

Portable Air Cleaners: Summary of Performance (Preliminary Draft)

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Exposure to particle pollution in the air is associated with negative health consequences for people who breathe the air. In July 2020, the Clairton Home Air Filter Distribution Program¹ distributed Portable Air Cleaners (PACs) in 46 Clairton homes and monitored the resulting impact on indoor air quality. Results indicate that use of PACs sharply reduces the number of particles in a house (see Appendix A), which would include both indoor and outdoor sources.

In 2019, the Pittsburgh region received an ‘F grade’ from the American Lung Association due to ozone and fine particle pollution. According to the EPA, “An extensive body of scientific evidence shows that exposure to fine particles can cause cardiovascular effects, including heart attacks, heart failure, and strokes, which results in hospital admissions, emergency department visits, and, in some cases, premature death.”² In 2017, the Pittsburgh region suffered an estimated 232 premature deaths related to air pollution, the most of any region outside of California.

Studies have found that as concentrations of particles in the air decrease, so do rates of morbidity and mortality. Portable Air Cleaners (PACs) are an effective tool for decreasing the concentration of particles indoors – where most people spend most of their time. PACs, also known as air purifiers, are devices that filter the air in a room or zone of a building. With HEPA³ filtration, they are capable of removing 99.97% of all particles larger than 0.3 microns that pass through the filter.

The EPA “Guide to Air Cleaners in the Home”⁴ states categorically that use of a PAC can “help to improve indoor air quality”. These improvements in air quality should result in better health or a reduction of allergic symptoms. Almost all cited intervention studies in the EPA document “found a significant improvement in at least one measured cardiovascular health outcome or marker of cardiovascular health outcomes, including all of the studies with strong experimental designs.” These included reductions of blood pressure and inflammation markers as well as improvements in measured lung function. However, the effects of particles on respiratory health are usually due to long-term exposure. Existing studies show varied and relatively small health improvements that can be distinctly attributed to the reduction of particles. It will likely take multi-year research projects examining prolonged use of PACs before stronger causal relationships can be established.

¹ A coalition of groups including [Clean Air Council](#), [Clean Water Action](#), [Clean Water Fund](#), Community Partners in Asthma Care, [Cornerstone Care Inc.](#), [One PA](#), [ROCIS](#), Valley Clean Air Now (VCAN) & [Women for a Healthy Environment](#) (WHE) developed the concept; Clean Water Fund submitted the proposal which was funded by The Heinz Endowments. Linda M Wigington & Associates (ROCIS) is the primary implementer with responsibility for selecting air PACs, interviewing selected applicants, providing short-term particle monitoring, and providing households with two to six portable air cleaners.

² <https://www.epa.gov/pmcourse/particle-pollution-exposure>

³ HEPA:(High Efficiency Particulate Air) Filter

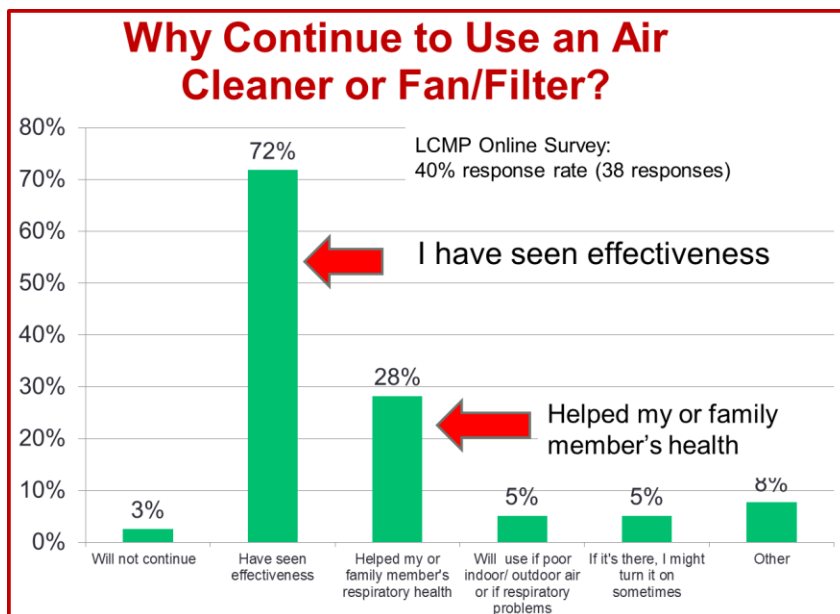
⁴ <https://www.epa.gov/indoor-air-quality-iaq/air-cleaners-and-air-filters-home>

The level of particles in a space will depend on the number of particles in the outside air, the house air exchange rate with outside, and the sources of indoor particles, plus the effects of the air cleaner. Each air cleaner, at a given setting, has a maximum capacity to reduce particles. The same air cleaner, operating at the same speed, will produce different results in different spaces. A PAC in a tight house, with a minimum of particle sources, will show better percent reduction than an identical air cleaner operating in a room with a significant particle load due to cooking or smoking, or a high air change rate with outside. However, the absolute reduction in the Clairton homes who received air cleaners was much larger for the homes with the highest pre-particle medians. See Appendix A for a summary of pre-post particle monitoring results ($\geq 0.5 \mu\text{m}$) for 37 of the Clairton homes who received air cleaners.

The Clairton results show that using a portable air cleaner (PAC) can sharply reduce the number of particles in a house, including fine particles, from both indoor and outdoor sources. The filters provided with carbon are also likely removing many of the airborne volatile organic compounds, although measurement of that efficacy was beyond the technical means of this project. From the standpoint of protecting vulnerable populations from local pollution outdoor sources, the filtration demonstration was clearly effective.

It was also evident that even a good particle filter has difficulty in creating low particle environments in houses with high indoor sources (e.g. smoking, vaping, etc.). And, as with any other remedial measure, the PACs are only useful when operated for long periods and properly maintained.

In the ROCIS Low Cost Monitoring Project⁵, based in Allegheny County, we surveyed PAC users to evaluate occupant satisfaction and use over time. The following chart summarizes the response from the 40% who replied to the questionnaire:



⁵ <http://rocis.org/rocis-low-cost-monitoring-project>

Studies of PAC use in response to wild fire smoke found that houses using air cleaners had far fewer particles than those without. However, over time, occupants discontinued PAC use due to concern over energy cost, noise, or the need to replace filters (Barn et al, 2007⁶). Some PACs have pre-filters which should be cleaned every 2-3 weeks; some filters should be replaced every three months; others have filters which only need to be replaced every 4-5 years.

While reduction in particles is well established through certification and testing, the ability of PACs to reduce other pollutants and odors is not. Two of the three PACs used in the Clairton Home Air Filter Distribution Project use carbon and other additives to reduce pollutants/odors in addition to providing HEPA filtration for particles. There is no industry-wide standard for evaluating that aspect of their performance.

CONCLUSION

There is conclusive evidence that mortality and morbidity increase with either short-term or long-term increased exposure to particles. There is conclusive evidence that portable air cleaners can substantially reduce indoor particle levels. There is less data linking air cleaners to improvement in specific biological markers of disease.

Due in part to the lack of industry standards that evaluate the performance of portable air cleaners in reducing other indoor contaminants other than particles, there is a lack of data linking portable air cleaners to reductions of exposure to other contaminants and their resulting health effects.

The Clairton Home Air Filter Distribution Program has demonstrated substantive particle reductions in almost every monitored house, regardless of their initial particle concentrations. While the opportunity for more data could be useful in targeting interventions, there is no justification for delay of either the recommendation for, or the deployment of, portable air cleaners.

⁶ <https://www.nature.com/articles/7500640#t2>

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APPENDIX A Preliminary Analysis Draft Clairton Home Air Filter Distribution Program

In the Clairton Home Air Filter Distribution Program households received from one to six portable air cleaners (PAC) in July and early August of 2020. A total of 153 portable air cleaners were distributed. From initial feedback, most participants were using the air cleaners 24/7. Portable air cleaners were placed in, and sized for all of the rooms where there was regular occupancy – both bedrooms and living spaces.

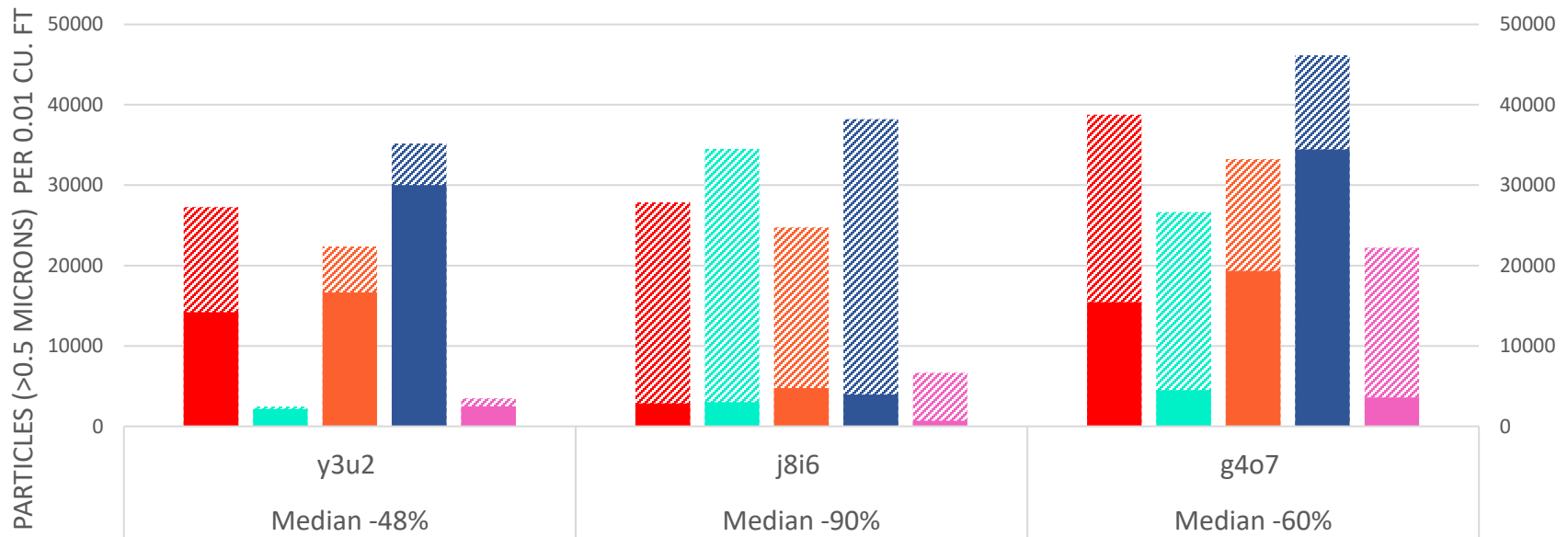
Thirty-seven sites are included in this analysis; the groupings are based on the pre-week median values.

Each Clairton site (46 households were served) received one 1700 Dylos particle monitor to use starting one week prior to delivery of the PACs. They were instructed to put the Dylos in the priority bedroom (where person with greatest health problems slept) and to keep the Dylos in the same location for the week after they got the PACs. We have one to three additional weeks of post data - in most cases they moved the Dylos to other rooms after the 1st post week.

The attached particle data ($\geq 0.5 \mu\text{m}$) compares the pre week with the 1st post week so that the Dylos location is matched except where noted otherwise. The post data analysis began at midnight of the day the participants received the PACs. There are a few cases where there was a delay in setting up the PACs so the post monitoring period may not have been precisely matched.

One outdoor Dylos monitoring site was used in Clairton. Some of our sites may have been more adversely affected by proximity to the US Steel CokeWorks. The pre and post data by site is also plotted on our LCMP data explorer (<http://rocis.org/rocis-data-explorer>). Enter the site ID and to see the individual data set, along with the outdoor Dylos data for the same time period. Some sites had partial data; the decision was made to include as many sites as possible.

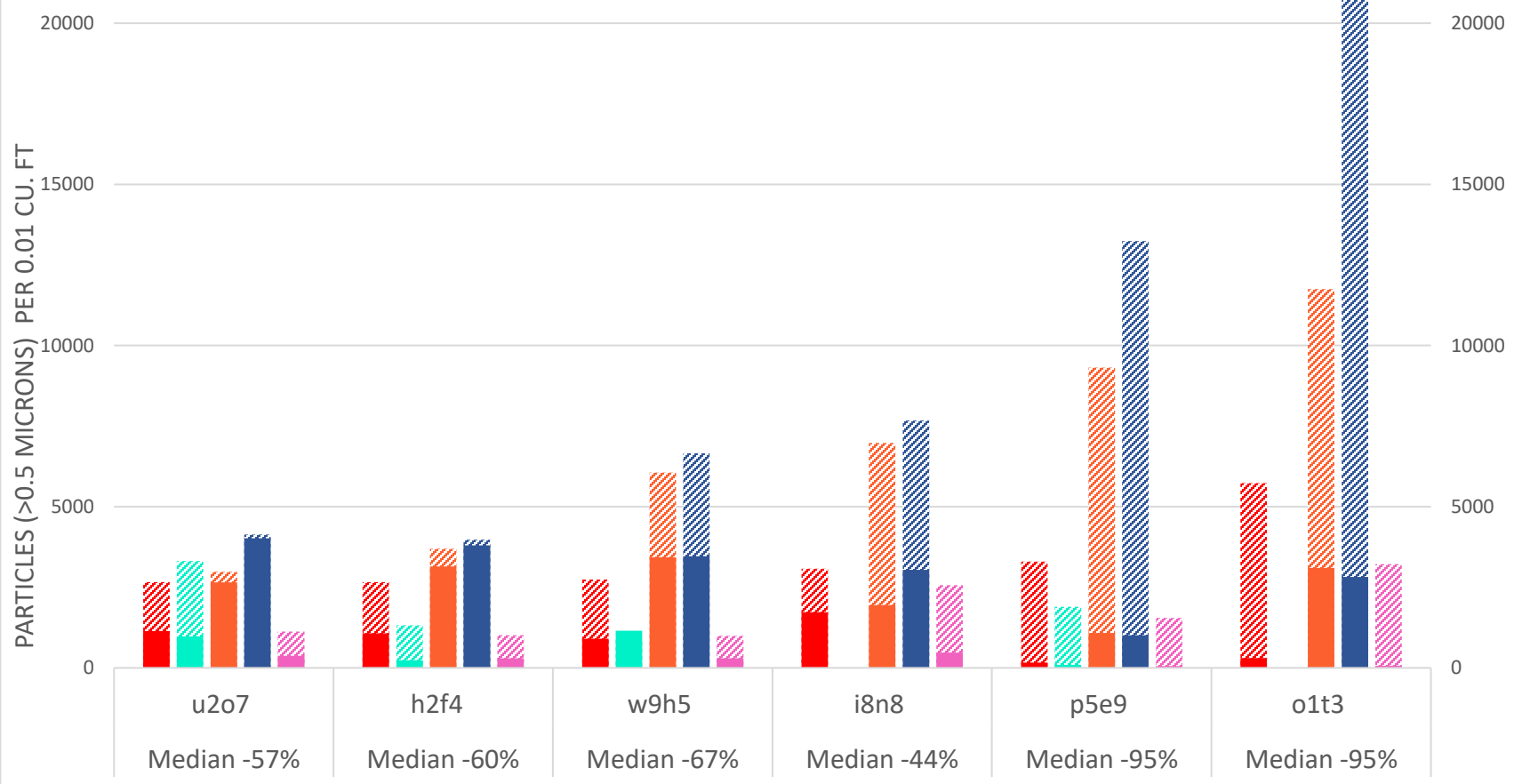
Before and after PACs: Change in indoor small particles (>0.5 microns) for participants with >27,000 median particles per 0.01 ft³ during week 1



CHANGE IN PARTICLES (>0.5 MICRONS) PER 0.01 CU. FT

- ▨ Median small wk 1 Indoor
 ▨ Median night wk 1 Indoor
 ▨ Mean small wk 1 Indoor
 ▨ 75% small wk 1 Indoor
 ▨ 25% small wk 1 Indoor
- Median small wk 2 Indoor
 ■ Median night wk 2 indoor
 ■ Mean small wk 2 Indoor
 ■ 75% small wk 2 Indoor
 ■ 25% small wk 2 Indoor

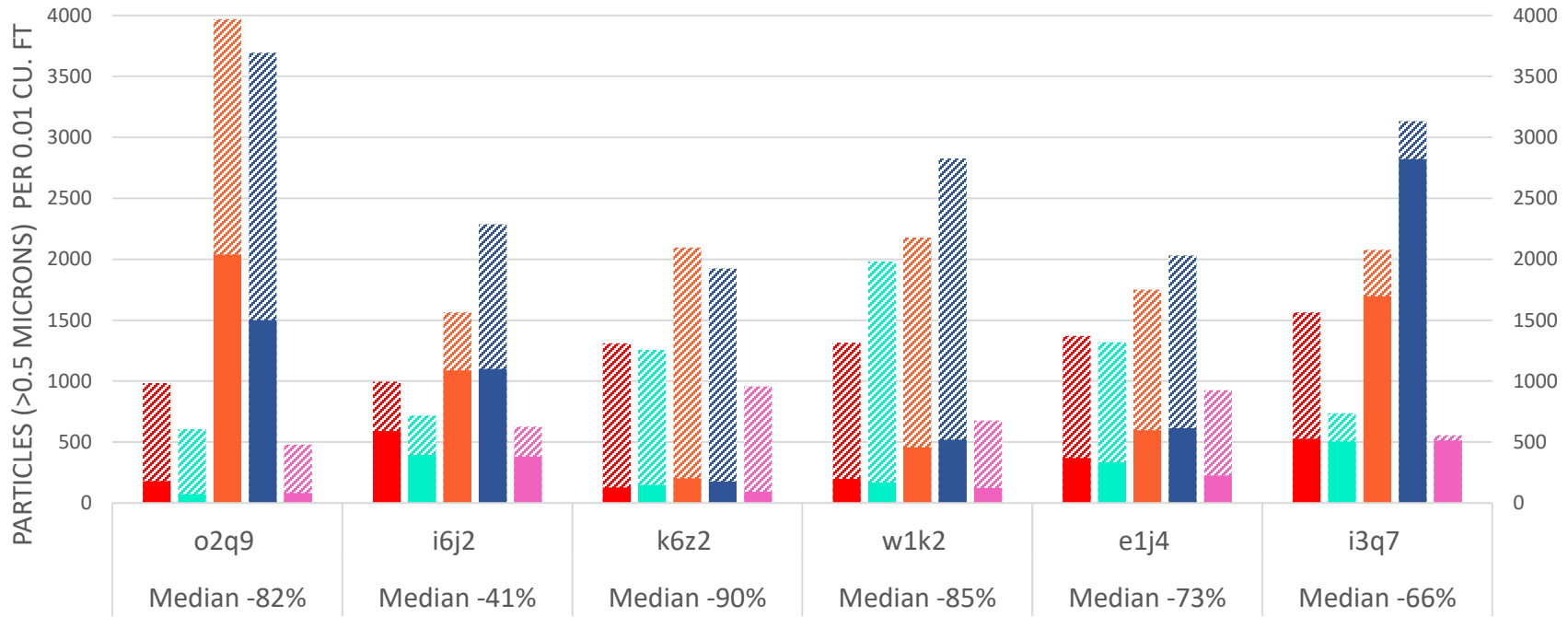
Before and after PACs: Change in indoor small particles (>0.5 microns) for participants with 2,000-6,000 median particles per 0.01 ft³ during week 1



CHANGE IN PARTICLES (>0.5 MICRONS) PER 0.01 CU. FT

- ▨ Median small wk 1 Indoor
- ▨ Median night wk 1 Indoor
- ▨ Mean small wk 1 Indoor
- ▨ 75% small wk 1 Indoor
- ▨ 25% small wk 1 Indoor
- Median small wk 2 Indoor
- Median night wk 2 indoor
- Mean small wk 2 Indoor
- 75% small wk 2 Indoor
- 25% small wk 2 Indoor

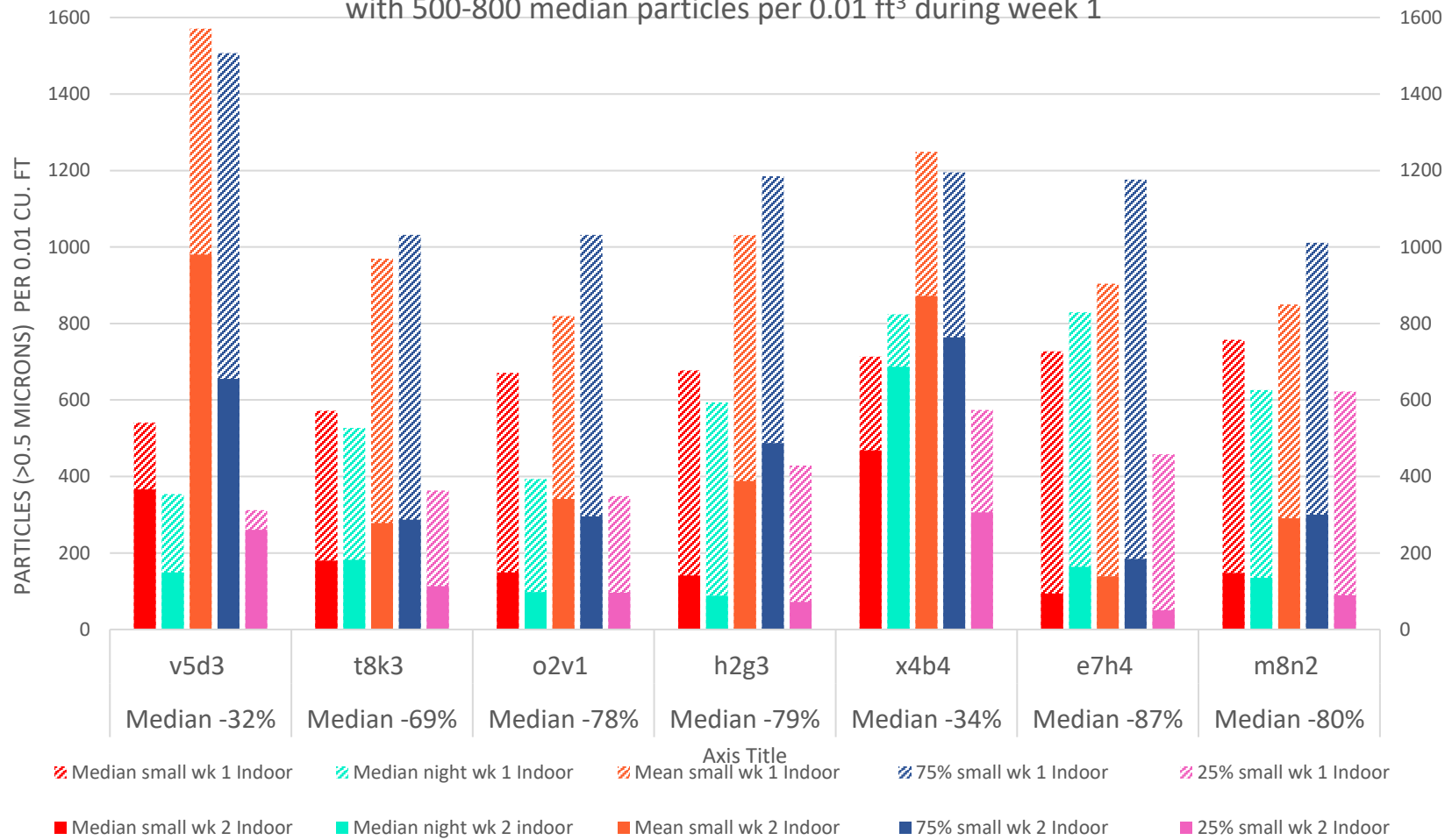
Before and after PACs: Change in indoor small particles (>0.5 microns) for participants with 900-2,000 median particles per 0.01 ft³ during week 1



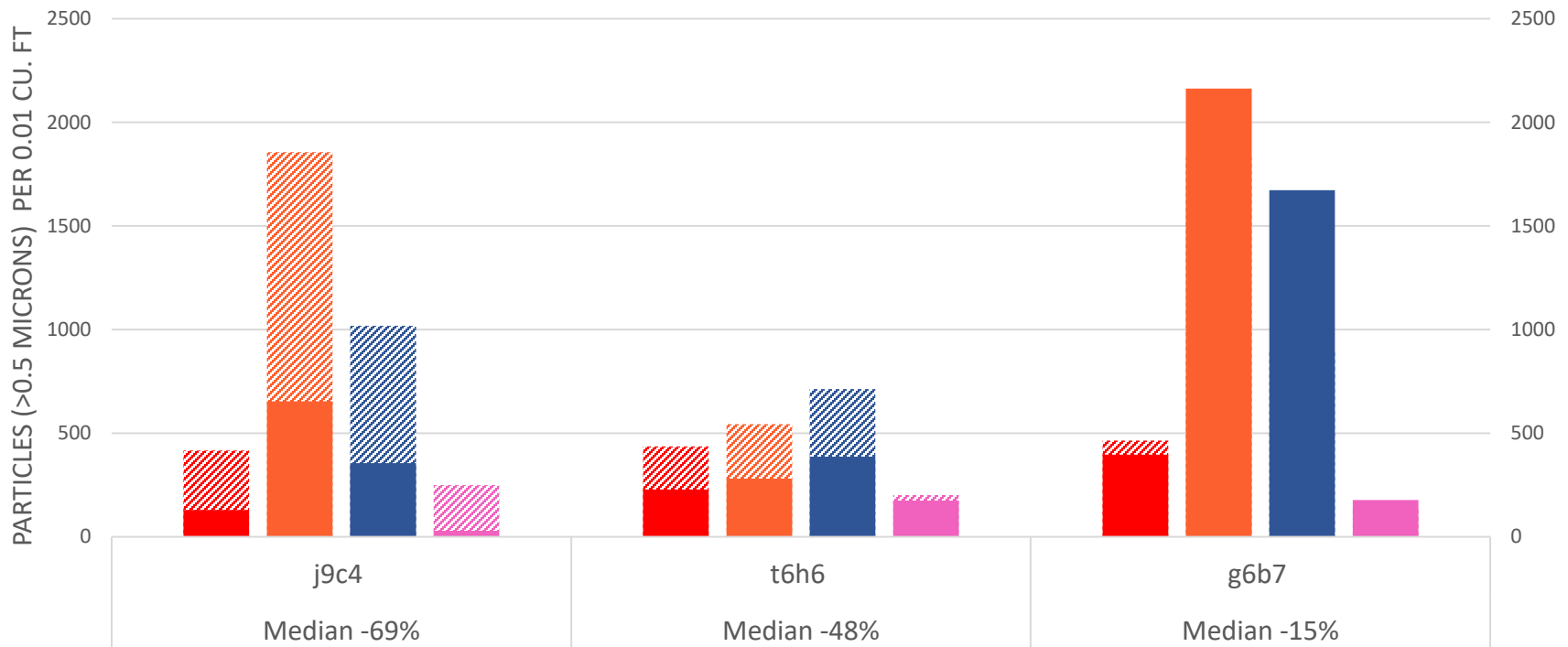
CHANGE IN PARTICLES (>0.5 MICRONS) PER 0.01 CU. FT

- Median small wk 1 Indoor
- Median night wk 1 Indoor
- Mean small wk 1 Indoor
- 75% small wk 1 Indoor
- 25% small wk 1 Indoor
- Median small wk 2 Indoor
- Median night wk 2 indoor
- Mean small wk 2 Indoor
- 75% small wk 2 Indoor
- 25% small wk 2 Indoor

Before and after PACs: Change in indoor small particles (>0.5 microns) for participants with 500-800 median particles per 0.01 ft³ during week 1



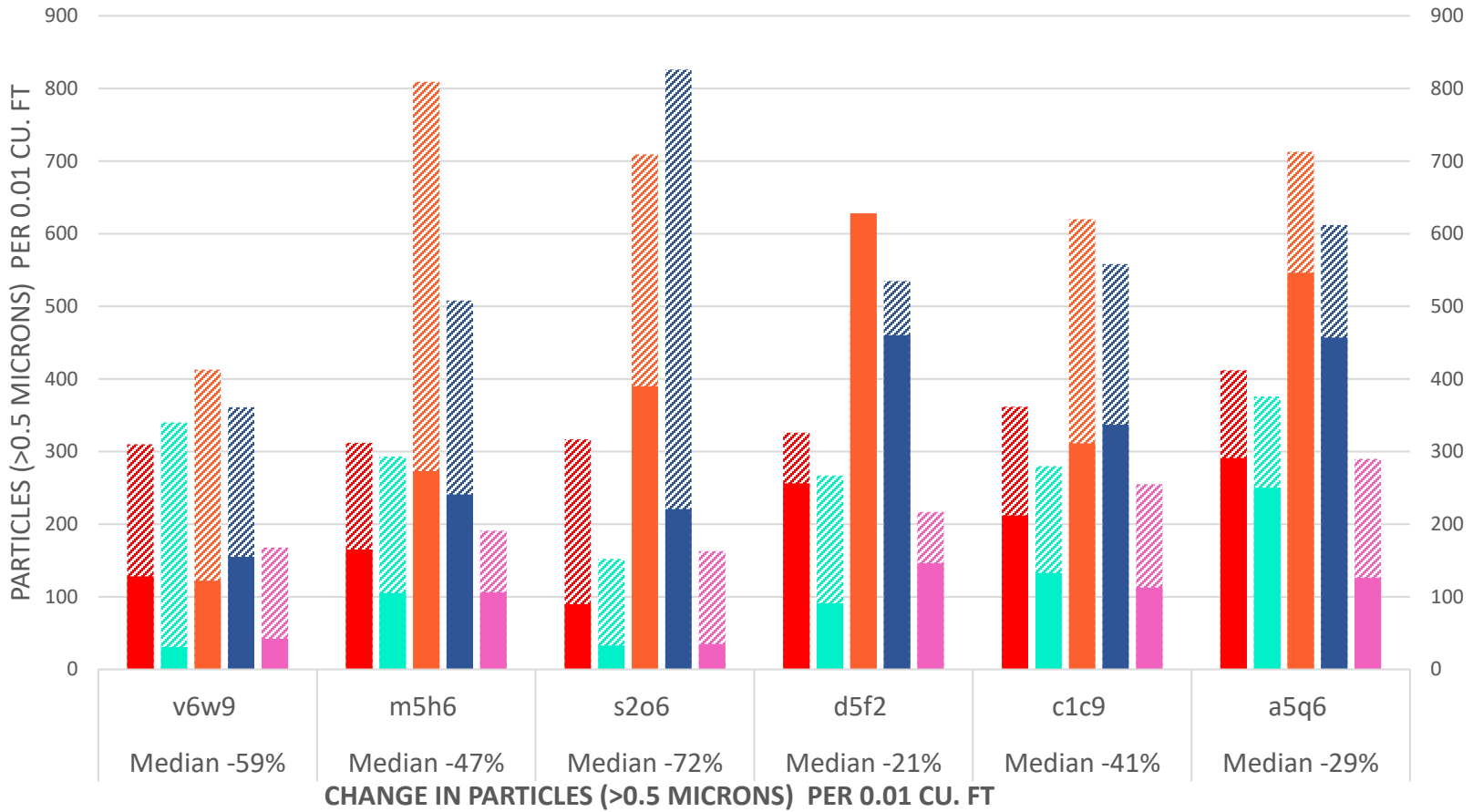
Before and after PACs: Change in indoor small particles (>0.5 microns) for participants with 415-470 median particles per 0.01 ft³ during week 1



CHANGE IN PARTICLES (>0.5 MICRONS) PER 0.01 CU. FT

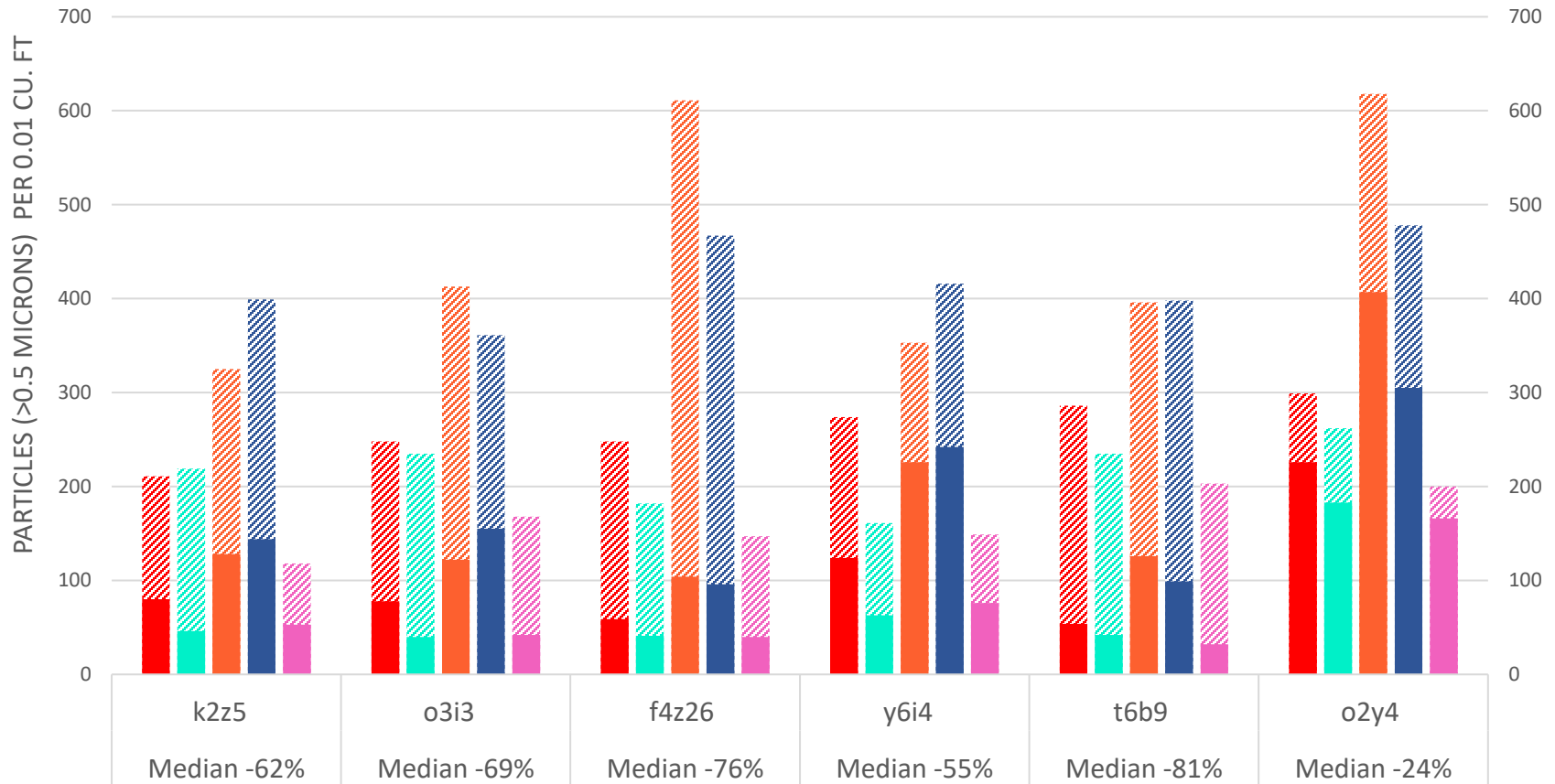
▨ Median small wk 1 Indoor
 ▨ Mean small wk 1 Indoor
 ▨ 75% small wk 1 Indoor
 ▨ 25% small wk 1 Indoor
■ Median small wk 2 Indoor
 ■ Mean small wk 2 Indoor
 ■ 75% small wk 2 Indoor
 ■ 25% small wk 2 Indoor

Before and after PACs: Change in indoor small particles (>0.5 microns) for participants with 300-415 median particles per 0.01 ft³ during week 1



- ▨ Median small wk 1 Indoor
 ▨ Median night wk 1 Indoor
▨ Mean small wk 1 Indoor
▨ 75% small wk 1 Indoor
▨ 25% small wk 1 Indoor
- Median small wk 2 Indoor
 ■ Median night wk 2 indoor
■ Mean small wk 2 Indoor
■ 75% small wk 2 Indoor
■ 25% small wk 2 Indoor

Before and after PACs: Change in indoor small particles (>0.5 microns) for participants with 200-300 median particles per 0.01 ft³ during week 1



CHANGE IN PARTICLES (>0.5 MICRONS) PER 0.01 CU. FT

- Median small wk 1 Indoor
- Median night wk 1 Indoor
- Mean small wk 1 Indoor
- 75% small wk 1 Indoor
- 25% small wk 1 Indoor
- Median small wk 2 Indoor
- Median night wk 2 indoor
- Mean small wk 2 Indoor
- 75% small wk 2 Indoor
- 25% small wk 2 Indoor