness were significant issues for academic building occupants. The associated SBS symptom factors had a varying effect on SBS symptoms (psychosocial work factors, personal, types of work, and occupational risk factors, and perceived IAQ complaints).

Conclusion

Concern for the protection and health of students in educational facilities has become critical, as noted in the papers reviewed, as they are more susceptible to contaminants than adults. Capacity and human components had a significant impact on the indoor climate. Due to the variety of times and places in which students spend their time in schools or institutions, they are susceptible to exposure to a variety of pollutants. The IAQ of an educational institution influences student wellbeing, performance, productivity, and cognitive processes. Certain variables, such as aspects of furniture, sunlight, and thermal and indoor air quality, have been shown to increase student satisfaction with the institution and attention span. Although poor IAQ can result in elevated CO_2 levels and a decrease in student performance due to respiratory problems, particles in the air caused by current contaminants can be inhaled by pupils. According to reports and studies published in peer-reviewed articles, IAQ is tracked and assessed in educational facilities to determine their criteria and identified health issues. As a result, several recommendations are made to create a healthier and safer environment for student activities. Additional research and analysis are required to further our knowledge and understanding of IAQ, IAQ estimation, and the development of evaluation and sampling techniques. Sufficient analysis of the effects of IAQ on children's and students' academic success, well-being growth, and cognitive processes.

References

1. Dias Pereira, L., Raimondo, D., Corgnati, S. P., & Gameiro da Silva, M. (2014). Assessment of indoor air quality and thermal comfort in Portuguese secondary classrooms: Methodology and results. *Building and Environment*, *81*, 69–80. https://doi.org/10.1016/j.buildenv.2014.06.008

2. Khalafalla, M. M., Banjar, F. M., Elamin, F. O., Babalghith, A. O., Omar, A., Bahathiq, A. A. A. M., ... & Badran, R. A. (2018). Indoor Air Quality and Prevalence of Sick Building Syndrome Among Office Workers in Umm Al-Qura University in Kingdom of Saudi Arabia. *Australian Journal of Basic and Applied Sciences*, 12(12), 26-31.

3. Tsantaki, E., Smyrnakis, E., Constantinidis, T. C., & Benos, A. (2022). Indoor air quality and sick building syndrome in a university setting: A case study in Greece. *International journal of environmental health research*, 32(3), 595-615.

4. Amin, N. D. M., Akasah, Z. A. & Razzaly, W. (2015). Architectural Evaluation of Thermal Comfort: Sick Building Syndrome Symptoms in Engineering Education Laboratories. *Procedia - Social and Behavioral Sciences*, 204, 19–28. https://doi.org/10.1016/j.sbspro.2015.08.105

5. Kamaruddin, A. S., Jalaludin, J., & Choo, C. P. (2015). Indoor air quality and its association with respiratory health among malay preschool children in Shah Alam and Hulu Langat, Selangor. *Advances in Environmental Biology*, 9(9), 17–26.

6. Nor Faeiza, M., Juliana, J., & Chua, P. H. (2016). Retrofitting and Purposed-built Buildings: Indoor air quality and Sick Building Syndrome among private higher learning institution students in Kuala Lumpur and Selangor. *Malaysian Journal of Public Health Medicine*, 16(January), 106–112.

7. Wu, Y., Lu, Y., & Chou, D. C. (2018). Indoor air quality investigation of a university library based on field measurement and questionnaire survey. *International Journal of Low-Carbon Technologies*, 13(2), 148–160.

8. Zainal, Z. A., Hashim, Z., Jalaludin, J., Lee, L. F., & Hashim, J. H. (2019). Sick Building Syndrome among Office Workers in relation to Office Environment and Indoor Air Pollutant at an Academic Institution, Malaysia. *Malaysian Journal of Medicine and Health Sciences*, 15(3), 126–134.

9. Yee, T. C. (2014). Indoor Environmental Quality (IEQ): A Case Study in Taylor's Universiti, Malaysia. *International Journal of Engineering and Applied Sciences*, 5(07), 1–11.

10. Argunhan, Z. & Avci, A. S. (2018). Statistical Evaluation of Indoor Air Quality Parameters in Classrooms of a University. *Advances in Meteorology*, 1–10.

11. Cionita, T., Adam, N. M., Jalaludin, J., Mansor, M., & Siregar, J. P. (2014). Measurement of indoor air quality parameters in daycare centres in Kuala Lumpur Malaysia. *Applied Mechanics and Materials*, 564(June), 245–249. https://doi.org/10.4028/www.scientific.net/AMM.564.245

12. Er, C. M., Sunar, N. M., Leman, A. M., Othman, N., Emparan, Q., Parjo, U. K., … Ideris, N. A. (2015). The Evaluation of Indoor Microbial Air Quality in Two New Commissioning Higher Educational Buildings in Johor, Malaysia. *Applied Mechanics and Materials*, 773–774, 1068–1072.

13. Sulaiman, S. A., Isa, N., Raskan, N. I., & Harun, N. F. C. (2013). Study of indoor air quality in academic buildings of a university. *Applied Mechanics and Materials*, 315, 389–393.