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LOW RELATIVE HUMIDITY AND EYE, NOSE, THROAT AND SKIN IRRITATION

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Abstract

The prevalence of eye, nose, throat and skin irritation in four office buildings was compared with the respondent's perception of humidity and the estimated indoor relative humidity (RH). Though respondents reporting symptoms believed that the RH was too low, there were few significant associations between symptom prevalence and RH.

Introduction

Low indoor RH (below 40%) has been linked to an increased incidence of upper respiratory infections due to higher viral survival rates (2). Low RH has also been reported to cause dryness or irritation of the skin, eye, nose and throat (2). There is some evidence that extremely low RH (below 20%) causes both eye (5) and skin irritation (9). However, experimental studies have shown that low RH does not affect the mucous membranes of the nose and throat (1,4). A climate chamber study of eight healthy males also found no difference in the number of complaints of skin or membrane dryness during 78 hours of exposure to 9% versus normal RH levels (1). An epidemiological study of English office workers found higher prevalence rates of dry skin, throat and stuffy nose among employees in an artificially ventilated versus naturally ventilated building, but there was no difference in the two building's RH (8). In another study, the prevalence of complaints was higher in a building with versus without humidification (6).

Method

Three modern sealed buildings with mechanical ventilation (K, D, and H) were studied after complaints of poor air quality. Building B, an older structure with natural ventilation only, had been selected as a control for building K. All were low-rise government offices, without humidifiers, in Victoria, B.C. Completed questionnaires were received from over 70% of the staff. Indoor RH and temperature was measured two to eight weeks after the questionnaires were completed. The measurements were taken during one day in building D and during 10 or more days in buildings K, B, and H.

The average indoor RH during the questionnaire survey was determined: 1) by estimating the indoor RH during the questionnaire and air quality surveys from the afternoon temperature and RH recorded at Victoria Airport (3) and the average indoor temperature during the air quality survey; and 2) by adjusting the estimate of the indoor RH during the questionnaire survey by the ratio between the estimated and observed indoor RH at the time of the air quality survey. The adjustment was needed to account for indoor sinks or sources of humidity. Table 1 gives average RH and other summary data for each building.

Table 1: Characteristics of each Building

Building	K	B	D	H
Quesionnaire Survey Date	Nov 9-16, 1984	Nov 9-16, 1984	Feb 1-8, 1985	July, 1986
Eligible Respondents				
Men	65	65	68	42
Women	49	42	84	54
Average Indoor Temperature	21.5°	21.0°	22.9°	21.4°
Estimated Indoor RH	28.3%	38.1%	26.8%	48.4%
Measured Indoor RH	22.1%	29.8%	39.5%	40.2%

The responses to four symptom questions; experience (at work) "eye irritation?", "sore or irritated throat?", "nose irritation?", and "skin dryness, rash, or itching?" and four RH perception indicators (PI); "Air too dry?", "Air too moist?", "Humidity just right?", and "Temperature too cold?" were analysed. The temperature question was included because people often feel cooler at low versus high RH (7). Symptom and PI responses were limited to "never," "rarely," "sometimes," and "always." Responses were combined for analysis; "never" and "rarely" into a "no" category and "sometimes" and "always" into a "yes" category. The analyses were restricted to fulltime staff over age 18. Standard Chi-square techniques were used to determine statistical significance and the Mantel-Haenszel summary Chi-square was used to stratify for other risk factors (10).

Results

The association between each symptom and five possible risk factors: the respondent's age, sex, education, asthma or allergy history, and workplace smoking habit, was determined. Age was not a risk factor in any of the analyses. Smoking was only associated with the PI "humidity just right?" among women. The most important risk factors were sex, education, and a history of asthma or allergy, in that order. Therefore, all further analyses were conducted separately for sex and stratified for either education or a history of asthma or allergy.

Symptom prevalence rates were higher among respondents who reported that the RH was too low. Table 2 gives the relative risk for each symptom for a positive response to each PI. For example, men who found the air too dry were 4.49 times more likely to report dry skin than men who did not find the air too dry. All four symptoms were strongly associated with the perception of dry air and, as expected, with a negative response to the humidity as "just right".

Table 2: Symptom relative risks for each PI (education stratified)

PI	Air Dry		Air Moist		Humidty Right		Temp. Cold	
Symptom	M	F	M	F	M	F	M	F
Dry Skin	4.49*	4.09*	--†	0.89	0.24*	0.41*	0.95	1.34
Nose Irritation	3.29*	1.76*	0.66	0.87	0.52*	0.41*	0.86	1.49
Throat Irritation	3.30*	2.24*	1.05	1.07	0.40*	0.56*	0.94	1.53*
Eye Irritation	2.48*	2.17*	0.72	1.31	0.51*	0.51*	1.35	0.95

* $P \leq .05$
† Too few positive responses for analysis.

Respondent perceptions of low RH were not supported by the analysis of symptom prevalence in buildings with "low" versus "high" RH. Table 3 gives symptom and PI prevalence rates for buildings H, B, and D and K combined. There were no significant differences in symptom or PI prevalence rates for buildings K and D (average RH of 27.5%) compared to building H (average RH of 48.4%). The absence of any associations is surprising because the occupants of buildings K and D were questioned in winter versus summer for building H. Nose, throat, and eye irritation are usually more common in winter because of colds or flu. However, a separate analysis, limited to individuals reporting colds or flu at work, also found no difference in symptom or PI prevalence rates between these buildings. Symptom and PI prevalence rates were also compared between buildings K and D combined and building B. Building B was naturally ventilated and had an estimated average RH of 38.1%. More men and women in buildings K and D felt that the air was too dry than in building B. Significant differences in symptom prevalence rates were also found for nose and throat irritation among men and for dry skin and nose irritation among women.

It is unlikely that the higher symptom prevalence rates in buildings D and K versus building B resulted from the difference in RH. Respondent bias is an alternative explanation because buildings K and D were investigated after complaints of poor air quality whereas building B was not. In addition, there were no significant differences between symptom prevalence rates in buildings K and D and building H, even though the RH in building H was 10.3 percentage points higher than in Building B. Also, a comparison of building B to H found higher prevalence rates for several symptoms in building H, even though the RH in building H was higher. This suggests that either recall bias, the different ventilation systems, or other factors, caused the higher prevalence rates in buildings K, D, and H.

Table 3: Symptom and PI prevalence rates (% reporting a "Yes" response).

Buildings	Men D+K	Men H	Men B	Women D+K	Women H	Women B
Dry Skin	21.6	24.4	9.7	54.0	56.9	33.3*†
Nose Irritation	36.3	29.3	14.8*	54.3	62.8	35.7*†
Throat Irritation	33.6	46.4	12.9*†	51.6	64.0	35.7 †
Eye Irritation	40.5	40.0	30.7	63.8	68.0	58.5
Air Too Dry	71.8	81.0	29.0*†	92.1	96.0	55.0*†
Air Too Moist	3.3	10.0	11.5	2.4	8.0	9.8
Humidity Just Right	50.0	52.5	85.0*†	22.8	26.0	72.5*†
Temperature Too cold	44.4	57.1	57.4	82.7	86.3	83.3

Statistically significant (P≤.05) differences in the prevalence rate (after adjusting for education and/or history of asthma or allergies) between buildings D+K combined and B marked with an '*' and between H and B with an '†'.

The use of the estimated RH during the questionnaire survey instead of the measured RH during the air quality survey changed building D from a "high" to a "low" RH building. Symptom and PI prevalence rates were compared between buildings D and K, in case the adjusted estimate of RH during the questionnare survey was less accurate than the measured RH during the air quality survey, but no significant differences were observed.

Conclusion

Our results are similar to those of the English office workers study (8): symptom prevalence rates were higher among respondents from artificially ventilated (D, K and H) versus naturally ventilated buildings (B), but no association with RH was found. The strong association between the respondent's perception of low RH and each symptom was not correlated with either the estimated or measured indoor RH. Also, though there is some experimental evidence that individuals with rhinitis from a cold or flu could be susceptible to mucous membrane dryness (4), there was no difference in symptom prevalence rates among respondents reporting a cold or flu from "low" versus "high" humidity buildings.

However, the results do not disprove the possibility that low RH causes these symptoms. The ability of the study to detect an association between low RH and symptoms was limited. For example, the questionnaire only probed for irritation and not for dryness. Also, the analyses were limited to comparing relatively small differences in the estimated RH. It is also possible that low RH interacts with other factors to cause "dry" symptoms. For example, low RH in conjunction with either high indoor air flow or high temperatures could cause dry skin or eye irritation whereas low RH by itself would not. This study could not examine these possibilities because 1) there was very little difference in temperature among the four buildings and 2) no indoor air flow data was available.

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