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Sick building syndrome, work factors and occupational stress

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The sick building syndrome has been associated with certain buildings and environmental characteristics and is estimated to affect up to 30% of new or renovated buildings. Investigations have concentrated on physical factors, and it is only recently that psychological factors have been examined. Work and personal factors have also been considered. Occupational stress has been found to be correlated with symptoms of the sick building syndrome, but much of the research has been of a cross-sectional nature, and it does not indicate whether stress is an active element or an outcome. There is a clear need for further research in this area to examine stress, personality and physical factors associated with the sick building syndrome longitudinally. There is also a clear need to assess the validity of the historical and self-report methods used to assess the sick building syndrome.

Key terms control, environment, personality, review, symptom reporting, work stress.

Definition and prevalence

The sick building syndrome has been associated with the occupancy of certain office buildings, and it is estimated to affect up to 30% of new or renovated buildings (1). The cost of the sick building syndrome to business has been estimated at GBP 350 to GBP 650 million in the United Kingdom, giving an indication of the scale of the problem in this particular country (2).

Definitions of the sick building syndrome include “a syndrome of non-specific malaise, the onset of which is associated with occupancy of certain modern office buildings” (3), “the chronic and concurrent experience of a characteristic set of symptoms which occur when people are at their place of work but which disappear at evenings and weekends” (4), and “a group of symptoms which people experience while they are in specific office buildings” (5). For the purpose of this review, the following definition will be adopted: “a collection of symptoms suffered by staff whilst at work in certain buildings; however, not all staff will have the same type, number or severity of symptoms” (6).

The types of symptoms have generally been divided into various categories, for example, “dry” symptoms (stuffy nose, dry throat, dry skin), “allergic” symptoms (runny or itchy nose, watery itchy eyes), “asthma” (chest

tightness), and “general” (undue lethargy and headache) (7). A second method of classification by Molhave (8) was sensoric irritation (dryness, smarting, irritating sensation, dryness in the eye, nose or throat), skin irritation (reddening, stinging, smarting, itching sensation or dry skin), neurotoxic symptoms (mental fatigue, reduced memory, lethargy, drowsiness, reduced concentration, headache, dizziness, intoxication, nausea and tiredness), nonspecific hyperreactions (running nose and eyes, asthma-like symptoms, respiratory sounds) and odor and taste complaints.

Prevalence studies of symptoms show substantial divergence between researchers, possibly due to variations in methodology or definitions of the syndrome (6). The Building Use Studies Group (BUS) conducted a study of 46 buildings with 4373 occupants and found a very high prevalence of lethargy (57%), stuffy nose (47%), dry throat (43%), headache (43%), and itching eyes (28%) over a period of one year, with the rates significantly elevated for women (9). Various studies show that women report more symptoms than men (10, 11), although this difference may be explainable by innocuous factors such as eyewear (12) or allergy to nickel (13). The rank of employment within the organizational hierarchy has emerged as another well documented risk factor (9, 10), lower grade staff reporting more symptoms.

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Risk factors

Research into causal factors of the sick building syndrome have examined a variety of sources, often representative of the domain of expertise of the researcher. The factors investigated include air-conditioning (9, 14), low ventilation rates (15, 16), low air velocity (17, 18), high temperature (15, 16, 19, 20), low relative humidity (15, 20, 21, 22), public sector buildings (9), age of the building (23), and volatile organic compounds (24–27), among others.

It is not surprising that different studies produce different outcomes, since buildings are host to complex interactions of physical environmental factors and psychosocial processes. Thus, although certain generalizable conclusions emerge from the mass of studies concerned with physical factors, focusing specifically upon these at the expense of the psychological and sociological factors of the building occupants hampers progress in research on the sick building syndrome (28). The focus on physical factors occurs perhaps because those involved in the field initially tend generally to envisage the psychology of the sick building syndrome as incidental. In fact it is central to the syndrome (29). In the following sections work and personal factors will be addressed before the role of occupational stress within the syndrome is discussed.

Work and personal factors

Job category has appeared as a potent predictor of symptoms of the sick building syndrome in many studies (23, 30, 31), although there are exceptions (32–34). Hedge et al (30) found that job category had a direct effect on job stress, and a more detailed presentation (31) showed that job type was also related to environmental satisfaction and perceived ambient conditions, though these effects fell from the equation during further analyses. Clearly, job category can act as a surrogate for various other psychosocial factors that impact on worker stress. Wilson & Hedge (9) suggest that these factors could include increased sensitivity to the indoor climate among sedentary workers, increased exposure to indoor pollutants, and more physical stress within this group. Levin (35) reiterates many of these points and places heavy emphasis on control over the work area and control over time. He suggests that the former is implicated as a cause of personal stress and reduced resistance. Levin, however, is unclear on what is meant by reduced resistance. There is evidence to suggest, though not specifically in the context of the sick building syndrome, that increased stress can result in immunologic changes, as found by Kiecolt-Glaser et al (36).

Control at work and of the environment has also emerged as an issue for the sick building syndrome, the claim being that modern office practices systematically reduce the level of personal control available to employees (37). A discussion of the relation of health to personal control is beyond the scope of this review, but it has been covered extensively by Sauter et al (38). According to the job control-job demands model of Karasek (39), which suggests that low control and high demands lead to strain in the worker, and the fact that stress is associated with the sick building syndrome, then it is possible that the level of personal control is instrumental in the sick building syndrome process. This possibility clearly needs to be determined by further research.

Many studies have shown a higher prevalence of sick building syndrome symptoms for users of visual display units (VDU) (10, 11, 40, 41) and persons subjected to office technology that is usually accompanied by more repetition, meaningless and demands, yet less decision latitude and opportunity to learn new things (42, 43). The possibility that physical factors emanating from the VDU are responsible for reported symptoms within this group has largely been debunked, and the focus has shifted to the psychosocial correlates (44–46). At least one study testifies that VDU workers exhibit higher levels of stress hormones in their blood, which are highly correlated with skin symptoms similar to those of the sick building syndrome (47). Hedge and his colleagues (30, 31, 34), in the light of their results, maintain that VDU use elevates stress and that stress moderates the effects of physical factors. The possibility that VDU use influences the perception of control is worthy of consideration and surfaces in the preliminary analyses of Hedge et al (31).

Personal control within and over the work process has not been sufficiently well researched within the area of the sick building syndrome. Despite the salience of personal control at work and its relation to health as a topic worthy of further research (48), there are no studies pertaining to the sick building syndrome.

Environmental control, or control over the environment, has been suggested as a contributor to the etiology of the sick building syndrome and as a promising avenue of research (7). Wilson & Hedge (9) found that, in the case of temperature, 88% of those with six or more symptoms responded that they had little or no control, 9% reported that they were neutral with regard to control, and only 3% stated they had full control over temperature. Among the group that reported no symptoms, 60% reported little or no control over the environment, 23% were neutral, and 17% reported full control. Hedge et al (30, 31), in path analyses using the same population, found that environmental control was influenced by the ventilation system in use, control over lighting, office

type, and organization type. It is of note that in these analyses environmental control acted via both the physical ambient conditions and environmental satisfaction when influencing symptom levels. This result is not surprising, since the ability to control the environmental parameters would generally lead to more acceptable conditions, the exception being when everyone within the office attempts to enforce their preference. Jaakola et al (49), however, suggest that control adds something above and beyond the benefits of direct stressor reduction. After finding that both dissatisfaction with perceived temperature and the actual temperature predict eye symptoms, these authors suggested that a policy of individual worker control should be adopted.

Potential social stressors within the office include overcrowding and unwanted social interactions, especially within open plan offices (4, 35). Hodgson et al (50) found that central nervous system, eye, nose, and throat symptoms were all highly correlated with the number of workers sharing a space. Skov et al (10) and Wilson & Hedge (9) also found crowding to be a risk factor. However, there also exist studies that do not support a clear-cut association of crowding with symptom incidence (40, 41, 51).

As early as 1987 Morris & Hawkins (52) were calling for an approach to the sick building syndrome that examined the type of person and organization which suffer from sick building syndrome rather than only the complaint itself (52). Personality is potentially important since it may moderate the effect of the physical and social surroundings of the workplace or modify the reporting behavior of building occupants. The handful of studies in the area are inconclusive. Bauer (53) was unable to differentiate a control group from two groups representing different levels of symptom reporting based upon the scores of the MMPI (Minnesota multiphase personality inventory) and the SCL-90-R (symptom checklist -90-released). Hedge et al (12) failed to isolate any of the three personality scales they used as predictors of the sick building syndrome symptoms, including a depression scale and the EPI (Eysenck personality inventory). Bachmann & Myers (40) found that scores on the Profile of Moods States Questionnaire for occupants of two buildings predicted musculoskeletal, skin, and lower respiratory problems, as well as tiredness, and in a second building mucosal irritation and headaches were added to the list. The authors noted that it is dubious whether psychological variables cause the sick building syndrome, a contention shared by Baker (28). It is more likely, as Raw (5) notes, that they gain their effect by modifying symptom reporting. For example, it is well known that negative affectivity influences the interpretation of bodily sensations as abnormal or alarming (54), and in the same way personality can affect the way the indoor environment is perceived (55).

Stress and the sick building syndrome

While work has been carried out to examine the role of occupational stress and the sick building syndrome, we must be clear about the interaction between the physical environment, the work environment, and the organizational environment. An appropriate model to begin with is that of Cox & Ferguson (56). With it, occupational health is determined by both hazards in the psychosocial and organizational work environments and by hazards in the physical work environment (figure 1). While the latter, if unfavorable, exact their toll directly via a physicochemical pathway, they also moderate the effect of the psychosocial hazards operating along the cognitive and psychophysiological pathway. In turn these physical hazards are moderated by those of the psychosocial environment; thus it is an interactive model. In short, occupational health is determined by two closely linked processes, the first relating to the physical surroundings, and the second to the psychosocial variables. Not surprisingly then, given this model, "a failure to investigate psychosocial factors including level of job satisfaction and workplace stresses and strains may lead an investigator to attribute all symptoms to some physical source like ventilation problems [p 222]" (57).

The role of stress in this model is seen as a link between the work environment and the effects on worker health as an initiator along the psychophysiological pathway (56). The sick building syndrome in this model can be seen as acting along both the hazards in the physical work environment pathway and the psychosocial and organizational environment pathway. However when the outcome of the sick building syndrome (ie, the various symptoms) are examined, many of them are similar to the symptoms that result from occupational stress. The next section of this paper examines the research carried out to assess the interactions between the sick building syndrome and occupational stress.

Various researchers have found correlations between work stress measures and the reporting of sick building syndrome symptoms. Norbäck et al (58) found that an index of psychosocial dissatisfaction that included a measure of work stress correlated significantly with sick building syndrome symptom reporting in their Swedish sample. Hodgson et al (50) used seven scales of job stress by House et al (59) on a sample of office workers in the United Kingdom and found large correlations across all the scales. Morris & Hawkins (52) found that none of the environmental measures in three buildings correlated strongly with symptoms of the sick building syndrome, and this finding held on a longitudinal basis over four weeks. In all three buildings, however, measures of stress were elevated among those suffering at least one symptom. Crawford & Hawkins (60), in their assessments of emergency control rooms, found that

Figure 1. Model of the work environment and occupational health.

high rates of sick building syndrome symptoms were accompanied by elevated stress from organizational and managerial sources, increased feelings of lack of control at work, and high levels of job satisfaction. Although surprising, the high levels of job satisfaction may be related to the nature of the work of emergency control room staff. For example, there were not only tasks such as VDU work, but also dealing and coping with crisis situations on a daily basis, which many of the staff found challenging and satisfying. However, a stress effect and feelings of lack of control were still occurring, in addition to high rates of sick building syndrome symptoms.

The work of Alan Hedge and his colleagues (61, 30, 31, 34, 12) has consistently found strong associations of symptom reporting with reported stress. In the most recent study (12), a thorough investigation of the building and personal factors of 939 workers in Michigan and Alabama, job stress emerged as a significant predictor, even when role stress and role ambiguity were included. Hedge has suggested that stress sensitizes the individual to the affect of physical factors within the building, as would be predicted by the Cox & Ferguson model (56). Stenberg & Wall (11) concur, but additionally propose a direct effect of stress on symptom reporting, thus broadening the suggested role of stress. If susceptibility to the sick building syndrome is modified by stress, then one would expect physiological measures to reflect this susceptibility. In fact, as Hedge et al (61) note, evidence of this has not been forthcoming; studies in this area would certainly pay dividends.

In nearly all studies including a measure of work stress, there are significant correlations with reported symptoms. Where studies have failed to find associations (62), the failure has been attributed to inadequacies of a single analogue scale (34). Clearly, the research does implicate stress as a factor in the sick building syndrome. To date there are no substantial longitudinal studies focusing on stress as a factor. Correlational studies are inadequate in indicating whether stress is an active element in the etiology of the sick building syndrome.

A proposed stress model of the sick building syndrome

A proposed model of the sick building syndrome is displayed in figure 2. The first assumption is that both the psychosocial and environmental stressors lead directly to discomfort and irritation of the mucous membranes, dermal sites, and cognitive complications. Stress is known to result in health complications (63), some of which bear a strong resemblance to those of the sick building syndrome, for example, headache, lethargy, tiredness, dizziness, and nausea. The model assumes these symptoms are etiologically equivalent to those of the sick building syndrome in many problem buildings, and the confusion surrounding the syndrome arises partly through a reluctance to concede this fact. The stress arises from various factors, including the level of personal control, social relations, job demands, and organiza-

Figure 2. Model proposed for the sick building syndrome (SBS).

tional design and structure. Personality is expected to act as a moderator of the reporting of symptoms; however, this may not be the only contribution that personality makes to the syndrome. With the experience of these symptoms, there are the concomitant uncertainties suggested by Vyner (64) and an attempt to allay these uncertainties by attaching the discomforts to a source within the work context, as Colligan (65) notes. The presence of an odor, for example, would act as a focus for these attributions, irrespective of the validity of the attribution. This stage is more complicated, however, since the attributional process is guided by social processes, a perceived contingency of symptoms and environmental factors, media coverage, and the perception of work and the organization. In addition, based on the theory of Abramson et al (66), the character of the attribution in terms of the three dimensions of internal-external, global-specific, and stable-unstable is expected to affect health outcomes of the attribution (67, 68). Finally, the acceptability of the perceived cause of a person's symptoms and the personality of the worker are expected to contribute to the resultant stress.

Of note in the model is the role of conditioning of the stress response. Since it is assumed that stressful experiences and exposure to environmental hazards result in symptoms characteristic of the sick building syndrome, the onset of symptoms becomes conditioned to salient cues within the environment, whether these form the attribution or not. Baker (28) touched on the idea, and, using physiological data from VDU operators, Berg et al

(47) invoked, as the unconditioned stimulus for skin irritation, "the total work environment, both physical and psychological, where the computer and screen have become the center [p 700]."

There is one major assumption implicit in much of the research on the sick building syndrome, especially with regard to stress, that actually mitigates against valid conclusions. The outcome variable of regression analyses (the statistical method most often adopted) is the subjective report of symptoms experienced within a certain time period prior to the survey. Retrospective reporting is generally assumed to be vulnerable to cognitive distortions of time periods, for example, forward and backward telescoping, and other biases. With practically the whole edifice of research in this area resting upon the validity of these self-reports, it is surprising that very few researchers question the assumption. Although Franck and his colleagues (69) have provided a certain amount of evidence that objective measures of eye manifestations correlate with self-reported discomfort, these correlations are fairly meager, and it is as yet impossible to validate self-reports of other symptoms of the sick building syndrome.

With the preceding statement in mind, it is not difficult to imagine that certain personality variables are concomitant with a lower threshold of reporting *and* a tendency to rate the psychosocial climate as deleterious. Staw & Ross (70) have applied such reasoning to the satisfaction-performance debate that has plagued occupational psychologists for years. Alternatively, em-

employees' disillusionment with organizational integrity and perceptions of mistreatment by the organization manifests as a conscious decision to express dissatisfaction in a legitimate, but somewhat displaced fashion, through overreporting. In essence, the costs and benefits of the job to the individual would dictate the distortion of the self-report. The perceived level of stress would be one such cost, and its perceived acceptability would be a factor influencing the ultimate distortions of symptom reports. In this sense self-report becomes a vehicle for expressing global dissatisfactions and must be considered in the context of organizational politics as a tool to vent their effect and ultimately modify the benefits of the job. Perhaps the majority of workers in the field fail to appreciate the social dynamics from which neat tidy data are gathered. Thorn (29) and Baker (28) discuss some of these aspects.

Howarth & Istance (46) found that the more retrospective method of reporting eye discomfort of VDU workers (ie, that characteristic of sick building syndrome research) did not accord with a day-by-day report. Furthermore, according to measures at the beginning of the day, the proclivity to report discomfort appeared to vary among functional groups within the office. The authors did not speculate on the reasons behind this finding, but perhaps conscious distortions vary between groups as a function of the impact of different work characteristics.

Need for further research

It should be apparent from this review that stress and the sick building syndrome are closely linked. However it is unclear whether stress contributes to increased symptom reporting in relation to the sick building syndrome or that symptoms of the sick building syndrome are actually an outcome of work stress. One cannot but be disappointed in the cross-sectional methodology used to investigate the role of stress. There is a glaring need to adopt a sounder methodology that allows robust conclusions to be made in the domain of the psychology of sick building syndrome and one that allows us to progress from the tentative, vague phrases "is correlated with" or "is associated with."

There is also a need for systematic longitudinal research that addresses concurrently the role of stress, personality, and the physical factors known to affect rates of the sick building syndrome. However, it is equally important that findings be incorporated into a coherent testable dynamic model of the syndrome. The major moratorium on generalizable conclusions from research, and the apparent disarray within the field, does not lie with any inadequacies of the definition of the sick building syn-

drome, but with the absence of any uniting framework or paradigm that emphasizes the psychology of the syndrome. The heuristic model presented in this review is designed to remedy this problem.

There are numerous other questions still to be tackled with regard to the sick building syndrome. The first issue is the validity of self-reports with respect to the sick building syndrome. For example, what is the discrepancy between a day-by-day reporting scheme and a more retrospective account? If there is a discrepancy, then does it vary as a function of reported stress or satisfaction? If it does, what are the implications for the existing findings? Pennebaker & Watson (54) discuss factors influencing symptom reporting that are unrelated to the physical environment, and Leeshaley & Brown (71) document the distortions of self-report that can occur in cases of perceived toxic exposure. Although there are no specific studies relating to the sick building syndrome, it would appear justifiable to generalize from these related areas and suggest that the sick building syndrome is the psychology of reporting behavior, just as much as it is the health of office workers.

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