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Review

Addressing sick building syndrome and its connection to headache disorders

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Introduction
Sick Building Syndrome (SBS), a term introduced by the World Health Organization in 1983, refers to the occurrence of acute health and comfort issues in individuals occupying specific indoor environments without an identifiable clinical cause. Among the most commonly reported symptoms are headaches, particularly migraines and tension-type headaches, which significantly affect daily functioning and workplace productivity.

Review
This review examines the primary environmental, chemical, biological, and psychosocial factors contributing to SBS and their influence on the onset and exacerbation of headaches. Poor indoor air quality, inadequate ventilation, and elevated carbon dioxide (CO_2) levels are identified as major physical factors. CO_2 concentrations above 1000 ppm are associated with impaired cognitive function, cerebral vasodilation, and the onset of headaches. Exposure to volatile organic compounds from office materials and cleaning agents, as well as biological contaminants such as mold and dust mites and electromagnetic radiation, is also implicated. In parallel, psychosocial elements such as occupational stress, poor ergonomics, and limited access to natural light exacerbate headache symptoms. The cumulative effect of these stressors contributes not only to physical discomfort but also to decreased performance and increased presenteeism. Preventive measures include improving ventilation systems, implementing green building practices, regulating humidity levels, implementing ergonomic interventions, and promoting mental well-being in the workplace.

Conclusions
SBS is a complex occupational health issue strongly associated with headache disorders. Addressing its multifactorial causes through integrated environmental and organizational strategies is essential for enhancing employee health, reducing headache incidence, and improving productivity. Tackling SBS represents both a health imperative and a strategic investment in workplace sustainability.

Keywords:
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Introduction

In 1983, the World Health Organization (WHO) first coined the term "Sick Building Syndrome" (SBS) to describe situations where occupants of a building experience acute health and comfort issues seemingly linked to the time spent indoors, despite the absence of a clearly identifiable illness or specific cause (1,2). Raising awareness about this growing concern in workplace environments is crucial, as SBS continues to impact employee well-being, productivity, and overall health four decades later (2,3).

Among other possible causes of the syndrome, the use of perfumes, some of which are known triggers for migraine attacks should be considered. A migraine sufferer sharing an office room with one or more individuals wearing such fragrances is likely to experience more frequent migraine episodes. This will be particularly concerning if the environment is poorly ventilated and confined (3–7).

As organizations strive for productivity and efficiency, the quality of the indoor environment is often overlooked, despite its critical impact on employee health and overall workplace performance (8–10). Sick building syndrome is a condition where individuals experience acute health effects and discomfort that appear to be linked to time spent in a particular building. However, a physician with no attentive intent can identify no specific illness or cause.

This syndrome has significant implications for employers, employees, and policymakers alike, especially in relation to headache disorders, which are among the most commonly reported symptoms.

Understanding sick building syndrome and headaches

Sick building syndrome manifests through a range of symptoms that typically resolve once the affected individuals leave the building. One of the most prevalent complaints associated with SBS is headache, which can be persistent and significantly impact daily functioning (2,4–6). Other common symptoms include dizziness, nausea, irritation of the eyes, nose, or throat, dry or itchy skin, difficulty concentrating, fatigue, and sensitivity to odors and light (8,9). Unlike Building-Related Illness (BRI), which has identifiable causes such as infections or allergic reactions, SBS remains largely idiopathic, making diagnosis and remediation challenging.

The syndrome is often linked to poor indoor air quality (IAQ), inadequate ventilation, and exposure to chemical and biological contaminants, all of which have been identified as potential triggers for tension-type headaches, migraines, and chronic daily headaches (8). Buildings with centralized air-conditioning systems, artificial lighting, and limited air circulation tend to have higher SBS, exacerbating headache disorders among occupants.

Primary causes of sick building syndrome and their impact on headaches

The primary causes of SBS are closely linked to environmental and occupational conditions that significantly contribute to the development and exacerbation of headaches, including migraines and tension-type headaches (4,5). Among the most critical factors is inadequate ventilation. Poor air circulation leads to elevated levels of carbon dioxide (CO_2), which may induce cerebral hypoxia, triggering headaches and intensifying pre-existing migraine conditions (8,11). Furthermore, failure to meet established ventilation standards, such as those recommended by ASHRAE, results in the accumulation of indoor pollutants, exacerbating symptoms commonly associated with SBS, particularly in individuals predisposed to neurological sensitivity (3,4,8,11).

Chemical contaminants from indoor sources represent another major contributor to SBS. Volatile organic compounds (VOCs), emitted by materials such as carpets, adhesives, office furniture, cleaning agents, and electronic equipment, are known headache triggers, especially among individuals who suffer from migraines. These substances can provoke sensory irritation and neurovascular responses, leading to acute or recurrent headache episodes (3,4,8,11). Additionally, pollutants originating from outdoor environments, including traffic-related emissions, industrial pollutants, and construction dust, may infiltrate indoor spaces, further deteriorating indoor air quality (IAQ). These external contaminants, when combined with insufficient filtration systems, increase the risk of airborne irritants contributing to headache onset (9).

Biological contaminants also play a significant role in SBS symptomatology. Mold spores, bacteria, dust mites, and pollen often proliferate in areas with high humidity and poor airflow. These agents can provoke immune and inflammatory responses in sensitive individuals, potentially leading to sinus-related headaches and triggering migraine attacks (12). Another hypothesized factor involves prolonged exposure to electromagnetic radiation from devices such as computers, smartphones, and wireless routers (8,10,13). Although the evidence is not yet definitive, some studies suggest a link between electromagnetic exposure and the development of headache symptoms and neurological discomfort, warranting further investigation.

Psychosocial factors within the built environment must also be acknowledged. Occupational stress, job dissatisfaction, poor workstation ergonomics, and social isolation can exacerbate muscle tension and emotional strain, which are known to contribute to tension-type headaches and worsen migraine severity (10,13–15). These factors are particularly concerning in modern workspaces where psychological demands often intersect with suboptimal physical environments. In sum, the primary causes of SBS constitute a multifaceted web of physical, chemical, biological, and psychosocial exposures that interact to increase the frequency and intensity of headaches among building occupants (1,2,4–7,15). Understanding these interrelated contributors is essential for developing comprehensive strategies to improve indoor environments and mitigate their impact on neurological health.

Health and productivity implications of SBS-induced headaches

The effects of SBS extend beyond individual health concerns and impact workplace efficiency and productivity. A particularly underrecognized consequence in occupational settings is *presenteeism*, a condition in which the employee is physically present at work but performs below capacity due to pain or discomfort, such as headache or migraine (16). Unlike absenteeism, which is more readily measured, presenteeism results in subtle but substantial declines in work output, creativity, and problem-solving ability, especially in roles requiring sustained attention or cognitive flexibility (16). Studies have consistently shown that inadequate indoor environmental quality (IEQ) can diminish executive function, reduce reaction time, and exacerbate errors, which collectively reduce operational efficiency and increase long-term costs (2,5–7,16).

Studies have shown that poor indoor air quality can lead to a decline in cognitive function, affecting decision-making and problem-solving skills. Furthermore, organizations may face increased healthcare costs and liability concerns if SBS-related headache issues are not addressed.

Preventive measures and solutions for headache management

The effective management and prevention of headaches associated with SBS demand comprehensive interventions targeting both environmental and occupational determinants (5,16,17). Among the most impactful strategies is the improvement of ventilation systems. Inadequate air circulation is directly linked to the accumulation of pollutants such as volatile organic compounds, particulate matter, and carbon dioxide, all of which are recognized headache triggers (8,11). Enhancing ventilation by increasing the rate of fresh air exchange and ensuring regular maintenance of systems significantly improves indoor air quality (IAQ). Studies have shown that employees who moved to buildings with optimized ventilation reported a 37% reduction in headache prevalence within one year, with this improvement maintained over a three-year period (6,7).

Complementing ventilation upgrades, the integration of green building practices has emerged as a key preventive measure (17). These approaches promote the use of low-emission materials—including paints, adhesives, furniture, and cleaning products—which reduce chemical exposure in the workplace. By incorporating standards for air quality, humidity control, and sustainable materials, green-certified buildings minimize environmental risk factors associated with headaches and improve overall occupant comfort (11,17).

Humidity regulation is another critical factor in headache prevention. Maintaining indoor humidity between 30% and 50% prevents the proliferation of mold, dust mites, and other biological contaminants that can trigger sinus inflammation and subsequent headache symptoms (16). Alongside this, allowing access to natural light and improving air circulation - through architectural design or operable windows has been associated with decreased incidence of light-sensitive migraines and increased general well-being.

Preventive strategies must also address ergonomic and psychosocial aspects of the work environment. Poor posture, suboptimal lighting, and prolonged screen exposure contribute to musculoskeletal strain and tension-type headaches. Implementing ergonomic furniture, promoting healthy workstation setups, and encouraging regular breaks throughout the workday are practical and cost-effective interventions (3,16). Additionally, organizational efforts to promote psychological well-being-such as stress-reduction programs, flexible work policies, and supportive leadership-can mitigate one of the most overlooked contributors to SBS: chronic occupational stress.

Finally, routine monitoring of indoor environmental conditions is essential for sustained headache prevention. Conducting regular IAQ assessments, using air quality sensors, and addressing issues proactively allows for early detection and mitigation of potential triggers

Carbon Dioxide (CO_2) levels and headache risk

Carbon dioxide (CO_2) concentration in indoor environments is a critical factor influencing air quality and overall health. Measured in parts per million (ppm), CO_2 levels can significantly impact cognitive function and well-being, with high concentrations associated with an increased risk of headaches (8,11).

Carbon dioxide concentration and health impacts

Carbon dioxide levels in the atmosphere typically range between 400-420 ppm. However, in poorly ventilated indoor spaces, concentrations can rise significantly,

leading to various physiological effects:
• 400-1000 ppm: Considered normal for indoor environments with good ventilation. No significant health effects are expected.
• 1000-2000 ppm: Can cause mild discomfort, drowsiness, and reduced concentration.
• 2000-5000 ppm: Associated with increased headache frequency, dizziness, fatigue, and impaired cognitive function.
• Above 5000 ppm: Potentially hazardous, leading to severe symptoms such as confusion, shortness of breath, and, in extreme cases, loss of consciousness.

Carbon dioxide and headache risk

Headaches are among the most frequently reported symptoms in environments with elevated CO_2 levels. The mechanisms by which high CO_2 concentrations contribute to headache development include:

1. Cerebrovascular Effects: Increased CO_2 levels lead to cerebral vasodilation, which can trigger migraines or tension-type headaches.
2. Reduced Oxygen Availability: High CO_2 displaces oxygen, leading to mild hypoxia, which can contribute to headache onset.
3. Poor Air Quality and VOC Accumulation: Elevated CO_2 is often accompanied by other indoor air pollutants, such as volatile organic compounds, further increasing the risk of headaches.
4. Increased Workload on the Respiratory System: The body compensates for high CO_2 levels by increasing respiration rate, which can lead to discomfort and headache symptoms.

Figure 1. Model of an air quality detector used to assess environmental conditions in enclosed spaces with poor ventilation, enabling analysis of how the number and movement of people affect air quality.

To minimize the risk of CO_2-induced headaches, ensuring proper ventilation in indoor environments is essential. Increasing the circulation of fresh air whether by opening windows, utilizing air purifiers, or maintaining heating, ventilation and air conditioning systems can significantly reduce the accumulation of carbon dioxide (8,11,16).

The use of CO_2 detectors is recommended to monitor indoor levels and keep them below 1000 ppm, a threshold associated with reduced risk of cognitive impairment and headache onset. In high-occupancy areas, implementing scheduled ventilation breaks can help prevent the buildup of CO_2, particularly in settings where prolonged exposure is common. Excessive CO_2 concentrations not only contribute to the development of headaches but also impair cognitive performance and overall well-being (8,11).

Therefore, adopting ventilation strategies and actively monitoring indoor air quality are effective measures to reduce headache prevalence and promote healthier living and working environments.

Conclusion

Sick building syndrome is a pressing occupational health concern with a strong correlation to headache disorders, which significantly impact employee well-being and workplace productivity. By acknowledging the underlying causes and implementing effective preventive measures, businesses and policymakers can create healthier work environments, reducing the incidence of workplace-related migraines, tension-type headaches, and sinus headaches. Addressing SBS is not only a matter of health but also an investment in organizational success and sustainability.

We hope this article underscores the urgency of tackling SBS and its relationship with headache disorders, encouraging stakeholders to take necessary action.

References

1. Finnegan MJ, Pickering CA, Burge PS. The sick building syndrome: prevalence studies. BMJ 1984;289:1573–5. Doi:10.1136/bmj.289.6458.1573.
2. Riesenberg DE, Arehart-Treichel J. “Sick building” syndrome plagues workers, dwellers. JAMA 1986;255:3063.
3. Niza IL, de Souza MP, da Luz IM, Broday EE. Sick building syndrome and its impacts on health, well-being and productivity: A systematic literature review. Indoor and Built Environment 2024;33:218–36. Doi:10.1177/1420326X231191079.
4. Tietjen G, Khubchandani J, Ghosh S, Bhattacharjee S, Kleinfelder J. Headache symptoms and indoor

environmental parameters: Results from the EPA BASE study. Ann Indian Acad Neurol 2012;15:95. Doi:10.4103/0972-2327.100029.
5. Husøy A, Katsarava Z, Steiner TJ. The relationship between headache-attributed disability and lost productivity: 3 Attack frequency is the dominating variable. J Headache Pain 2023;24:7. Doi:10.1186/s10194-023-01546-9.
6. Bourbeau J, Brisson C, Allaire S. Prevalence of the sick building syndrome symptoms in office workers before and after being exposed to a building with an improved ventilation system. Occup Environ Med 1996;53:204–10. Doi:10.1136/oem.53.3.204.
7. Bourbeau J, Brisson C, Allaire S. Prevalence of the sick building syndrome symptoms in office workers before and six months and three years after being exposed to a building with an improved ventilation system. Occup Environ Med 1997;54:49–53. Doi:10.1136/oem.54.1.49.
8. Mansor AA, Abdullah S, Ahmad AN, Ahmed AN, Zulkifli MFR, Jusoh SM, et al. Indoor air quality and sick building syndrome symptoms in administrative office at public university. Dialogues in Health 2024;4:100178. Doi:10.1016/j.dialog.2024.100178.
9. González-Díaz SN, Hernández-Salcido GJ, de Lira-Quezada CE, Cantú-Hernández JA, Macouzet-Sánchez C, Macias-Weinmann A, et al. Sick building syndrome: do outdoor pollutants and pollen affect it? Frontiers in Allergy 2024;5. Doi:10.3389/falgy.2024.1383079.
10. Vafaeenasab MR, Morowatisharifabad MA, Taghi Ghaneian M, Hajhosseini M, Ehrampoush MH. Assessment of Sick Building Syndrome and Its Associating Factors Among Nurses in the Educational Hospitals of Shahid Sadoughi University of Medical Sciences, Yazd, Iran. Glob J Health Sci 2014;7. Doi:10.5539/gjhs.v7n2p247.
11. Camelia A. Sick Building Syndrome Dan Indoor Air Quality. Jurnal Ilmu Kesehatan Masyarakat 2011;2:79–84.
12. Pardo A, Israeli E. The Sick Building Syndrome as a Part of the Autoimmune (Autoinflammatory) Syndrome Induced by Adjuvant. Autoimmune Disorders, Wiley; 2024, p. 155–66. Doi:10.1002/9781119858430.ch15.
13. Phipps RA, Sisk WE, Wall GL. A comparison of two studies reporting the prevalence of the sick building syndrome in New Zealand and England. N Z Med J 1999;112:228–30.
14. Silva JS e, Fernandes MA. Validation of the Brazilian version of the questionnaire for detection of sick building syndrome. International Journal of Occupational Safety and Ergonomics 2023;29:765–72. Doi:10.1080/10803548.2022.2082129.
15. Crawford J, Bolas S. Sick building syndrome, work factors and occupational stress. Scand J Work Environ Health 1996;22:243–50. Doi:10.5271/sjweh.138.
16. Begasse de Dhaem O, Sakai F. Migraine in the workplace. ENeurologicalSci 2022;27:100408. Doi:10.1016/j.ensci.2022.100408.
17. Liphadzi M, Temidayo O, Aigbavboa CO, Thwala W, T P, Aliu J. GREEN BUILDING: AN ANTIDOTE TO SICK BUILDING SYNDROME MENACE IN AFRICA. Proceedings of the Creative Construction Conference 2023, Online: Budapest University of Technology and Economics; 2023, p. 632–44. Doi:10.3311/CCC2023-082.

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