**FACTORS AFFECTING *SICK BUILDING SYNDROME* (SBS) COMPLAINTS AMONG WORKERS: LITERATURE REVIEW**

Anjas Andi Saputro, Dyah Utari, Arga Buntara

Department of Public Health, Faculty of Health Sciences

Universitas Pembangunan Nasional Veteran Jakarta

Jln. RS Fatmawati Pondok Labu, Jakarta Selatan, 12450

Email: anjasandis@upnvj.ac.id

**ABSTRACT**

Sick Building Syndrome (SBS) is a set of health symptoms that occur due to someone’s activity in a room or building. Recently, humans tend to do the work and activities inside a building. Therefore, this increases the risk of symptoms such as dizziness, headaches, nasal, skin and throat irritations. The aim of this study was to determine the factors that affected SBS symptoms on workers using a literature review method. All articles were searched and retrieved from electronic databases such as Pubmed, Google Scholar and Emerald Insight by looking at various significant factors of SBS in articles published from 2010 to 2020. A total of 31 journal articles reporting significant factors of SBS were collected. These factors include personal factors (age, gender, history of illness/allergies, smoking habits); physical factors (temperature, light, humidity, ventilation, noise); chemical factors (CO2, CO, VOCs, Formaldehyde); psychosocial factors (weak psychosocial, working period, working time, job satisfaction); and work environment factors (cigarette smoke, room hygiene and cleanliness, building design, unpleasant odor, IAQ). It is suggested that workers need to maintain personal health status, practice relaxation, wear a mask and not to smoke. Moreover, companies should conduct a regular health check and monitor the work environment.

***Keywords*:** *Risk Factors, Indoor Air Quality, Sick Building Syndrome*

**1. INTRODUCTION**

In this era, the world has entered the industrial revolution of 4.0, where technology and information are increasing rapidly. In this era, the need for technology is also increasing. An increase followed the increasing need for technology in need of office development [1]. There are many office buildings in Indonesia, especially in Jakarta. Research data from Colliers International Indonesia shows that there are 189 high-rise buildings in Jakarta, of which 113 buildings are apartments, 31 are hotels, and 45 are offices [2].

Humans tend to spend up to 80% of their time indoors. This condition makes humans breathe more often the polluted air in the room. This air can come from household gas pollutants, motor vehicle emissions that stick to clothes, and toxic gases from construction materials or furniture in the room [3].

Several factors interfere with indoor air quality (IAQ). It is including inadequate ventilation (52%), sources of contaminants in the room (16%), sources of contaminants outside (10%), the presence of microorganisms such as bacteria, viruses, and fungi (5%), the presence of building materials using contaminated materials (4%), and others (location and use of buildings) (13%) [4].

One of the diseases due to bad IAQ is Sick Building Syndrome (SBS). SBS is a collection of symptoms or complaints experienced by workers in a building or room [5]. Symptoms can include dizziness, itching, irritation of the eyes, nose, skin, and throat, and dry cough [6]. Some of these symptoms can appear when a person is inside a room/building and disappears when they go outside [1].

Several factors influence SBS incidences, such as physical factors (temperature, humidity, lighting, ventilation, noise, and vibration) and chemical factors (cigarette smoke, formaldehyde, organic contaminants, pesticides, aromatic compounds, carbon monoxide, carbon dioxide, NO3, and O3). Biological and psychological factors also influence the incidence of SBS [7]. According to the Environmental Protection Agency of America (EPA), rooms that use Air Conditioner (AC) tend to quickly grow *Legionella* pathogenic bacteria, causing *Legionellosis* disease and SBS symptoms. Besides, [5] shows that psychosocial factors, such as high workload and job satisfaction, are related to SBS incidence.

Many factors influence SBS complaints. Until now, many publications, both national and international, discuss the risk factors for SBS. Based on this, the researcher wanted to conduct further studies in identifying the literature to see the risk factors associated with SBS simultaneously based on previous research.

**2. METHODS**

This study uses articles searched and retrieved from electronic databases such as Pubmed, Google Scholar, and Emerald Insight by looking at various SBS's significant factors in articles published from 2010 to 2020. The search keywords used were “*Sick Building Syndrome*”, “*Sick Building Syndrome factors*” and “*Risk Factors of Sick Building Syndrome*”.

The search results found 5208 journals matching the keyword. A total of 1370 journals were found based on year relevance (less than ten years). Of these journals, 327 journals met the criteria on the abstract. From 327 journals, they were screened and obtained 272 duplicate journals, and no full-text articles were available, 18 journals had no primary data available, and six journals had a study sample of fewer than 10 participants. Of these, 31 full-text journals that match the criteria were obtained.

**3. RESULT**

In this study, researchers used 31 journals analyzed with different locations from various countries and in different time frames. All journals found used a cross-sectional research design with 20 national journals and 11 international journals researching in the past ten years. The variables studied were varied, ranging from two variables to 27 variables.

Table 1 Research Overview

| No | Researcher Name | Nation | Years | Study Design | ∑ Samples | Researched Variables | Significant Variables |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | Fahruniza Meiga Mawarni [8] | Indonesia | 2019 | *cross-sectional* | 107 | 7 | 1 |
| 2 | Mona A. Abdel-Hamid, et al. [5] | Egypt | 2013 | *cross-sectional* | 826 | 23 | 12 |
| 3 | Parbati Dhungana, Manisha Chalise [9] | Nepal | 2019 | *cross-sectional* | 234 | 21 | 9 |
| 4 | Fang-Lee Lim, et al. [10] | Malaysia | 2015 | *cross-sectional* | 695 | 17 | 6 |
| 5 | Mohammad Reza Vafaeenasab, et al. [11] | Iran | 2015 | *cross-sectional* | 265 | 7 | 3 |
| 6 | Mohammad Javad Jafari, et al. [12] | Iran | 2015 | *cross-sectional* | 170 | 7 | 3 |
| 7 | Bo Sahlberg, et al. [13] | North Europe | 2012 | *cross-sectional* | 159 | 7 | 3 |
| 8 | Francenco Chirico, et al. [14] | Italy | 2017 | *cross-sectional* | 161 | 26 | 7 |
| 9 | Sedina Kalender Smajlovic, Andreja Kukec, Mateja Dovjak [15] | Slovenia | 2019 | *cross-sectional* | 258 | 9 | 1 |
| 10 | Akhmad Zaelani [16] | Indonesia | 2015 | *cross-sectional* | 40 | 5 | 5 |
| 11 | Morrys Antoniusman [17] | Indonesia | 2013 | *cross-sectional* | 46 | 7 | 2 |
| 12 | Machfud Fauzi [18] | Indonesia | 2015 | *cross-sectional* | 49 | 5 | 2 |
| 13 | Okta Sulistia Sari, Dwi Wahyuni [19] | Indonesia | 2016 | *cross-sectional* | 86 | 12 | 2 |
| 14 | Angga Satria Tritama, Farizi Rachman, Denny Dermawan [20] | Indonesia | 2017 | *cross-sectional* | 34 | 4 | 3 |
| 15 | Lestari Ayu, Indah Budiastutik, Elly Trisnawati [21] | Indonesia | 2016 | *cross-sectional* | 51 | 3 | 1 |
| 16 | Hanny Dwi Raharjo, Wiediartini, Denny Dermawan [6] | Indonesia | 2017 | *cross-sectional* | 62 | 7 | 4 |
| 17 | Siti Saffanah, Rafiah Maharani Pulungan [22] | Indonesia | 2019 | *cross-sectional* | 53 | 5 | 2 |
| 18 | Alfreda Effie Ardian, Sudarmaji [23] | Indonesia | 2014 | *cross-sectional* | 44 | 11 | 3 |
| 19 | Mery Puspawita [24] | Indonesia | 2019 | *cross-sectional* | 45 | 5 | 2 |
| 20 | Annisa Nanda Asri [1] | Indonesia | 2019 | *cross-sectional* | 70 | 10 | 5 |
| 21 | Desti Putri Wulandari [25] | Indonesia | 2016 | *cross-sectional* | 72 | 3 | 1 |
| 22 | Ari Muhammad Ridwan, Evi Nopiyanti, Agus Joko Susanto [26] | Indonesia | 2018 | *cross-sectional* | 242 | 9 | 3 |
| 23 | Ilman Adhitiya, Widodo Hariyono [27] | Indonesia | 2020 | *cross-sectional* | 47 | 2 | 2 |
| 24 | Puspita Adela Rahardjo [28] | Indonesia | 2020 | *cross-sectional* | 89 | 5 | 2 |
| 25 | Riskita Ikmala [29] | Indonesia | 2018 | *cross-sectional* | 42 | 10 | 4 |
| 26 | Rizki Adi Sulistyanto [30] | Indonesia | 2017 | *cross-sectional* | 35 | 10 | 3 |
| 27 | Christabel Caroline Franswijaya [31] | Indonesia | 2013 | *cross-sectional* | 73 | 6 | 1 |
| 28 | Esi Lisyastuti [32] | Indonesia | 2010 | *cross-sectional* | 90 | 8 | 1 |
| 29 | A. Norhidayah, et al. [3] | Malaysia | 2012 | *cross-sectional* | 79 | 7 | 2 |
| 30 | Zuliza Md Saad, Dr. Irniza Rasdi, Dr. Emilia Zainal Abidin [33] | Malaysia | 2016 | *cross-sectional* | 264 | 6 | 2 |
| 31 | Sepideh Keyvani, et al. [34] | Iran | 2017 | *cross-sectional* | 41 | 7 | 3 |

Based on the literature analysis results, it is known that the factors that influence SBS are seen from various factors (personal, physical, chemical, psychosocial, and work environment). Of these factors, physical factors are the most common risk factors found in SBS research. Of the 31 journals analyzed, 12 journals showed that temperature was associated with SBS, followed by humidity (10 journals) and light for seven journals (Table 3). In Table 2, the most common personal factors found were age (10 journals) and history of disease/allergies (5 journals). In Table 4, the most common chemical factor found is CO2 (2 journals). The most common psychosocial factors found in SBS research are working period (5 journals) and work environment factors found, namely cigarette smoke, Indoor Air Quality (IAQ), and unpleasant odors (3 journals).

Table 2 Personal Factors Affecting SBS

|  |  |  |
| --- | --- | --- |
| **No** | **Personal Factors** | **Total (Articles)** |
| 1. | Age | 10 |
| 2. | History of Disease/Allergy | 5 |
| 3. | Gender | 4 |
| 4. | Smoking Habit | 4 |

Table 3 Physical Factors Affecting SBS

|  |  |  |
| --- | --- | --- |
| **No** | **Physical Factors** | **Total (Articles)** |
| 1. | Temperature | 12 |
| 2. | Humidity | 10 |
| 3. | Light | 7 |
| 4. | Ventilation | 4 |
| 5. | Noise | 3 |

Table 4 Chemical Factors Affecting SBS

|  |  |  |
| --- | --- | --- |
| **No** | **Chemical Factors** | **Total (Articles)** |
| 1. | CO2 | 2 |
| 2. | CO | 1 |
| 3. | VOCs | 1 |
| 4. | Formaldehyde | 1 |

Table 5 Psychosocial Factors Affecting SBS

|  |  |  |
| --- | --- | --- |
| **No** | **Psychosocial Factors** | **Total (Articles)** |
| 1. | Working Period | 5 |
| 2. | Weak Psychosocial | 3 |
| 3. | Working Time | 1 |
| 4. | Job Satisfaction | 1 |

Table 6 Work Environment Factors Affecting SBS

|  |  |  |
| --- | --- | --- |
| **No** | **Work Environment Factors** | **Total (Articles)** |
| 1. | Cigarette Smoke | 3 |
| 2. | *Indoor Air Quality*/IAQ | 3 |
| 3. | Unpleasant Odor | 3 |
| 4. | Building Design | 2 |
| 5. | Cleanliness | 1 |

From the results, there are many factors associated with SBS, and the temperature factor has many studies that state a significant relationship (12 journals). That makes the temperature factor the most influencing factor for SBS complaints compared to other factors.

**4. DISCUSSIONS**

**Personal Factors**

The results of the analysis of 31 journals showed that the personal factors of workers were divided into several factors, namely age, gender, history of disease/allergies, and smoking habits. From the study analysis results, ten journals proved that age had a significant relationship with SBS complaints. Research conducted by [22] shows that productive age (25-54 years) tends to experience SBS complaints compared to non-productive ages. That happens because, at that age, the person is at his optimal period, so they must do more work.

Other things also influence the relationship between age and the incidence of SBS. [32] states that young people are more comfortable experiencing stress than older people who are more adaptive. Young people will be more able to feel mild symptoms than older people who rarely pay attention to these symptoms because they pay more attention to severe chronic disease symptoms. Also, young people tend to have a lifestyle that increases SBS's risk, such as eating irregularly and not nutritionally, smoking, sleeplessness, workaholics, and other psychosocial problems.

The results of the analysis study stated that gender was associated with complaints of SBS. A total of four journals said that women tend to be at risk of experiencing SBS than men. This matter in line with the research of [10], which states that women tend to experience SBS than men because women have more roles, both in work and in the household.

[6] argues that women do more paperwork than men, thus increasing the workload for women. Even in physical types, women and men are very different. Men are physically strong than women, so that muscle fatigue tends to be a little. Meanwhile, women are more easily tired and experience various psychosomatic complaints, which means that women are more sensitive to their surroundings related to physical and psychosocial factors at work.

The results of the analysis study stated that disease history is a risk factor for SBS. Five research studies said that a person's history of allergies is a risk factor for the occurrence of SBS complaints. Research studies in Nepal, Malaysia, and Italy mostly say that allergies are associated with SBS complaints. Is it because, in the body of an allergic person, an early reaction or sensation appears to the allergens in the environment around them [9,10,14].

Other research studies suggest that a history of asthma has a significant relationship with SBS complaints. A person who has a history of asthma complains of symptoms or complaints similar to those of SBS. It happens because asthma is a respiratory disorder caused by a poor work environment. Temperature and humidity parameters that are less than standard can cause symptoms or complaints about people with asthma.

The analytical study results show that as many as four literature states that smoking is a significant factor in workers' complaints of SBS. A cigarette can contain chemicals that are harmful to the body. Besides, cigarette smoke also consists of pollutants in the form of CO and CO2.

If the smoking habit is not stopped and continues to be done, it can cause environmental pollution and can lead to various SBS complaints such as respiratory problems, sore eyes, and coughs [1]. Besides, those who do not smoke will feel the effects of cigarette smoke released by active smokers such as sore eyes, coughing, disturbed breathing, etc [30].

**Physical Factors**

The results of the analysis from 31 journals showed that physical factors divided into several factors, namely temperature, humidity, light, ventilation, and noise. The results of the analytical study show that temperature is a very influential factor in the complaints of SBS. A total of 12 journals say that temperature is a risk factor for the occurrence of SBS complaints. It also makes temperature a dominant factor in this study. This matter is in line with the theory of [32], which states that temperature is a risk factor for the occurrence of SBS in workers.

Generally, temperature plays an essential role in maintaining body conditions such as metabolism, oxygen consumption, and blood pressure. When the air temperature of a room does not meet health standards, a person's body will lose heat so that the body will try to balance it with the ambient temperature through the evaporation process. When the room temperature increases, the high temperature will merge with the released body heat so that the body will feel uncomfortable. Conversely, if the room temperature is too low, it can cause stiffness in the blood vessels, so that body movement is limited [28].

From the results, it founded that light is a risk factor for the occurrence of SBS in workers. Seven articles state that light is significantly associated with SBS complaints. Research in Egypt and Iran suggests that poor lighting linked to symptoms such as eye irritation, fatigue and headaches. Other studies suggest that insufficient or inappropriate lighting can cause eye fatigue, persistent eye fatigue can lead to eye health problems.

The results of the analytical study show that humidity has a significant relationship with SBS complaints among workers. A total of 10 articles show a significant relationship between humidity and complaints of SBS so that humidity is the second dominant factor that affects after age.

High humidity can cause bacteria and fungi to live and thrive, the consequences of which can include skin diseases and respiratory problems. Conversely, low humidity can dry out skin, which can make it easier to wrinkle and cause chapped lips. [35].

Relative humidity in the range of 40% -50% is the most suitable and healthy condition for work. These conditions also allow for a reduced incidence of respiratory infections and an increase in flu recovery. At a relative humidity above 60%, symptoms of eye irritation, eye fatigue, and sneezing will occur. At a relative humidity below 30% and above 60% can increase the growth of bacteria while viruses at a relative humidity below 50% and above 70%. Bacteria, viruses, and other microorganisms can cause health problems due to the manifestation of the body's response to foreign matter.

Ventilation is an essential factor in causing complaints of SBS. In the results of the analytical study, four journals that were the source of the literature stated that poor ventilation control was associated with the incidence of SBS in workers. This matter is in line with the theory of [23] which states that poor ventilation control is a risk factor for SBS.

Inadequate ventilation will affect air distribution and availability of fresh air. The existence of ventilation is essential to regulate the airflow rate. Airflow velocity will affect air movement and air change in the room. The less airflow speed will cause pollutants not to move rooms entirely so that pollutant air will settle in the ventilation and inhaled by the body.

The results of the analysis study showed that three journals had a significant relationship between noise and complaints of SBS. The study conducted by [9] had the same results as [5] who said that noise disturbance had a significant relationship with SBS complaints where the most complaints felt by workers were eye complaints and general symptoms. Another study says that if a place is too noisy, it can cause a feeling of uneasiness and can cause hearing loss.

**Chemical Factors**

The results of the analysis from 31 journals showed that chemical factors divided into several factors, namely CO2, CO, VOCs, and formaldehyde. Two articles have a significant relationship between CO2 and complaints of SBS. A study conducted by [23] shows that workers experience almost all SBS symptoms with CO2 levels below average. Then at CO2 levels above average, the symptoms felt are nasal congestion and itching. Another study says that CO2 levels above 800 ppm are more at risk for causing SBS complaints, especially eye irritation and upper respiratory tract disorders [28].

The results of the analytical study indicate that CO is associated with SBS complaints. The study conducted by [33] is in line with the opinion of [36] which states that indoor CO can be a pollutant which, if inhaled by humans, can cause SBS-like symptoms such as dizziness and nausea. It happens because CO is a gas that is odorless and has a stronger attachment to hemoglobin (Hb) than O2. Therefore, if the CO inhaled, it will replace O2 Hb and result in a reduced O2 supply in the body. The side effects of this condition are dizziness and nausea, and in other cases, it can lead to a reduction in the brain's ability to work until death.

The results of the analysis study stated that VOCs had a significant relationship with SBS complaints among workers. This matter is in line with the theory put forward by [37] that SBS caused by a combination of several factors, such as chemical pollutants which are flammable (SO2, NO2, and CO) and chemical pollutants from indoors (VOCs, formaldehyde, paints, varnishes, cigarette smoke).

Generally, VOCs in a building has a higher concentration than outdoors. The highest VOC emissions occur when synthetic materials used in a new environment, such as room renovation, new room paint, new carpet installation, to the use of new furniture [32].

The results of the analysis study stated that the presence of formaldehyde affected the occurrence of complaints of SBS. It proves the theory of Rizqiyah et al. (2018) which states that chemical factors consisting of construction products, household products, formaldehyde, odors, and Environmental Tobacco Smoke (ETS) are factors that can cause complaints from SBS.

Formaldehyde can enter the body in various ways, such as inhalation, ingestion, and even though the skin. Formaldehyde that enters the body can interact with molecules in cells and body tissues such as protein and DNA so that it can cause cell function disorders. At high concentrations, it can cause protein precipitation and lead to cell death. [38].

**Psychosocial Factors**

The results of the analysis of 31 journals show that psychosocial factors divided into several factors, namely weak psychosocial, working period, working time, and job satisfaction. Psychosocial factors not explicitly explained in some of these research studies. Generally, psychological factors, such as work stress, physical/social isolation, coworker relationships, moral support, role conflicts, positions, and other psychosocial conditions are related to the symptoms of SBS.

The results of the analysis study stated that poor psychosocial conditions affect the incidence of SBS in workers. The symptoms of SBS felt by workers can be influenced by factors from outside the environment, such as personal problems, family, work which considered to increase a person's sensitivity in feeling SBS complaints. In his research said that the symptoms associated with SBS more caused by stress than the condition of the building or environment.

From the results of the analysis study, it founded that tenure was related to the incidence of SBS. A total of 5 (five) journal articles said that the tenure variable had a significant relationship with SBS complaints. A study conducted by [6] states that there is a relationship between the working time and SBS complaints felt by workers. This matter is in line with the study conducted by [26]. The longer a person works in a place, the higher the risk of being exposed to environmental factors that can cause health problems, especially SBS.

The results show that the working time of a person affects the complaints of SBS. A study conducted by [18] states that there is a relationship between the working time and SBS complaints. A person with working hours of more than 8 hours per day has a higher risk of experiencing SBS complaints than people with working hours of less than 8 (eight) hours per day.

This matter is in line with [28], which states that inappropriate work duration or working time can be a factor affecting the incidence of SBS. The length of time a person works is generally 6-10 hours. The rest (14-18 hours) used for family life, community, rest, sleep and recreation [18]. The working time affects the incidence of SBS because workers spend their time in the building with a lot of work and accumulation coupled with inadequate room conditions.

The results of the analytical study show that job satisfaction has a significant relationship with SBS complaints. Low job satisfaction will reduce a person's morale. Individuals who have low morale will reduce their focus in doing specific jobs so that it will have an impact on the health of the job.

**Work Environment Factors**

The results of the analysis from 31 journals, found that the work environment factors divided into several factors, namely cigarette smoke, unpleasant odors, building design, hygiene/cleanliness, and Indoor Air Quality (IAQ).

The results of the analytical study show that the work environment factor has many variables that are significant to the incidence of SBS. Research studies conducted in Egypt, Italy and Indonesia stated that the presence of cigarette smoke affected SBS.

Cigarette smoke in the workroom can disturb the air in the room. Cigarette smoke contains various chemical compounds, such as CO, CO2, and formaldehyde. If an active smoker smokes cigarettes and expels non-smoking people in the room will inhale the smoke in the room, various chemicals and other particulates. In a certain amount, cigarette smoke can interfere with health and cause symptoms or complaints such as sore eyes, coughing, shortness of breath, and headaches.

Apart from cigarette smoke, another work environment factor that also influences the incidence of SBS is the bad smell. The presence of this smell can distract a person while working. Research conducted by [34] stated that unpleasant odors had a significant relationship with SBS complaints. These unpleasant odors can come from toilets, sewerage, medicines, and kitchen waste. Symptoms that can arise from these smells include dizziness, headaches, sneezing, and respiratory problems.

Other work environment factors that influence this study are building design and room cleanliness. Rooms that have partitions tend to have low air circulation. This condition makes the dirty air around it will not be exchanged with cleaner air.

The cleanliness of the room also needs attention. Substances from chemicals or micro-organisms in the room will affect the quality of indoor air. The use of ventilation is essential so that it can block pollutants and other hazardous substances from entering the room.

The results of the analysis study found that 3 (three) articles state that indoor air quality variables have a relationship to the incidence of SBS. This matter is in line with the opinion of [32] which states that factors that have the potential to cause indoor SBS are a decrease in room air quality, human density, room materials, room decoration, and ventilation systems.

Indoor air quality can be affected by chemical compounds in the air, particulates, microbial contaminants, temperature, humidity, building construction, psychosocial conditions/stressors, and workers' health status (history of allergies or asthma).

**5. CONCLUSION**

From the 31 kinds of literature used in this study, it founded that the significant factors influenced workers complaints of SBS were personal factors (age, gender, history of disease/allergies, smoking habits); physical factors (temperature, light, humidity, ventilation, noise); chemical factors (CO2, CO, VOCs, Formaldehyde); psychosocial factors (weak psychosocial, working period, working time, job satisfaction); and work environment factors (cigarette smoke, cleanliness, building design, unpleasant odors, IAQ).

**ACKNOWLEDGMENT**

This research was fully self-funded and there is no conflict of interest

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