

# Risk Factors and Prevalent of Sick Building Syndrome among Back-office Workers in a Thai University Hospital

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## Abstract

**Objective:** To investigate risk factors and prevalent of sick building syndrome (SBS) among back-office workers in a Thai university hospital.

**Methodology:** This cross-sectional study was conducted among 165 back-office workers who always had been working in their office rooms not less than 3 months. Two anonymous self-administrated questionnaires collected data. Ten parameters of Indoor air quality were measured by air sampling. Multiple logistic regression was used to identify risk factors associated with SBS.

**Result:** The prevalence of SBS symptoms was 80% sample, followed by 68.5% with less specific symptoms and 41.8% suffering from poor concentration, with 40.6% experiencing similar prevalence in both groups of irritated, dry or watering eyes, and irritated, runny or blocked nose dry, and 26.7% sore throat. The result of the model shows that neuroticism, visual display terminal used, and allergy history were risk factors related to SBS (p-value <0.05).

**Conclusion:** Neuroticism, allergy history, and visual display terminal used were risk factors of SBS. These findings suggest that hospital administrators should be aware of neuroticism worker, allergic history, and visual display terminals used to prevent SBS symptoms among back-office worker who may leave their jobs due to aggravated symptoms and decreased productivity.

**Keywords:** Sick building syndrome, Back-office worker, Hospital, Allergy history, Neuroticism, Visual display terminal.

## Introduction

Sick building syndrome (SBS) is an acute health effect experience of the occupants. It seems to link occupant spent time in the building that cannot identify as a specific cause or the symptom, different individual symptom experience in the same

building <sup>(1)</sup>. The cause of SBS is usually directed to several factors that work in combination and build up to a point at which people within the area start to be physically affected <sup>(2)</sup>. Usually, the symptoms disappear or improve altogether when occupants left out the building and the symptoms often return when they re-entered the building <sup>(3)</sup>. Prevalent of SBS in hospitals

in Thailand was 24.62% up to 70.80% <sup>(4, 5)</sup>. SBS etiology was reported as occupational factors, working related to equipment like computer, carbonless paper,

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photocopier, fax machine, printer, etc. <sup>(6-8)</sup>

Therefore, the investigators would like to study back-office workers who work in a hospital. While most studies concerns SBS have been conducted in cold climate countries, limited research in hot/humid climates. Air conditioners were used extensively in Thailand and mostly were split type. The air condition rooms usually had no ventilation. The literature on personality traits related to SBS was also limited in Thailand.

### Methodology

A cross-sectional comparative study conducted on 165 back-office workers in a tertiary university hospital in Thailand who had been working for not less than 3 months and always works in their offices. The air conditioner system in their offices was a split-type system.

**Questionnaire Survey:** Two self-administered questionnaires collected independent variables and dependent variables. Work sensation and SBS symptom questionnaire included: Occupant characteristics contained gender, age, and allergy history; Work conditions explained work related equipment, working hours/week. Also, SBS symptoms were at least one symptom experience while workers spent time in the workplace and did not occur at home within 3 months. There were 5 symptom groups included; (I) irritated, dry or watering eyes (sometimes described as itching, tiredness, redness, burning or difficulty wearing contact lenses); (II) irritated, runny or blocked nose (sometimes described as congestion, nosebleeds, itchy, or stuffy nose); (III) dry or sore throat (sometimes described as irritation, upper airway irritation, or difficulty swallowing); (IV) dryness, itching or irritation of the skin, occasionally with a rash; (V) less specific symptoms such as headache, lethargy, irritability, and poor concentration <sup>(9)</sup>. The personality type

questionnaire contained introversion/extroversion domain, and stability/neuroticism domain <sup>(10)</sup>. The personality type questionnaire classified personality type. This questionnaire consisted of 57 items to understanding personality of Eysenck's Personality Inventory (EPI). There were three scores, extrovert score (E score) and neurotic (N score) were out of 24. Lie score was out of 9 <sup>(10)</sup>. The questionnaires were prepared in English and translated into the Thai language. The content validity of instruments was conducted by an expert panel to review, edit, and double-check the questionnaire to ensure the validity of the initial and translation (IOC  $\geq 0.5$ ). Data collected in the questionnaires after obtaining ethical approval from the Human Research Ethics Committee of Thammasat University, No.3 (No.017/2020). Thai questionnaire, reliability was evaluated and calculated the Cronbach's alpha by SPSS. The acceptable value for each item was  $> 0.75$ . Data collection, workers self-reported 2 questionnaires and returned them to the investigator 1 week later.

**Indoor Air Quality Assessment:** Indoor air quality parameters were measured by sampling equipment. Eight parameters of IAQ, temperature, relative humidity, carbon dioxide, carbon monoxide, ozone, formaldehyde, volatile organic compounds, and particulate were recorded half an hour for four time slots <sup>(11)</sup>. Each slot recorded data every 5 minutes. The concentration level of each parameter was calculated from the average of 4 time slots. Mould and bacteria samples were collected 250 liters <sup>(12)</sup>. The mould was cultured in 2% Malt Extract Agar (MEA) and incubated for 5 days at 25°C. Bacteria were cultured in Tryptone Soya Agar (TSA) media and incubated by incubator for 2 days at 35-37°C. Bacteria and mold were counted every 24 hours after incubation for 18-24 hours <sup>(13)</sup>. Indoor air data were compared with Singapore Standard SS: 2009 <sup>(14)</sup>.

**Statistical analysis:** After data collected and entry completed, categorical variables were presented as frequency and percentages, while mean and standard deviation presented continuous variables. The binary logistic regression was used to identify factors associated with SBS. Univariable model was performed to calculate the crude odds ratio (COR) with a corresponding 95% confidence interval. The potential risk factors associated with SBS in the univariable analysis with *p*-value <0.10 or clinically relevant factors were included into the multiple

logistic regression using backward selection with 0.05 level of significance.

**Result**

Among the 18 back-office rooms in a tertiary university hospital in Thailand. Table 1 shows indoor air quality measurement result. More than 5% of the rooms were nonstandard IAQ parameters, temperature (11.1%), relative humidity (5.6%), formaldehyde (44.4%), and bacteria (33.3%).

**Table 1 indoor air quality measurement result (n=18).**

Indoor air quality parameters	Min	Max	Mean	SD	Nonstandard	Standard	
					Number (%)	Number (%)	
Temperature (°C)	23.4	27.0	25.0	0.8	2 (11.1)	16 (88.9)	
Relative humidity (%)	44.0	73.2	59.2	6.6	1 (5.6)	17 (94.4)	
Carbon dioxide (ppm)	110	611	344.72	146.33	0 (0.0)	18 (100.0)	
Carbon monoxide (ppm)	0.00	1.10	0.36	0.35	0 (0.0)	18 (100.0)	
Ozone (ppm)	(below than limit of detection)				0 (0.0)	18 (100.0)	
Formaldehyde (ppm)	0.01	0.34	0.12	0.09	8 (44.4)	10 (55.6)	
Volatile Organic Compounds (ppm)	0.88	1.65	1.11	0.18	0 (0.0)	18 (100.0)	
Particles (mg/m3)	PM 2.5	2.30	14.90	6.48	3.42	0 (0.0)	18 (100.0)
	PM 10	7.30	39.80	19.96	8.76	0 (0.0)	18 (100.0)
Mould (cfu/m3)	35	305	123.6	67.3	0 (0.0)	18 (100.0)	
Bacteria (cfu/m3)	170	1,325	455.0	289.1	6 (33.3)	12 (66.7)	

Table 2 shows 5 groups SBS symptom prevalence. Most of the participants (80%) had experienced at least 1 symptom and 1 day per week. They had experienced at least one SBS symptom, included 1-3 day/week and ≥4 day/week. Most of them had experience SBS symptom 1-3 day/week in all symptom groups; (I) less specific symptoms such as headache, lethargy,

irritability, and poor concentration (68.5%); (II) dryness; itching, or irritation of the skin, occasionally with a rash (41.8%); (III) irritated, dry or watering eyes (40.6%), (IV) irritated, runny, or blocked nose (40.6%); and (v) dry or sore throat (26.7%).

**Table 2 Prevalence of sick building syndrome symptoms (n=165).**

Sick Building Syndrome <sup>a</sup> (n=132, 80%)	1-3 day/week	≥4 day/week	Total
	Number (%)	Number (%)	Number (%)
Irritated, dry or watering eyes	53 (32.1)	14 (8.5)	67 (40.6)
Irritated, runny or blocked nose	59 (35.8)	8 (4.8)	67 (40.6)
Dry or sore throat	35 (21.2)	9 (5.5)	44 (26.7)
Dryness, itching or irritation of the skin, occasionally with a rash	57 (34.5)	12 (7.3)	69 (41.8)
Less specific symptoms such as headache, lethargy, irritability and poor concentration	95 (57.6)	18 (10.9)	113 (68.5)

<sup>a</sup> Able to select more than one answer

Table 3 shows the total of 165 workers (89.1% female) was included in this study. The mean ( $\pm$  SD) age was  $36.10 \pm 9.06$  years. More than one-thirds (35.8%) of workers had a history of allergy. More than 70% used visual display terminal (VDT) (89.7%), photocopier (70.3%), and printer (90.3%) during their work. The distribution of personality type, introversion/extraversion domain, more than two-thirds of participants were introverts, and the rest were

extroverts (69.1% and 30.9%, respectively). Stability/neuroticism domain, more than a half of participants were stable, and the rest were neurotic. (57.6% and 42.4%, respectively). Workplace environment, nearly half of the participants worked in the nonstandard environment, temperature (3.6%), relative humidity (5.5%), formaldehyde (47.9), and bacteria (30.3%).

**Table 3 Number and percentage of independent variable (n=165).**

Variables		Number	%	
Gender	Male	18	10.9	
	Female	147	89.1	
Age (years) (Min=22, Max=59, Mean=36.10, SD=9.064)	<30	51	30.9	
	30-39	52	31.5	
	>39	62	37.6	
Allergy history	No	106	64.2	
	Yes	59	35.8	
Work related equipment	Carbonless paper	No	99	60.0
		Yes	66	40.0
	Visual display terminal	No	17	10.3
		Yes	148	89.7
	Photocopier	No	49	29.7
		Yes	116	70.3
	Fax machine	No	123	74.5
		Yes	42	25.5
Printer	No	16	9.7	
	Yes	149	90.3	
Working hours/week (Min=30, Max=56, Mean=39.39, SD=5.829)	<36	79	47.9	
	36-40	52	31.5	
	>40	34	20.6	
Personality types	Introversion/Extraversion domain	Introversion	114	69.1
		Extraversion	51	30.9
	Stability/Neuroticism domain	Stability	95	57.5
		Neuroticism	70	42.4
Indoor air quality	Temperature	Nonstandard	6	3.6
		Standard	159	96.4
	Relative humidity	Nonstandard	9	5.5
		Standard	156	94.5
	Formaldehyde	Nonstandard	79	47.9
		Standard	86	52.1
	Bacteria	Nonstandard	50	30.3
		Standard	115	69.7

Table 4 shows independent variable data and the relationship with SBS (n=165). The crude odds ratio (COR) of SBS with corresponding to 95% confidence level (95% CI) among workers with allergy history were 3.02 (95% CI: 1.17-7.81, *p*-value=0.023) compared to workers without allergy history, and worker who worked with visual display terminal (VDT) were also statistically significant (COR=3.28, 95% CI: 1.14-9.42, *p*-value=0.027). In addition, workers with neuroticism were 4.23 times more likely

to be SBS than those with stability (95% CI: 1.64-10.93, *p*-value=0.002).

In the multivariate level, it was shown that allergy history, working with visual display terminal and neuroticism were independently associated with SBS (adjusted odds ratio [AOR]: 2.83; 95% CI: 1.05-7.59, AOR =3.42; 95% CI: 1.10-10.61, and AOR =4.40; 95% CI: 1.65-11.74, respectively) as shown in Table 5.

**Table 4 The relationship of independent variables and SBS. (n=165).**

Characteristics			Number	SBS		Crude OR (95% CI)	<i>p</i> -value	
				n	%			
Gender	Male		18	13	72.2	1.00	0.386	
	Female		147	119	81.0	1.64 (0.54-4.96)		
Age (years)	<30		51	40	78.4	1.06 (0.43-2.60)	0.601	
	30-39		52	44	84.6	1.60 (0.61-4.19)		
	>39		62	48	77.4	1.00		
Allergy history	No		106	79	74.5	1.00	0.023 *	
	Yes		59	53	89.8	3.02 (1.17-7.81)		
Work related equipment	Carbonless paper	No	99	77	77.8	1.00	0.384	
		Yes	66	55	83.3	1.43 (0.64-3.19)		
	Visual display terminal	No	17	10	58.8	1.00	0.027 *	
		Yes	148	122	82.4	3.28 (1.14-9.42)		
	Photocopier	No	49	39	79.6	1.00	0.932	
		Yes	116	93	80.2	1.04 (0.45-2.38)		
	Fax machine	No	123	99	80.5	1.00	0.789	
		Yes	42	33	78.6	0.89 (0.38-2.10)		
	Printer	No	16	11	68.8	1.00	0.243	
		Yes	149	121	81.2	1.96 (0.63-6.11)		
Working hours/week	<36		79	63	79.7	1.00	0.985	
	36-40		52	42	80.8	1.07 (0.44-2.57)		
	>40		34	27	79.4	0.98 (0.36-2.65)		
Personality types	Introversion/Extraversion domain	Introversion	114	92	80.7	1.15 (0.51-2.56)	0.736	
		Extraversion	51	40	78.4	1.00		
	Stability/Neuroticism domain	Stability	95	68	71.6	1.00		0.002 *
		Neuroticism	70	64	91.4	4.23 (1.64-10.93)		
Indoor air quality	Temperature	Nonstandard	6	4	66.7	1.00	0.415	
		Standard	159	128	80.5	2.06 (0.36-11.79)		
	Relative humidity	Nonstandard	9	7	77.8	1.00	0.864	
		Standard	156	125	80.1	1.15 (0.23-5.82)		
	Formaldehyde	Nonstandard	79	62	78.5	1.00	0.640	
		Standard	86	70	81.4	1.20 (0.56-2.57)		
	Bacteria	Nonstandard	50	38	76.0	1.00	0.398	
		Standard	115	94	81.7	1.41 (0.63-3.16)		

**Table 5 Multivariate logistic regression analysis the factors related to SBS.**

Factors		Adjusted OR (95% CI)	p-value
Stability/Neuroticism domain	Stability	1.00	0.003 *
	Neuroticism	4.40 (1.65-11.74)	
Visual display terminal	No	1.00	0.033 *
	Yes	3.42 (1.10-10.61)	
Allergy history	No	1.00	0.039 *
	Yes	2.83 (1.05-7.59)	

## Discussion

The prevalence of SBS symptoms (80%) is higher than previous studies (24.62%-70.80%)<sup>(4, 5)</sup>. Etiology of SBS is difficult particular to identify, usually directed to several factors, work in combination and build up to a point at the people within the area start effects<sup>(2)</sup>. Allergy history related to SBS symptoms. The result was similar to the former study by Runeson et al. (2006) that SBS was associated with an allergy history<sup>(15)</sup>. The VDT had a statistically significant relationship with SBS. Consistent with previous research, VDT related to general symptoms, mucosal irritation, and eye irritation<sup>(8, 16)</sup>. SBS symptoms related to neuroticism. This finding supports previous study (Bobi et al., 2009) that reported neuroticism risk factors for SBS<sup>(17)</sup>. This study found not only three independent variables related to SBS, but also temperature, relative humidity, formaldehyde, and bacteria could contribute to SBS<sup>(7, 14, 18-20)</sup>.

Neuroticism is a personality trait that contributed to sensory processing more sensitivity factors as a predictor of subjective health complaints<sup>(21)</sup>. Sensitive person has allergic reaction when they exposure to minor allergen<sup>(22)</sup>. Worker with an allergic history, pre-existing allergic symptoms occur during the period of high temperature<sup>(23)</sup>. Relative humidity can indirectly affect the incidence of allergies, relate to allergenic organisms such as viruses and bacteria<sup>(24, 25)</sup>. Exacerbations of allergic symptoms as well

as with increased risk of allergy development have been associated with bacterial<sup>(26)</sup>. The usual sources of bacteria are building occupants, decomposed food, stagnant water, insects, bugs, pets, and condensation surfaces<sup>(14)</sup>. Formaldehyde is a sensitizer and irritant<sup>(27)</sup>.

Prevention of SBS should reduced risk factors by cleaning and ventilation<sup>(28)</sup>. Cleaning and ventilation can improve the indoor environment. A major factor in preventing SBS is cleaning<sup>(25)</sup>. The two purposes of ventilation are to provide fresh air and to remove or dilute pollution<sup>(9)</sup>. Using the VDT was related to SBS symptoms<sup>(29)</sup>. Provide information and training to the worker can improve the quality of life in the workplace as ergonomic postures, comfort, and maintaining the level of lighting<sup>(30)</sup>. Also, they have to keep moving and take breaks<sup>(31)</sup>.

Limitation of the study, most of the participants were more female than male (89.1% and 10.9%, respectively). Therefore, further evaluation of sex differences is needed using a larger number participants to confirm the findings.

## Conclusion

As a result, neuroticism, allergy history, and visual display terminal used were risk factors for SBS. Possible risk factors elimination may decrease SBS prevalence. The hospital administrators should improve not only indoor environment but also

cleaning back-office rooms. Back-office workers should get information and training using the VDT, and understand SBS.

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**Conflict of Interest:** Nil

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