**Supplemental Content**

A randomized, double-blind, crossover intervention study of traffic-related air pollution (TRAP) and airway inflammation in healthy adults

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# Table S1: Monitoring equipment and parameters

|  |  |  |  |
| --- | --- | --- | --- |
| Instrument | Company | Type | Pollutants |
| DustTrak | TSI, USA | DustTrak 8520 | PM2.5 |
| Q-Trak | TSI, USA | TSI 8552 | Temp and RH |
| Aeroqual | Aeroqual. Inc, New Zealand | Series 500 | NO2 |
| Micro Aeth | Aethlabs, USA | AE51 | BC |

In this study, we monitored the real time data of PM2.5, NO2, black carbon, temperature and relative humidity (RH). The monitoring instrument information is shown in Supplement Table S1.

# Text S1: The powered air purifying respirator (PAPR)

The intervention used in this study is comprised of headtop (face mask), PAPR (OptimAir 3000, MSA, USA), filters (for particles and organic gas), connecting hoses, belts, NiMH battery and charger. The system can deliver 130L/min airflow and is typically used in occupational settings whenever long-term clean filtered air is needed.

The PAPR meets requirements of the EN12941 TH3 class. Maximum inward leakage is less than 0.2%. For particle filter, maximum particle filter penetration is less than 0.2%. Also, the gas filter in this study is effective against organic gases and vapors with a boiling point higher than 65oC (volatile organic compounds), certain inorganic gases and vapors (Cl2, H2S, HCN, etc.), sulfur dioxide or other acidic gases and vapors, and ammonium or organic ammonium derivatives. The battery life is more than 8hr with the particle filter and more than 4hr with the combination filter (both particle and organic gas filter).

# Figure S1: Participant with PAPR

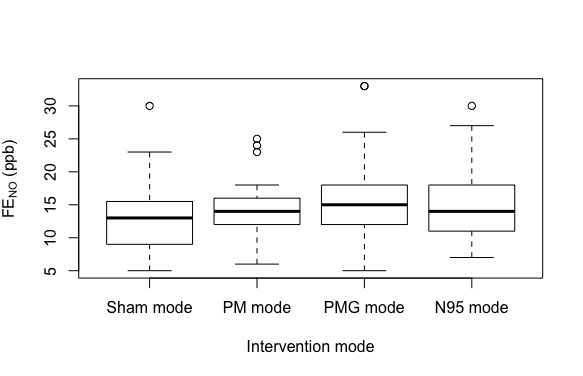
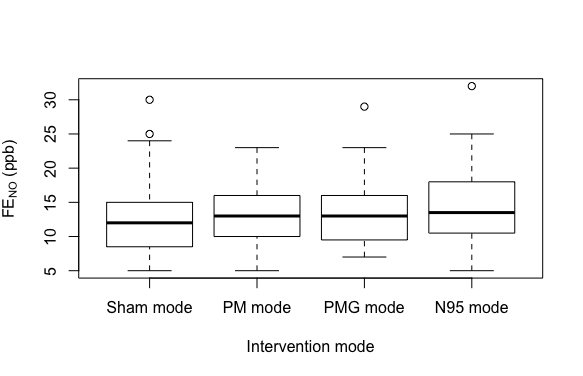


Pictured in Fig. S1 is a participant wearing a PAPR.

# Table S2: FENO over time and intervention modes (ppb)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Baseline (p=0.22) | | | | | | | |
|  | Sham |  | PM |  | PMG |  | N95 |
| 25th | 9.0 |  | 12.0 |  | 12.0 |  | 11.0 |
| 50th | 13.0 |  | 14.0 |  | 15.0 |  | 14.0 |
| Mean | 13.2 |  | 13.8 |  | 15.6 |  | 15.1 |
| 75th | 15.3 |  | 16.0 |  | 18.0 |  | 18.0 |
| After exposure (p=0.78) | | | | | | | |
|  | Sham |  | PM |  | PMG |  | N95 |
| 25th | 8.8 |  | 10.0 |  | 9.8 |  | 10.8 |
| 50th | 12.0 |  | 13.0 |  | 13.0 |  | 13.5 |
| Mean | 12.9 |  | 13.3 |  | 13.5 |  | 14.2 |
| 75th | 15.0 |  | 16.0 |  | 16.0 |  | 17.5 |
| 1 hr after exposure (p=0.68) | | | | | | | |
|  | Sham |  | PM |  | PMG |  | N95 |
| 25th | 11.0 |  | 11.0 |  | 11.8 |  | 12.0 |
| 50th | 14.0 |  | 14.0 |  | 13.0 |  | 14.5 |
| Mean | 15.3 |  | 15.7 |  | 14.9 |  | 16.6 |
| 75th | 18.3 |  | 20.0 |  | 17.0 |  | 22.3 |
| 2 hr after exposure (p=0.89) | | | | | | | |
|  | Sham |  | PM |  | PMG |  | N95 |
| 25th | 11.5 |  | 12.0 |  | 11.0 |  | 12.0 |
| 50th | 15.0 |  | 15.0 |  | 14.0 |  | 15.0 |
| Mean | 16.1 |  | 15.2 |  | 15.4 |  | 16.2 |
| 75th | 19.0 |  | 18.0 |  | 19.3 |  | 18.8 |
| 4 hr after exposure (p=0.80) | | | | | | | |
|  | Sham |  | PM |  | PMG |  | N95 |
| 25th | 12.8 |  | 15.0 |  | 12.0 |  | 13.5 |
| 50th | 15.5 |  | 18.0 |  | 16.0 |  | 16.0 |
| Mean | 17.2 |  | 18.2 |  | 16.6 |  | 18.0 |
| 75th | 21.3 |  | 20.0 |  | 22.0 |  | 24.0 |
| 6 hr after exposure (p=0.96) | | | | | | | |
|  | Sham |  | PM |  | PMG |  | N95 |
| 25th | 13.0 |  | 12.0 |  | 11.8 |  | 12.0 |
| 50th | 15.0 |  | 16.0 |  | 15.5 |  | 16.0 |
| Mean | 16.4 |  | 16.7 |  | 15.9 |  | 16.5 |
| 75th | 20.0 |  | 21.0 |  | 18.3 |  | 21.0 |

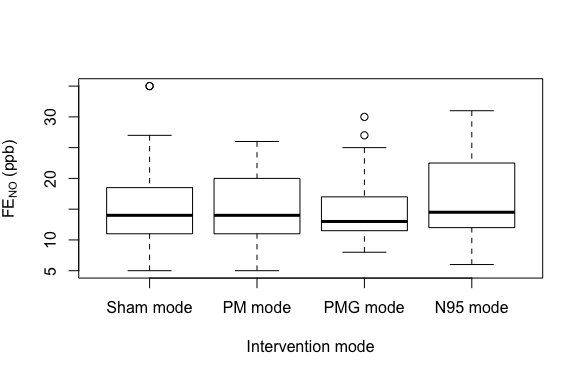
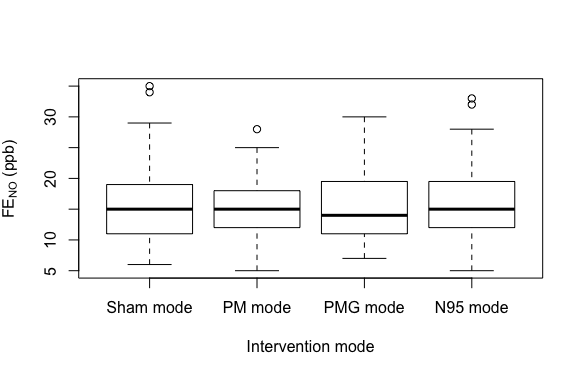
# Figure S2: FENO levels for different intervention modes and measurement time points

FENO (ppb)

FENO (ppb)

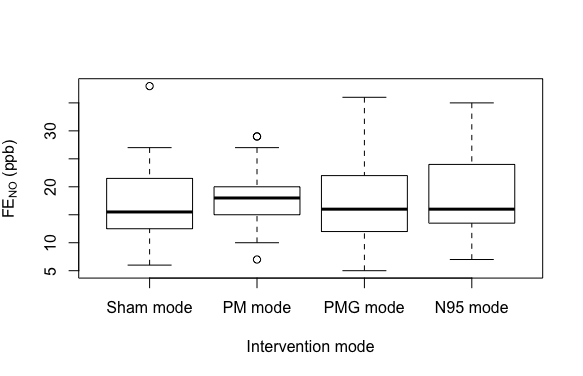
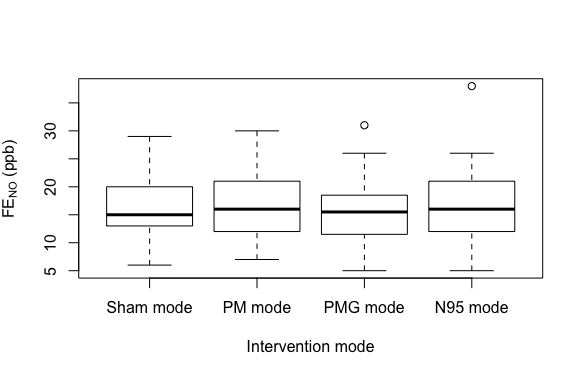
(a) FENO level before exposure (baseline) (b) FENO level immediately post exposure

FENO (ppb)

FENO (ppb)

(c) FENO level 1 hr post exposure (d) FENO level 2 hr post exposure

FENO (ppb)

FENO (ppb)

(e) FENO level 4 hr post exposure (f) FENO level 6 hr post exposure

# Table S3: ΔFENO over time and intervention modes (ppb)

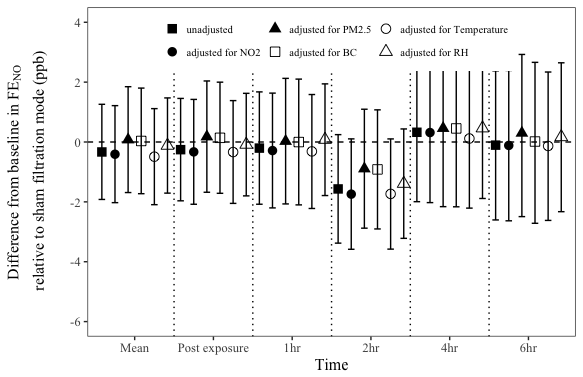
|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| ΔFENO mean post exposure **(p=0.03)\*** | | | | | | | |
|  | Sham |  | PM |  | PMG |  | N95 |
| 25th | -0.3 |  | 0.6 |  | -1.8 |  | -1.5 |
| 50th | 2.3 |  | 1.8 |  | 1.0 |  | 1.7 |
| Mean | 2.3 |  | 2.0 |  | -0.2 |  | 1.2 |
| 75th | 4.2 |  | 3.6 |  | 2.5 |  | 3.3 |
| ΔFENO immediately post exposure (p=0.26) | | | | | | | |
|  | Sham |  | PM |  | PMG |  | N95 |
| 25th | -2.0 |  | -2.0 |  | -4.0 |  | -3.3 |
| 50th | -0.5 |  | -1.0 |  | -2.0 |  | -1.0 |
| Mean | -0.3 |  | -0.5 |  | -2.0 |  | -0.9 |
| 75th | 2.0 |  | 2.0 |  | 0.0 |  | 2.0 |
| ΔFENO 1-hr post exposure **(p=0.03)** | | | | | | | |
|  | Sham |  | PM |  | PMG |  | N95 |
| 25th | 0.0 |  | 0.0 |  | -3.0 |  | -2.0 |
| 50th | 2.0 |  | 1.0 |  | 1.0 |  | 1.5 |
| Mean | 2.1 |  | 1.9 |  | -0.7 |  | 1.5 |
| 75th | 4.0 |  | 4.0 |  | 2.0 |  | 3.0 |
| ΔFENO 2-hr post exposure (p=0.06) | | | | | | | |
|  | Sham |  | PM |  | PMG |  | N95 |
| 25th | 0.0 |  | -1.0 |  | -2.0 |  | -1.0 |
| 50th | 2.0 |  | 2.0 |  | -1.0 |  | 1.0 |
| Mean | 2.9 |  | 1.3 |  | -0.1 |  | 1.1 |
| 75th | 6.0 |  | 4.0 |  | 2.0 |  | 3.0 |
| ΔFENO 4-hr post exposure (p=0.06) | | | | | | | |
|  | Sham |  | PM |  | PMG |  | N95 |
| 25th | 0.8 |  | 2.0 |  | -2.0 |  | -1.0 |
| 50th | 3.5 |  | 4.0 |  | 1.0 |  | 3.0 |
| Mean | 4.0 |  | 4.4 |  | 1.3 |  | 3.1 |
| 75th | 7.3 |  | 7.0 |  | 4.0 |  | 6.5 |
| ΔFENO 6-hr post exposure (p=0.23) | | | | | | | |
|  | Sham |  | PM |  | PMG |  | N95 |
| 25th | 0.3 |  | 0.0 |  | -2.0 |  | -2.0 |
| 50th | 3.0 |  | 2.0 |  | 0.0 |  | 1.5 |
| Mean | 3.1 |  | 2.9 |  | 0.6 |  | 1.4 |
| 75th | 6.0 |  | 5.0 |  | 5.0 |  | 4.0 |

\* figures in bold showed significant at the level of 0.05

# Table S4: Summary statistics for exposure variables during wearing different intervention modes

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| NO2 (μg/m3) (p=0.12) | | | | | | | |
|  | Sham |  | PM |  | PMG |  | N95 |
| 25th | 66.0 |  | 66.0 |  | 66.1 |  | 68.0 |
| 50th | 71.5 |  | 70.5 |  | 73.0 |  | 74.0 |
| Mean | 73.7 |  | 70.0 |  | 75.7 |  | 76.4 |
| 75th | 80.0 |  | 79.0 |  | 87.9 |  | 81.5 |
| PM2.5 (μg/m3) (p=0.11) | | | | | | | |
|  | Sham |  | PM |  | PMG |  | N95 |
| 25th | 79.8 |  | 78.0 |  | 62.3 |  | 52.3 |
| 50th | 165.0 |  | 191.0 |  | 122.5 |  | 81.0 |
| Mean | 169.2 |  | 182.3 |  | 177.1 |  | 119.0 |
| 75th | 215.8 |  | 257.0 |  | 256.2 |  | 163.5 |
| BC (μg/m3) (p=0.53) | | | | | | | |
|  | Sham |  | PM |  | PMG |  | N95 |
| 25th | 5.6 |  | 5.2 |  | 4.0 |  | 4.6 |
| 50th | 7.2 |  | 10.1 |  | 6.3 |  | 6.2 |
| Mean | 9.1 |  | 8.8 |  | 7.7 |  | 7.6 |
| 75th | 13.0 |  | 13.4 |  | 11.2 |  | 10.6 |
| Relative humidity (%) (p=0.07) | | | | | | | |
|  | Sham |  | PM |  | PMG |  | N95 |
| 25th | 29.6 |  | 38.9 |  | 31.4 |  | 25.5 |
| 50th | 40.5 |  | 48.5 |  | 48.1 |  | 33.1 |
| Mean | 43.2 |  | 51.5 |  | 48.0 |  | 40.4 |
| 75th | 58.4 |  | 66.5 |  | 64.1 |  | 58.6 |
| Temperature (oC) (p=0.38) | | | | | | | |
|  | Sham |  | PM |  | PMG |  | N95 |
| 25th | -0.9 |  | -0.5 |  | -0.5 |  | -2.0 |
| 50th | 1.5 |  | 0.5 |  | 0.30 |  | 0.7 |
| Mean | 3.7 |  | 2.2 |  | 1.9 |  | 3.4 |
| 75th | 9.6 |  | 6.3 |  | 4.6 |  | 9.2 |

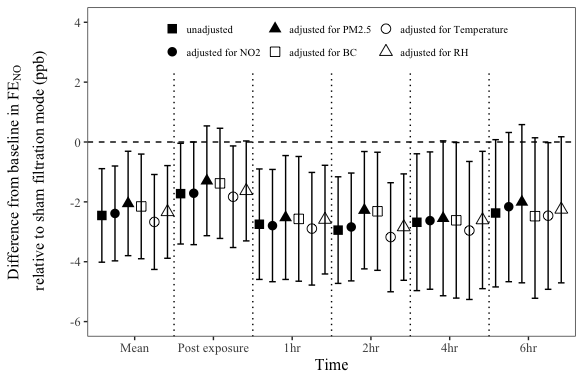
# Figure S3: Mixed model results after controlling for roadside pollutant concentrations or meteorology



Difference from baseline in FENO (ppb)

relative to sham filtration mode

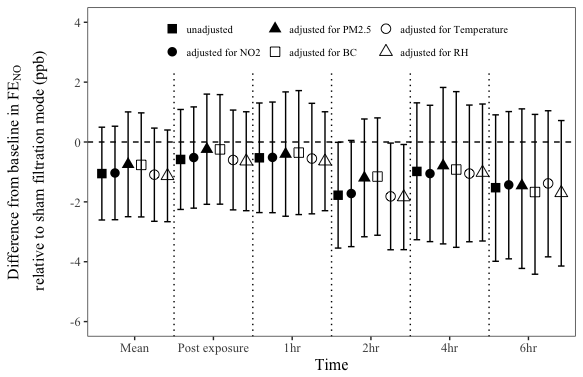
(a) PM mode vs. Sham mode



Difference from baseline in FENO (ppb)

relative to sham filtration mode

(b) PMG mode vs. Sham mode



Difference from baseline in FENO (ppb)

relative to sham filtration mode

(c) N95 mode vs. Sham mode

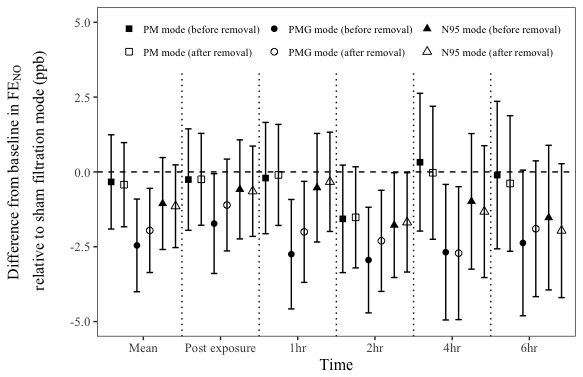
Change (and 95% CIs) in ΔFENO from baseline by intervention mode relative to the sham mode for the mean of all post-exposure FENO measurements and for each time point with or without adjustment for air pollutants and meteorology.

# Figure S4: Variation of baseline FENO level across participants



General speaking, the baseline FENO level should be in a narrow variation range for every participant. So we characterized the trend of each participant in FENO baseline level over four intervention modes in Figure S4; participant #3, #6, #31 and #34 experienced very high FENO levels in a some mode. We retained these higher values in our primary model, but excluded them in a sensitivity analysis.

# Figure S5: Change (and 95% CIs) in ΔFENO from baseline by intervention mode relative to the sham mode for the mean of all post-exposure FENO measurements and for each time point before and after excluding baseline FENO outliers.



Difference from baseline in FENO (ppb)

relative to sham filtration mode