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The National Institute for Occupational Safety and Health Indoor Environmental Evaluation Experience. Part Two: Symptom Prevalence

Robert Malkin, Thomas Wilcox, and William K. Sieber

Division of Surveillance, Hazard Evaluations and Field Studies,
National Institute for Occupational Safety and Health, Cincinnati, OH 45226

In October 1992 a national news program aired a segment that discussed health effects associated with the indoor, nonindustrial environment. As a direct result of this program, by February 1993 the National Institute for Occupational Safety and Health health hazard evaluations program received approximately 500 requests to evaluate health and environmental problems in offices, schools, and other nonindustrial work settings related to the indoor environment. Of the 160 work sites selected for a site visit, 105 were office buildings. In 80 of these, the investigation followed a prescribed protocol for both symptoms and environmental data collection in a study area within each building. Using a standardized, self-administered questionnaire, symptom prevalences of 18 symptoms and 4 symptom groups were calculated using three different definitions: (1) on the day of the evaluation; (2) at least once a week during the preceding 4 weeks; and (3) at least once a week during the preceding 4 weeks, and having the symptom improve when the employee left the workplace. Prevalences of the most commonly reported symptoms, using the latter definition, were: tired or strained eyes (33%); dry, itching, or irritated eyes (30%); unusual tiredness, fatigue, or drowsiness (26%); headache (25%); tension, irritability, or nervousness (23%); and stuffy or runny nose, or sinus congestion (22%). All 18 symptoms were more likely to be reported by females, and 40 percent of female respondents reported experiencing at least one upper respiratory symptom (sore or dry throat, stuffy/runny nose or sinus congestion, or sneezing) at least once a week that improved when they left work. Limitations of the study include the nonrandom selection of buildings and the self- selection of the evaluated areas within buildings by the health hazard evaluation requestor. MALKIN, R.; WILCOX, T.; SIEBER, W.K.: THE NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH INDOOR ENVIRONMENTAL EVALUATION EXPERIENCE. PART TWO: SYMPTOM PREVALENCE. APPL. OCCUP. ENVIRON. HYG. 11(6):540–545; 1996.

Over the past 15 years the National Institute for Occupational Safety and Health (NIOSH) has received an increasing number of requests for health hazard evaluations (HHEs) concerning symptoms thought to be related to conditions in the indoor, nonindustrial environment. Similar problems have been investigated in Europe and other parts of the world.[1–3] In 1983 the World Health Organization defined "sick building syndrome" as increased prevalence of headache, fatigue, dizziness, irritative symptoms of the eye, nose, and throat, and airway infections.[4] As noted by Crandall,[5] after a television news broadcast concerning indoor air quality in October 1992, the NIOSH HHE program received approximately 500 requests by February 1993 concerning health and environmental problems in nonindustrial indoor environments. These requests represented a more than threefold increase in the yearly number of such HHEs.

The study of health effects in the nonindustrial indoor environment is a perplexing task in that the effects are symptoms in search of a disease and cause, and there are no definitive diagnostic tests for many of the symptoms.[6] NIOSH investigators assessed the prevalence of symptoms in a selected study area at each evaluated site using a standardized questionnaire. These questionnaires were combined from all sites to generate a database of buildings in which at least three employees (the minimum number required for a valid HHE request), a union representative, or management reported symptoms felt to be related to the indoor environment. The goal of this study was to use this database to generate data regarding symptom prevalences and environmental conditions across a wide variety of nonindustrial settings. This database could then be compared with an ongoing Environmental Protection Agency (EPA) study of nonproblem buildings from the nonindustrial workplace, known as the Building Assessment Survey and Evaluation (BASE) study, which is still in progress. This article provides a descriptive summary of symptom prevalences within office work sites that were identified by the HHE requesters as having health complaints, and compares them with symptom prevalences as described in initial reports from the BASE study. Future statistical analyses of these data will examine the relationship between environmental parameters and symptom reporting.

Methods

Because of the large number of requests for HHEs, the HHE program did not have the resources to respond to all 500 requests, and 160 were chosen by selecting every third request in the order in which they were received. Of these requests, 105 were from office buildings. The field work was carried out by industrial hygienists and medical investigators from various branches and divisions of NIOSH. A standardized protocol was developed for these evaluations for the purpose of devel-

oping a database which combined data from multiple buildings. Each investigation included an industrial hygiene evaluation of the building, interviews with selected building occupants, and a self-administered symptom questionnaire. All investigators received training concerning the study protocol.

In large buildings, questionnaires were to be administered to approximately 50 to 75 occupants of one contiguous area in the building of primary concern to the requesters, although the actual number may have been more or less than the projected 50 to 75 per site. If the number of occupants in the building was less than 50, investigators were instructed to administer the questionnaire to all occupants of the building. For each selected site, the protocol dictated that NIOSH investigators were to give questionnaires to all employees working in the evaluated area of concern to the requester who were present on the day of the investigation.

The questionnaire was based on a joint NIOSH/EPA questionnaire developed for evaluating the indoor environment, and asked for information on:

1. Symptoms experienced both on the day of the survey and during the previous 4 weeks, and whether symptoms got better, stayed the same, or got worse when the employee was "away from work (e.g., holidays, weekends)." Data were collected for 18 symptoms (Table 1).
2. History of physician-diagnosed illnesses (eight questions) that might be workplace related or might exacerbate work-related symptoms. These included sinus infection, migraine, eczema, allergies, or asthma (Table 4).
3. Perceived comfort parameters including temperature, odors, and humidity (nine questions), both on the day of the survey and during the previous 4 weeks (Table 5).

Potential frequency responses to the symptom questions included: (1) not in the last 4 weeks; (2) 1 to 3 days in the last 4 weeks; (3) 1 to 3 days a week in the last 4 weeks; and (4) almost every day. A follow-up question asked whether the symptom was experienced "today" (the day of the survey). For calculating prevalence rates, only symptoms reported frequently were considered; a response of 1 to 3 days a week in the last 4 weeks or almost every day was considered a "yes" response. Prevalences were calculated for symptoms that met this frequency requirement and were temporally associated with the workplace (i.e., the symptoms improved when the employee was away from the work site, for whatever period of time). These criteria have, in some studies of indoor air quality, been used to define a work-related symptom.[1,2] Since it is possible that a symptom that does not usually improve when away from the building could also be due to conditions at work, prevalences of symptoms without this temporal association are also reported, along with the prevalences of symptoms that participants reported experiencing on the day of the survey.

Several symptom groups were defined corresponding to organ systems, and prevalences were calculated for having one or more of the symptoms in a group at least once a week that improved away from work. System groups included upper respiratory symptoms (sore or dry throat, stuffy or runny nose, sneezing); respiratory symptoms (wheezing, chest tightness, cough, shortness of breath); and neurologic symptoms (headache, difficulty remembering things, unusual tiredness or fatigue, dizziness or lightheadedness).

To assess how severely employees were affected by symptoms, additional symptom groups were defined which required a participant to have more than one symptom, one day a week or more, that improved away from work. The multiple respiratory group required having at least three of the following symptoms: shortness of breath, cough, chest tightness, and wheezing. A category called multiple atopic symptoms was developed to assess the number of employees possibly having allergic symptoms, and required all three of the following: sneezing, eye irritation, and stuffy/runny nose/nasal congestion. A category called multiple sick building syndrome symptoms required at least three of the following five symptoms: headache, sore or dry throat, stuffy or runny nose or nasal congestion, unusual fatigue, or irritated eyes. These symptoms have, in studies of the nonindustrial indoor environment by NIOSH and other researchers, been shown to have high prevalence rates.[1,2,7–9] Reporting multiple symptoms of this type can indicate the impact of symptoms among occupants in a building.

To determine if the prescribed protocol was followed by individual NIOSH medical investigators in the field, a questionnaire survey of these investigators was conducted after the entire project was completed. Upon review of this survey and review of individual investigator reports for those investigators that did not complete the survey, 115 (72%) of the 160 HHEs were considered usable for further analysis. Of the 115 buildings with usable data, 80 were office buildings; the remainder were schools, healthcare facilities, and other types of workplaces. This decision to include the office buildings in the analysis was based on whether the protocol was followed and whether both usable industrial hygiene and questionnaire data were available. Twenty-five office buildings were excluded from the original 160 HHEs: no symptom data were available for employees in five buildings (investigators had the option of not administering the questionnaire in small workplaces), inappropriate data collection protocols (such as administering the questionnaire to a sample of workers) were used in 14 buildings, and improper identification of the employees to be studied (such as collecting symptom data in an area where no environmental data were collected) was a factor in six of the projects. Only results from office buildings where the prescribed protocol was followed are reported here.

Results

A total of 2435 questionnaires from 80 office buildings were analyzed. The mean number of questionnaires per site was 30 (range, 5 to 92) and the median number of questionnaires was 25. There were 814 male participants (34%) and 1607 female participants (66%). There were 450 (19%) who currently smoked cigarettes, 670 (27%) former smokers, and 1304 (54%) who had never smoked.

The individual symptom prevalences, using the three different definitions, are shown in Table 1. The most commonly reported symptoms frequently experienced at work in the last 4 weeks were eye strain (45%), unusual fatigue (42%), irritated eyes (42%), and stuffy or runny nose or sinus congestion (39%). The most commonly reported frequent symptoms that improved when the employee left work were eye strain (32%), irritated eyes (30%), fatigue (25%), and headache (25%). The most commonly reported symptoms on the day of the survey

TABLE 1. IEQ Symptom Survey: Symptom Prevalences in Office Buildings Overall and Range for Individual Work Sites (n = 2435)

Symptom*	Experienced 1 to 3 Days per Week in the Last 4 Weeks, or Every or Almost Every Work Day	Experienced 1 to 3 Days per Week in the Last 4 Weeks, or Every or Almost Every Work Day, and Gets Better Away from Work	Experienced at Work on the Day of The Survey
Tired or strained eyes	45% (14–78%)	32% (0–64%)	41% (0–74%)
Dry, itching, or irritated eyes	42% (0–71%)	30% (0–67%)	39% (0–71%)
Unusual tiredness, fatigue, or drowsiness	42% (14–80%)	25% (0–59%)	33% (0–80%)
Headache	35% (9–67%)	25% (0–67%)	29% (0–67%)
Tension, irritability, or nervousness	31% (0–63%)	23% (0–55%)	24% (0–54%)
Stuffy or runny nose, or sinus congestion	39% (0–80%)	21% (0–55%)	38% (0–100%)
Pain or stiffness in back, shoulders, or neck	36% (0–80%)	21% (0–48%)	33% (0–75%)
Sneezing	29% (0–71%)	18% (0–55%)	21% (0–52%)
Sore or dry throat	24% (0–71%)	16% (0–71%)	23% (0–54%)
Cough	19% (0–67%)	9% (0–67%)	18% (0–60%)
Dry or itchy skin	26% (0–67%)	9% (0–40%)	24% (0–67%)
Difficulty remembering things or concentrating	17% (0–80%)	9% (0–29%)	13% (0–75%)
Dizziness or lightheadedness	12% (0–50%)	8% (0–50%)	8% (0–40%)
Feeling depressed	14% (0–34%)	8% (0–29%)	11% (0–40%)
Shortness of breath	10% (0–60%)	5% (0–33%)	7% (0–75%)
Nausea or upset stomach	9% (0–50%)	5% (0–50%)	7% (0–40%)
Chest tightness	9% (0–60%)	6% (0–50%)	7% (0–50%)
Wheezing	7% (0–40%)	4% (0–33%)	5% (0–60%)

*Symptoms are listed in decreasing prevalence of symptoms that were experienced 1 to 3 days per week in the last 4 weeks, or every or almost every workday, and that get better away from work.

were the same as those reported one or more days per week over the last 4 weeks. Recurring pain or stiffness in the back, shoulders, or neck was reported by 36 percent of participants and by 33 percent on the day of the survey, with 20 percent of respondents reporting that the symptom improved when they left work. Symptom prevalence by gender is given in Table 2. Symptom prevalences among women were, in most cases, nearly twice as high as those reported by men.

Group symptoms are presented in Table 3. Prevalence of work-related symptoms ranged from 16 percent for respiratory symptoms to 41 percent for neurologic symptoms. Multiple respiratory symptoms (three of four possible symptoms) were reported by 2 percent. Nineteen percent of the respondents met the criteria for multiple sick building syndrome symptoms, and 8 percent had multiple symptoms suggestive of atopy. As with individual symptoms, women had greater prevalence rates of group symptoms (Table 3), including multiple sick building syndrome symptoms (24% of women and 9% of men) and multiple atopic symptoms (10% of women and 4% of men).

The self-reported prevalence of physician-diagnosed conditions among respondents is given in Table 4. Fifty-one percent of respondents reported that sinus infection was "ever" diagnosed by a physician (with 31% reporting that the condition was diagnosed after they started work in the building), and asthma was reportedly diagnosed in 12 percent of respondents (with 3% reporting that the diagnosis was made after starting work in the building). Females had higher prevalence rates of all medical conditions.

Table 5 summarizes employee reports regarding perceived environmental conditions at their workstations on the day of the survey and during the 4 weeks preceding the survey. Fifty

TABLE 2. Symptom Prevalence by Gender For Symptoms That Occurred at Least Once a Week in the Last 4 Weeks and Got Better Away from the Work Site (n = 2435)

Symptom	Prevalence Within All Buildings (%)	
	Male	Female
Tired or strained eyes	23	37
Dry, itching, or irritated eyes	19	35
Unusual tiredness, fatigue, or drowsiness	17	31
Headache	11	30
Tension, irritability, or nervousness	15	26
Stuffy or runny nose, or sinus congestion	17	24
Pain or stiffness in back, shoulders, or neck	13	23
Sneezing	13	21
Sore or dry throat	8	19
Cough	6	11
Dry or itchy skin	5	11
Difficulty remembering things or concentrating	6	11
Dizziness or lightheadedness	5	11
Feeling depressed	4	8
Shortness of breath	2	6
Nausea or upset stomach	2	6
Chest tightness	4	7
Wheezing	3	4

TABLE 3. Grouped Symptom Prevalence Overall and Range for Individual Work Sites (n = 2435)

	Symptoms Experienced 1 to 3 Days per Week in the Last 4 Weeks, or Every or Almost Every Work Day, and Get Better Away From Work (%)		
	Male	**Female**	**Total**
Grouped symptoms: employee experiences any one symptom			
Upper respiratory symptoms: sore or dry throat, stuffy or runny nose, sneezing	25 (0–78)	39 (0–100)	35 (0–71)
Respiratory symptoms: wheezing, chest tightness, cough, shortness of breath	11 (0–50)	18 (0–67)	16 (0–67)
Neurologic symptoms: headache, difficulty remembering things, dizziness or lightheadedness, unusual tiredness or fatigue	25 (0–71)	49 (0–100)	41 (0–75)
Grouped symptoms: employee experienced at least three symptoms			
Multiple respiratory (at least three of the following): shortness of breath, cough, chest tightness, wheezing	0.8 (0–17)	3 (0–33)	2 (0–39)
Multiple neurologic (at least three of the following): headache, difficulty remembering things, dizziness or lightheadedness, unusual tiredness or fatigue	3 (0–50)	9 (0–67)	7 (0–33)
Sick building syndrome (at least three of the following): dry or irritated eyes, sore or dry throat, stuffy or runny nose, unusual tiredness or fatigue, headache	9 (0–50)	24 (0–78)	19 (0–64)
Atopic (all three symptoms): sneezing, nasal congestion, eye irritation	4 (0–50)	10 (0–100)	8 (0–33)

percent of respondents perceived insufficient air movement, 9 percent reported too much air movement, 35 percent frequently were too hot, 32 percent frequently were too cold, 10 percent detected frequent chemical odors in the workplace, and 15 percent frequently detected tobacco smoke odors. The second column reports results for the perceived environmental conditions on the day of the survey. The results are very similar to those shown in the first column for workstation environmental conditions experienced more than one day per week. It shows that 44 percent of the respondents perceived that the ventilation system was not providing sufficient air movement, 24 percent thought it was too hot, and 27 percent felt that it was too cold during at least part of their workday.

Discussion

The cause of the seemingly high prevalence of symptoms among office workers has not been determined. Comparison of these data to those of previous studies of the office environment by other authors is difficult because of the differing definitions of what constitutes a work-related symptom in each study. For instance, Burge *et al.*[1] defined a work-related symptom as one that had occurred more than twice in the last 12 months and improved away from the office. Skov *et al.*,[2] in their study of town halls in Denmark, used a definition similar to ours, where work-related symptoms were defined as "yes, daily" or "yes, some times a week," combined with "yes, it improves on days off/during weekends or vacations." As in our data set, all symptom prevalences in their study were higher in women than in men. Although the case definitions were similar, our prevalences for comparable symptoms for women were higher than those reported by Skov *et al.*[2] with the exception of fatigue, which had an identical prevalence rate in both studies. This difference may be explained by the method of selection of the buildings in the two studies: Skov *et al.*[2] studied town halls in 13 municipalities whose employees' symptom status was unknown, while we looked at buildings, or parts of buildings, in which some workers or the employer perceived a problem. The collective prevalences in

TABLE 4. Reported Diagnosed Medical Conditions Among Study Participants (n = 2435)

	Prevalence Total (%)	**Prevalence Male (%)**	**Prevalence Female (%)**	**Range Among Buildings, All Respondents (%)**
Sinus infection	51	39	56	0–88
Asthma	12	9	14	0–43
Migraine	22	12	27	0–55
Eczema	9	6	11	0–33
Hay fever	27	27	27	0–67
Dust allergy	29	24	32	0–69
Mold allergy	22	18	24	0–55
Cat allergy	13	11	15	0–40

TABLE 5. Perceived Environmental Deficiencies (n = 2435)

Complaint	Condition Was Experienced More Than 1 Day per Week in the Last 4 Weeks (%)	Condition Was Experienced on the Day of the Survey (%)
Too little air movement	50	44
Too much air movement	9	8
Temperature too hot	35	24
Temperature too cold	32	27
Too humid	12	10
Too dry	35	32
Chemical odors	10	9
Tobacco smoke odors	15	11

our study may not be comparable to those generated in other studies because of these differences in case definition, building selection, and questionnaire used. However, the prevalence rates presented in this study are useful for the broad range of problem buildings that NIOSH has been asked to evaluate.

Results of other selected NIOSH studies of individual problem buildings (requested by the employee's union) and of a Washington State study of four nonproblem buildings[10] are presented in Table 6. The evaluations of the individual problem buildings were requested by the unions because of reports of widespread symptoms experienced by their members while at work. The nonproblem buildings in the Washington State study were selected because they met the requirements of the U.S. EPA for inclusion in their BASE study. The BASE study used a symptom questionnaire almost identical to the questionnaire used in this study and very similar to those used in the studies of buildings 1, 2, and 3. The definition of a work-related symptom was identical to that used in this study and the other NIOSH studies reported here.

Reported symptom prevalences were similar in all of these studies; the prevalence rates in the present NIOSH study of self-selected problem buildings were very similar, for most symptoms, to the prevalence rates in the four nonproblem buildings evaluated in the Washington State study. Only mildly increased prevalence rates are seen in the NIOSH studies of problem buildings (buildings 1, 2, and 3) when compared with the Washington State study. Differences in prevalence rates were found to be greatest for the respiratory symptoms cough and wheezing. This agreement for most symptoms suggests that there may be a surprisingly high baseline of prevalence rates for many symptoms in office buildings throughout the country, and that the designation of a building as a problem building may be related to factors other than symptom prevalence.

Prevalences of symptoms, whether they improved or not after a worker left the office, are presented in this article. To focus only on symptoms that improve when leaving the office assumes that there is a short-acting environmental stimulant, such as an allergen or irritant, that is causative for increased symptoms. However, whether these are relevant or exclusive mechanisms for the development of symptoms in the indoor environment is not known at this time, and relief of even true work-related symptoms may not always occur upon leaving work. The author's experience in the NIOSH HHE[7–9,11] program has been that there is often a group of workers that report very severe, debilitating symptoms that originally may have improved upon leaving work, but no longer improve unless the individual leaves the workplace for an extended period of time, such as a vacation. Considering only symptoms that improve when leaving the workplace, possibly within a few hours, may underestimate both the prevalence and severity of symptoms in a building.

Table 1 shows that, in some buildings studied, the range of prevalence rates for certain symptoms was broad, with some symptoms having a high prevalence rate in some buildings. The reason for the high rate of some symptoms could not be ascertained during the environmental surveys conducted by NIOSH industrial hygienists. In the future we plan to conduct statistical analyses of environmental factors and their relation to symptom prevalence in work areas included in this analysis.

Limitations of this study relate to the manner in which the buildings were selected for study, the manner in which individuals were selected for participation in each of the studied buildings, and the way problem areas within each building

TABLE 6. Prevalence of Symptoms Occurring at Least Once a Week and Improving Away from Work Found in Other Studies (Percent)

Symptom	Building 1: Detroit, Michigan[9] n = 184	Building 2: Harrisburg, Pennsylvania[11] n = 416	Building 3: Cleveland, Ohio[8] n = 127	Present Study n = 2435	Washington State Office Buildings[10] (Nonproblem Buildings) n = 646
Dry, itching, or irritated eyes	27	36	30	30	30
Tired or strained eyes	30	40	43	32	38
Unusual tiredness, fatigue, or drowsiness	30	33	43	25	25
Headache	23	28	25	25	24
Sore or dry throat	28	21	28	16	
Stuffy or runny nose or sinus congestion	24	31	26	21	21
Cough	12	9	11	9	5
Wheezing	4	2	6	4	2
Concentration problems	7	8	10	9	11
Dizziness or lightheadedness	9	8	9	8	7

were identified. First, all sites were in buildings where at least one person thought there was a problem, but the extent of the problem was not known. The set of HHE requests received was neither random nor based on definable criteria other than that at least three employees or the employer were concerned about symptoms or environmental quality. Second, because participation was limited to employees who were present on the day of the evaluation, it was possible that the more symptomatic employees were more likely to be absent. Conversely, symptomatic employees may have been more motivated to complete the questionnaire. Third, identification of the problem area was left to the discretion of the project officer, who was under instructions to evaluate, if possible, the area of most concern to the requester. It was not determined whether these areas were representative of the buildings as a whole or of other problem areas that may have existed within these buildings. Fourth, in a multi-tenant office building, NIOSH investigators were able only to evaluate the work site of the requesters, and not adjoining work sites in the same building. Fifth, workers in buildings with well-known problems (i.e., widely discussed) may be more likely to report symptoms. Despite these limitations, the agreement of this study with other NIOSH studies conducted by the authors and studies conducted by other researchers adds credibility to these results. These findings demonstrate that, in the buildings evaluated for this study, symptoms in the indoor nonindustrial environment were pervasive and were consistent with findings from our previous experience. Although certain specific symptoms may not appear to have serious health consequences, 19 percent of respondents met our criteria for multiple sick building syndrome symptoms. This seemingly high prevalence of multiple symptoms may play a role in disrupting workers' ability to function in the workplace. The large number of buildings evaluated in this study (with different environmental conditions and building construction) and people surveyed (with differing job duties such as government, insurance, or general office work) makes these data useful for comparison with prevalence rates in other office buildings with reported problems. Furthermore, prevalence rates in the Washington State study of buildings without known problems are similar to the prevalence rates reported in this study for many of the studied symptoms, suggesting a baseline rate for some of the symptoms found in the office environment.

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Editor's Note: The third and final paper reporting on "The NIOSH Indoor Environmental Evaluation Experience" is currently in peer review. Part III, "Associations Between Environmental Factors and Self-Reported Health Conditions," will be published in an upcoming issue of Applied.