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# ASSOCIATION OF PERSONAL AND WORKPLACE CHARACTERISTICS WITH REPORTED HEALTH SYMPTOMS OF 6771 GOVERNMENT EMPLOYEES IN WASHINGTON, DC

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## ABSTRACT

An indoor air quality questionnaire was completed by 6771 employees of two government agencies. Regression analyses on 12 clusters of health symptoms indicated that both personal and workplace characteristics were associated with symptoms. The variables associated with the largest number of symptoms at both agencies were DRY AIR/DUSTY OFFICE, CHEMICAL/PAINT ODORS, HOT STUFFY AIR, and SENSITIVITY TO CHEMICALS. Other variables that were often significantly associated with symptoms were GLARE, CARPET/DRAPE ODOR, DUST/MOLD ALLERGY, CAREER FRUSTRATION, and JOB PRESSURE/CONFLICT.

## INTRODUCTION

A study of indoor air quality in four office buildings was carried out in 1989 near Washington, DC (1,2). Three buildings were used by the Environmental Protection Agency (EPA) and the fourth by the Library of Congress (LOC). The sponsors of the study were the EPA and the National Institute for Occupational Safety and Health (NIOSH).

A questionnaire was provided to approximately 5000 employees of the EPA and about 3500 employees of the LOC. An analysis of 3948 completed EPA questionnaires has been carried out (3,4).

The main objective of the present study was to perform identical analyses on the EPA and LOC data sets separately to determine "robust" relationships between symptoms and workplace or personal characteristics. An additional objective was to expand the analyses to include not only the "last year" health symptoms but also the "last week" and job-related symptoms as well. Finally, several questions concerning absenteeism and productivity have been newly analyzed.

## METHODS

The questionnaire, which was tested and validated on two groups of workers, included 32 health symptoms, 15 questions on odors, 10 questions on comfort, 25 questions on the workplace, 28 questions on psychosocial aspects, and 25 questions on personal characteristics. Respondents characterized symptom prevalence

"last year" and also "last week". They were asked whether the symptom "got better, got worse, or stayed the same" after leaving work; job-related symptoms might be expected to improve on leaving work.

To reduce the number of variables, and also to increase the orthogonality of remaining variables, principal components analyses (PCA) were carried out on the health, comfort, odor, and psychological questions, resulting in 12 health, four comfort, six odor and four psychological factors. The 50 personal and workplace characteristics were also reduced to 40 variables, for a total of 54 independent variables. For each of the 12 health factors, multiple regressions were performed on the "last year", "last week" and "job-related" data for the EPA and LOC data sets separately, resulting in 72 regressions.

**Association with workplace.** One question asked if people associated their symptoms with the workplace. More than half the respondents did so. A multiple regression was carried out on this question using the combined LOC and EPA data sets.

**Productivity.** Two questions dealt with productivity. The first asked if respondents' ability to work was affected by their symptoms. The second asked if respondents had left work early or stayed home because of their symptoms. Pearson correlation coefficients of the 32 health symptoms with the answers to these questions were determined. A multiple regression was carried out on these two questions using the combined LOC and EPA data sets.

**Spatial analysis.** Multiple regressions adding eight "sectors" (representing six contiguous sections of the main EPA building plus the other two buildings) to the 54 independent variables were carried out on each of the 12 health factors for the EPA data set. Similar regressions were carried out using the eight floors of the LOC building as spatial variables.

**Gender effect.** Since females had higher symptom prevalences than males, an attempt was made to determine whether the difference could be explained completely by other variables. A binary variable for gender was added to the 54 independent variables and the multiple regressions were repeated for all health factors in the EPA and LOC data sets separately.

**Dust.** Since previous studies (3,4,5) have indicated the importance of dust in building-related symptoms, correlations of all variables with reported dustiness were determined.

**Sensitivity to chemicals.** Previous studies (3,4) determined that sensitivity to chemicals was associated with a number of symptoms. Therefore the correlations of all variables with self-reported sensitivity to chemical fumes were calculated.

**Comparison of building populations.** Possible differences between the EPA and LOC responses were investigated by combining the two data sets and adding a binary variable identifying the two sites. Multiple regressions were carried out on the 12 health factors for the combined data set.

**RESULTS**

The most common symptoms included headache, sinus congestion, fatigue, runny nose, sore eyes, tension, dry skin, and difficulty concentrating. About two/thirds of the positive responses for each symptom were reported as job-related.

Multiple regression results were similar for the "last year", "last week" and "job-related" analyses; therefore results from a composite ranking are reported here.

**Headache and nausea.** DRY AIR/DUSTY OFFICE and HOT STUFFY AIR were the variables most closely associated ($p<0.001$) with headache and nausea. At the EPA, PAINT/CHEMICAL ODOR and JOB PRESSURE were also significant ($p<0.01$). For men only at the EPA, NEW CARPET ODOR was associated ($p<0.001$) with increased symptom frequency. For females only at the LOC, DUST/MOLD ALLERGY and PRINTING/COPYING ODOR were related ($p<0.001$).

**Nasal symptoms.** DRY AIR/DUSTY OFFICE and DUST/MOLD ALLERGY were associated the most strongly ($p<0.001$) with sinus congestion, runny nose and other nasal symptoms. HOT STUFFY AIR was also associated ($p<0.01$) with these symptoms. At the EPA, PAINT/CHEMICAL ODOR and NEW CARPET ODOR were associated ($p<0.01$) with increased symptom frequency. At the LOC, COLD DRAFTY AIR was related ($p<0.01$) to increased frequency.

**Chest tightness, wheezing and shortness of breath.** PRE-EXISTING ASTHMA was strongly associated ($p<0.001$) with these symptoms. At the EPA, PAINT/CHEMICAL ODOR ($p<0.001$) was related to these symptoms. At the LOC, PRINTING/COPYING ODOR was strongly associated ($p<0.0001$) with these symptoms. At the EPA, NEW CARPET ODOR was associated ($p<0.01$) with increased frequency. At the LOC, DUST/MOLD ALLERGY was related ($p<0.01$).

**Eye irritation.** DRY AIR/DUSTY OFFICE and GLARE were the variables most strongly associated ($p<0.001$) with eye problems. Persons who wore contact lenses were also more likely to report eye problems ($p<0.01$). At the EPA, PAINT/CHEMICAL ODOR and NEW CARPET ODOR were also associated ($p<0.01$) with this symptom. At the LOC, HOT STUFFY AIR and DUST/MOLD ALLERGY were associated ($p<0.01$) with eye irritation.

**Sore throat, dry throat, hoarseness.** DRY AIR/DUSTY OFFICE was strongly associated ($p<0.0001$) with these symptoms. Two other symptoms less strongly associated ($p<0.01$) with throat problems were PAINT/CHEMICAL ODOR and HOT STUFFY AIR. At the EPA, NEW CARPET ODOR was also associated ($p<0.001$) with throat problems. At the LOC, DUST/MOLD ALLERGY was associated ($p<0.01$) with throat problems.

**Fatigue and sleepiness.** HOT STUFFY AIR and DRY AIR/DUSTY OFFICE were strongly associated ($p<0.001$) with unusual fatigue and sleepiness. Also related ($p<0.01$) was the psychological variable CAREER FRUSTRATION. At the EPA, PAINT/CHEMICAL ODOR was also associated ($p<0.01$) with fatigue.

**Chills and fever.** COLD DRAFTY AIR was strongly associated

($p<0.0001$) with chills and fever, and DRY AIR/DUSTY OFFICE less strongly associated ($p<0.01$). At the EPA, PAINT/CHEMICAL ODOR was also associated ($p<0.001$) with chills.

**Muscle aches, joint pain, pain in neck, shoulder, back.** DRY AIR/DUSTY OFFICE, GLARE, and DISCOMFORT were the variables most strongly associated ($p<0.001$) with these symptoms. At the EPA, PAINT/CHEMICAL ODOR was also significant ($p<0.001$). At the LOC, HOT STUFFY AIR was also significant ($p<0.01$).

**Depression, tension, difficulty concentrating/remembering.** The three psychological variables UNDERUTILIZATION, CAREER FRUSTRATION, and JOB PRESSURE/CONFLICT were all strongly associated ($p<0.0001$) with these symptoms.

**Dizziness.** At the EPA, PAINT/CHEMICAL ODOR and NEW CARPET ODOR were the variables most strongly associated ($p<0.001$) with this symptom. At the LOC, DRY AIR/DUSTY OFFICE and DUST/MOLD ALLERGY were significant ($p<0.001$).

**Dry skin.** DRY AIR/DUSTY OFFICE was strongly associated ($p<0.0001$) with this symptom. PRE-EXISTING ECZEMA was also associated ($p<0.001$) with dry skin.

**Problems with contact lenses.** DRY AIR/DUSTY OFFICE was strongly associated ($p<0.001$) with this symptom.

**Productivity.** Two "comfort" variables (HOT STUFFY AIR and DRY AIR/DUSTY OFFICE) were associated the most strongly ($p<0.001$) with reports of reduced ability to work. Two different variables (CHEMICAL/PAINT ODORS and CAREER FRUSTRATION) were more likely to be associated ($p<0.001$) with leaving work early or not coming to work. Other variables associated ($p<0.01$) with absenteeism included SENSITIVITY TO CHEMICALS, NEW CARPET ODOR (EPA only), and DUST AND MOLD ALLERGIES (LOC only).

**Spatial analysis.** No spatial variable at any of the buildings was significantly associated with any health factor.

**Gender effect.** Gender was significantly associated with a number of health factors, but was seldom among the top three variables in terms of the strength of the association. One exception was for headache and nausea, where being female was one of the most important risk factors ($p<0.001$).

**Comparison of building populations.** Working at the LOC was consistently associated with higher symptom prevalence, but the differences were seldom statistically significant.

**Dust.** The characteristics showing the strongest correlations with dusty offices were GLARE, CAREER FRUSTRATION, LIGHTS TOO DIM, DESK AND CHAIR DISCOMFORT, and HEAVY WORKLOAD.

**Sensitivity to chemicals.** The variables showing the strongest correlations with sensitivity to chemicals were DUST, GLARE, CAREER FRUSTRATION, and JOB PRESSURE/CONFLICT. SMOKERS were significantly less likely to report sensitivity to chemicals.

## DISCUSSION

Some variables appeared repeatedly in association with symptoms at both the EPA and the LOC. These included "comfort" variables (HOT STUFFY AIR, DRY AIR/DUSTY OFFICE); odors (CHEMICAL/PAINT ODORS); workstation environment (GLARE); a possible measure of susceptibility (SENSITIVITY TO CHEMICALS); and psychological (or organizational) variables (JOB PRESSURE, CAREER FRUSTRATION). These variables show consistent associations with symptoms in two large and independent data sets and may therefore have a general relation with health symptoms in other buildings. A number of previous investigations (3,5) of health problems in buildings have concluded that the problems are multifactorial; the results of this study support that conclusion.

One variable appeared often in association with symptoms at the EPA, but seldom at the LOC: NEW CARPET ODOR. The EPA had 17000 yards of new carpet installed one year prior to the study, whereas little if any new carpet was present at the LOC. The appearance of this variable in connection with symptoms at EPA suggests that this new carpet or something connected with the process of carpet installation could have affected the health of some EPA employees.

Conversely, the variable DUST AND MOLD ALLERGIES appeared more often in association with symptoms at the LOC than at the EPA. It has been previously suggested that health problems at the Madison Building could have been due to molds or fungi resulting from the extensive greenery maintained in a central atrium. However, concurrent measurements of bioaerosols showed no elevated concentrations at the LOC building (1).

Comfort variables (HOT STUFFY AIR and DRY AIR/DUSTY OFFICE) were most closely associated with reduced productivity on the job. Absenteeism, on the other hand, was more closely associated with medical conditions (DUST AND MOLD ALLERGIES, SENSITIVITY TO CHEMICALS), apparent chemical exposure (CHEMICAL/PAINT ODORS, NEW CARPET ODOR), or psychological variables (CAREER FRUSTRATION). Preller (6) also found a strong effect of allergy and job dissatisfaction on productivity. However, Preller's findings of effects of work at video display units, age, and education were not replicated in this study. Raw (7) found sharing an office with four or more persons to have a negative effect on productivity; our office sharing index, (private office, shared enclosed office, and open area) displayed no such association.

Symptom frequencies appeared high. For example, over 4000 headaches were reported in one week by about 4000 EPA employees. This corresponds to about 250,000 headaches per year among the 5000 employees. Recent attempts to evaluate the cost of headaches and other minor symptoms have provided costs in the range of $1.50 to $8.00 per headache. This would correspond to an annual cost of $375,000 to $2,000,000 for this symptom alone. Headache was the symptom most frequently mentioned (by 16% of EPA respondents) as causing them to stay home or leave work early. Thus steps to reduce the frequency of headache (and other minor symptoms) could be cost-effective. Among the workplace variables associated with headaches were glare, dust, hot stuffy air, and

the odor of paint and chemicals. Improved cleaning and ventilation procedures and steps to reduce glare (e.g., fitting computers with glare-reducing screens) could improve productivity. Other variables associated with headache were measures of stress, such as conflicting demands on an employee's time. Work on these problems could also improve productivity.

A question of interest is whether restricting symptoms to be job-related will provide significantly different results from those obtained by analyzing all responses. The present study suggests that either type of analysis can be performed without significantly different results, and that studies using one or the other method of analysis can be appropriately compared.

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