ENHANCED PARTICLE FILTRATION IN A NON-PROBLEM OFFICE ENVIRONMENT: SUMMARY FINDINGS FROM A DOUBLE-BLIND CROSSOVER INTERVENTION STUDY

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ABSTRACT

In a double-blind crossover study in an office building without known complaints, enhanced particle filtration greatly reduced concentrations of submicron airborne particles and was associated with slight improvements in most questionnaire outcomes. However, chance effects could be excluded only for confusion, too stuffy, and too humid. Higher temperatures even within conventional comfort limits were related to significant worsening of many questionnaire outcomes.

INTRODUCTION

Previous evidence suggests unidentified indoor particulate contaminants may increase nonspecific symptoms and thermal dissatisfaction in office workers [1, 2]. The authors conducted a controlled, double-blind crossover study of enhanced particle filtration in an office building without known complaint history. Summary information on this study has been previously published [3, 4].

METHODS

Standard filters (estimated 3% efficiency at 0.3 microns) in ventilation systems of two floors were replaced, on alternate floors weekly over four weeks, with highly efficient particle filters (estimated ≥95% efficiency at 0.3 microns). Weekly questionnaires assessed worker symptom severity, performance indicators, and environmental dissatisfaction. Temperature, humidity, ventilation rate, particle concentrations, and microbiological parameters (endotoxin, ergosterol, and beta-1,3-glucans) were measured. Repeated-measures ANOVA analysis models were used.

RESULTS

Eighty percent (392) of eligible participants returned the initial questionnaire. Weekly response rates averaged 63% over the four crossover weeks; usable questionnaires averaged 58%. Baseline symptom prevalences were average and ventilation rates were typical for US office buildings. Microbiological parameters measured were very low. Temperature and relative humidity were mostly within accepted comfort limits. Enhanced filtration greatly reduced concentrations of submicron size particles, but not particles larger than 2 microns. Enhanced filtration was associated with slight improvements in 13 of 16 worker outcomes (see examples in Table), but chance effects could be excluded only for the confusion scale, "too stuffy," and "too humid" (p-values=0.005, 0.01, 0.03). Higher temperatures even within the accepted comfort range (observed range 22.2-25.6°C) were strongly related to worsening of many outcomes (examples in Table). Temperature adjustment changed some filtration effect estimates substantially.

Table. Estimated changes in selected outcomes with enhanced filtration and increased temperature

Outcome	With enhanced filtration		Per 1°C temperature increase	
	change in outcome*	p-value	change in outcome*	p-value
headache	-3.6%	0.51	20.2%	0.02
confusion scale	-3.7%	0.005	8.9%	0.0001
too stuffy	-6.1%	0.01	20.0%	0.0001

* estimated in models including terms for filtration and temperature; change expressed as percent of outcome mean

DISCUSSION

Enhanced filtration in this blinded study was associated with slight improvements in 13 of 16 questionnaire outcomes, with three of these improvements unlikely to be due to chance. We can only speculate on mechanisms through which removal of submicron airborne indoor particles in a building without known contamination or occupant complaints could improve mental clarity and thermal comfort. Replication of this intervention will be necessary to confirm the findings in similar buildings and to assess potentially greater benefits in buildings with higher particulate contaminant levels or lower ventilation rates. Study findings also suggest that keeping summer office temperatures at the lower end of the current comfort range may substantially improve occupant symptoms and performance. Our analyses indicate that careful measurement of and adjustment for indoor temperatures is critical in studying subtle effects of indoor environments.

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