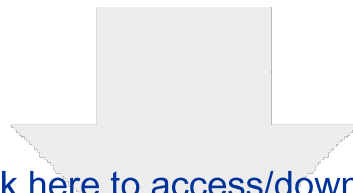


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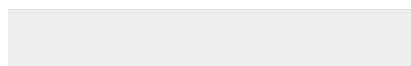
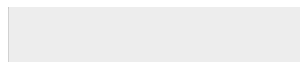


Table 1. Study Sites in Elizabeth, NJ

Group	Variable	All Sites	F	L	M
Recruited Apartments					
Total number of units		24	9	4	11
Gender	Female	20	6	4	10
	Male	4	3	-	1
Age	55-64	8	3	1	4
	65-74	10	4	2	5
	75-84	5	2	1	2
Smoking Status	Smoking	8	5	-	3
	Non-smoking	16	4	4	8
Bedroom number	1	19	9	4	6
	2	5	-	-	5
Air Conditioner (AC)	Window AC	19	9	-	10
	Central AC	4	Common areas	4	-
	No AC	1		-	1
Building Characteristics					
	Building age		1967	2001	1938
	Window type		Hung windows	Awning windows	Hung windows
	Window dimensions		0.6mx1.2m with 35% openable area.	0.7mx1.4m with 40% openable area.	0.6mx1.2m with 35% openable area.

Table 2. Mann-Whitney test for PM_{2.5} levels between active and rest period. *Statically significant at 0.05 level.

Unit Code	Smoking status	Heatwave days		Non-Heatwave days	
		p-value	Median Active PM2.5 - Median Rest PM2.5, $\mu\text{g}/\text{m}^3$	p-value	Median Active PM2.5 - Median Rest PM2.5, $\mu\text{g}/\text{m}^3$
Empty	Non-smoking	0.282	-2.5	0.000*	-1.0
F201	Smoking	0.417	-17.5	0.002*	8.5
F202	Smoking	0.103	-74.0	0.009*	34.5
F203	Smoking	0.428	15.0	0.348	4.0
F204	Smoking	0.001*	9.5	0.000*	8.0
F211	Smoking	0.000*	82.5	0.000*	59.0
F207	Non-smoking	0.000*	7.0	0.000*	3.0
F208	Non-smoking	0.003*	9.0	0.000*	4.0
F209	Non-smoking	0.000*	24.0	0.000*	13.0
F210	Non-smoking	0.000*	3.0	0.000*	3.0
L001	Non-smoking	0.087	-6.0	0.074	0.0
L002	Non-smoking	0.911	0.0	0.017*	0.0
L003	Non-smoking	0.587	0.0	0.013*	1.0
L004	Non-smoking	0.772	-1.0	0.001*	-1.0
M103	Smoking	0.815	-0.5	0.001*	2.0
M108	Smoking	0.002*	17.0	0.000*	23.5
M112	Smoking	0.006*	3.5	0.001*	-5.0
M101	Non-smoking	0.000*	3.5	0.000*	2.0
M102	Non-smoking	0.004*	4.0	0.001*	0.0
M104	Non-smoking	0.591	7.0	0.000*	2.0
M105	Non-smoking	0.498	-5.0	0.699	-1.0
M106	Non-smoking	0.037*	2.5	0.700	-1.0
M109	Non-smoking	0.021*	2.0	0.019*	0.0
M110	Non-smoking	0.016*	1.5	0.641	0.0
M111	Non-smoking	0.000*	4.0	0.000*	1.0

Table 3. Mann-Whitney test for I/O ratio between active and rest period. *Statically significant at 0.05 level.

Unit Code	Smoking status	Heatwave days		Non-Heatwave days	
		p-value	Median Active I/O - Median Rest I/O	p-value	Median Active I/O - Median Rest I/O
Empty	Non-smoking	0.748	0.056	0.058	0.000
F201	Smoking	0.501	-0.556	0.000*	2.000
F202	Smoking	0.147	-6.986	0.001*	5.525
F203	Smoking	0.393	0.447	0.081	1.797
F204	Smoking	0.000*	0.947	0.000*	1.667
F211	Smoking	0.000*	6.060	0.000*	7.995
F207	Non-smoking	0.000*	0.393	0.000*	0.333
F208	Non-smoking	0.000*	0.492	0.000*	0.534
F209	Non-smoking	0.000*	2.051	0.000*	1.583
F210	Non-smoking	0.000*	0.214	0.000*	0.394
L001	Non-smoking	0.213	-0.288	0.396	-0.048
L002	Non-smoking	0.119	0.036	0.000*	0.033
L003	Non-smoking	0.094	0.040	0.000*	0.125
L004	Non-smoking	0.560	0.013	0.000*	-0.078
M103	Smoking	0.403	0.133	0.000*	0.302
M108	Smoking	0.001*	3.077	0.000*	2.821
M112	Smoking	0.000*	0.282	0.072	-0.333
M101	Non-smoking	0.000*	0.384	0.000*	0.286
M102	Non-smoking	0.000*	0.226	0.000*	0.091
M104	Non-smoking	0.742	21.969	0.000*	13.400
M105	Non-smoking	0.000*	-0.333	0.000*	-0.100
M106	Non-smoking	0.000*	0.200	0.001*	0.000
M109	Non-smoking	0.000*	0.143	0.000*	0.143
M110	Non-smoking	0.000*	0.156	0.000*	0.000
M111	Non-smoking	0.000*	0.333	0.000*	0.235

Table 4. Mann-Whitney test for PM_{2.5} levels between smokers' and non-smokers' units. *Statically significant at 0.05 level.

	Median PM _{2.5} for smokers' units, µg/m ³	Median PM _{2.5} for non-smokers' units, µg/m ³	p-value
Heatwave Days			
Site F	66.5	19.0	0.000*
Site M	29.0	14.0	0.000*
Non-heatwave Days			
Site F	49.0	11.0	0.000*
Site M	20.0	7.0	0.000*

Table 5. Mann-Whitney test for I/O between smokers' and non-smokers' units. *Statically significant at 0.05 level.

	Median I/O for smokers' units, µg/m ³	Median I/O for non-smokers' units, µg/m ³	p-value
Heatwave Days			
Site F	5.065	1.330	0.000*
Site M	1.910	1.000	0.000*
Non-heatwave Days			
Site F	6.140	1.300	0.000*
Site M	2.290	1.000	0.000*

Table 6. Kruskal-Wallis Test p-values for PM_{2.5} levels in three sites. *Statically significant at 0.05 level.

Non-smokers' Units			
	Site F	Site L	Site M
Site F	-		
Site L	0.000*	-	
Site M	0.000*	0.000*	-
Smokers' Units			
Site F	-	-	
Site M	0.000*	-	-

Table 7. Kruskal-Wallis Test p-values for I/O in in three sites. *Statically significant at 0.05 level.

Non-smokers' Units			
	Site F	Site L	Site M
Site F	-		
Site L	0.000*	-	
Site M	0.000*	0.000*	-
Smokers' Units			
Site F	-	-	
Site M	0.000*	-	-

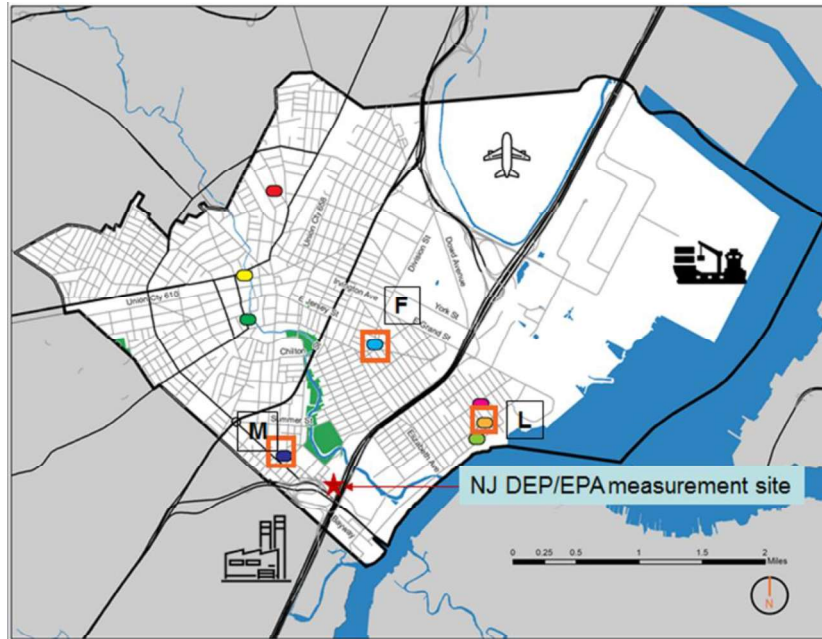


Figure 1. Study sites in Elizabeth, NJ

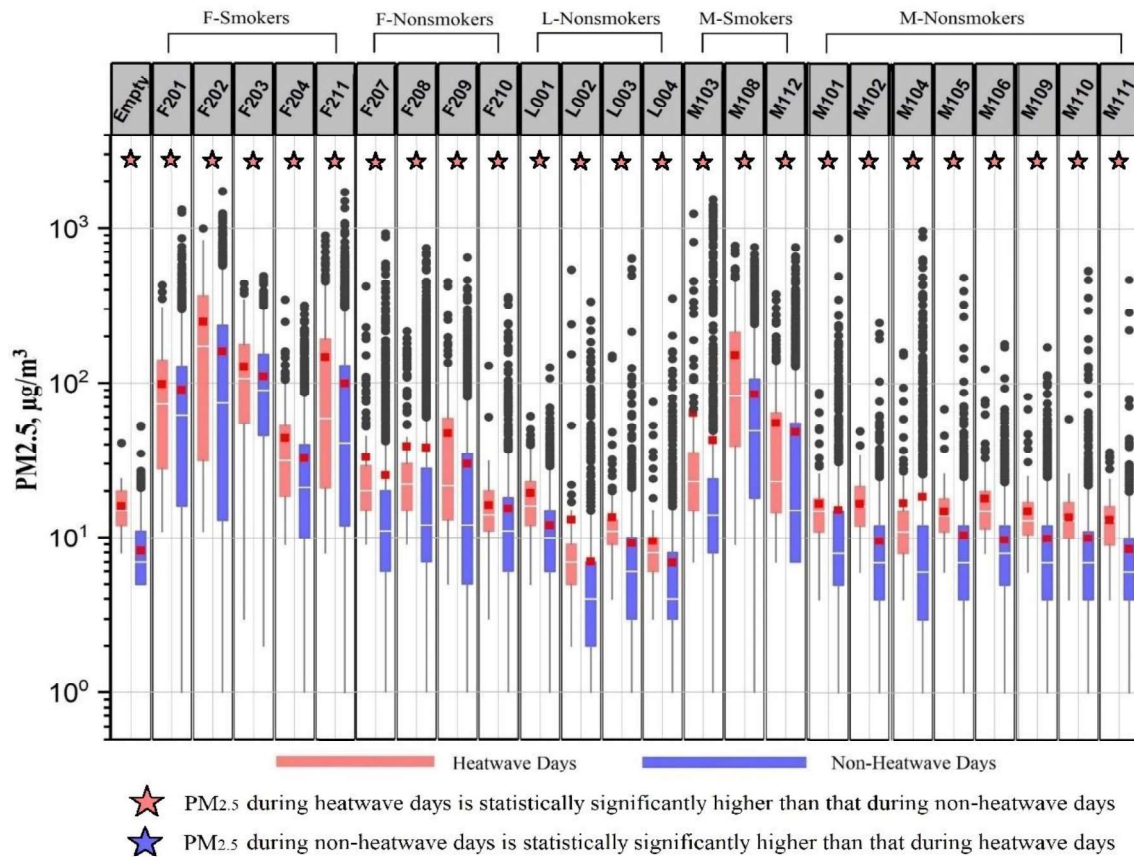


Figure 2. PM_{2.5} level for each unit during heatwave days and non-heatwave days. The black stars represent a statistically significant difference ($p < 0.05$) between the heatwave and non-heatwave groups. The lower, middle and upper lines of each box plot are 25th percentile, median, and 75th percentile of the data. The red box is the mean value. The gray dots are the outliers.

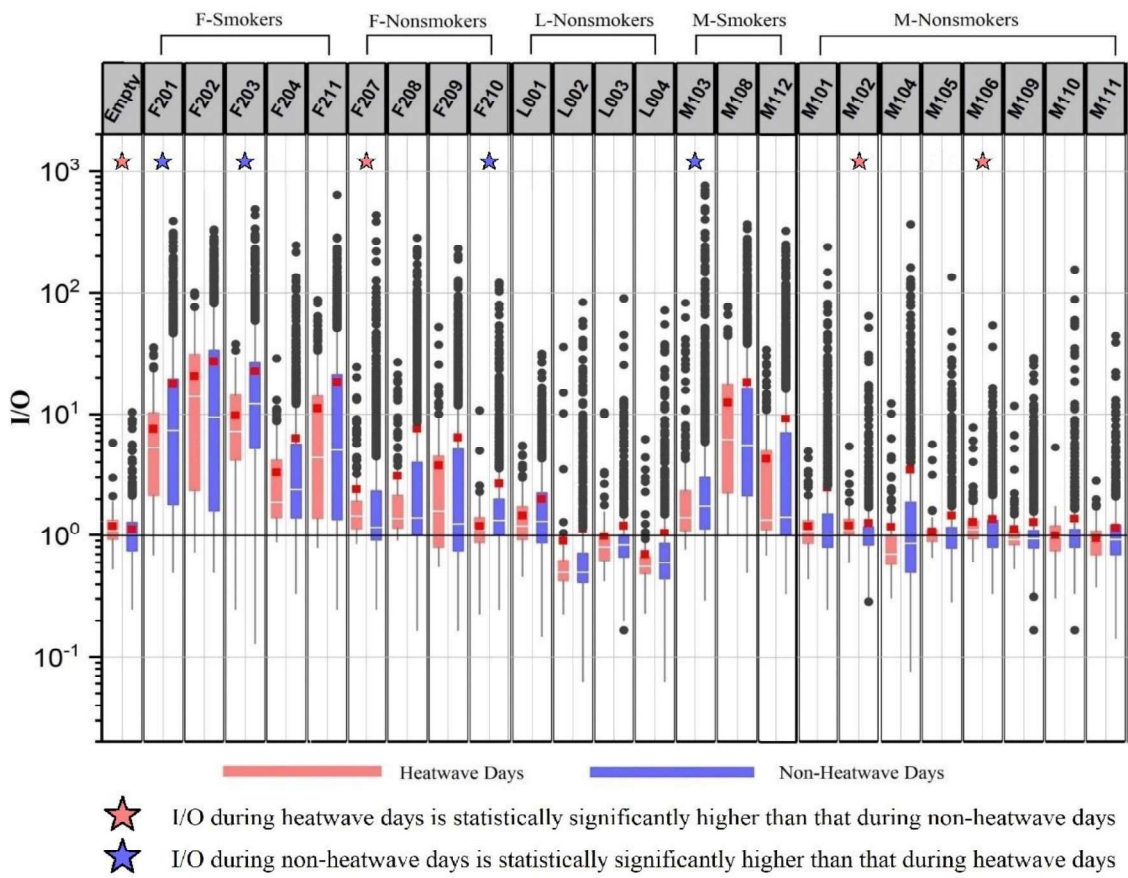
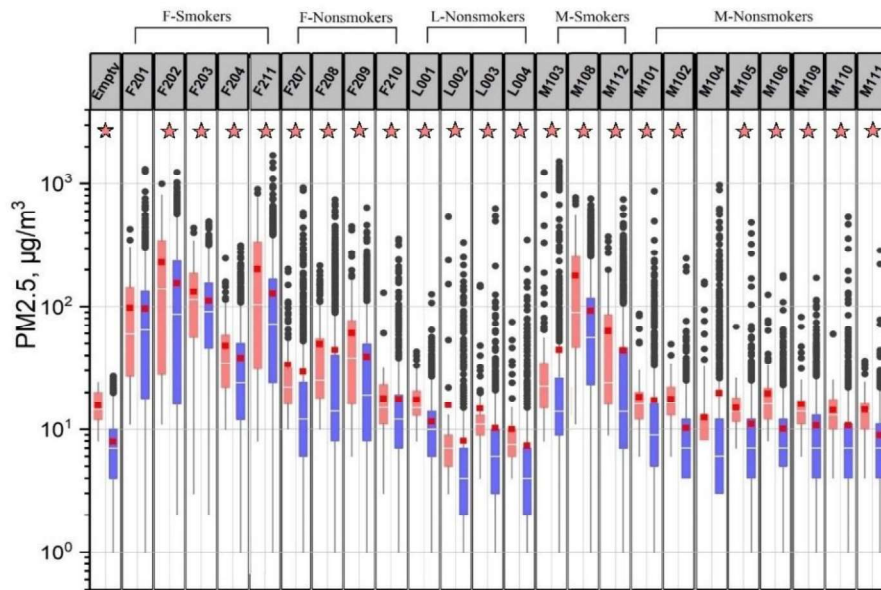


Figure 3. I/O for each unit during heatwave days and non-heatwave days. The black stars represent a statistically significant difference ($p < 0.05$) between the heatwave and non-heatwave groups. The lower, middle and upper lines of each box plot are 25th percentile, median, and 75th percentile of the data. The red box is the mean value. The gray dots are the outliers.

(A) Active period PM_{2.5}



(B) Rest period PM_{2.5}

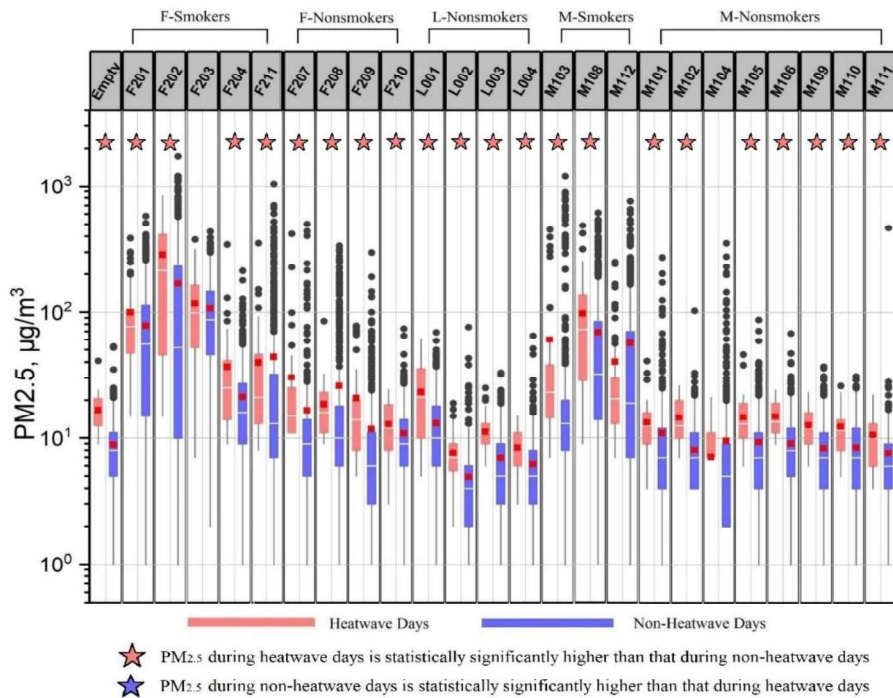
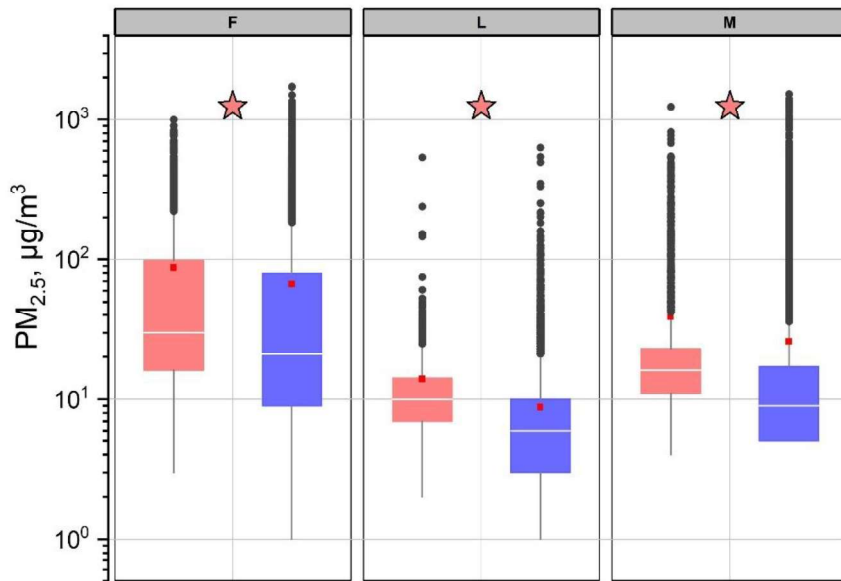


Figure 4. Active and rest periods PM_{2.5} levels for each unit in heatwave days and non-heatwave days. The black stars represent a statistically significant difference ($p < 0.05$) between the heatwave and non-heatwave groups. The lower, middle and upper lines of each box plot are 25th percentile, median, and 75th percentile of the data. The red box is the mean value. The gray dots are the outliers. (A) Active period PM_{2.5}, (B) Rest period PM_{2.5}.

(A) PM_{2.5} levels for different sites



(B) PM_{2.5} levels for different sites and smoking status

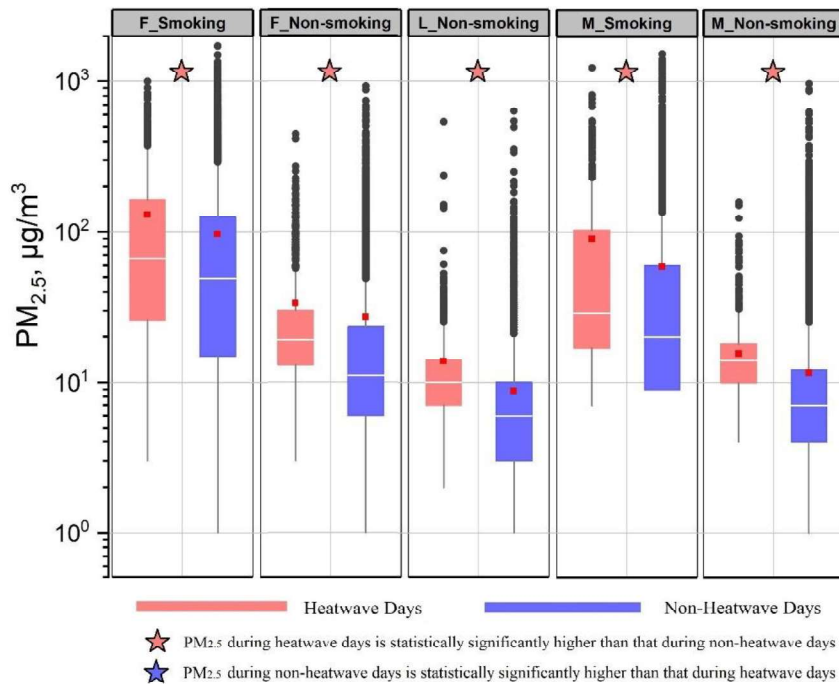
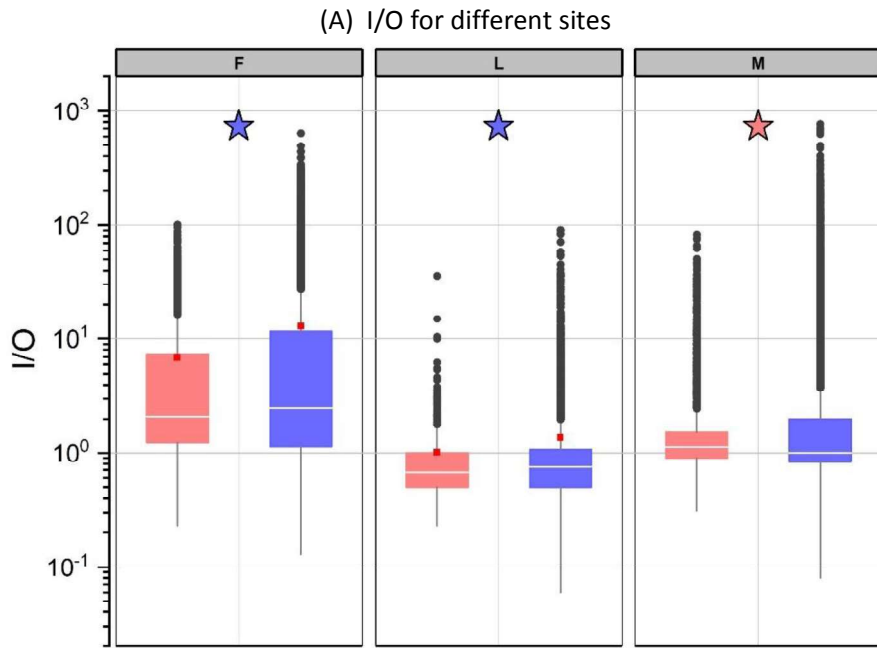


Figure 5. PM_{2.5} levels for each site in heatwave days and non-heatwave days grouping by smoking status. The black stars represent a statistically significant difference ($p < 0.05$) between the heatwave and non-heatwave groups. The lower, middle and upper lines of each box plot are 25th percentile, median, and 75th percentile of the data. The red box is the mean value. The gray dots are the outliers. (A) PM_{2.5} levels for different sites. (B) PM_{2.5} levels for different sites and smoking status.



(A) I/O for different sites and smoking status

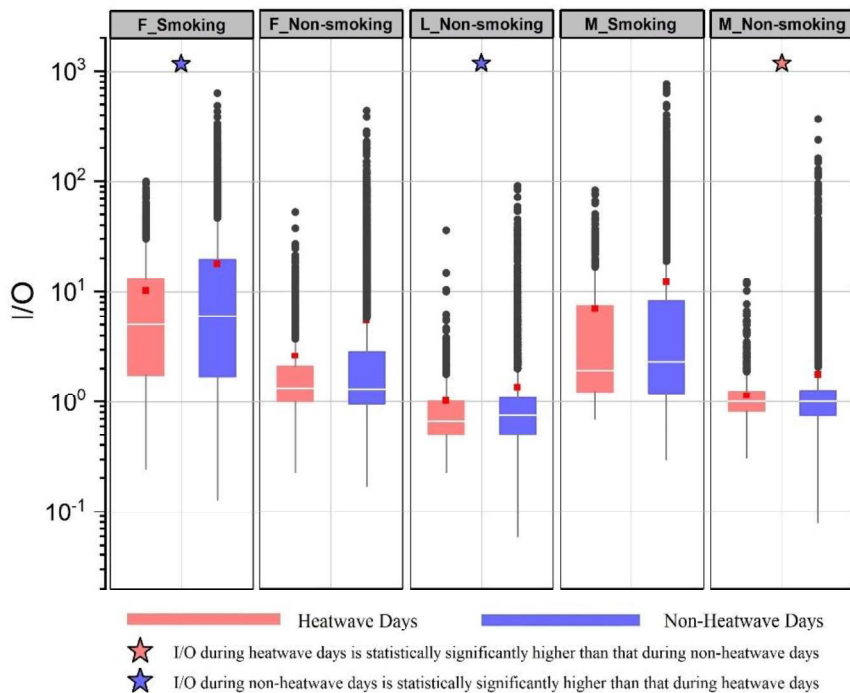
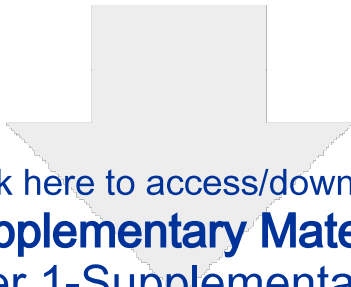


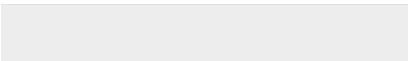
Figure 6. I/O for each site in heatwave days and non-heatwave days grouping by smoking status. The black stars represent a statistically significant difference ($p < 0.05$) between the heatwave and non-heatwave groups. The lower, middle and upper lines of each box plot are 25th percentile, median, and 75th percentile of the data. The red box is the mean value. The gray dots are the outliers. (A) I/O for different sites. (B) I/O for different sites and smoking status.



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Supplementary Material

Heatwave- paper 1-Supplemental_02-02-23.docx



Highlights

Indoor PM_{2.5} levels increased in 24 tested apartments during heatwaves.

Median hourly I/O PM_{2.5} ratios in most apartments tended to decrease with heatwaves.

The presence of smoking had a negative effect on PM_{2.5} levels during heatwaves and regular days.

Author contributions

Ruikang He contributed to conceptualization, data curation, formal analysis, investigation, methodology, original draft, review, and editing.

Ioanna Tsoulou contributed to data collection and review.

Sanjeevi Thirumurugesan, Brian Morgan, and Stephania Gonzalez contributed to data collection and sensor installation.

Deborah Plotnik and Jennifer Senick contributed to the study concept and coordination.

Clinton Andrews contributed to conceptualization, funding acquisition, coordination, supervision, methodology, and resources.

Gediminas Mainelis contributed to conceptualization, funding acquisition, supervision, review, and editing.

All authors have approved the manuscript.