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Sick Building Syndrome Study of a Historical Place in Karachi

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Abstract. Sick building syndrome (SBS) is characterized by a group of common symptoms that occur inside the building like working offices, schools, malls or industries. It causes many adverse health effects due to tightly packed indoor environment. This is the first study done at the historical place of Karachi pertaining to SBS. A questionnaire based survey was conducted in Empress market, Karachi in October 2018 to find out the negative impact on human health as well as to give awareness about SBS to workers. This building consists of almost 280 shops and workers. The workers suffer from common health diseases like headache, fatigue and dryness of the throat. Congested areas, no ventilation, poor design and heavy traffic were observed. Fans were the only source of ventilation. SBS effects can be reduced by the good ventilation source, proper cleaning system, building maintenance and proper bimonthly checkup of the workers.

Keywords: sick building syndrome, indoor environment, awareness, human health, ventilation systems

Introduction

The sick building syndrome (SBS) is a condition that causes acute health effects and uncomfortable situations linked with the time spent in the building or any closed space (EPA, 1991). According to occupational health and safety (OHS) "SBS" is a group of illnesses and symptoms that make a building miserable to many occupants. There is no acceptable single definition of SBS. The complaint can be specifically in a particular zone in a building or may spread throughout the building and is ascribed to poor indoor air quality (Hamdi and Ahmad, 2023; Heinkel, 2016; Marmot *et al*., 2006). SBS symptoms are non-specific like coughing, skin redness and dryness, nasal congestion, irritation (throat, nose and eye), neurotoxic effects (irritability, headache and mental fatigue) odour sensitivity, gastrointestinal disturbance, difficulty in concentration, behavioural changes and allergies. These symptoms persist for 2 weeks minimum. The building is considered sick whenever more than 20 or 50% workers face aforementioned symptoms (Dutheil *et al*., 2022; Wang *et al*., 2022; Murniati, 2020).

Indoor air quality is influenced by different chemicals and biological pollutants. The pollutants can either be released from indoor or outdoor activities, entering buildings through air intake vents or indoor activity. SBS major contributors are physico-chemical, biological, individual and psychological parameters (Ghaffarianhoseini *et al*., 2018). These factors are responsible for SBS namely, building design (ventilation), building material, dust, outdoor trapped pollutant, improper maintenance, bio-aerosol, carbon-monoxide and fibres. Poor ventilated buildings give space to pollutants to accumulate and thus can reach a higher concentration than typically found outside. However, almost people spend upto 80% of their life at indoor places like home or at workplaces (Dutheil *et al*., 2022; Huo *et al*., 2020; Norhidayah *et al*., 2013; Khan and Karuppayil, 2012). Furthermore, it is reported that 30-200% SBS symptoms were observed frequently in mechanical ventilated buildings than others (Zein and Hijazi, 2021). According to earlier investigations, indoor dwellers' exposure to microbial components was similarly linked to SBS. Fungus and mold can grow more rapidly inside and within typical building materials whenever the relative humidity is high (Fu *et al*., 2021).

A review paper shows that buildings' physical features (design) is significant to appear SBS symptoms (Ghaffarianhoseini *et al*., 2018), while a study in Mashhad, Iran on office workers revealed that there was no significant effect of location of building on quantity and type of micro-organisms (Sarkhosh *et al*., 2021). Indoor air pollution can be as deadly as outdoor pollution. The quality of air in huge traffic around an area or a building is a matter of concern where thousands of workers including the customers are exposed to air pollution. It determines our health and has a direct impact on the economy influencing the productivity of that building's occupants. Healthy life means active workers and positive economic growth. Therefore, this

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research was carried out in an enclosed area of Empress market where high traffic was observed. Furthermore, it is the busiest, most crowded historical market place to determine whether or not this oldest building is sick, the study also aims to know about the workers' awareness of SBS.

Materials and Methods

Study area. Empress market is in the center of Saddar town, which is the multi-traditional business hub of Karachi, Pakistan. Saddar town is situated between 24° 51' and 30.5280" N; 67° 0' and 6.7824" is E coordinates. The town is also considered as the heart of Karachi. Empress market is one of the oldest, historical and the busiest market place where workers are selling commodities in huge amounts.

In 1995, Empress market was declared as a Pakistan protected heritage site. The building is made from red bricks, cement and painted through calcium hydroxide called slaked lime or commonly known as Chuna. This building was designed in a symmetrical manner. A courtyard between enclosed areas with its motto is 'under one-roof shopping culture'. There are nearly 258-280 shops and 347 stalls (Soomro *et al*., 2020; Soomro and Soomro, 2017).

Sampling method. Empress market was selected as a historical and busiest place to study the health problems related to a building as well as to provoke awareness about SBS among the workers. It is situated between 24° 51' 26.99" N and 67° 01' 27.60" E coordinates. According to Google earth it covered an area about 4,678 m^2 and perimeter about 286 m (Fig. 1). The survey was conducted in October 2018 by filling questionnaire forms. On Saturday, during day time (9:00 a.m. to 4:30 p.m.) 20 questionnaires were filled in random order almost in all parts of an enclosed area of the market.

In this study all stall keepers and those workers who work in the courtyard and outside area of the market were excluded owing to the fact that they worked in an open area of the market. There were no records with respect to the number of workers so, it could be around 258 workers. Simply those workers selected who worked in an enclosed area of the market for the study. Consequently, only 20 workers agreed to fill the questionnaire. Respondents all were male as shown in (Fig. 2). This survey includes two parts, namely demographic and workplace data.

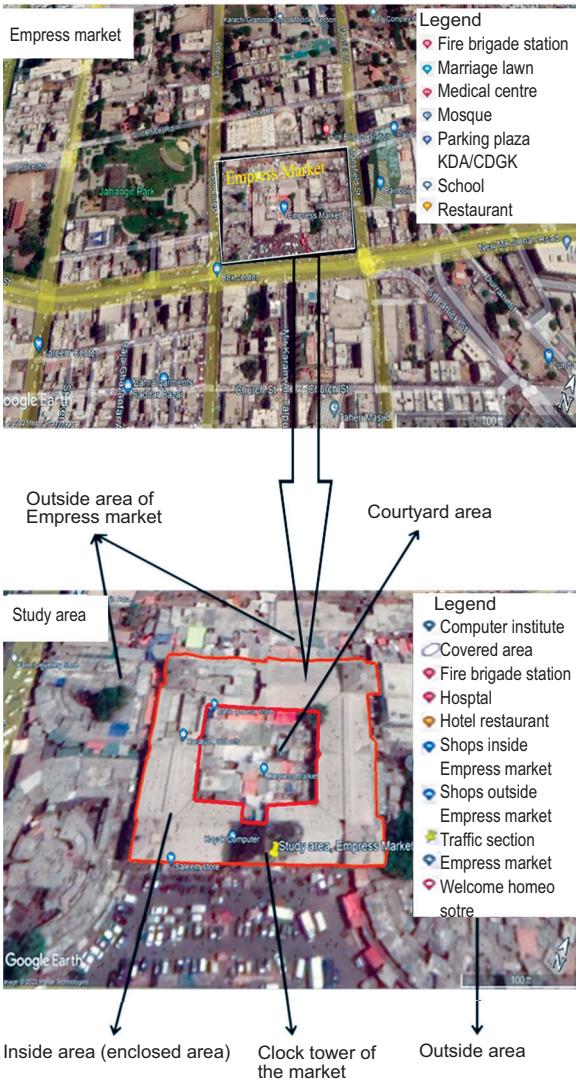

Fig. 1. Study area, Empress market, Karachi, Pakistan.

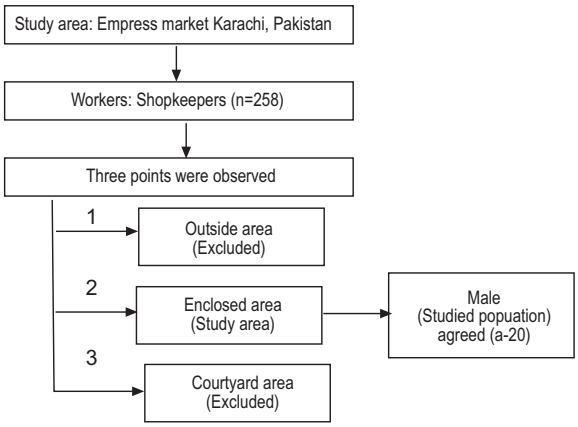

Fig. 2. Flow chart of selection of point.

Demographic data. The first part of the questionnaire include demographic information which includes age, residing area location, education, job description, gender, age of residing building, number and type of windows, time of exposure to dust and smoke, presence of any workplace in the vicinity of residing place building.

Workplace data. The other part of the study was about their workplace and the influence of the workplace on the respondent. It constitutes the duration at workplace, age of building, feeling of illnesses (if yes, it is better on the days away from building), exposure to active or passive smoke, fungal growth (visually noticed), heating/cooling and humidifier system, ventilation system, awareness about SBS, maintenance and cleaning of building. Lastly their comments were recorded.

Ethic statement. The questionnaire was filled after asking permission from the respondents. Before filling the questionnaire, respondents were informed that the survey is related to sick building syndrome to give them awareness about SBS.

Results and Discussion

Demographic data of the workers. There were approximately 280 shops where workers were almost of different ages. In this study 20 workers' ages ranging from 27-60 years and their average age (years) grand total was 38.8±12.57 years by using pivot data. Few of them attended middle school, whereas the majority attended secondary school, graduated, while others were uneducated.

Moreover, 4 workers' residing in the building is >15 y., 7 workers 10-15 y., 6 workers 6-9 y. and 2 workers 2-5 y. On the other hand, 1 butcher man has a workplace near his residence and that was more than 15 years old. Number of windows in their living-place was < 3 and windows were sliding, mostly residential place areas contain only 1 window. It showed that the demographic condition in respect of ventilation was poor.

Workplace data. The study demonstrates that some of them have been working there for more than 10 years, while others were new to the work place, their ages between 20-30 years. Table 1 shows that the workers spent almost 9-12 h/day in the market, some spent 6-8 h and some more than 12 h.

95% workers were exposed to active smoking along with passive smoking. During this survey more than half of the workers agreed that heating/cooling and humidifier systems were available at the workplace. Depending on 20 respondents, 60% of workers were using fans, windows and opened areas for ventilation, whereas 40% were unaware of ventilation systems.

According to this study workers at Empress market attended secondary school, while few attended middle school, graduated and several were illiterate but the

Table 1. Workplace data of workers

Illnesses	Heating/cooling and humidifier system			
	Don't know	No	Yes	Grand total
Duration at workplace		2		2
<12 h				
dry throat		1		1
headache and fatigue		1		1
6-8 h		1	2	3
headache and fatigue		1	2	3
9-12 h	1	6	8	15
Allergy			1	1
anxiety and depression		1		1
dry throat			2	2
headache and fatigue	1	3	5	9
runny nose		1		1
sinus problem		1		1
Grand total	**1**	**9**	**10**	**20**

The results from Fig. 3 revealed that more than half of the workers complained of headache and fatigue and the rest of them faced dry throat, runny nose, allergy, sinus problem, anxiety and depression.

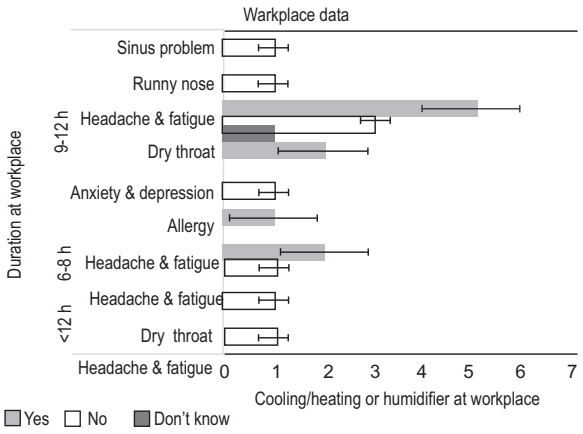

Fig. 3. Work duration and ailments of the workers at workplace.

study conducted on office workers in Mashhad, Iran, there was no meaningful connection between SBS and schooling/education (Sarkhosh *et al*., 2021). The workers were shopkeepers, sellers/salesman, butcher, shop-holder, printer and tailor. There was no occupational activity like factory near the residing area of the workers, one of the butcher was living near the Empress market. Most workers spent overtime at their workplace however, according to National Labour law profile of Pakistan, standard working hours/day are 9 h moreover 48 h/week including prayer and lunch time. It should not exceed than these hours. Their health will be affected due to overtime at the work-place, Sarkhosh *et al*. (2021) observed that more than 8 h/day showed significant relation with SBS.

Thus, headache and fatigue are common symptoms among workers of the market. They mentioned that the headache and fatigue disappear when they go away from the workplace building. A study in Singapore, reported that fatigue and drowsiness were found as common symptoms (Thach *et al*., 2019). Similarly, in Iran, Mashhad, drowsiness, headache, feeling exhausted and heavy head, skin dryness, weakness and muscle pain were common symptoms among office workers (Sarkhosh *et al*., 2021).

Another study revealed that the main causes of SBS are poor ventilation and carbondioxide (Dutheil *et al*., 2022). Nonetheless, it was observed that with high traffic around Empress market, there was an increased concentration of CO level among customers and sellers. Male gender being a contender of this huge traffic that exhales high concentrations of CO level, which has highly chronic effects on old age people (Sabzwari and Fatmi, 2011). There was no significant relationship between weather and SBS but humidity was significant with SBS, which is discovered by Sarkhosh *et al*. (2021).

All the workers were frequently exposed to dust, smoke and noise as they travel all the way home to their workplace by means of public transport, they do not use any protective measures. Smoking or even second-hand smoking can lead to certain chronic diseases including lung disease, cancer, cardiovascular diseases and as well as neurocognitive deficits, WHO (2022) reported that smoking leads to > 8 million deaths per year (>7 million due to active and 1.2 million passive smokers death occur) in addition, 1.3 million users live in developing countries. Researchers found a significant association between IAQ (Indoor air quality) and SBS. Problems associated with indoor air environments are the main reason of SBS (Wang *et al*., 2022; Thach *et al*., 2019; Heffernan, 2016).

The cleanliness of the market is the responsibility of Karachi Metropolitan Corporation but they only visit the market twice a year just to collect the rent. Cleaning is done only twice a week by the workers their selves, they have kept personal sweepers for cleaning.

Meat shop which needs proper cleaning and a hygienic environment which was one of the dirtiest places in the market. They cleaned it twice a week and just with water and no other detergents etc. were used to clean up. Certain fungal growth was observed in some zones in the meat shop. Microbiological analysis is required to study fungus growth in meat shop areas. Moisture is the main reason of fungal growth. Exposure to fungus can lead to disease like asthma or rhinitis and it is reported that there were many studies found association between fungal exposure and respiratory symptoms moreover, indoor species of fungus depend on climate and building construction (Baxi *et al*., 2016). There was an unbearable odor but it was quite normal for them.

The other place in the market was the spice shop where varieties of spices were sold. Shopping around this area caused continuous irritation of the throat and eye even to the customers. Although the shopkeepers around it were habitual to the odour. The shops inside it which is very packed with very little ventilation. Soomro *et al*. (2020) reported that the well ventilated and barrier free space of this market was lost. It was observed that workers were using in candescent light during day time, which shows that there was a blockage of natural sources of light.

The study shows that most areas had mechanical sources (fan) for ventilation. One of the respondents (worker) said that before the construction of shops around the market it was fully vented with continuous air flow but the new construction around the market (illegal shops) blocked the air flow.

Although this study contains a small number of workers, extensive data is required in order to find accurate results of SBS. However, Empress market can be considered as sick building because more than half of the workers faced the same issue *i.e*. headache and fatigue and they don't have these problems when away from the market place.

According to Raosoft the sample size calculated was 20 with confidence interval 90% and with the 7% error, for 5% we should have taken 30 samples but that was not feasible during data collection because respondents were not ready to answer the questions. Hence, a comprehensive assessment of IAQ of the Empress market and for the lifestyle of the workers required to be done.

Conclusion

For the first time, a study on sick building syndrome was conducted at the historically significant Empress Market in Karachi, Pakistan. It is concluded that workers faced common health illnesses *viz*. headache, fatigues and dry throat when they are in the market place. Especially when they spend overtime they had headache and fatigue. As aforesaid, the main cause of SBS is poor ventilation in the workplace also owing to the stall holders having covered up their area blocking natural light and ventilation that was causing ill health issues. Even though the design of the market provides the best natural ventilation system, unfortunately at the time of survey workers were using fans and lights, likewise the number of windows in their residential place was less, and consequently, workers faced poor ventilation in both the market and residential place.

Recommendations

Moreover, a comprehensive survey along with assessment of an IAQ required to study sick building syndrome of Empress market. Furthermore, it consists of workers health, job satisfaction, environmental condition, work's ergonomics, stress level, demographic information, building design after encroachment of illegal shops on outside area of the Empress market. Indoor air quality should be monitored through accurate devices. An adequate maintenance of the building by the concerned authorities and regular checkups of the workers is recommended. Indoor smoking should be strictly prohibited. Aerosol products like air fresheners should be avoided.

Illegal encroachment should be observed and strictly controlled which leads to the condition like SBS but simultaneously they should provide them a place where they can restart their work to resolve the socio-economic issues.

A shopkeeper suggested that: "Awareness programs regarding healthy environment and cleanliness should be initiated in the market".

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Conflict of Interest. The authors declare that they have no conflict of interest.

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