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Several Factors Responsible For Sick Building Syndrome in Urban Settings: Literature Review

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ABSTRACT
Introduction: Urban dwellers are more susceptible to the adverse effects of air pollution and climate change. Sick building syndrome (SBS) relates to health issues experienced by workers as a result of indoor activities, air pollution, and climate change. The incidence of SBS is strongly correlated with environmental factors both within and outside the workplace.
Objective: To identify current factors associated with the incidence of sick building syndrome in urban areas
Method: Review of the literature compiled in both English and Indonesian from the databases of PubMed, Scopus, and Google Scholar. The literature, which is available in full text publications, was collected during the period of the last five years, from 2019 to 2024.
Results: Temperature, relative humidity, microbes, air pollution, psychological factors, light, and ventilation in a room or workplace were some of the variables that affect the incidence of sick building syndrome in urban settings.
Conclusion: SBS was related to a number of factors, including temperature, relative humidity, ventilation, lighting, pathogens, and psychosocial factors. These elements may have an individual or combined effect on worker productivity and the development of SBS.

Keywords: Environmental Health; Urban; Air pollution; Sick Building Syndrome

INTRODUCTION

Climate change and air pollution are serious problems in environmental health. Residents in urban areas are vulnerable to the effects of climate change and air pollution. In addition, rapid economic development and urbanization are increasing the health burden in cities (1). The quality of the environment in a building or room is very important for health, because the majority of people in urban areas spend 80-90% of their time indoors (2).

The health issues associated with indoor activities, air pollution, and climate change include sick building syndrome (SBS), which affects workers (3). SBS describes a variety of non-specific disease symptoms, such as irritation of the eyes, nose, and throat, mental fatigue, headaches, nausea, dizziness, and skin irritation, which are related to the frequency of working at a workplace (4).

Environmental factors in the office are closely related to SBS, such as building humidity, noise, air circulation, volatile organic compounds, airborne mold, microbial volatile organic compounds (MVOCs), psychosocial conditions, gender, genetics, allergies, and room temperature. Exposure to the external environment can also affect indoor environmental conditions (5-7).

There are numerous risk factors for occupational health and safety that affect building employees. These environmental elements have an impact on the risks that arise in indoor work situations. In addition, more people and workers are engaging in indoor activities as a result of the Covid-19 event, which has turned into a pandemic in 2019–2022. The working habits of office workers, who often keep quieter in the workplace, are impacted by these indoor activity patterns (8).

Numerous environmental factors have been shown in prior study to have an impact on the development of SBS in workers. These elements influence one another directly or indirectly and are interconnected. This study provides an overview of the most recent research on the causes of sick building syndrome in cities. Environmental, social, and biological factors are examples of these variables.

METHOD

A review of the literature was conducted in both English and Indonesian, using data from the PubMed, Scopus, and Google Scholar databases to identify the factors associated with Sick Building Syndrome in urban settings. The literature is in the form of full-text publications and spans the last five years, from 2019 to 2024. Any publications with titles indicating study in the domains of veterinary medicine, nursing, midwifery, or pharmacy were excluded from consideration for the selecting research manuscripts. When compiling this literature review, these manuscripts won't be chosen. Research publications with details on biological, psychological, and environmental aspects of SBS met the inclusion requirements.

RESULTS

Ten articles were found to be related to the assignment of writing after an analysis of several articles extracted from multiple databases using preset keywords and criteria. These articles demonstrate how several factors affect the prevalence of sick building syndrome in urban areas:

Table 1. Results of Literature Review articles

No.	Authors (year)	Title	Objective	Variable	Result
1	Alfadhylla Rosalina Wibisono, Nurjazuli, Tri Joko, Suhartono (2022) (12)	Faktor Risiko Kejadian *Sick Building Syndrome* Pada Pegawai Dinas Lingkungan Hidup Dan Kehutanan Provinsi Jawa Tengah	Untuk mengetahui apakah ada hubungan antara kualitas lingkungan fisik udara dan karakteristik individu dengan kejadian SBS di Dinas Lingkungan Hidup dan Kehutanan Provinsi Jawa Tengah	Suhu, Kelembaban, Intensitas Cahaya, Air change per hour, umur, jenis kelamin, masa kerja, kebiasaan merokok	Prevalensi kejadian SBS adalah 60,7%. Keluhan SBS yang paling banyak dirasakan pegawai adalah kulit kering, hidung berair, bersin, dan gatal, serta mata gatal. Berdasarkan hasil uji statistik, terdapat hubungan antara jenis kelamin dan kebiasaan merokok dengan kejadian SBS

2	M. Anas Nasrulloh, Abdul Hakim Zakkiy Fasya (2023) (13)	Gambaran Kejadian Sick Building Syndrome (SBS) pada Pegawai Kantor PT. PLN (Persero) UP3 Surabaya Selatan Kota Surabaya	Untuk memberikan gambaran dampak dari kejadian *Sick Building Syndrome* di PLN	Umur, jenis kelamin, kondisi psikososial, kebiasaan merokok, dan faktor ruang kerja yaitu perawatan ac, dan luas ventilasi.	Responden usia tua, laki-laki, merokok, bekerja di suhu >26 C mengalami SBS
3	Ridhayani Adiningsih, Miftah Chairani Hairuddin (2021) (14)	The Incidence of Sick Building Syndrome and Its Causes on Employees at the Governor's Office of West Sulawesi Province	To determine the relationship of air quality in space to the incidence of Sick Building Syndrome	Air temperature, humidity, light intensity, levels of CO and CO2, levels of dust, and the number of germs in the air.	The dust level in the room and the temperature of the outside environment both affect the risk of SBS. The incidence of Sick Building Syndrome (SBS) was significantly correlated with both air temperature and dust levels.
4	Parbati Dhungana, Manisha Chalise (2020) (15)	Prevalence of sick building syndrome symptoms and its associated factors among bank employees in Pokhara Metropolitan, Nepal	to assess the prevalence of sick building syndrome symptoms and its associated factors among bank employees.	age, sex, education, smoking status, job position, type of workplace, working hours, overtime work, and history of allergy,	The most common general symptom among the participants, fatigue, was reported by over half of respondents. The results of this study demonstrated the strong correlation between psychosocial factors including work pressure and support from coworkers who experience SBS symptoms and indoor environmental variables including perceived physical environment, disturbance from temperature, and noise.
5	Zukun Wang, Junjie Liu, Mingyao Yao, Mingtong He, Wenzhe Shang, Xinyue Dong (2024) (16)	Indoor air quality and sick-building syndrome at a metro station in Tianjin, China	To compare between the two seasons focused on the influence of ambient pollution on the ventilation effect related to sick building syndrome	PM2.5 and PM1 concentrations, metal compositions, Ventilation, air temperature, relative humidity, and carbon dioxide (CO2) concentration	$PM_{2.5}$ contained more metal in winter than in spring. $PM_{2.5}$ in winter contained more metal in winter than in spring. With a lower relative humidity in winter, the coefficient of friction between railway wheels and rails increased, thus increasing particle emission.
6	Xi Fu, Dan Norbäck, Qianqian Yuan, Yanling Li, Xunhua Zhu, Jamal Hisham Hashimf, Zailina Hashimg, Faridah Ali, Qiansheng Hub, Yiqun Deng, Yu Sun (2021) (17)	Association between indoor microbiome exposure and sick building syndrome (SBS) in junior high schools of Johor Bahru, Malaysia	To associate between indoor microbiome and SBS	Bacteria, fungi, dust	A greater number of possible risk bacteria and a lower concentration of potential protective bacteria were found in classrooms with higher indoor relative humidity and evident moisture or fungus. A few microbiomes linked to SBS.
7	Sedina Kalender Smajlovi´c, Andreja Kukec,	Association between Sick Building	to assess the association between SBS	Air quality (indicator: carbon dioxide (CO2) (ppm)), horizontal	Healthcare workers reported a higher prevalence of SBS

	Mateja Dovjak. (2019) (18)	Syndrome and Indoor Environmental Quality in Slovenian Hospitals: A Cross-Sectional Study	symptoms and measured environmental parameters at a Slovenian general hospital.	illumination (lx), indoor relative humidity level (%), indoor air temperature (C), and noise level (dB(A)). Indoor air temperature, the indoor relative humidity level, and the noise	symptoms; however, no significant correlation was found between the number of SBS symptoms and the measured mean values for air temperature, relative humidity, the lighting, air quality (CO2 concentration), and noise level in the hospital wards where the workers were employed.
8	JiantaoWeng, Yuhan Zhang, Zefeng Chen, Xiaoyu Ying, Wei Zhu, Yukai Sun (2022) (19)	Field Measurements and Analysis of Indoor Environment, Occupant Satisfaction, and Sick Building Syndrome in University Buildings in Hot Summer and Cold Winter Regions in China	To analyse and compare the indoor environment, occupant satisfaction, selfreported SBS, and learning efficiency of green, retrofitted, and conventional college classrooms in hot summer and cold winter regions of China	Air temperature, relative humidity, CO2 and PM2.5 concentration, desktop illuminance sound pressure level	The CB had the lowest frequency of SBS, which was subsequently followed by the GB and the RB. It was concluded that users of the building should have the autonomy to manage the temperature and windows, and that the architecture of natural ventilation should be enhanced. Temperature and CO2 concentration management should be given careful consideration in order to lessen the incidence of SBS symptoms.
9	Cuong Hoang Quoc, Giang Vu Huong, Hai Nguyen Duc (2020) (20)	Working Conditions and Sick Building Syndrome among Health Care Workers in Vietnam	To evaluate the correlation between SBS and the symptoms among HCWs	Room temperature, relative humidity, lighting, electromagnetic radiation, level of noise, air velocity, CO2	Working conditions are crucial and have an enormous effect on SBS. Hospital workers are subjected to physical stressors in their work environment, which may raise their severity and SBS score. Variations in room temperature, dust, and dirt, as well as lightning and stuffy or "bad" air, were the main causes of SBS.
10	Efthymia Tsantaki, Emmanouil Smyrnakis, Theodoros C. Constantinidis, Alexis Benos (2022) (21)	Indoor air quality and sick building syndrome in a university setting: a case study in Greece	To estimate the perceived IAQ and the prevalence of SBS symptoms in the entirety of a Mediterranean university, during a period of limited finansial support.	Dust, indoor air	The IAQ Discomfort Scale was found to be a significant predictor of all SBS symptoms by regression analysis. The multifactorial nature of SBS symptoms was highlighted by the associations found between a number of other predictors and the following symptoms: Mucosal (atopy and sleep problems), Dermal (atopy and exposure to chemical agents), Total (female

				sex, atopy, and sleep problems), General (sleep problems, exposure to biological agents, PC use-related problems, Psychosocial Work Scale, and Job satisfaction).

DISCUSSION

Sick Building Syndrome symptoms

The low air quality in the building is linked to a number of symptoms of SBS, including as dry cough, headache, eye, nose, and throat irritation, dry and itchy skin, and body weakness. Urban office workers' productivity is greatly reduced by these problems, which are often minor and can persist for up to two weeks. (9).

According to the World Health Organization (WHO), symptoms of SBS include eye irritation, headache, dry lips, dry skin, runny nose, sneezing, nausea, dizziness and drowsiness. Other symptoms include stress, chest pain, back pain, hand and arm pain, bloating, tiredness, and difficulty concentrating. Workers often report experiencing fatigue, dry skin, dry lips, headaches, and a general feeling of tiredness and lethargy (10).

Sick building syndrome complications are able to classified, although measuring SBS is impossible in many circumstances where symptoms are not clinically evident. Most people with SBS are employees who work in or on buildings on an ongoing basis. An 80% of workers are thought to have SBS, despite the fact that the etiology is unknown and the symptoms and complaints do not go away. SBS is frequently accompanied by weakness, sensitivity to light scents, and difficulties focusing (11). A 60.7% of people have SBS. Employees who suffer SBS most frequently report having dry skin, runny noses, itchy eyes, sneezing, and itching (12).

Factors Causing Sick Building Syndrome

Although a single cause of SBS remains difficult to identify, indoor air pollution is the primary source of most SBS complaints. The United States Occupational Health and Safety Administration has released research findings showing that there are five main sources of air pollution in 466 buildings in the USA. Inadequate ventilation can contribute 2% of pollutants to buildings due to obstruction of fresh air entry, uneven air distribution, and poor ventilation system maintenance. As much as 17% of indoor air pollution comes from devices or equipment including photocopiers, tissue paper, wallpaper and paper glue, floor cleaners, air fresheners, and dyes from printed materials. As much as 11%, the wrong location of the fresh air intake holes or ventilation can cause pollution from outside the building to also enter the room. As many as 3% of materials used in construction can be contaminated, including formaldehyde, glue, asbestos, fiberglass and other building materials. Air ducts, cooling equipment, and overall systems can contain up to 5% microbial-causing contamination originating from bacteria, fungi, protozoa, and other microbial products (10).

Excessive paper used, smoking, indoor dust, and computer used are examples of individual behavioral factors that contribute to the increased prevalence of SBS. High room temperature (more than 26˚C in an air-conditioned room) is a contributing factor to SBS. Very little air flow (10 L/sec/person) indoors also contributes to SBS. The temperature factor is an important contributor to the occurrence of SBS (13).

Air temperature plays a crucial role in creating work comfort, due to the human body produces heat through metabolic processes. Recommendations from the National Institute for Occupational Safety and Health (NIOSH) suggest that work environment temperatures should not exceed 26 °C for men and 24 °C for women. Extreme temperature conditions, both hot and cold, can cause increased fatigue, decreased concentration, and symptoms of SBS. Therefore, it is important to manage the temperature in the work environment so that it remains within a comfortable range and supports the well-being and productivity of workers. According to the Minister of Manpower Regulation no. 5 year 2018, office work spaces are expected to comply with indoor air temperature limits ranging from 23˚C to 26˚C. Indoor air temperature measurements can be carried out using the direct reading method by referring to the SNI 16-7061-2004 standard. The environmental temperature measurement process involves natural dry and wet temperature components (14).

Very high or low air humidity levels are often associated with decreased air quality. Low relative humidity (RH) can be the cause of SBS symptoms such as coughing, eye irritation, and throat irritation. Low humidity can also increase the risk of asthma and other infectious diseases. Relative humidity is also a factor that influences microbial survival. When relative humidity drops below 60%, germs and household dust have more opportunities to survive on surfaces, which can cause respiratory problems, including asthma. Low humidity levels can accelerate mold growth and dust buildup on cold surfaces. Therefore, maintaining appropriate humidity levels is essential to improve the comfort and health of indoor environments. The health impacts of workers due to humidity that does not meet standards include SBS symptoms such as eye irritation, throat and coughing. Low relative humidity can increase susceptibility to infectious diseases and asthma. Apart from that, humidity also affects the survival of microorganisms (15).

Apart from environmental factors, it turns out that elements that are not related to the environment, such as psychological problems and personal work problems, also have an impact on complaints from workers affected by SBS and are thought to influence a person's vulnerability to SBS. Investigation of the origins of SBS influenced by various factors, with emphasis on ventilation, pollutants, and other parameters (16). Characteristic parameters related to SBS include the ventilation system of building contaminants (carbon dioxide, carbon monoxide, dust, etc.), occupants (age, gender, occupation, etc.), building shape, electromagnetic radiation, no environmental control, lighting (17).

Biological factors that cause SBS include that bacteria and fungi in indoor air are influenced by temperature, relative humidity, ventilation, carbon dioxide levels, oxygen concentration and dust. Other studies have revealed that the concentration of bacteria and mold in indoor air is statistically significantly related to temperature or relative humidity. These factors also did not differ statistically significantly from carbon dioxide, PM_{10}, or $PM_{2.5}$ concentrations. The presence of bacteria and fungi also affects the health, comfort and productivity of workers (18).

Management and Prevention of Sick Building Syndrome

Several things that can be done in efforts to overcome and prevent SBS include window settings. The construction of a building, including the arrangement of windows, has the potential to prevent and treat SBS. The benefits of this window arrangement are not only limited to providing additional ventilation for rooms that require air circulation, but also include psychosocial benefits. Decreased humidity at the base of the building can prevent SBS. This phenomenon is caused by the ability of microorganisms, especially germs, to spread and reproduce optimally in areas with high levels of humidity. It is important to consider isolating and controlling areas susceptible to moisture, as high levels of humidity can damage Building fixture materials (19).

Ventilation is an important method of controlling air quality. Ventilation is used to remove contaminants from indoors affected by pollution. Ventilation system design requires consideration of several factors, including the quality of the outdoor air that will be used, potential pollutants that need to be monitored in their distribution, possible sources of contamination, and indoor air distribution (20). Providing health education and promotion to building occupants or workers is also a crucial factor so that they have awareness and can avoid potential sources of contaminants that impact their health. This can be a countermeasure for SBS (21).

CONCLUSION

Temperature, humidity, ventilation, lighting, germs and psychosocial factors are factors related to SBS in urban areas. These factors can contribute individually or collectively in influencing worker productivity and the emergence of SBS.

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