Effects of Working Environment and Stress on Sick Building Syndrome among Manufacturing Employees

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Abstract

Unhealthy employees are inclined to be absent from work and tend to have low job performance and productivity. Among the most cited causes of employees' illness are Sick Building Syndrome (SBS) and stress. However, empirical evidence on the effects of ventilation, temperature, lighting and noise and stress on Sick Building Syndrome (SBS) are inconsistent and fragmented in nature. The combined effects of both physical environment and psychological state of stress on SBS have not been investigated in tandem with each other. Therefore, this study focused on effects of physical aspects of workplace in terms of ventilation, temperature, lighting and psychological aspect in terms of stress on Sick Building Syndrome (SBS). Gender and age were controlled as these variables were often regarded to have spurious effects on the relationship among constructs. Data were collected via self-administered survey among 447 manufacturing employees. It is found that only temperature and stress have significant effects (R2= 62.6%) on SBS when age and gender were controlled. Stress has the highest Beta value which indicates stronger influence on SBS. The finding indicates the importance of both management and prevention of physical and psychological aspects of workplace for reducing occupational hazard such as SBS. However, stress might pose a greater risk for employees suffering from SBS.

Keywords
Sick Building Syndrome; Stress; Working Environment; Manufacturing

1. Introduction

The sick building syndrome (SBS) covers numerous nonspecific symptoms experienced by employees working specific buildings such as headache, eye, nose or throat irritation, dry or itching skin, hoarseness of voice, allergies, cold, and flu-like symptoms. This feeling of ill health increases absenteeism and causes a decrease in productivity of the workers. As SBS is progressively becoming a major occupational hazard all over the globe, the cause, management and prevention of SBS has become imperative. According to The World Health Organization, 20% of the USA, and 20% of the Western Hemisphere population is subjected to Sick Building Syndrome (SBS). In USA alone, almost half of working US population or 64 million employees has reported SBS symptoms. The estimated national productivity decline is about 3% (Runeson-Broberg & Norbäck, 2013). In Malaysia, however, the prevalence of sick building syndrome in Malaysia is unknown. However, based on three separate local studies (Ahmad & Hassim, 2015; Fadilah, 2012; Fauzan, Jalaludin, & Choo Chua, 2016), SBS prevalence in Malaysia is estimated from about 30 to 70 %. In terms of empirical evidence, majority of studies have been focusing on office employees (e.g. Abdel-Hamid, A Hakim, Elokda, & Mostafa, 2013; Fadilah, 2012) and the effect of physical working environment such as ventilation (e.g. Maddalena et al., 2015), and ventilation contaminants (e.g. Norbäck & Nordström, 2008). Only several studies (Crawford & Bolas, 1996; Mendelson, Catano, & Kelloway, 2000) have included both the physical and psychological aspects of workplace and their influence on SBS. Furthermore, the role of stress and predictor or outcome of SBS is unclear. This is further compounded with the facts that SBS symptoms and stress symptoms are overlapping to certain extent. As such, this study focuses on the effects of physical work environment (temperature, ventilation, lighting and noise) and psychological stress on SBS among manufacturing employees.

This paper is organized as follows. Section 2 reviews literature related to formulation of hypotheses while Section 3 discusses the methodology used. Section 4 highlights the result of this study and finally Section 5 discusses the results and concludes this paper.

2. Literature Review

Research on identifying the single cause of SBS has been ongoing since the 1970s, but to no avail (Passarelli, 2009). It is claimed that the cause of SBS is stemmed from several factors that work in tandem with each other. Majority of studies (e.g. Cao, Shang, Dai, & Zhu, 2013) have been highlighting quality and effectiveness of the internal ventilation system as the main cause of SBS while the psychological aspect such as stress has not received adequate attention. In fact, several researchers such as Ooi (1997)and Lu et al. (Lu et al., 2007) claimed that SBS may not be sole dependent on physical aspects of workplace. Ooi (1997) in particular argued that despite substantial improvement of physical working environments, cases of SBS have not receded.

2.1 Working Environment and Sick Building Syndrome

Epidemiological theory of accident causation reiterates that the relationships between environmental factors and disease. In essence, ineffective circulation and ventilations contamination within the atmosphere from both inside and outside the building could be the major cause of SBS. Prolonged exposure to high numbers of ventilation contaminants such as CO, CO2, VOCs could cause headaches and fatigue to shortness of breath (Joshi, 2008). It is estimated that the VOC levels in confined spaces sometimes reach 100 times those of outside air (AIHA Construction and Toxiology Committees and Green Building Working Group, 2017). Similarly, an environment with extreme temperature (too hot or too cold) causes adverse physical reaction employees especially to those who are susceptible to either extreme temperature. Moreover, dry, airless conditions could lead to coughing, a sore throat and, in some cases, increased risk of dehydration adding to distress on the human body. On the other hand, noise pollution within buildings is inevitable due to operational activities and use of machines. Nonetheless, high level of noise could impair hearing and disrupt effective communication (Suter, 1991). Lighting is an important aspect in working environment where a lack of natural daylight or mechanical lighting can cause discomfort to employees. Lighting should be equally distributed, does not flicker, too bright and emit the right type of lighting for employees' comfort. Studies on the effects of ventilation and temperature are numerous (Scopus data from 2000 to present indicate at least 26 studies) while studies on noise and lighting is lacking. Despite numerous studies on ventilation and SBS, the findings are divergent.

2.2 Stress and Sick Building Syndrome

According to The Environmental Illness Resource (EIR), 2007), stress and anxiety resulting from the working position, for long periods of time, and pressures of meeting work criteria can also contribute to the causes of SBS. In similar vein, The General Adaptation Syndrome also indicates the diminishing body immune system if the cause of stress has not abated. In terms of empirical gap, the causal linkage between stress and SBS has been speculative at best due to design limitation (P. L. Ooi & Goh, 1997) . However, Ooi and Goh (1997) argued that stress is more likely the predictor based on the increasing prevalence of SBS despite improved work environments. In their study, they found that employees who had high level of physical and mental stress are more likely to report SBS. Furthermore, there are emerging studies on the effect of psychosocial factors such as low social support (e.g. (Runeson-Broberg & Norbäck, 2013) and role overload (Mendelson et al., 2000). In fact, Crawford and Bolas (Crawford & Bolas, 1996) proposed a model linking stress and SBS via the psychophysiological pathway. Based on this model, this study is aimed to test the effect of both work environment and stress on SBS.

3. Methodology

This study used cross-sectional survey to collect 447 manufacturing employees' perception on working environment (ventilation, temperature, lighting and noise), stress and SBS. All items in the questionnventilationes used 5-points Likert Scale on frequency of occurrence (1 – Never to 5 – Frequent). There were twelve items measuring working environment, seven items measuring stress and another seven items measuring SBS to yield a total of 26 items. These items were adapted from several established measures such as Perceived Stress Scale (Cohen, Kamarck, & Mermelstein, 1983), and Office Environment Survey (Alan Hedge & WIllian A. Erickson, 1997). Each measurement was found to be reliable with Cronbach's alpha values ranging from 0.707 for working environment, 0.864 for SBS and 0.888 for stress. Exploratory factor analysis (EFA) was performed to ensure measures' validity. Kaiser-Meyer Olkin (KMO) measurement of sampling adequacy for all measures was more than 0.5 (Working Environment' KMO= 0.777; SBS's KMO = 0.864; Stress's KMO = 0.888), and significant at $p< 0.001$. Working environment' items loaded to four factors which accounted for 63.73% of variance. SBS's items yield a single factor that explained 56.05% of variance while stress was also a single factor with 59.84% of variance explained.

Once the reliability and validity of the measures had been established, data were analyzed descriptively and inferentially using multiple linear regressions. Descriptive data were tabulated in terms of frequency, mean and standard deviation. Temperature, Ventilation, Noise, Lighting and Stress were regressed on SBS while controlling for gender and age.

4. Results

This section presents the results of data analyses that were performed after data cleaning. Majority of respondents in this study were male (53.2%) while the balance was female (46.8%). Majority of respondents is between 20 to 30 years old (55.7%), followed by 30.4% 31 to 40 years old, and 12.8% is between 41 to 50 years old. Majority (60.9%) has been working 1 to 5 years while 22.6% between 6 to 10 years, 10.1% has been working 11 to 15 years.

4.1 Descriptive Results

As shown in Table 1, ventilation quality and temperature were perceived as satisfactory (M=2.593, SD=0.694; M=2.487, SD=0.668) while lighting and noise were considered very good (M=3.677, SD=1.281; M=3.106, SD=0.67). However, standard deviation for the lighting is very large indicating disagreement among responses. This might indicate that good lighting is not evenly distributed throughout the companies. In terms of stress, the mean is low indicating low stress level perceived by the respondents. However, in terms of SBS prevalence, the mean is moderate (M=2.45) indicating presence of SBS symptoms.

Table 1. Descriptive Statistics

Variables		Freq	%	Mean	SD
Working Environment					
Ventilation				2.593	0.694
	Poor (1.00 - 2.33)	180	40.3		
	Satisfactory (2.34 - 3.66)	200	44.7		
	Very Good (3.67 - 5.00)	67	15		
Temperature				2.487	0.668
	Poor (1.00 - 2.33)	181	40.5		
	Satisfactory (2.34 - 3.66)	227	50.8		
	Very Good (3.67 - 5.00)	39	8.7		
Lighting				3.677	1.281
	Poor (1.00 - 2.33)	22	4.9		
	Satisfactory (2.34 - 3.66)	164	36.7		
	Very Good (3.67 - 5.00)	261	58.4		
Noise				3.106	0.67
	Poor (1.00 - 2.33)	42	9.4		
	Satisfactory (2.34 - 3.66)	219	49		
	Very Good (3.67 - 5.00)	186	41.6		
Stress				2.128	0.828
	Low (1.00 - 2.33)	274	61.3		
	Moderate (2.34 - 3.66)	147	32.9		
	High (3.67 - 5.00)	26	5.8		
Sick Building Syndrome				2.45	0.733
	Low (1.00 - 2.33)	206	46.1		
	Moderate (2.34 - 3.66)	203	45.4		
	High (3.67 - 5.00)	38	8.5		

4.2 MLR Results

Multiple linear regressions performed indicate that both physical and psychological factors explained 62.3% of variance in SBS (Model 1). When gender and age were controlled, the variance explained increased slightly to 62.6% (Model 2). However, only two variables were significant predictors which are temperature and stress as shown in Table 2. In terms of strength, stress has stronger influence on SBS compared to temperature. This implies that individual psychological state has greater effect on SBS symptoms rather than the physical workplace inadequacies.

Table 2. Regression Results on Predictors of SBS

	Model 1			Model 2		
Variable	B	SE B	β	B	SE B	β
Temperature	0.171	0.036	0.171**	0.171	0.036	0.0171**
Ventilation	0.021	0.033	0.023	0.023	0.033	0.026
Lighting	-0.005	0.036	-0.005	-0.001	-0.02	-0.01
Noise	-0.031	0.036	-0.027	-0.025	0.037	-0.022
Stress	0.692	0.034	0.694**	0.688	0.034	0.69**
Gender				0.088	0.048	0.055
Age				0.019	0.032	0.017
R^2		0.623			0.626	
F for change in	R^2	145.528**			104.858**	

* $p<0.05$ ** $p<0.001$

5. Discussion and Conclusions

The findings of this paper indicate the superior influence of psychological factors over working environment. In fact, this study indicates alignment with the Herzberg's Two Factor Theory where the presence of motivator would improve job satisfaction while the absence of hygiene factors would lead not lead to more satisfaction. In a nutshell, the working environment must be conducive for working but its inadequacies would not lead to SBS unless severe. However, stress has far reaching effect and in fact might be the mediator between the link of work environment and stress. In fact Abdullah, Abdul Hamid, Amirul Shaif, Shamsuddin, & Wahab (2016) argued that there is a need to examine this interaction more closely.

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