



In-home air purifiers and allergy symptoms: A randomized cross-over trial in older adults

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Background and Aim

Particulate matter (PM) is an indoor air pollutant that can increase the risk of allergic diseases². Socio-economic status and location of home can influence PM levels². For those with allergic rhinitis (AR), nasal symptoms may be caused by PM disrupting the immune system's defense against allergens³. It is believed that using air purifiers may reduce the probability of developing allergic diseases by decreasing ambient particle levels³. The aim of the present study was to determine whether HEPA air purifier units in homes can reduce allergy symptoms.

Methods

Data for the present study were derived from the Home Air Filtration for Traffic-Related Air Pollution (HAFTRAP) study, which is a double-blind, randomized crossover trial of in-home high-efficiency particulate arrestance (HEPA) air filtration to reduce ultrafine particles (UFP) exposure in Somerville, Massachusetts, USA. The trial enrolled individuals who were 30 years of age or older, lived full time at their house in Somerville MA within 200 meters of the highway, had cognitive capacity to fill out questionnaires, and spoke English or Spanish. The trial excluded entry to individuals who currently smoked/vaped or allowed indoor smoking/vaping because air purifiers are ineffective against such indoor sources. Additionally, participants were not enrolled if they had occupational or regular exposures to traffic pollution outside of the home, or significant combustion sources inside the home, other than cooking. Participants were enrolled between September and June, with the intent to enroll participants in cooler months when the levels of particulate matter tend to be higher.

Participant households were randomized to 30 days of either HEPA filtration or sham filtration, with air purifier units placed in the living room and bedroom, followed by a 30-day washout period, and then a subsequent 30-day period of the alternative intervention. Questionnaires were administered at the beginning and at the end of each intervention period, resulting in four data collection time points. Relevant to the present study, participants were asked to respond to four allergy symptom questions using the stem "In the last month how often did you experience the following? runny or stuffy nose; itchy nose; sneezing; itchy eyes." Responses were recorded using a four-point scale: never, once or twice, a few times a week, every day. For this analysis, responses were converted to number of days of symptoms in the last month: never=0, once or twice=1.5, a few times a week=12, every day=30.

Results

Table 1. Demographic Characteristics of Participants (n = 98)

| | |
|---|-------------|
| Randomized to sequence, n (%) | |
| HEPA then sham filtration | 43 (43.9) |
| Sham then HEPA filtration | 55 (56.1) |
| Recruitment period, n (%) | |
| Jan 1 - Mar 14 and Oct 16 - Dec 31 | 69 (70.4) |
| Mar 15 - Apr 7 and Sep14 - Oct 15 | 29 (29.6) |
| Age in years, mean (standard deviation) | 42.3 (10.9) |
| Age category, n (%) | |
| < 40 years | 50 (51.0) |
| 40 years or older | 48 (49.0) |
| Sex, n (%) | |
| Male | 45 (45.9) |
| Female | 51 (52.1) |
| Non-binary | 2 (2.0) |
| Ethnicity and race, n (%) | |
| Hispanic | 18 (18.4) |
| White, non-Hispanic | 68 (69.4) |
| Black, non-Hispanic | 4 (4.1) |
| Asian, non-Hispanic | 6 (6.1) |
| Other, non-Hispanic | 2 (2.0) |
| Highest level of education, n (%) | |
| Grade or high school | 12 (12.2) |
| Some college | 13 (13.3) |
| College or university degree | 32 (32.7) |
| Graduate degree | 41 (41.8) |
| Work status, n (%) | |
| Unemployed | 19 (19.4) |
| Part-time working | 10 (10.2) |
| Full-time working | 69 (70.4) |
| Total annual household income, n (%) | |
| < \$48,000 | 9 (9.2) |
| \$48,000 to \$84,999 | 15 (15.3) |
| \$85,000 or greater | 58 (59.2) |
| Declined to answer | 16 (16.3) |
| Number of days of symptoms in the last month, mean (standard deviation) | |
| Runny or stuffy nose | 8.1 (11.0) |
| Itchy nose | 4.3 (8.7) |
| Sneezing | 6.9 (8.9) |
| Itchy eyes | 3.2 (6.0) |

Results (cont.)

Table 2. Change in Number of Days of Symptoms Experienced in the Last Month

| | HEPA (N = 98) mean (se) P-value | Sham (N = 98) mean (se) P-value | Mean difference (95% CI) | P-value |
|----------------------|---------------------------------------|---------------------------------------|--------------------------------|---------|
| Runny or stuffy nose | -3.1 (0.7) < 0.001 | -2.5 (0.7) 0.001 | -0.6 (-2.6 to 1.3) | 0.54 |
| Itchy nose | -1.0 (0.5) < 0.039 | -2.3 (0.5) < 0.001 | 1.3 (0.0 to 2.6) | 0.047 |
| Sneezing | -1.8 (0.6) 0.008 | -1.0 (0.6) 0.14 | -0.8 (-2.6 to 1.0) | 0.39 |
| Itchy eyes | -1.3 (0.5) 0.01 | -0.4 (0.5) 0.39 | -0.9 (-2.0 to 0.3) | 0.13 |



Figure 1. HEPA filter.

Linear mixed models were used to compare the mean change in number of days of symptoms between the HEPA and sham filtration groups. For each participant, change in symptoms was calculated as the difference between the beginning and end of each intervention period. The model included a random intercept to account for the within-person correlation, as well as sequence and period effects, and was adjusted for allergy symptom response at the beginning of each intervention period. All statistical analyses were carried out using SAS 9.4 (SAS Institute Inc., Cary, NC), and results with p-values < 0.05 were deemed statistically significant.

Of the 156 participants enrolled into the trial between November 2020 and March 2024, 143 answered all four allergy symptom questions. As 45 participants answered "never" to all four allergy symptom questions at trial entry, they were excluded from the analyses. The demographic characteristics of the remaining 98 participants are shown in Table 1. The mean age of the participants was 42.3 years, 52.1% were female, 69.4% were non-Hispanic White, 18.4% were Hispanic, 80.6% were working either part-time or full-time, and 74.4% were of higher socioeconomic status. As 70.4% of the participants were enrolled during non-allergy seasons (Jan 1 – Mar 14 and Oct 16 – Dec 31), the mean number of days of reported symptoms was low, from 3.2 days of itchy eyes to 8.1 days of runny or stuffy nose.

Having either filtration configuration in their home, participants reported significantly fewer number of days with allergy symptoms, on average (Table 2). Additional small mean reductions in allergy symptoms were observed for runny or stuffy nose, sneezing, and itchy eyes during HEPA filtration, albeit not statistically significant. Surprisingly, the mean number of days of itchy nose was significantly 1.3 days higher during the HEPA filtration period than during the sham filtration period.

Conclusions

As participants reported fewer number of days of allergy symptoms, on average, during both the HEPA and sham filtration periods, our findings most likely suggest a social desirability response to having an air purifier in the home. The further reductions in allergy symptoms were observed among participants during the HEPA filtration periods were too small to reach statistical and clinical significance. An alternative, but in our opinion, less likely explanation might be that air movement from the air purifier fans, which was the same in both configurations, was responsible for reductions in symptoms.

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References

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