Supplementary files

Effectiveness of Indoor Air Purification Intervention in Improving Cardiovascular Health: A Systematic Review and Meta-Analysis of Randomized Controlled Trials

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Appendix A. Search strategy

1. Search Strategy for Ovid Embase:

1	((particulate matter or PM or ultrafine particle or dust or air or airborne or dust or particle or PM or HEPA or ozone or carbon monoxide or CO or sulphur dioxide or nitrogen dioxide) adj5 (cleaner? or filter? or filtration? or purifier? or purification?)).tw.
2	((air or airborne) adj3 (pollutant$ or polluted or contamination or contaminated or quality)).tw.
3	exp particulate matter/ or (PM or ultrafine particle or ozone or carbon monoxide or CO or sulphur dioxide or nitrogen dioxide).tw.
4	exp diabetes mellitus/ or diabet$.tw.
5	exp cardiovascular diseases/ or (cardio?vascular adj5 (disease$ or ill$ or abnormalit$ or disorder? or syndrom$ or symptom$ or function? or condition? or effect$ or response? or impact? or benefit? or advantag? or evaluat$ or assessment?)).tw.
6	exp hypertension/ or (hypertens$ or high blood pressure?).tw.
7	exp hyperlipidemia/ or (hyperlipidem$ or Hypercholesterolemia$ or hypertriglyceridemia$ or arteriosclerosis or atherosclerosis or atheromata* or atherogenesis or biomarker?).tw.
8	exp heart diseases/ or (((heart or cardiac or coronary) adj5 (disease$ or ill$ or abnormalit$ or disorder? or syndrom$ or symptom$ or function? or condition? or effect$ or response? or impact? or benefit? or advantag? or evaluat$ or assessment?)) or arrythmia?).tw.
9	exp cerebrovascular disorders/ or ((cerebrovascular or vascular or carotoid$) adj5 (disease$ or ill$ or abnormalit$ or disorder? or syndrom$ or symptom$ or function? or condition? or effect$ or response? or impact? or benefit? or advantag$ or evaluat$ or assessment?)).tw.
10	exp asthma/ or (asthma$ or allerg$).tw.
11	exp pulmonary disease chronic obstructive/ or copd.tw.
12	((cardio?pulmonary or respirat$ or lung$ or airway$ or airflow$ or bronch$ or pulmonary) adj5 (obstruct$ or disease$ or ill$ or abnormalit$ or disorder? or syndrom$ or symptom$ or function? or condition? or effect$ or response? or impact? or benefit? or advantag? or evaluat$ or assessment?)).tw.
13	exp mental disorders/ or ((mental or anxiet$ or mood or psychological or sleep) adj5 (disease? or disorder?or condition? or effect$ or response? or impact? or benefit? or advantag? or evaluat$ or assessment?) or depression).tw.
14	or/2-13
15	crossover-procedure/ or double-blind procedure/ or randomized controlled trial/ or single-blind procedure/ or (random$ or factorial$ or crossover$ or cross over$ or placebo$ or (doubl$ adj blind$) or (singl$ adj blind$) or assign$ or allocate$ or volunteer$).tw.

16	1 and 14 and 15
17	limit 16 to humans
18	remove duplicates from 17

2. Search Strategy for Ovid Medline:

1	((particulate matter or PM or ultrafine particle or dust or air or airborne or dust or particle or PM or HEPA or ozone or carbon monoxide or CO or sulphur dioxide or nitrogen dioxide) adj5 (cleaner? or filter? or filtration? or purifier? or purification?)).tw.
2	((air or airborne) adj3 (pollutant$ or polluted or contamination or contaminated or quality)).tw.
3	exp particulate matter/ or (PM or ultrafine particle or ozone or carbon monoxide or CO or sulphur dioxide or nitrogen dioxide).tw.
4	exp diabetes mellitus/ or diabet$.tw.
5	exp cardiovascular diseases/ or (cardio?vascular adj5 (disease$ or ill$ or abnormalit$ or disorder? or syndrom$ or symptom$ or function? or condition? or effect$ or response? or impact? or benefit? or advantag? or evaluat$ or assessment?)).tw.
6	exp hypertension/ or (hypertens$ or high blood pressure?).tw.
7	exp hyperlipidemia/ or (hyperlipidem$ or Hypercholesterolemia$ or hypertriglyceridemia$ or arteriosclerosis or atherosclerosis or atheromata* or atherogenesis or biomarker?).tw.
8	exp heart diseases/ or (((heart or cardiac or coronary) adj5 (disease$ or ill$ or abnormalit$ or disorder? or syndrom$ or symptom$ or function? or condition? or effect$ or response? or impact? or benefit? or advantag? or evaluat$ or assessment?)) or arrythmia?).tw.
9	exp cerebrovascular disorders/ or ((cerebrovascular or vascular or carotoid$) adj5 (disease$ or ill$ or abnormalit$ or disorder? or syndrom$ or symptom$ or function? or condition? or effect$ or response? or impact? or benefit? or advantag$ or evaluat$ or assessment?)).tw.
10	exp asthma/ or (asthma$ or allerg$).tw.
11	exp pulmonary disease chronic obstructive/ or copd.tw.
12	((cardio?pulmonary or respirat$ or lung$ or airway$ or airflow$ or bronch$ or pulmonary) adj5 (obstruct$ or disease$ or ill$ or abnormalit$ or disorder? or syndrom$ or symptom$ or function? or condition? or effect$ or response? or impact? or benefit? or advantag? or evaluat$ or assessment?)).tw.
13	exp mental disorders/ or ((mental or anxiet$ or mood or psychological or sleep) adj5 (disease? or disorder? or condition? or effect$ or response? or impact? or benefit? or advantag? or evaluat$ or assessment?) or depression).tw.

14	or/2-13
15	((randomized controlled trial or controlled clinical trial).pt. or randomized.ab. or randomised.ab. or placebo.ab. or randomly.ab. or trial.ab. or groups.ab.) not (exp animals/ not humans.sh.)
16	1 and 14 and 15
17	limit to humans
18	remove duplicates from 17

3. Search Strategy for PubMed:

(((air purification) OR (air purifier) OR (air filtration) OR (Air Filters [mh]) OR (air cleaner)) AND ((Air pollution [mh]) OR (Indoor air pollution [mh]) OR (Particulate Matter [mh]) OR (PM) OR (ultrafine particle) OR (ozone) OR (carbon monoxide) OR (CO) OR (sulphur dioxide) OR (nitrogen dioxide))) AND (((randomized controlled trial [pt] OR controlled clinical trial [pt] OR randomized [tiab] OR placebo [tiab] OR drug therapy [sh] OR randomly [tiab] OR trial [tiab] OR groups [tiab]) NOT (animals [mh] NOT humans [mh])) AND (((((Cardiovascular Abnormalities [mh]) OR (Cardiovascular Deconditioning [mh]) OR (Cardiovascular Diseases [mh]) OR (Cardiovascular Agents [mh]) OR (Heart Disease Risk Factors [mh]) OR (Cardiac Rehabilitation [mh]) OR (Cardiology [mh]) OR (Cardiovascular System [mh])) OR ((Hypertension [mh]) OR (Familial Primary Pulmonary Hypertension [mh]) OR (Essential Hypertension [mh])) OR ((Atherosclerosis [mh]) OR (Coronary Artery Disease [mh]) OR (Intracranial Arteriosclerosis [mh]) OR (Carotid Artery Diseases [mh])) OR ((Inflammation [mh]) OR (Inflammation Mediators [mh])))))

4. Search Strategy for Web of Science:

1	TS=air purification* OR TS=air purifier* OR TS=air filtration* OR TS=air filter* OR TS=air cleaner*
2	TS=Air pollution* OR TS=Indoor air pollution* OR TS=Particulate Matter* OR TS=PM OR TS=ultrafine particle* OR TS=ozone OR TS=carbon monoxide OR TS=CO OR TS=sulphur dioxide OR TS=nitrogen dioxide
3	TS=cardiovascular disease* OR TS=cardiovascular abnormalit* OR TS=cardiovascular disorder? OR TS=cardiovascular syndrom* OR TS=cardiovascular symptom* OR TS=cardiovascular function* OR TS=cardiovascular condition* OR TS=cardiovascular effect* OR TS=cardiovascular response* OR TS=cardiovascular impact* OR TS=cardiovascular benefit* OR TS=cardiovascular advantage*
4	TS=hypertension OR TS=hypertens* OR TS=high blood pressure*
5	TS=hyperlipidemia OR TS=arteriosclerosis OR TS=atherosclerosis OR TS=atheromata* OR TS=atherogenesis
6	TS=heart diseases OR TS=cardiac function* OR TS=cardiac condition* OR TS=cardiac effect* OR TS=cardiac response* OR TS=cardiac impact* OR TS=cardiac benefit* OR TS=cardiac advantage*

7	TS= clinical trial* OR TS=research design OR TS=comparative stud* OR TS=evaluation stud* OR TS=controlled trial* OR TS=follow-up stud* OR TS=prospective stud* OR TS=random* OR TS=placebo* OR TS=(single blind*) OR TS=(double blind*)
8	3 OR 4 OR 5 OR 6
9	1 AND 2 AND 8 And 7

Appendix B. Principle for reaching the overall risk-of-bias judgement

Overall risk-of-bias judgement	Principle
Low risk of bias	All domains for the result are judged as low risk of bias
Some concerns	At least one domain for the result is judged as some concerns
High risk of bias	At least one domain for the result is judged as high risk of bias; Or, Multiple domains for the result are judged as some concerns.

The detailed signalling questions (i.e., criteria) used for assessing each domain can be found at https://www.riskofbias.info/welcome/rob-2-0-tool/archive-rob-2-0-cross-over-trials-2016 (Sterne et al. 2019).

Appendix C. Definitions for the five reasons in the downgrade process of the GRADE approach

Reason	Definition
Risk of bias (Guyatt et al. 2011a)	This may occur when there are limitations in the design, conduct and analysis of the study, such as insufficient randomization, failure to allocation concealment, lack of blinding, and loss to follow-up, etc.
Inconsistency (Guyatt et al. 2011b)	This could be evaluated based on the dissimilarity of point estimates, extent of overlap of confidence intervals, and the tests of heterogeneity and I^2 statistic.
Indirectness (Guyatt et al. 2011c)	This may occur when the population do not share the same characteristics (e.g., age, sex, health condition); or when the interventions tested differ from the intervention of interest; etc.
Imprecision (Guyatt et al. 2011d)	This may occur with wide 95% confidence interval, small total sample size, or small number of events.
Publication bias (Guyatt et al. 2011e)	This may occur when there are unreported studies (mainly due to insignificant results). Funnel plot is the most popular approach to help assess publication bias.

As stated in the main text, according to the GRADE (the Grading of Recommendations Assessment, Development, and Evaluation) guidelines, the quality of the evidence is usually rated as high (++++), moderate (+++), low (++) or very low (+). For randomized controlled trials, the body of the evidence for each group of studies would start with high level (++++), and then it could be downgraded for the five specific reasons.

Appendix D. Documentation of risk of bias assessment using the Cochrane Risk-of-Bias Version 2 (RoB2) tool

Study: Allen et al. 2011, British Columbia, Canada
Health outcomes: blood pressure, reactive hyperaemia index, C-reactive protein, and interleukin-6. The assessment applies to all health outcomes.

References:

Allen RW, Carlsten C, Karlen B, Leckie S, Eeden SV, Vedal S, et al. 2011. An air filter intervention study of endothelial function among healthy adults in a woodsmoke-impacted community. Am J Respir Crit Care Med 183: 1222–1230; doi: 10.1164/rccm.201010-1572OC.

Domains	Low	Some concerns	High	Comment	Quote (indicate reference)
Domain 1: Randomization process	X			The allocation sequence was random. All participants received sham and true air filtration, indicating an equal proportion of participants allocated to each of the two interventions.	'The order of filtration or nonfiltration was random.' ; 'Each participant's home was monitored for two consecutive...'
Domain 2: Deviations from the intended interventions		X		The internal filters of air purifiers were removed and the participants were not aware of the intervention. However, no information was provided to indicate whether there was a wash-out period.	'HEPA filters were operated normally during one 7-day period and without the internal filters in place (i.e., placebo filtration) during the other period, thus blinding participants to the filters' status.'
Domain 3: Missing outcome data		X		A total of 56 participants were recruited initially, but only 45 participants were included in the data analyses. The availability of data was lower than 90%, which might be insufficient. As all participants received two interventions (i.e., sham and true), the proportions of missing data were similar across interventions. Therefore, the risk of bias due to missing data might be with some concerns.	'Before analysis, we excluded eight participants who did not have complete $PM_{2.5}$ and F_{inf} data to allow for direct comparisons of effects between different exposure indicators. In addition, before analysis we removed one pregnant participant, one participant with Raynaud syndrome, and one participant...'
Domain 4: Measurement of the outcomes		X		No information was provided to indicate whether the outcome assessors were aware of the intervention received by the study participants.	'A trained technician performed manual band cell counts on thin blood smears that were air dried, fixed with methanol, and stained with Wright stain.'; 'At the end of each 7-day period, a study technician measured microvascular endothelial function and collected blood and urine samples at the participant's home.'
Domain 5: Selective reporting	X			Only one measurement method was used for each outcome. They used two analysis methods to show the intervention effects (i.e., paired t-test and linear mixed model) and presented both of the results.	e.g., 'Microvascular endothelial function was measured via peripheral artery tonometry using the portable EndoPAT 2000 instrument...'; Table 3 presented mean values of each group; Figures 2-4 showed the results of mixed models.

Study: Bräuner et al. 2008, Copenhagen, Denmark
Health outcomes: blood pressure, reactive hyperaemia index, C-reactive protein, interleukin-6, and fibrinogen. The assessment applies to all health outcomes.

References:

Bräuner EV, Forchhammer L, Møller P, Barregard L, Gunnarsen L, Afshari A, et al. 2008. Indoor Particles Affect Vascular Function in the Aged. Am J Resp Crit Care 177:419–425; doi:10.1164/rccm.200704-632oc.

Domains	Low	Some concerns	High	Comment	Quote (indicate reference)
Domain 1: Randomization process	X			The allocation sequence was random. All participants received sham and true air filtrations, indicating an equal proportion of participants allocated to each of the two interventions.	'The project design was a double-blind crossover intervention with randomized order of 48-hour exposure to recirculated particle-filtered and nonfiltered indoor air in the volunteer's homes'; '...were placed in the bedroom and living room of each apartment during the study period (either with or without a HEPA filter, according to scenario...)'
Domain 2: Deviations from the intended interventions		X		The internal filters of air purifiers were removed and the participants were not aware of the intervention. However, no information was provided to indicate whether there was a wash-out period.	'The project design was a double-blind crossover...'; 'either with or without a HEPA filter, according to scenario...'; 'When the HEPA filter was removed, filtration efficiency of the unit was less than 10%, with unchanged noise, airflow, and appearance.'
Domain 3: Missing outcome data	X			A total of 42 participants were recruited initially, and 41 were included in the data analyses. Although there were three missing data points for reactive hyperaemia index, the availability of data was more than 90%, which was sufficient according to RoB2.	'A total of 21 couples, aged 60–75 (median, 67) years and mean body mass index of 25 (SD, 3.24), were recruited, and one female was later excluded.'; '...three missing data points for the MVF score...'
Domain 4: Measurement of the outcomes	X			Double-blind design prevented bias when outcome assessors evaluated health outcomes.	'The project design was a double-blind crossover...'
Domain 5: Selective reporting	X			Only one measurement method was used for each outcome. They used two analysis methods to show the intervention effects and presented both of the results.	e.g., 'MVF was measured ... using reactive hyperemia peripheral arterial tonometry (RH-PAT), as previously described in detail (21–23)...'; Table 2 presented geometric mean values of each group; '...as assessed in the mixed-effects model with inclusion of filtration as a categorical variable (Table 2).'

Study: Chen et al. 2015, Shanghai, China
Health outcomes: blood pressure, pulse pressure, C-reactive protein, interleukin-6, and fibrinogen. The assessment applies to all health outcomes.

References:

Chen R, Zhao A, Chen H, Zhao Z, Cai J, Wang C, et al. 2015. Cardiopulmonary benefits of reducing indoor particles of outdoor origin: A randomized, double-blind crossover trial of air purifiers. J Am Coll Cardiol 65: 2279–2287; doi: 10.1016/j.jacc.2015.03.553.

Domains	Low	Some concerns	High	Comment	Quote (indicate reference)
Domain 1: Randomization process	X			The allocation sequence was random. All participants received sham and true air filtrations, indicating an equal proportion of participants allocated to each of the two interventions.	'This intervention was designed as a randomized double-blind crossover study...were randomized into 2 groups...'; '...used an air purifier placed in the center of the room for 48 h...and then another 48 h of using a sham air purifier under the same conditions. The other group simply reversed the order...'
Domain 2: Deviations from the intended interventions	X			The sham air purifiers were used during the sham period and the participants were not aware of the intervention. There was a 2-week washout period to reduce carry-over effects.	'...with the only difference being removal of the filter gauze in the sham purifiers.'; '...followed by a 2-week washout period, and then another 48 h of using a sham air purifier under the same conditions.'
Domain 3: Missing outcome data	X			No missing data. All participants completed the study.	'All participants completed this study.'
Domain 4: Measurement of the outcomes	X			Double-blind design prevented bias when outcome assessors evaluated health outcomes.	'This intervention was designed as a randomized double-blind crossover study...'
Domain 5: Selective reporting	X			Only one measurement method was used for each outcome. They used two analysis methods to show the intervention effects and presented both of the results.	e.g., 'We measured the other biomarkers using enzyme-linked immunosorbent assays...'; Table 2 presented geometric mean values of each group; Tables 3 and 4 presented the results of mixed-effects models.

Study: Chuang et al. 2017, Taipei, China
Health outcomes: blood pressure, C-reactive protein, and fibrinogen. The assessment applies to all health outcomes.

References:

Chuang H-C, Ho K-F, Lin L-Y, Chang T-Y, Hong G-B, Ma C-M, et al. 2017. Long-term indoor air conditioner filtration and cardiovascular health: A randomized crossover intervention study. Environ Int 106:91–96; doi:10.1016/j.envint.2017.06.008.

Domains	Low	Some concerns	High	Comment	Quote (indicate reference)
Domain 1: Randomization process	X			The allocation sequence was random. All participants received sham and true air filtrations, indicating an equal proportion of participants allocated to each of the two interventions.	Figure 1 showed the randomization and cross-over process.
Domain 2: Deviations from the intended interventions		X		Sham air filters were used during the sham intervention period, and the participants did not know the filter's status. However, no information was provided to indicate whether there was a wash-out period.	'For the control intervention phase ... research staff added a false air conditioner filter to their air conditioner'
Domain 3: Missing outcome data	X			No missing data.	Figure 1 showed that all participants completed the trials.
Domain 4: Measurement of the outcomes		X		No information was provided to indicate whether the outcome assessors were aware of the intervention received by the study participants, although they stated that the data analysts were blinded.	'The research staff who were responsible for data analysis and all participants were blinded to the intervention assignment...'
Domain 5: Selective reporting	X			Only one measurement method was used for each outcome. They used two analysis methods to show the intervention effects and presented both of the results.	e.g., '...using a portable blood pressure mon- itoring system (DynaPulse, model 5000A; Pulse Metric, San Diego, CA).'; Table 2 presented the mean values of each group and t-test results; Table 3 presented the results of mixed-effects models.

Study: Cui et al. 2018, Shanghai, China
Health outcomes: blood pressure, pulse pressure, and interleukin-6. The assessment based on interleukin-6 is different from the one based on blood pressure and pulse pressure.

References:

Cui X, Li F, Xiang J, Fang L, Chung MK, Day DB, et al. 2018. Cardiopulmonary effects of overnight indoor air filtration in healthy non-smoking adults: A double-blind randomized crossover study. Envrion Int 114: 27–36; doi: 10.1016/j.envint.2018.02.010.

1. Assessment based on blood pressure and pulse pressure.

Domains	Low	Some concerns	High	Comment	Quote (indicate reference)
Domain 1: Randomization process	X			The allocation sequence was random. All participants received sham and true air filtrations, indicating an equal proportion of participants allocated to each of the two interventions.	'The order of true filtration and sham filtration was determined using cluster-randomization...'; '...received both true and sham indoor air filtration in a double-blinded randomized crossover study.'
Domain 2: Deviations from the intended interventions	X			The sham air purifiers looked identical with the true ones, therefore the participants were blinded. In addition, there was a 2-week washout period to reduce carry-over effects.	"...the 'sham filtration' refers to the use of the same air purifiers with all the three filters removed."; 'True and sham filtration sessions were separated by a two-week washout interval.'
Domain 3: Missing outcome data	X			They recruited 73 participants initially, and 70 completed the trial. The availability of data was more than 95%, which was sufficient according to RoB2.	'...73 were eligible and recruited into the study. One participant dropped out due to a scheduling conflict, and another participant dropped out due to an aversion to blood draw.'; 'Seventy-one participants completed the entire study. One participant was excluded from statistical analysis due to self-reported secondhand smoke exposure from a roommate.'
Domain 4: Measurement of the outcomes	X			The double-blind design prevented bias when outcome assessors evaluated health outcomes.	'The true and sham filtration devices looked identical, the participants and research staff members that assessed health indicators were blinded to the order of true and sham "ltration interventions.'
Domain 5: Selective reporting	X			Only one measurement method was used for each outcome, and the outcomes were measured at multiple time points, all of which were presented. They used two analysis methods to show the intervention effects and presented both of the results.	e.g., 'We used performed pulse wave analysis and systolic and diastolic blood pressure (sBP, dBP) measurements (VICORDER® cardiovascular and peripheral vascular testing instrument, SMT Medical, Würzburg, Germany).'; Appendix Fig. S5 presented the within-participant differences in the duration of true and sham filtration; Figures 2 and 3 presented the results of mixed-effects models.

2. Assessment based on interleukin-6.

Domains	Low	Some concerns	High	Comment	Quote (indicate reference)
Domain 1: Randomization process	X			The allocation sequence was random. All participants received sham and true air filtrations, indicating an equal proportion of participants allocated to each of the two interventions.	'The order of true filtration and sham filtration was determined using cluster-randomization...'; '...received both true and sham indoor air filtration in a double-blinded randomized crossover study.'
Domain 2: Deviations from the intended interventions	X			The sham air purifiers looked identical with the true ones, therefore the participants were blinded. In addition, there was a 2-week washout period to reduce carry-over effects.	"...the 'sham filtration' refers to the use of the same air purifiers with all the three filters removed."; 'True and sham filtration sessions were separated by a two-week washout interval.'
Domain 3: Missing outcome data			X	The data for interleukin-6 was only collected from 39 participants.	Shown in Figure 3.
Domain 4: Measurement of the outcomes	X			The double-blind design prevented bias when outcome assessors evaluated health outcomes.	'The true and sham filtration devices looked identical, the participants and research staff members that assessed health indicators were blinded to the order of true and sham "ltration interventions.'
Domain 5: Selective reporting	X			Only one measurement method was used for each outcome, and the outcomes were measured at multiple time points, all of which were presented. They used two analysis methods to show the intervention effects and presented both of the results.	e.g., 'The concentration of interleukin-6 (IL-6), soluble P-selectin (sCD62P), and von Willebrand factor (VWF) was quanti"ed using MILLIPLEX® MAP kits (Merck Millipore catalog # HSTCMAG-28SK-01, HCVD2MAG-67 K, and HCVD3MAG-67K, respectively).'; Appendix Fig. S5 presented the within-participant differences in the duration of true and sham filtration; Figures 2 and 3 presented the results of mixed-effects models.

Study: Dong et al. 2019, Beijing, China
Health outcomes: blood pressure and pulse pressure. The assessment applies to all health outcomes.

References:

Dong W, Liu S, Chu M, Zhao B, Yang D, Chen C, et al. 2019. Different cardiorespiratory effects of indoor air pollution intervention with ionization air purifier: Findings from a randomized, double-blind crossover study among school children in Beijing. Environ Pollut 254: 113054; doi: 10.1016/j.envpol.2019.113054.

Domains	Low	Some concerns	High	Comment	Quote (indicate reference)
Domain 1: Randomization process	X			The allocation sequence was random. All participants received sham and true air filtrations, indicating an equal proportion of participants allocated to each of the two interventions.	Shown in Figure 1. 'A randomized, double-blind crossover study was conducted from December 2017...'
Domain 2: Deviations from the intended interventions			X	For the control group, the air purifiers were only turned off, which might be easily recognised by some participants as the noise generated by the machine would be different.	"...'real' (machine turned on) and 'sham' (machine turned off) purification, in a random order with a 2-month washout period."
Domain 3: Missing outcome data	X			Among 48 participants recruited, only 44 finished the whole study. The availability of data was more than 90%, which was sufficient according to RoB2.	Shown in Figure 1.
Domain 4: Measurement of the outcomes	X			The double-blind design prevented bias when outcome assessors evaluated health outcomes. Furthermore, the same investigator ran the same tests across different time points in the trial, avoiding possible variation arising between different investigators.	'A randomized, double-blind crossover study was conducted from December 2017...'; 'To avoid possible variation arising between different investigators, the same investigator ran the same tests throughout the study wherever possible.'
Domain 5: Selective reporting	X			Only one measurement method was used for each outcome. They used two analysis methods to show the intervention effects and presented both of the results.	e.g., 'blood pressure was measured using an automated oscillometric monitor (HEM-7052;Omron Healthcare Co. Ltd., Japan)...'; Table 2 presented the mean values of each group and paired t-test results; Figure 2 presented the results of mixed-effects models.

Study: Kajbafzadeh et al. 2015, British Columbia, Canada
Health outcomes: reactive hyperaemia index, C-reactive protein, and interleukin-6. The assessment applies to all health outcomes.

References:

Kajbafzadeh M, Brauer M, Karlen B, Carlsten C, Eeden S van, Allen RW. 2015. The impacts of traffic-related and woodsmoke particulate matter on measures of cardiovascular health: a HEPA filter intervention study. Occup Environ Med 72:394; doi:10.1136/oemed-2014-102696.

Domains	Low	Some concerns	High	Comment	Quote (indicate reference)
Domain 1: Randomization process	X			The allocation sequence was random. All participants received sham and true air filtrations, indicating an equal proportion of participants allocated to each of the two interventions.	'The order of filtration and placebo filtration was selected randomly'; 'Each home was monitored during two consecutive 7-day periods... During one 7-day period the units were operated with a HEPA filter in place and during the other 7-day period there was no HEPA filter in the unit...'
Domain 2: Deviations from the intended interventions		X		The internal filters were removed during the sham intervention period, and the participants did not know the filter's status. However, no information was provided to indicate whether there was a wash-out period.	'...during the other 7-day period there was no HEPA filter in the unit (i.e. placebo filtration), thereby blinding participants to intervention status.'
Domain 3: Missing outcome data		X		A total of 83 subjects participated in the study, but only 68 had data for reactive hyperaemia index and 52 had data for C-reactive protein. However, the proportions of missing data were similar across interventions.	Shown in Table 3.
Domain 4: Measurement of the outcomes			X	The outcome assessors might have known the intervention status of each participant when evaluating the health outcomes.	'...to participate in this randomized, single-blind crossover intervention study.'
Domain 5: Selective reporting	X			Only one measurement method was used for each outcome. They used two analysis methods to show the intervention effects and presented both of the results.	e.g., 'Microvascular endothelial function was measured...using a portable EndoPAT 2000 device (Itamar Medical Ltd, Cesari, Israel)...'; Table 3 presented the mean values of each group and paired t-test results; Figure 2 presented the results of mixed-effects models.

Study: Karottki et al. 2013, Copenhagen, Denmark
Health outcomes: no results were included in the meta-analysis.

References:

Karottki DG, Spilak M, Frederiksen M, Gunnarsen L, Brauner EV, Kolarik B, et al. 2013. An indoor air filtration study in homes of elderly: cardiovascular and respiratory effects of exposure to particulate matter. Environ Health-uk 12:116; doi:10.1186/1476-069x-12 116.

Domains	Low	Some concerns	High	Comment	Quote (indicate reference)
Domain 1: Randomization process	X			The allocation sequence was random. All participants received sham and true air filtrations, indicating an equal proportion of participants allocated to each of the two interventions.	'The project was designed as a double-blind cross-over intervention with randomized order of exposure to recirculated particle-filtered or sham-filtered indoor air in the home of the participants.'; '... the subjects served as their own controls'
Domain 2: Deviations from the intended interventions		X		A dummy filter with the same pressure drop and noise level was used as the control intervention, and the participants were blinded. However, no information was provided to indicate whether there was a wash-out period.	'In the period with sham filtration, we used a dummy filter that conferred the same pressure drop and noise level.'; 'The project was designed as a double-blind cross-over intervention with randomized order...'
Domain 3: Missing outcome data	X			Forty-eight people participated the trial, and only one baseline reactive hyperaemia index test and 14 spirometer tests (this outcome is not related to our results) were not recorded. Therefore, the availability of data was more than 95%.	'One baseline MVF test and 14 spirometer tests were not recorded due to instrument failure.'
Domain 4: Measurement of the outcomes	X			The outcome assessors were blinded. Furthermore, the same researcher ran the same tests in the trial, avoiding possible variation arising between different investigators	'The participants as well as the researcher measuring health outcomes were blinded to the exposure scenario.'; 'The same experienced researcher determined MVF and lung function and collected blood samples in all the participants' homes'
Domain 5: Selective reporting	X			Only one measurement method was used for each outcome, and the outcomes were measured at multiple time points, all of which were presented. They used two analysis methods to show the intervention effects and presented both of the results.	e.g., 'Resting blood pres- sure was measured using a WelchAllyn DuraShock DS54 manometer (Welch Allyn GmbH & Co. KG, Deutschland) before each MVF measurement.'; Table 3 presented the median values of each group at multiple time points; Table 4 presented the results of mixed-effects models.

Study: Li et al. 2017 and Chen et al. 2018, Shanghai, China (Two publications from one randomized controlled trial)
Health outcomes: blood pressure, and pulse pressure.

References:

#1 Li H, Cai J, Chen R, Zhao Z, Ying Z, Wang L, et al. 2017. Particulate matter exposure and stress hormone levels: A randomized, double-blind, crossover trial of air purification. Circulation 136: 618–627.

#2 Chen R, Li H, Cai J, Wang C, Lin Z, Liu C, et al. 2018. Fine particulate air pollution and the expression of microRNAs and circulating cytokines relevant to inflammation, coagulation, and vasoconstriction. Envrion Health Perspect 126: 017007; doi: 10.1289/EHP1447.

Domains	Low	Some concerns	High	Comment	Quote (indicate reference)
Domain 1: Randomization process	X			The allocation sequence was random. All participants received sham and true air filtrations, indicating an equal proportion of participants allocated to each of the two interventions.	'...we conducted a randomized, double-blind, crossover trial of air purification...'; '...received alternate treatments in random order at each study period intermitted by a 12-day washout period.'
Domain 2: Deviations from the intended interventions	X			The internal filters were removed during the sham purification period, therefore the participants were blinded. In addition, there was a 12-day washout period to reduce carry-over effects.	'...for the treatment of sham purification, we simply removed the filter gauze.'; '...received alternate treatments in random order at each study period intermitted by a 12-day washout period.'
Domain 3: Missing outcome data	X			Sixty people participated the trial and data from 55 were included in the data analyses. The availability of data was more than 90%, which is sufficient according to RoB2.	Shown in Figure 1.
Domain 4: Measurement of the outcomes	X			The double-blind design prevented bias when outcome assessors evaluated health outcomes.	'...we conducted a randomized, double-blind, crossover trial of air purification...'
Domain 5: Selective reporting		X		Only one measurement method was used for each outcome. Without the reporting of mean values for each intervention groups, they only reported the results of mixed-effects models to show the intervention effects.	Figure 3 and Figure VI (in the online-only Data Supplement) presented the results of mixed-effects models for blood pressure, pulse pressure, and C-reactive protein.

Study: Liu et al. 2020b, Beijing, China
Health outcomes: blood pressure.

References:

Liu W, Huang J, Lin Y, Cai C, Zhao Y, Teng Y, et al. 2021. Negative Ions Offset Cardiorespiratory Benefits of PM2.5 Reduction from Residential Use of Negative Ion Air Purifiers. Indoor air. 2021. 31(1):220–228. doi:10.1111/ina.12728.

Domains	Low	Some concerns	High	Comment	Quote (indicate reference)
Domain 1: Randomization process	X			The allocation sequence was random. All participants received sham and true air filtrations, indicating an equal proportion of participants allocated to each of the two interventions.	'Each participant was randomly assigned into two groups undergoing two indoor air filtration sessions (true vs. sham, Figure S1 of the SI)', also shown in Figure S1.
Domain 2: Deviations from the intended interventions			X	Although there was a washout period to reduce carry-over effects, the blinding process of air cleaners might be noticed by participants, as they just cut the power line inside (which may have resulted in different noise levels).	'The duration of each session was one week and the washout time between the two sessions was two weeks.'; 'In the sham filtration session, we kept the facade of NIAPs but cut their power line inside so that all participants were blinded for the filtration conditions.'
Domain 3: Missing outcome data	X			No missing data.	'Fifty-six healthy college students of Tsinghua Universit...'; 'We performed week-long interventions with NIAPs in the dormitories of 56 healthy college students living in Beijing.'
Domain 4: Measurement of the outcomes	X			The double-blind design prevented bias when outcome assessors evaluated health outcomes.	'our study has several strengths such as the randomized double-blind cross-over design...'
Domain 5: Selective reporting	X			Only one measurement method was used for each outcome. They used two analysis methods to show the intervention effects and presented both of the results.	Table S1 presented the mean values of blood pressure for each group and paired t-test results; Figures 1 and 2 presented the results of mixed-effects models.

Study: Morishita et al. 2018, Midtown Detroit, USA
Health outcomes: blood pressure and pulse pressure. The assessment applies to all health outcomes.

References:

Morishita M, Adar SD, D'Souza J, Ziemba RA, Bard RL, Spino C, et al. 2018. Effect of Portable Air Filtration Systems on Personal Exposure to Fine Particulate Matter and Blood Pressure Among Residents in a Low-Income Senior Facility. Jama Intern Med 178:1350; doi:10.1001/jamainternmed.2018.3308.

Domains	Low	Some concerns	High	Comment	Quote (indicate reference)
Domain 1: Randomization process	X			The allocation sequence was random. All participants received sham and true air filtrations, indicating an equal proportion of participants allocated to each of the two interventions.	'Interventions included 3 blinded scenarios in computer-generated random order: unfiltered ambient air exposure (sham filtration), low-efficiency (LE) HEPA-type filtration, and high-efficiency (HE) true-HEPA filtration'
Domain 2: Deviations from the intended interventions	X			The internal filters were removed during the sham purification period, therefore the participants were blinded. In addition, there was a 1-week washout period to reduce carry-over effects.	'...For the "w/o filter" condition, the air cleaner was operated normally without any filter element (i.e., sham filtration) so that filtration status was unknown to the subjects.' (in supplementary file); 'Each scenario lasted 3 days, separated by 1-week washout periods.'
Domain 3: Missing outcome data	X			No missing data.	Shown in Figure 1.
Domain 4: Measurement of the outcomes	X			The double-blind design prevented bias when outcome assessors evaluated health outcomes.	'...was a randomized, double-blind, 3-way crossover in- tervention study conducted from October...'
Domain 5: Selective reporting	X			Only one measurement method was used for each outcome. They used two analysis methods to show the intervention effects and presented both of the results.	e.g., 'Brachial BP was determined using the dominant arm resting at heart level per guidelines...' (in supplementary file); Table 2 presented the mean values of health outcomes for each group; Figure 2 presented the results of mixed-effects models.

Study: Padró-Martínez et al. 2015, Somerville, USA
Health outcomes: blood pressure, and pulse pressure. The assessment applies to all health outcomes.

References:

Padró-Martínez LT, Owusu E, Reisner E, Zamore W, Simon MC, Mwamburi M, et al. 2015. A randomized cross-over air filtration intervention trial for reducing cardiovascular health risks in residents of public housing near a highway. Int J Environ Res Public Health 12: 7814–7838; doi: 10.3390/ijerph120707814.

Domains	Low	Some concerns	High	Comment	Quote (indicate reference)
Domain 1: Randomization process	X			The allocation sequence was random. All participants received sham and true air filtrations, indicating an equal proportion of participants allocated to each of the two interventions.	'...pairs of participants were studied in parallel with one participant starting with HEPA and the other with sham filtration with assignment randomized'; 'Each participant was exposed to HEPA-filtered air for 21 days and unfiltered (sham) air for 21 days.'
Domain 2: Deviations from the intended interventions		X		Sham internal filters were used during the sham purification period, therefore the participants were blinded. However, no information was provided to indicate whether there was a wash-out period.	'Regardless of which filter was in use (HEPA or sham), the sound and appearance of the equipment was the same; thus, participants did not know which filter was in use.'
Domain 3: Missing outcome data	X			Twenty-one people received intervention, and the data from 20 were included in the data analysis. The availability of data was more than 95%.	'The study was conducted in 20 apartments (21 participants)... our final data set included 19 apartments and 20 participants.'
Domain 4: Measurement of the outcomes	X			The double-blind design prevented bias when outcome assessors evaluated health outcomes.	'The study design was a randomized, double-blind crossover trial with the goal of having 50% of participants start with HEPA filtration...'; 'Nurses from the Visiting Nurses Association (VNA) of Eastern Massachusetts performed three visits to each participant's apartment...'; 'The lab was blinded to the intervention status of the blood samples...'
Domain 5: Selective reporting	X			Only one measurement method was used for each outcome. They used three analysis methods to show the intervention effects and presented both of the results.	e.g., '...diastolic and systolic blood pressure were measured in the right and then left arms of seated participants using an automatic blood pressure machine (Model #HEM711ACN2, Omron Healthcare, Kyoto, Japan).'; Tables 1, 3 and 4 showed the differences in change of health outcomes between intervention groups and mean values of health outcomes for each group; Table 5 presented the results of generalized estimating equations.

Study: Shao et al. 2017, Beijing, China
Health outcomes: blood pressure, C-reactive protein, interleukin-6, and fibrinogen. The assessment applies to all health outcomes.

References:

Shao D, Du Y, Liu S, Brunekreef B, Meliefste K, Zhao Q, et al. 2017. Cardiorespiratory responses of air filtration: A randomized crossover intervention trial in seniors living in Beijing Beijing Indoor Air Purifier StudY, BIAPSY. Sci Total Environ 603:541–549; doi:10.1016/j.scitotenv.2017.06.095.

Domains	Low	Some concerns	High	Comment	Quote (indicate reference)
Domain 1: Randomization process	X			The allocation sequence was random. All participants received sham and true air filtrations, indicating an equal proportion of participants allocated to each of the two interventions.	'the filtration units were randomly allocated in active-mode (with HEPA filters) in half of the households for 2 weeks and in sham-mode (without HEPA filters) in the other half of the households for 2 weeks, then the filtration modes were switched for another 2 weeks.'
Domain 2: Deviations from the intended interventions		X		HEPA filters were removed during the sham purification period, therefore the participants were blinded. However, no information was provided to indicate whether there was a wash-out period.	'...in sham-mode (without HEPA filters) in the other half of the households for 2 weeks...'
Domain 3: Missing outcome data	X			No missing data.	Shown in Figure 1.
Domain 4: Measurement of the outcomes		X		No information was provided to indicate whether the outcome assessors were aware of the intervention group received by participants when evaluating the health outcomes.	
Domain 5: Selective reporting	X			Only one measurement method was used for each outcome. They used two analysis methods to show the intervention effects and presented both of the results.	e.g., 'Serum CRP was detected with Beckman image 800 (Immuno Turbidimetry). Serum IL-6 and IL-8 were analyzed by a Cytometric Bead Array (CBA) (BD Biosciences, U.S.).'; Table 3 presented the mean values of health outcomes for each group; Table 4 presented the results of mixed-effects models.

Study: Weichenthal et al. 2013, Southern Manitoba, Canada
Health outcomes: blood pressure and reactive hyperaemia index. The assessment applies to all health outcomes.

References:

Weichenthal S, Mallach G, Kulka R, Black A, Wheeler A, You H, et al. 2013. A randomized double-blind crossover study of indoor air filtration and acute changes in cardiorespiratory health in a First Nations community. Indoor air 23: 175–84; doi: 10.1111/ina.12019.

Domains	Low	Some concerns	High	Comment	Quote (indicate reference)
Domain 1: Randomization process	X			The allocation sequence was random. All participants received sham and true air filtrations, indicating an equal proportion of participants allocated to each of the two interventions.	'The order of air filtration (i.e., working or placebo) was randomly assigned, and both participants and technicians conducting health measurements were blinded to the type of filter in their home each week'; 'Each home participated over a continuous 3-week period: 1 week with a working air filter, 1 week with a placebo air filter...'
Domain 2: Deviations from the intended interventions	X			The internal filters were removed during the sham purification, therefore the participants were blinded. In addition, there was a 1-week washout period to reduce carry-over effects..	'There were no differences in external appearance or noise produced when air filters were equipped with working versus placebo filters.'; '...and a 1-week washout period in between with the air filter removed from the home.'
Domain 3: Missing outcome data		X		Thirty-seven people participated the study. Twenty-nine participants were included for the analysis of blood pressure, and 24 ones were included for reactive hyperaemia index. The availability of data was lower than 90%, which might be insufficient. As the proportions of missing data were similar across interventions (shown in Table 3), the risk of bias due to missing data might be with some concerns.	'Thirty-seven people in 20 homes were recruited to par- ticipate in the study.'; Final number of participants included in data analysis was shown in Table 3.
Domain 4: Measurement of the outcomes	X			The outcome assessors were unaware of the intervention group received by participants when evaluating the health outcomes.	'Clinical measurements were collected at the beginning and end of each 1-week segment of the study by trained community technicians blinded to the type of filter in the home.'
Domain 5: Selective reporting		X		Only one measurement method was used for each outcome. Without the reporting of mean values for each intervention groups, they only reported the results of mixed-effects models to show the intervention effects.	e.g., 'Endothelial function was examined using the non-invasive Endo- PAT 2000 instrument (Itamar Med- ical Ltd, Cesari, Israel), which determines a reactive hyperemia index (RHI) based on responses in the digi- tal vascular.'; Tables 3 and 4 presented the results of mixed-effects models for blood pressure and reactive hyperaemia index.

Appendix E. Summary of risk of bias across studies (outcome-specific)

	Domain 1	Domain 2	Domain 3	Domain 4	Domain 5	Overall judgement
Allen et al. 2011	Low	Some concerns	Some concerns	Some concerns	Low	High
Bräuner et al. 2008	Low	Some concerns	Low	Low	Low	Some concerns
Chen et al. 2015	Low	Low	Low	Low	Low	Low
Chuang et al. 2017	Low	Some concerns	Low	Some concerns	Low	High
Cui et al. 2018	Low	Low	Low	Low	Low	Low
Dong et al. 2019	Low	High	Low	Low	Low	High
Li et al. 2017	Low	Low	Low	Low	Some concerns	Some concerns
Liu et al. 2020b	Low	High	Low	Low	Low	High
Morishita et al. 2018	Low	Low	Low	Low	Low	Low
Padró-Martínez et al. 2015	Low	Some concerns	Low	Low	Low	Some concerns
Shao et al. 2017	Low	Some concerns	Low	Some concerns	Low	High
Weichenthal et al. 2013	Low	Low	Some concerns	Low	Some concerns	High

Figure S1. Summary of risk of bias for the studies included in the meta-analysis for systolic blood pressure and diastolic blood pressure.

Domain 1: risk of bias arising from the randomization process;
Domain 2: risk of bias arising from deviations from the intended interventions;
Domain 3: risk of bias arising from missing outcome data;
Domain 4: risk of bias in the measurement of the outcomes;
Domain 5: risk of bias in selective reporting.

	Domain 1	Domain 2	Domain 3	Domain 4	Domain 5	Overall judgement
Chen et al. 2015	Low	Low	Low	Low	Low	Low
Cui et al. 2018	Low	Low	Low	Low	Low	Low
Dong et al. 2019	Low	High	Low	Low	Low	High
Li et al. 2017	Low	Low	Low	Low	Some concerns	Some concerns
Morishita et al. 2018	Low	Low	Low	Low	Low	Low
Padró-Martínez et al. 2015	Low	Some concerns	Low	Low	Low	Some concerns

Figure S2. Summary of risk of bias for the studies included in the meta-analysis for pulse pressure.

Domain 1: risk of bias arising from the randomization process;
Domain 2: risk of bias arising from deviations from the intended interventions;
Domain 3: risk of bias arising from missing outcome data;
Domain 4: risk of bias in the measurement of the outcomes;
Domain 5: risk of bias in selective reporting.

	Domain 1	Domain 2	Domain 3	Domain 4	Domain 5	Overall judgement
Allen et al. 2011	Low	Some concerns	Some concerns	Some concerns	Low	High
Bräuner et al. 2008	Low	Some concerns	Low	Low	Low	Some concerns
Kajbafzadeh et al. 2015	Low	Some concerns	Some concerns	High	Low	High
Weichenthal et al. 2013	Low	Low	Some concerns	Low	Some concerns	High

Figure S3. Summary of risk of bias for the studies included in the meta-analysis for reactive hyperaemia index.

Domain 1: risk of bias arising from the randomization process;
Domain 2: risk of bias arising from deviations from the intended interventions;
Domain 3: risk of bias arising from missing outcome data;
Domain 4: risk of bias in the measurement of the outcomes;
Domain 5: risk of bias in selective reporting.

	Domain 1	Domain 2	Domain 3	Domain 4	Domain 5	Overall judgement
Allen et al. 2011	Low	Some concerns	Some concerns	Some concerns	Low	High
Bräuner et al. 2008	Low	Some concerns	Low	Low	Low	Some concerns
Chen et al. 2015	Low	Low	Low	Low	Low	Low
Chuang et al. 2017	Low	Some concerns	Low	Some concerns	Low	High
Kajbafzadeh et al. 2015	Low	Some concerns	Some concerns	High	Low	High
Shao et al. 2017	Low	Some concerns	Low	Some concerns	Low	High

Figure S4. Summary of risk of bias for the studies included in the meta-analysis for C-reactive protein.

Domain 1: risk of bias arising from the randomization process;
Domain 2: risk of bias arising from deviations from the intended interventions;
Domain 3: risk of bias arising from missing outcome data;
Domain 4: risk of bias in the measurement of the outcomes;
Domain 5: risk of bias in selective reporting.

	Domain 1	Domain 2	Domain 3	Domain 4	Domain 5	Overall judgement
Allen et al. 2011	Low	Some concerns	Some concerns	Some concerns	Low	High
Bräuner et al. 2008	Low	Some concerns	Low	Low	Low	Some concerns
Chen et al. 2015	Low	Low	Low	Low	Low	Low
Cui et al. 2018	Low	Low	High	Low	Low	High
Kajbafzadeh et al. 2015	Low	Some concerns	Some concerns	High	Low	High
Shao et al. 2017	Low	Some concerns	Low	Some concerns	Low	High

Figure S5. Summary of risk of bias for the studies included in the meta-analysis for interleukin-6.

Domain 1: risk of bias arising from the randomization process;
Domain 2: risk of bias arising from deviations from the intended interventions;
Domain 3: risk of bias arising from missing outcome data;
Domain 4: risk of bias in the measurement of the outcomes;
Domain 5: risk of bias in selective reporting.

	Domain 1	Domain 2	Domain 3	Domain 4	Domain 5	Overall judgement
Bräuner et al. 2008	Low	Some concerns	Low	Low	Low	Some concerns
Chen et al. 2015	Low	Low	Low	Low	Low	Low
Chuang et al. 2017	Low	Some concerns	Low	Some concerns	Low	High
Shao et al. 2017	Low	Some concerns	Low	Some concerns	Low	High

Figure S6. Summary of risk of bias for the studies included in the meta-analysis for fibrinogen.

Domain 1: risk of bias arising from the randomization process;
Domain 2: risk of bias arising from deviations from the intended interventions;
Domain 3: risk of bias arising from missing outcome data;
Domain 4: risk of bias in the measurement of the outcomes;
Domain 5: risk of bias in selective reporting.

Appendix F. Leave-one-out sensitivity analyses

	SBP, mmHg	DBP, mmHg	Pulse Pressure, mmHg	RHI, no unit	CRP, mg/L	IL-6, pg/ml	Fibrinogen, (SMD, no unit)
Summary estimates	-2.28 (-3.92, -0.64)	-0.35 (-1.52, 0.83)	-0.86 (-2.07, 0.34)	0.10 (-0.04, 0.24)	-0.23 (-0.63, 0.18)	0.04 (-0.32, 0.40)	-0.11 (-0.27, 0.05)
Omitted Study							
Allen et al. 2011	-2.44 (-4.16, -0.72)	-0.36 (-1.62, 0.90)	/[a]	0.08 (-0.05, 0.20)	-0.35 (-1.02, 0.32)	0.05 (-0.32, 0.41)	/
Bräuner et al. 2008	-2.15 (-4.34, 0.03)	-0.47 (-2.06, 1.13)	/	0.04 (-0.10, 0.19)	-0.38 (-0.97, 0.21)	0.02 (-0.42, 0.46)	-0.12 (-0.29, 0.05)
Chen et al. 2015	-2.27 (-3.94, -0.60)	-0.30 (-1.49, 0.90)	-0.98 (-2.26, 0.30)	/	-0.36 (-0.93, 0.21)	-0.02 (-0.4, 0.36)	-0.12 (-0.29, 0.04)
Chen et al. 2018	/	/	/	/	/	/	/
Chuang et al. 2017	-1.59 (-2.90, -0.28)	0.24 (-0.39, 0.86)	/	/	-0.13 (-0.35, 0.10)	/	0.02 (-0.25, 0.28)
Cui et al. 2018	-2.59 (-4.34, -0.84)	-0.65 (-1.92, 0.62)	-0.46 (-1.94, 1.01)	/	/	0.05 (-0.48, 0.58)	/
Dong et al. 2019	-2.43 (-4.22, -0.64)	-0.39 (-1.68, 0.90)	-1.56 (-2.98, -0.15)	/	/	/	/
Kajbafzadeh et al. 2015	/	/	/	0.16 (0.02, 0.30)	-0.25 (-0.71, 0.21)	0.03 (-0.33, 0.40)	/
Karottki et al. 2013	/	/	/	/	/	/	/
Li et al. 2017	-2.20 (-4.10, -0.31)	-0.33 (-1.57, 0.92)	-0.60 (-1.94, 0.74)	/	/	/	/
Liu et al. 2020b	-2.67 (-4.34, -1.01)	-0.54 (-1.85, 0.77)	/	/	/	/	/
Morishita et al. 2018	-2.25 (-3.95, -0.54)	-0.32 (-1.55, 0.91)	-0.79 (-2.04, 0.45)	/	/	/	/
Padró-Martínez et al. 2015	-2.12 (-3.78, -0.46)	-0.27 (-1.46, 0.92)	-0.80 (-2.02, 0.42)	/	/	/	/
Shao et al. 2017	-2.55 (-4.21, -0.90)	-0.56 (-1.75, 0.64)	/	/	-0.24 (-0.67, 0.19)	0.1 (-0.27, 0.47)	-0.14 (-0.31, 0.03)
Weichenthal et al. 2013	-2.15 (-3.88, -0.43)	-0.20 (-1.39, 1.00)	/	0.13 (0.01, 0.25)	/	/	/

CRP, C-reactive protein; DBP, diastolic blood pressure; IL-6, interleukin-6; RHI, reactive hyperaemia index; SBP, systolic blood pressure; SMD, standardized mean difference.
[a] "/" represents that the study did not report the specific outcome.

Appendix G. Subgroup analyses

Table S1. Subgroup analyses for the effects of indoor air purifier interventions on blood pressure

Subgroup	No. of study	Systolic blood pressure		Diastolic blood pressure	
		Effect size (95%CI), mmHg	P value [a]	Effect size (95%CI), mmHg	P value [a]
Health condition					
Healthy subjects only	7	-2.41 (-4.38, -0.43)	0.798	-0.30 (-1.71, 1.11)	0.888
Mixed	5	-1.83 (-4.90, 1.24)		-0.50 (-2.90, 1.91)	
Blood pressure level at baseline [b]					
High	6	-3.92 (-7.09, -0.75)	0.070	-0.99 (-3.21, 1.23)	0.367
Low	6	-1.04 (-2.41, 0.33)		0.59 (-0.46, 1.65)	
Study setting					
At home	7	-3.48 (-6.06, -0.89)	0.091	-1.04 (-2.92, 0.84)	0.215
At school	5	-0.92 (-2.34, 0.51)		0.89 (-0.16, 1.94)	
Type of air purifier					
Physical (e.g., HEPA)	9	-2.78 (-4.73, -0.82)	0.321	-0.42 (-1.93, 1.08)	0.869
Electrostatic or ionization	3	-0.77 (-3.23, 1.70)		0.01 (-1.93, 1.95)	
Baseline $PM_{2.5}$ level [c]					
≤ 25 μg/m^3	4	-3.88 (-7.12, -0.64)	0.059	-1.19 (-3.39, 1.02)	0.201
> 25 μg/m^3	7	-0.93 (-2.35, 0.48)		0.72 (-0.46, 1.89)	
Intervention-$PM_{2.5}$ level [c]					
≤ 10 μg/m^3	5	-1.96 (-3.58, -0.35)	0.667	0.03 (-0.40, 0.47)	0.679
> 10 μg/m^3	6	-2.38 (-5.97, 1.20)		-0.58 (-3.14, 1.98)	
Intervention duration					
≤ 7 days	8	-1.40 (-2.96, 0.15)	0.113	0.19 (-0.39, 0.76)	0.063
> 7 days	4	-3.98 (-8.2, 0.25)		-1.10 (-4.36, 2.17)	
Risk of bias					
Low or some concerns	8	-3.05 (-5.14, -0.97)	0.183	-0.45 (-2.12, 1.21)	0.849
High	4	-0.53 (-2.32, 1.26)		0.17 (-1.19, 1.53)	
Location					
China	7	-1.72 (-4.50, 1.06)	0.512	0.00 (-2.05, 2.04)	0.501
Western countries	5	-3.01 (-3.75, -2.27)		-0.06 (-0.51, 0.39)	

[a] Z-test was conducted to test the significance of difference between the subgroups.
[b] High: systolic blood pressure ≥120 mmHg.
[c] Only 10 of the 11 randomized controlled trials measuring blood pressure as health outcomes reported the post-intervention $PM_{2.5}$ levels.

Table S2. Subgroup analyses for the effects of indoor air purifier interventions on PP, CRP and IL-6

Subgroup	PP, mmHg			CRP, mg/L			IL-6, pg/ml		
	No. of study	Effect size (95%CI)	P value [a]	No. of study	Effect size (95%CI)	P value [a]	No. of study	Effect size (95%CI)	P value [a]
Health condition									
Healthy subjects only	4	-0.72 (-1.98, 0.54)	0.450	4	-0.37 (-1.08, 0.34)	0.837	4	0.11 (-0.26, 0.48)	0.053
Mixed	2	-2.40 (-6.55, 1.76)		2	-0.22 (-0.53, 0.09)		2	-1.8 (-3.7, 0.1)	
Study setting									
At home	2	-2.40 (-6.55, 1.76)	0.450	5	-0.36 (-0.93, 0.21)	0.554	4	-0.09 (-0.67, 0.5)	0.589
At school	4	-0.72 (-1.98, 0.54)		1	-0.02 (-0.53, 0.49)		2	0.12 (-0.34, 0.58)	
Type of air purifier									
Physical (e.g., HEPA)	5	-1.56 (-2.98, -0.15)	0.063	/ [b]	/	/	/	/	/
Electrostatic or ionization	1	1.00 (-1.31, 3.31)		/	/	/	/	/	/
Baseline $PM_{2.5}$ level [c]									
≤ 25 μg/m^3	1	-1.90 (-6.69, 2.89)	0.641	4	-0.38 (-0.98, 0.22)	0.550	3	0.07 (-0.54, 0.68)	0.898
> 25 μg/m^3	4	-0.72 (-1.98, 0.54)		2	-0.02 (-0.53, 0.49)		3	0.02 (-0.43, 0.47)	
Intervention-$PM_{2.5}$ level [c]									
≤ 10 μg/m^3	2	-1.95 (-4.33, 0.43)	0.269	3	-0.15 (-0.41, 0.10)	0.402	3	0.07 (-0.54, 0.68)	0.898
> 10 μg/m^3	3	-0.39 (-1.81, 1.03)		3	-1.24 (-3.78, 1.30)		3	0.02 (-0.43, 0.47)	
Intervention duration									
≤ 7 days	4	-0.51 (-1.87, 0.85)	0.272	4	-0.13 (-0.35, 0.10)	0.003	5	0.1 (-0.27, 0.47)	0.069
> 7 days	2	-2.16 (-4.76, 0.45)		2	-2.78 (-4.53, -1.03)		1	-1.78 (-3.78, 0.22)	
Risk of bias									
Low or some concerns	5	-1.56 (-2.98, -0.15)	0.063	4	-0.43 (-1.26, 0.39)	0.794	4	0.04 (-0.33, 0.41)	0.958
High	1	1.00 (-1.31, 3.31)		2	-0.22 (-0.52, 0.09)		2	-0.01 (-1.93, 1.91)	
Location									
China	4	-0.72 (-1.98, 0.54)	0.450	3	-1.24 (-3.78, 1.3)	0.402	3	0.02 (-0.43, 0.47)	0.898
Western countries	2	-2.04 (-6.55, 1.76)		3	-0.15 (-0.41, 0.1)		3	0.07 (-0.54, 0.68)	

CRP, C-reactive protein; IL-6, interleukin-6; PP, pulse pressure.

[a] Z-test was conducted to test the significance of difference between the subgroups.

[b] "/" represents no subgroups.

[c] One randomized controlled trial that measured PP did not report the $PM_{2.5}$ levels.

Appendix H. Meta-analysis results for IL-6 and fibrinogen

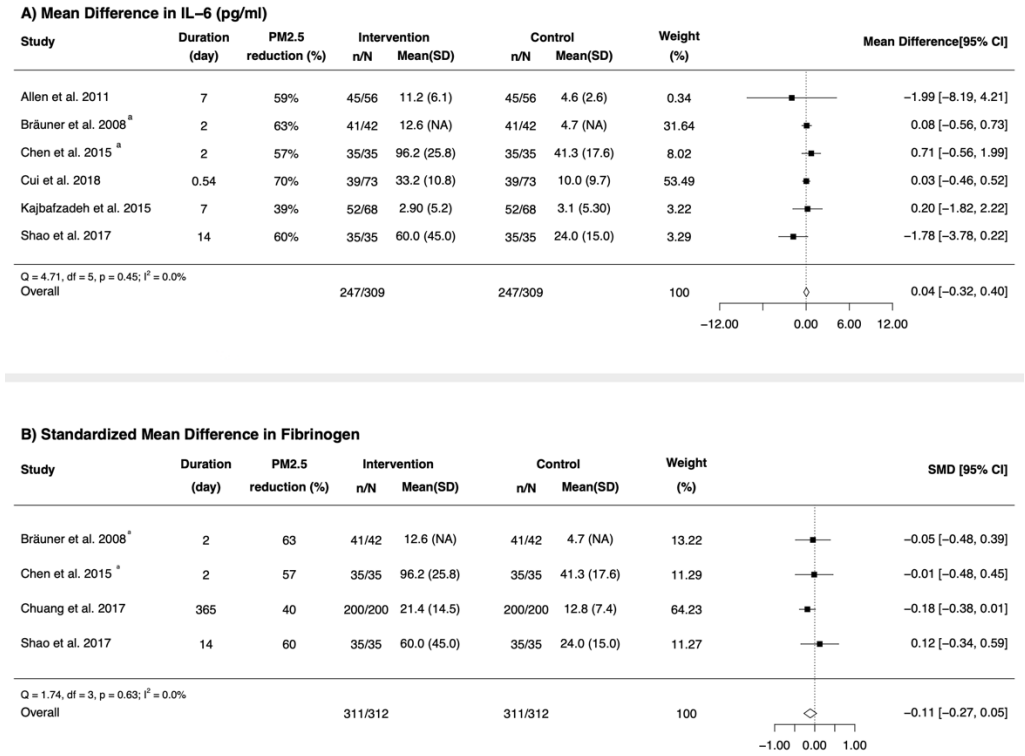

Figure S1. Forest plots of the mean difference in (A) IL-6 and (B) fibrinogen in relation to indoor air purifier interventions.

n = the number of participants being recruited initially; N = the number of participants completing the intervention; "Mean (SD)" represents the mean and standard deviation of $PM_{2.5}$ for each group (unit, $\mu g/m^3$); [a] Geometric means were converted to arithmetic means.

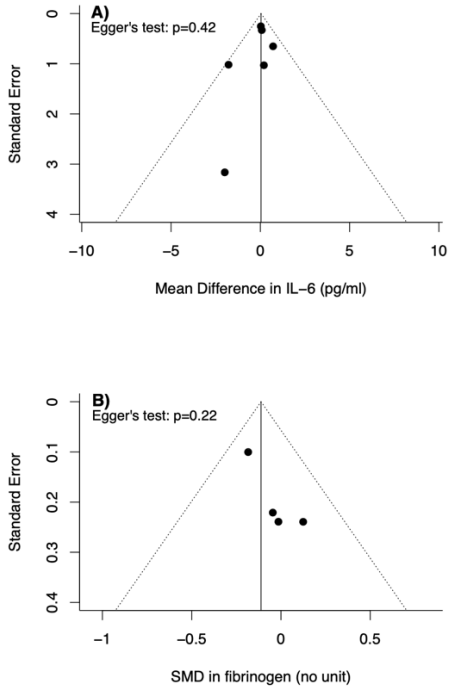

Figure S2. Funnel plots showing publication bias.

Note: (A) IL-6; (B) fibrinogen.

Appendix I. Three relevant ongoing RCTs registered in *ClinicalTrails.gov*

Authors and locations	Study design	Estimated enrollment	Population characteristics	Planned intervention period	Type of air purifier	Setting	Washout	Outcomes of interest
Timothy 2017, Hong Kong SAR	Parallel	140	70 years and older; all subjects are diabetic and mild cognitive impaired participants; no smokers.	12 months	HEPA Air Filtration	At home	Not Applicable	Endothelial function, cognitive impairment
Robert 2019, USA	Cross-over	55	60 years and older; also include healthy participants; no smokers.	28 days	HEPA Air Filtration	At home	No	Blood pressure, heart rate variability
Douglas 2020, USA	Cross-over	288	40 years and older; all subjects are overweight and/or pre-hypertensive or pre-diabetic participants; no smokers.	30 days	HEPA Air Filtration	At home	30 days	Blood pressure, C-reactive protein, D-dimer

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