SHORT TERM EFFECTS OF TRAFFIC RELATED AIR POLLUTION ON CARDIORESPIRATORY OUTCOMES AMONG LOW INCOME RESIDENTS FROM EL PASO, TX

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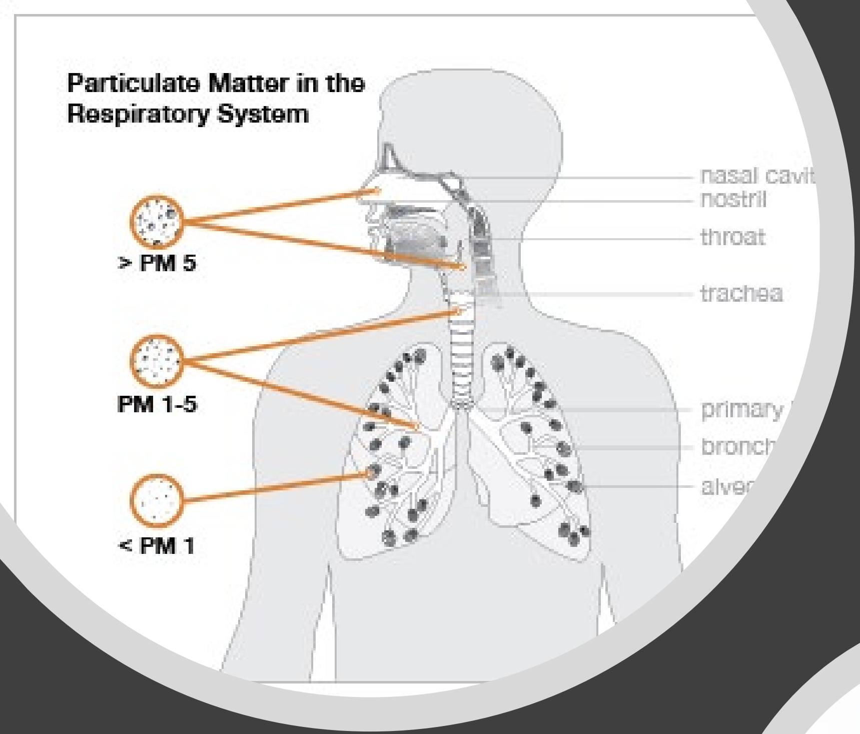
Research Objective

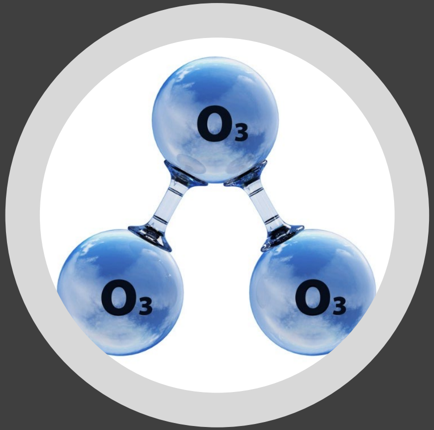
- **Goal 1:** Establish the short-term association between cardiorespiratory health outcomes and traffic-related air pollutants in residents of low-income communities of El Paso, TX.
  - **Objective 1:** Assess relationships between respiratory health measures for lung function and inflammation and traffic-related air pollutants
  - **Objective 2:** Assess the relationship between cardiovascular health outcomes (obesity, metabolic syndrome risk factors) and traffic-related air pollutants
  - **Objective 3:** Determine if a participant has metabolic syndrome and relationships with traffic-related air pollutants.

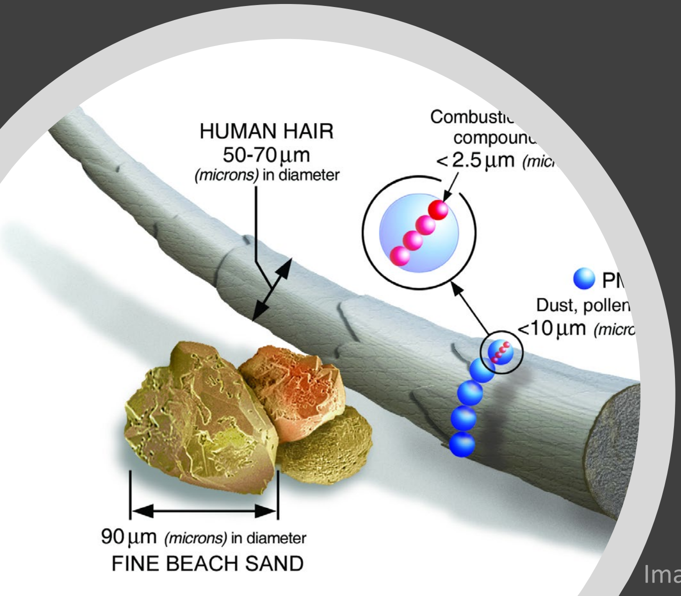
Air Pollution

- 43.5 million exposed to traffic pollution in the U.S. (living within 1 block) [1]
- More likely to affect those in underserved communities[2]
- Abundant evidence of adverse health effects [3-5]
- ↑ Mortality due to cardiorespiratory complications [6-7]

1. Li et al. 2011
2. Raysoni et al. 2013
3. Greenwald et al. 2013
4. Zora et al. 2013
5. Sarnat et al. 2012
6. Dockery et al. 1993
7. Pope et al. 1995







Respiratory effects

- Traffic related air pollution is a major preventable cause of respiratory disease[8]

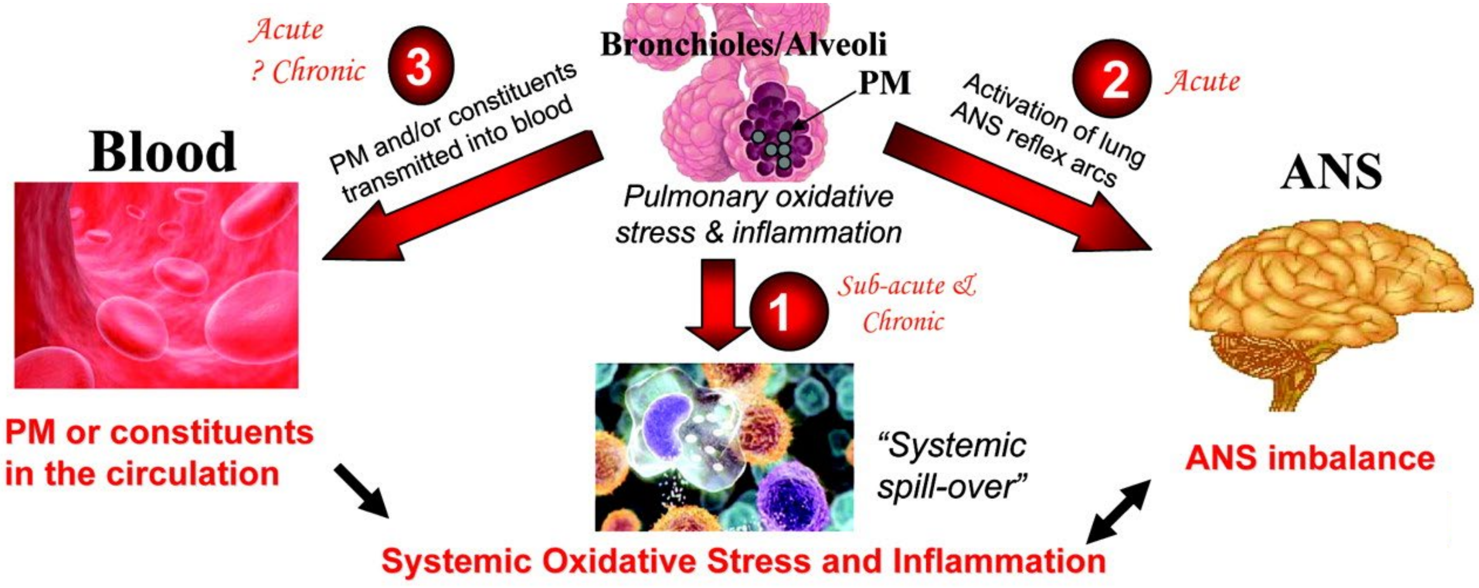
- Exposure or inhalation to air pollutants
  - ↑ airway inflamation[9]
  - ↓ exercise performance[10]
  - ↓ lung function[11]

Images retrieved from: http://aurametrix.weebly.com/topics/particulate-matter

8. Laumbach & Kipen. 2012
9. Holguin 2007
10. Rundell et al. 2008
11. Cutrufello. 2012

Cardiovascular Effects

Biological pathways have linked traffic-related pollutants with cardiovascular disease through three intermediary pathways with subsequent biological responses[12]



Retrieved and adapted from https://www.ahajournals.org/doi/10.1161/CIR.0b013e3181dbece1

12. Brook et al 2010

Short term exposure assessments

Short-term exposure to air pollutants

Time periods of exposure for some biomarkers is not clearly defined

- ↑ air pollutant concentrations over short periods (PM, NO_2, and O_3)[13]
  - one or several days led to ↑ CVD mortality and morbidity
- Blood pressure, HDL-cholesterol, LDL-cholesterol, fasting glucose, and HbA1c [14]
  - Affected by 1-day average, 2 to 6-day averages of PM
- HDL-cholesterol measures [15]
  - $PM_{2.5}$ from previous 5 days
- The MESA study on metabolic syndrome [16]
  - Daily exposure over the 2, 7, 30, and 60 days prior of PM, NO_2, and O_3

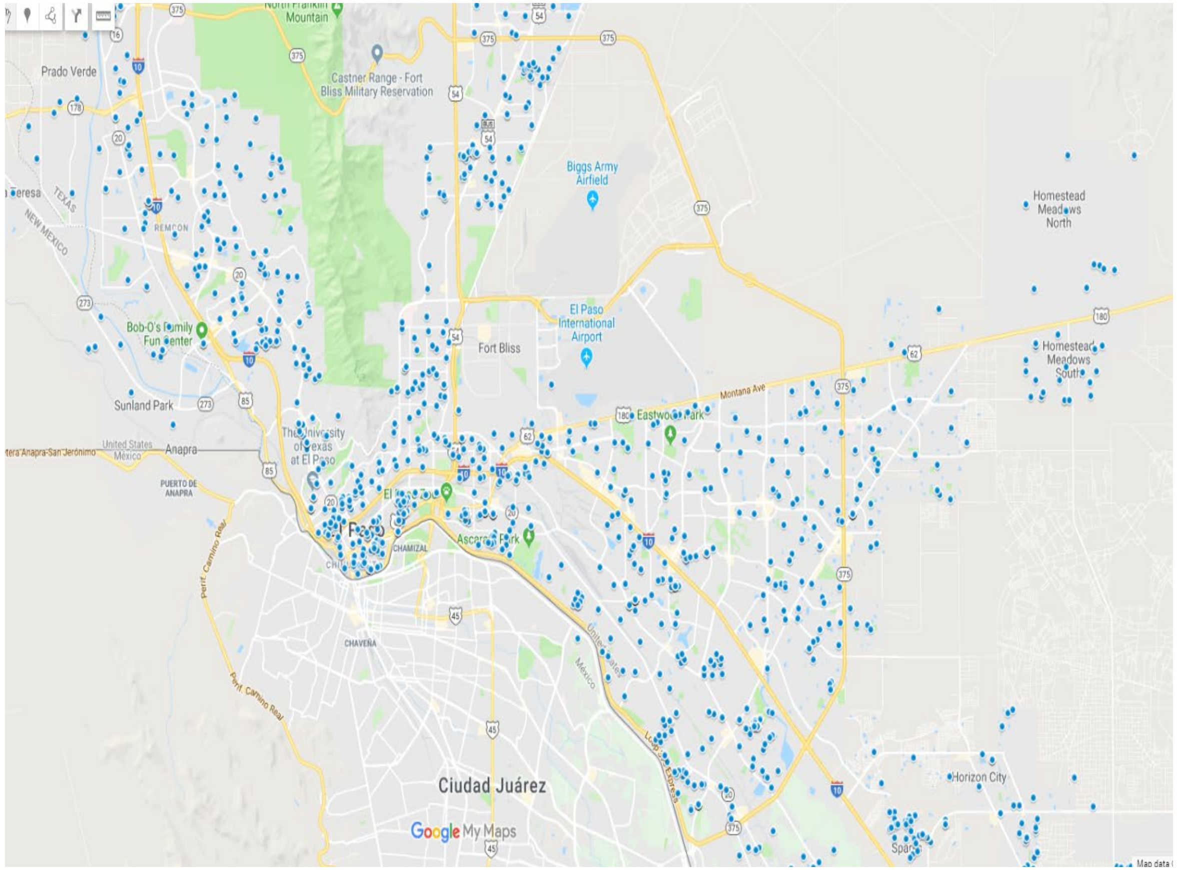
13. Pope et al 2006
14 Chuang et al 2010
15. Bell et al 2017
16. Park et al 2010

Evidence-based Screening for Obesity, Cardiorespiratory Disease, and Environmental Exposures in Low-income El Paso Households Study

Large epidemiological study (2014-2020) serving over 5000 low-income residents of El Paso, Texas

1st Year Data (2014-15):

- N = 662 residents from The Housing Authority for the City of El Paso (HACEP)
- Female (84%)
- Hispanic (98%)
- Mean age 48 years old (SD=13.8)
- BMI Average 30.6
  - (Obese 46%, overweight 35%)



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Respiratory Measurements

Lung inflammation:

Exhaled Nitric Oxide (eNO)

Lung function:

Spirometry

Forced vital capacity (FVC)

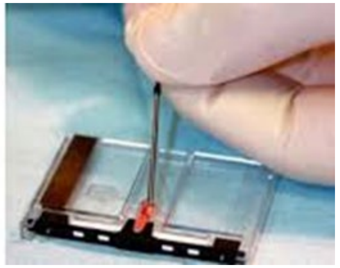
Forced expiratory volume in one second (FEV_1)

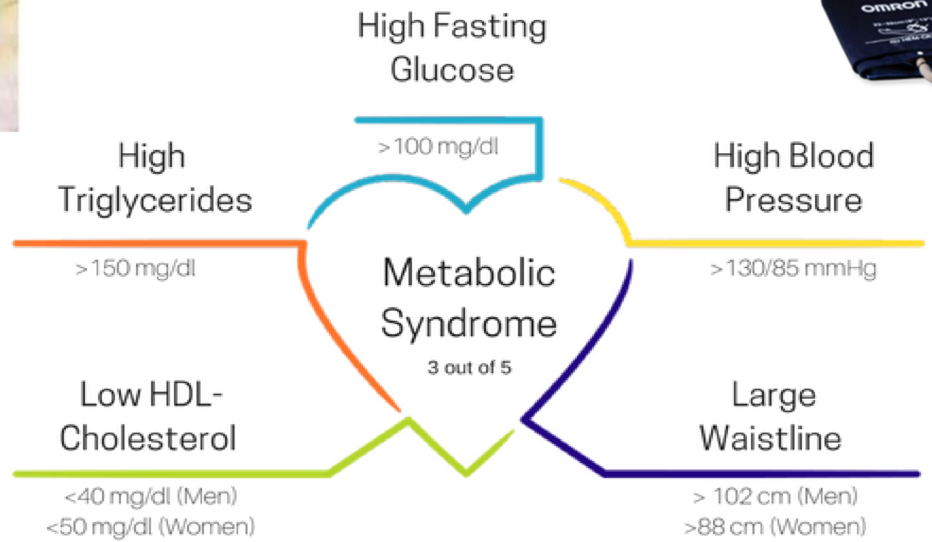
Peak expiratory flow (PEF)

Cardiovascular Measurements

Metabolic syndrome consists of a group of associated risk factors that occur together, increasing the risk of cardiovascular disease, and type 2 diabetes[17]

- A person must have at least 3/5 risk factors to be diagnosed with metabolic syndrome
- Prevalent in 23% of U.S.

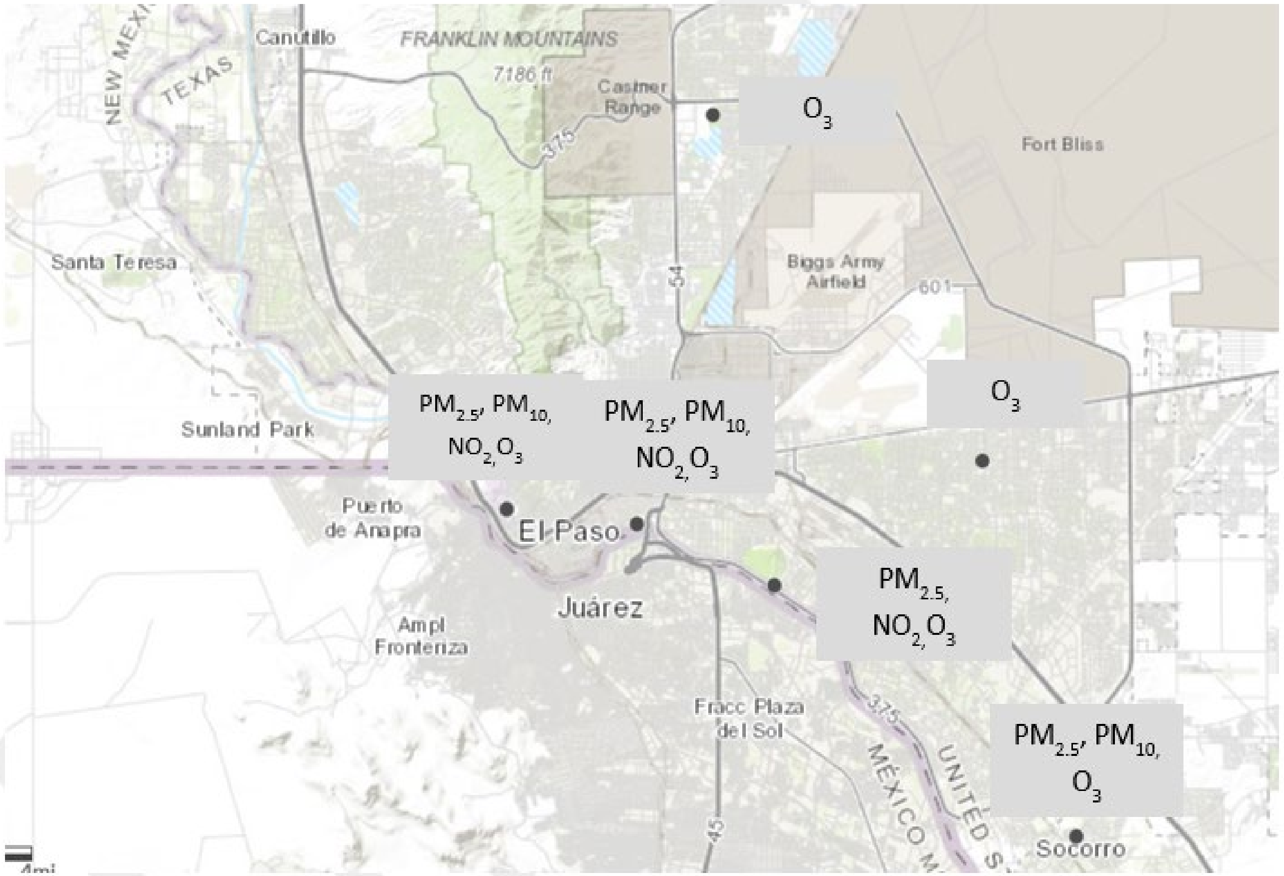




17. Saklayen et al. (2018)

Data Collected for the Study

- Study period: 1 year
  - Sep 2014 – May 2015
- Air quality CAMS data
  - $PM_{2.5}$, PM_{10}, NO_2 and ozone
- Health measurements (n=662)
  - eNO, Spirometry, Obesity, MetS
- Each participant assigned to representative CAMS station based on address
- Short term exposures (1-hour average concentration 24, 48, 72, 96 hours) before the date of examination

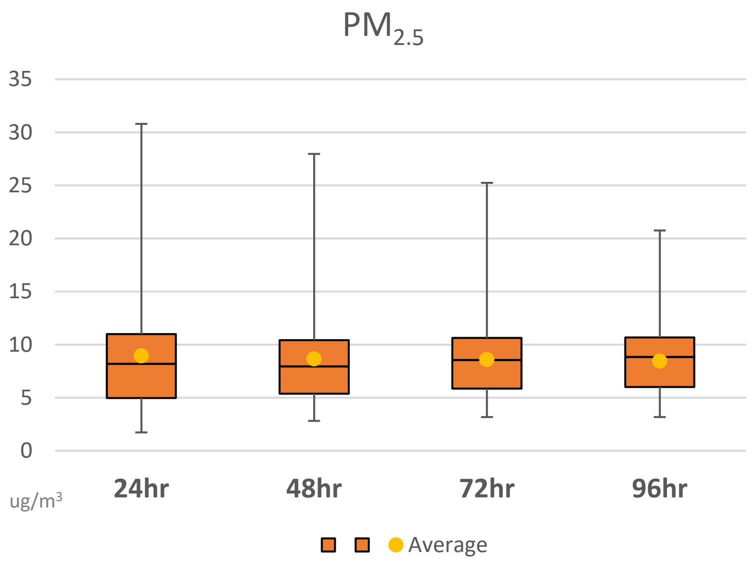


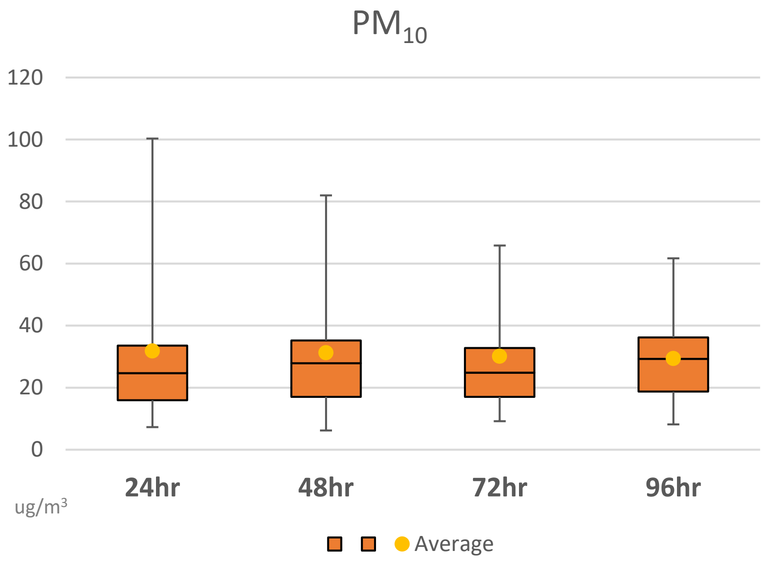
Statistical Analysis

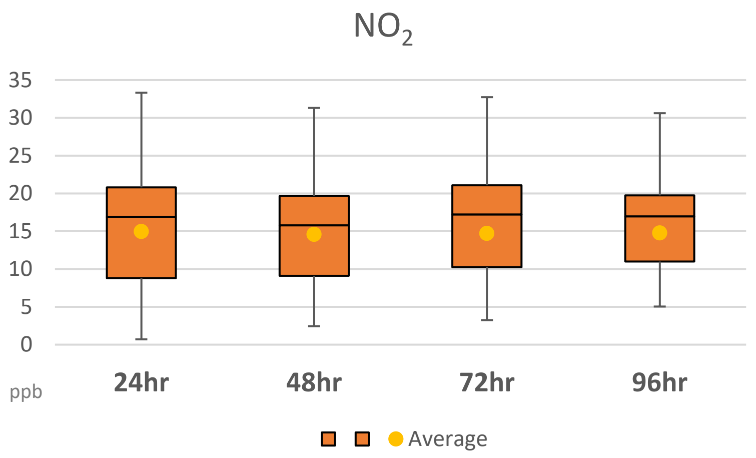
- Summary statistics of air pollution metrics ($PM_{2.5}$, PM_{10}, NO_2, O_3)
- Pollutant averaged with exposure periods (24-, 48-, 72-, 96-hr)
- Summary statistics of respiratory and cardiovascular outcomes
- Correlation analyses with air quality monitoring
- Short-term exposure analyses using linear and logistic regression models

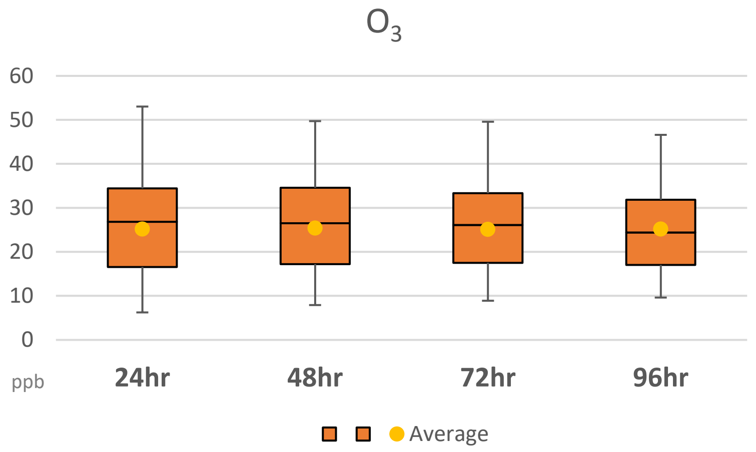
CAMS results

Data summary of Air pollutants		Median	Mean	SD
$PM_{2.5}$	24hr	7.771	**8.932**	**5.555**
	48hr	7.849	**8.642**	**4.880**
	72hr	7.949	**8.589**	**4.017**
	96hr	7.844	**8.435**	**3.380**
PM_{10}	24hr	24.854	**31.820**	**24.156**
	48hr	24.374	**31.259**	**19.996**
	72hr	24.990	**30.128**	**15.998**
	96hr	25.632	**29.376**	**13.571**
NO_2	24hr	12.702	**14.954**	**8.177**
	48hr	12.981	**14.580**	**7.037**
	72hr	14.088	**14.700**	**6.025**
	96hr	13.779	**14.751**	**5.243**
O_3	24hr	24.150	**25.159**	**10.747**
	48hr	25.261	**25.389**	**9.755**
	72hr	24.724	**25.096**	**9.474**
	96hr	24.451	**25.176**	**9.270**



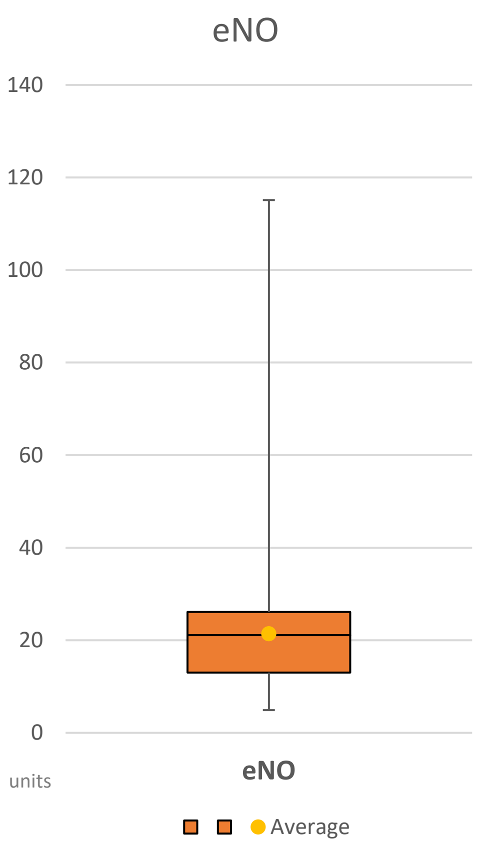


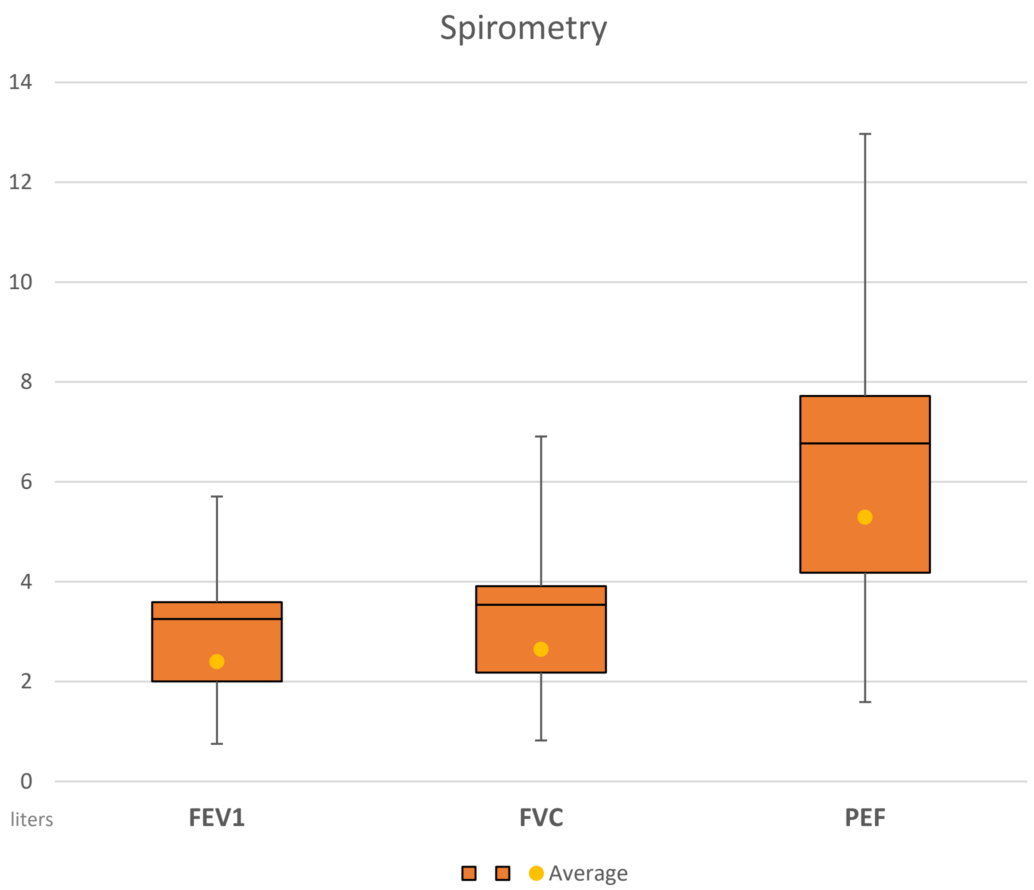




Respiratory outcomes

	Median	Mean	SD
eNO	18.000	**21.369**	**14.006**
FEV1	2.340	**2.399**	**0.623**
FVC	2.553	**2.646**	**0.732**
PEF	5.128	**5.290**	**1.688**
FEV1 %Pred	92.000	**95.872**	**30.532**
FVC %Pred	82.000	**84.645**	**24.289**
PEF %Pred	95.000	**95.786**	**26.984**
FEV1/FVC	0.920	**0.914**	**0.070**
FEV0.5Best	1.940	**1.993**	**0.502**
FEV1Best	2.440	**2.509**	**0.640**
FVCBest	2.680	**2.768**	**0.770**
PEFBest	6.050	**6.107**	**1.732**





Respiratory associations

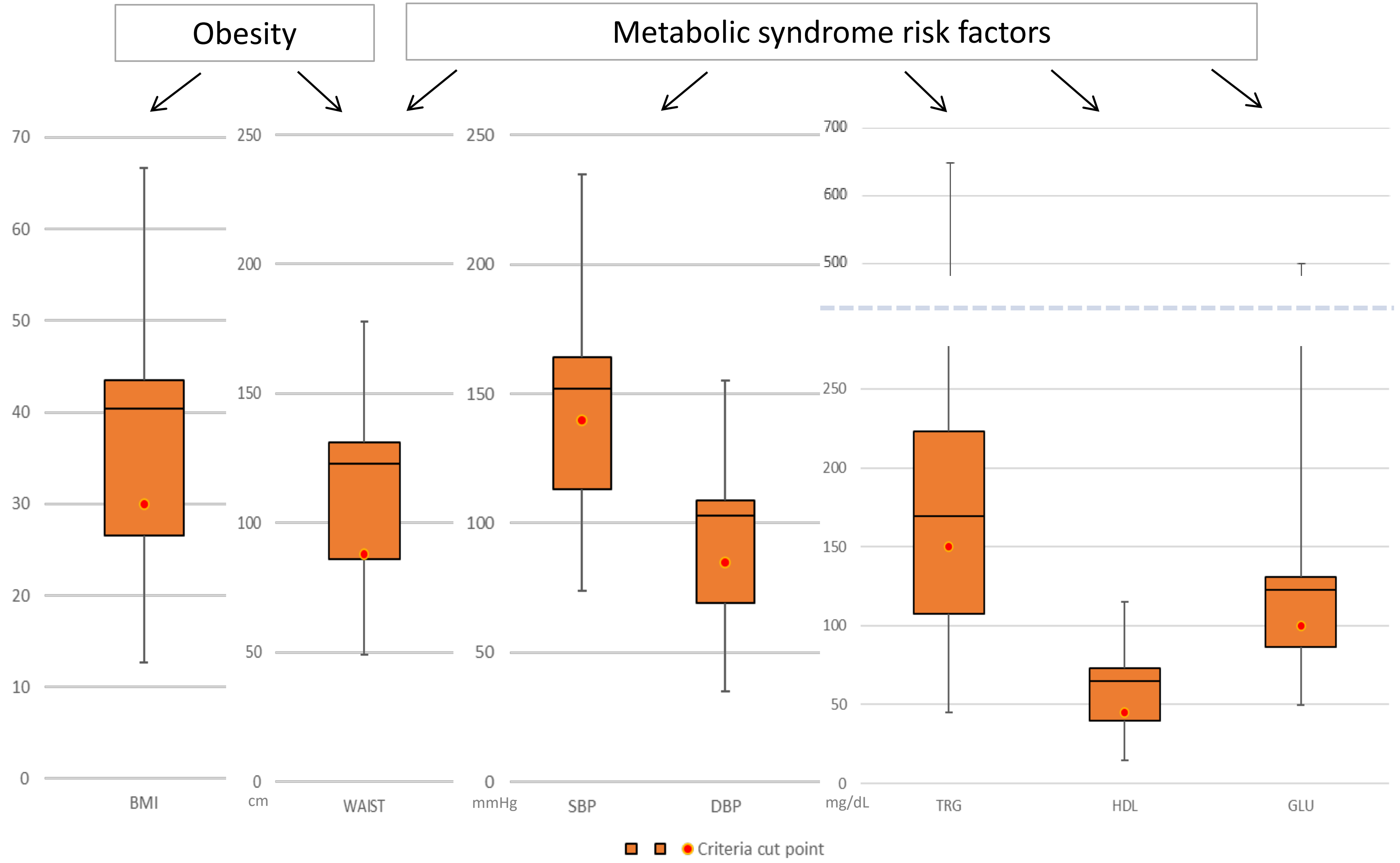
Respiratory Outcome[1]	Pollutant		Estimate	Std. Error	t value	p-value
FEV_1	**$PM_{2.5}$**	**24hr**	**-0.011**	**0.005**	**-2.080**	***0.038**
		48hr	**-0.014**	**0.006**	**-2.381**	***0.018**
		72hr	-0.012	0.007	-1.725	0.085
		96hr	-0.017	0.008	-2.148	*0.032
PEF	**$PM_{2.5}$**	**24hr**	**-0.048**	**0.015**	**-3.289**	***0.001**
		48hr	**-0.058**	**0.016**	**-3.555**	***0.000**
		72hr	**-0.054**	**0.019**	**-2.883**	***0.004**
		96hr	**-0.068**	**0.022**	**-3.120**	***0.002**
	NO_2	**24hr**	**-0.023**	**0.009**	**-2.496**	***0.013**
		48hr	**-0.028**	**0.011**	**-2.561**	***0.011**
		72hr	-0.023	0.013	-1.787	0.075
		96hr	**-0.028**	**0.014**	**-1.987**	***0.047**
FEV_1/FVC	$PM_{2.5}$	24hr	-0.006	0.008	-0.765	0.445
		48hr	-0.007	0.009	-0.877	0.381
		72hr	-0.015	0.010	-1.563	0.119
		96hr	**-0.023**	**0.011**	**-2.062**	***0.040**
	NO_2	**24hr**	**-0.011**	**0.005**	**-2.342**	***0.020**
		48hr	-0.007	0.006	-1.170	0.243
		72hr	-0.013	0.007	-1.963	0.050
		96hr	**-0.019**	**0.007**	**-2.540**	***0.011**
	O_3	**24hr**	**0.008**	**0.004**	**2.057**	***0.040**
		48hr	0.005	0.004	1.242	0.215
		72hr	0.006	0.004	1.338	0.182
		96hr	0.006	0.004	1.453	0.147

*)Indicates significant association $p<0.05$

1)FVC showed no associations, FEV_1 showed no associations with PM_{10} and O_3, FEV_1/FVC showed no associations with PM_{10}

Cardiovascular outcomes

	Median	Mean	SD
BMI	29.690	**30.560**	**6.580**
Waist	94.000	**95.456**	**14.414**
Systolic BP	125.000	**127.772**	**20.626**
Diastolic BP	75.000	**76.178**	**11.409**
Triglycerides	161.000	**186.043**	**114.664**
HDL	48.000	**49.714**	**14.583**
Fasting Glucose	94.500	**108.682**	**46.478**



Cardiovascular associations

Risk Factor[1]	Pollutant	24hr	48hr	72hr	96hr
BMI	**$PM_{2.5}$**	0.070	0.064	***0.080**	0.069
	PM_{10}	0.022	0.018	0.017	0.009
	NO_2	0.048	0.065	0.065	0.052
	O_3	-0.010	-0.018	-0.024	-0.015
Waist Circumference	**$PM_{2.5}$**	***0.113**	***0.121**	***0.134**	***0.129**
	PM_{10}	0.031	0.043	0.045	0.045
	NO_2	***0.126**	***0.149**	***0.158**	***0.142**
	O_3	***-0.098**	***-0.112**	***-0.117**	***-0.107**
HDL-cholesterol	$PM_{2.5}$	0.038	0.040	0.026	0.023
	PM_{10}	0.049	0.042	0.043	0.045
	NO_2	-0.031	-0.024	-0.037	-0.047
	O_3	0.072	0.069	0.077	***0.087**
Fasting Glucose[2]	**$PM_{2.5}$**	***0.087**	***0.087**	0.065	0.059
	PM_{10}	***0.091**	***0.084**	0.070	0.075
	NO_2	0.054	0.064	0.052	0.043
	O_3	-0.029	-0.052	-0.051	-0.045

*)Indicates significant association $p<0.05$
1)No significant associations with blood pressure or triglycerides
2) Box-Cox Transformation: bc.glucose = [glucose^(-2)-1]/(-2)

Logistic regression models

Variables[1]	Pollutant		Estimate	Std. Error	p-value
High Waist Circumference[2]	$PM_{2.5}$	24 hr	0.030	0.016	0.057
		48 hr	0.038	0.018	*0.037
		72 hr	0.060	0.022	*0.007
		96 hr	0.070	0.026	*0.007
	NO_2	24 hr	0.027	0.010	*0.008
		48 hr	0.036	0.012	*0.002
		72 hr	0.048	0.014	*0.001
		96 hr	0.055	0.016	*0.001
	O_3	24 hr	-0.016	0.008	*0.038
		48 hr	-0.019	0.008	*0.025
		72 hr	-0.021	0.009	*0.014
		96 hr	-0.022	0.009	*0.013
Low HDL[3]	O_3	24 hr	-0.017	0.007	*0.021
		48 hr	-0.020	0.008	*0.014
		72 hr	-0.021	0.008	*0.014
		96 hr	-0.024	0.009	*0.005
High Glucose[4]	$PM_{2.5}$	24 hr	0.034	0.015	*0.023
		48 hr	0.037	0.017	*0.028
		72 hr	0.030	0.020	0.137
		96 hr	0.026	0.024	0.283
	PM_{10}	24 hr	0.008	0.003	*0.022
		48 hr	0.008	0.004	*0.044
		72 hr	0.008	0.005	0.097
		96 hr	0.009	0.006	0.143
	NO_2	24 hr	0.014	0.010	0.155
		48 hr	0.023	0.012	0.054
		72 hr	0.027	0.014	*0.048
		96 hr	0.024	0.016	0.121

1) No significant associations with high blood pressure or high triglycerides
2) No significant associations with PM_{10}
3) No significant associations with $PM_{2.5}$, PM_{10}, NO_2
4) No significant associations with O_3

Variables	Pollutant		Estimate	Std. Error	p-value
Metabolic Syndrome	$PM_{2.5}$	24 hr	0.022	0.015	0.155
		48 hr	0.029	0.017	0.091
		72 hr	0.037	0.021	0.076
		96 hr	0.049	0.024	*0.043
	PM_{10}	24 hr	0.003	0.003	0.357
		48 hr	0.003	0.004	0.456
		72 hr	0.003	0.005	0.489
		96 hr	0.005	0.006	0.377
	NO_2	24 hr	0.019	0.010	0.059
		48 hr	0.027	0.012	*0.021
		72 hr	0.039	0.014	*0.004
		96 hr	0.054	0.016	*0.001
	O_3	24 hr	-0.018	0.007	*0.014
		48 hr	-0.025	0.008	*0.003
		72 hr	-0.026	0.008	*0.003
		96 hr	-0.027	0.009	*0.002

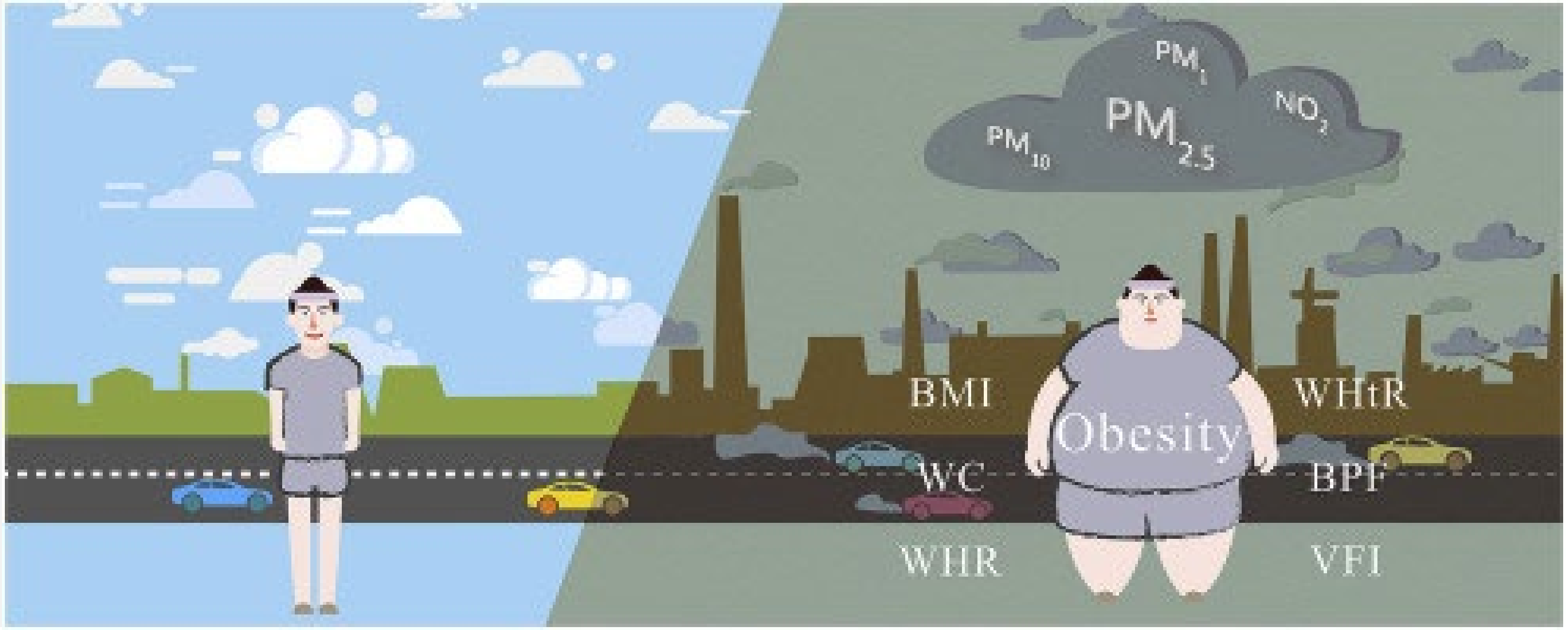
*)Indicates significant association $p<0.05$

Discussion

- **Indicators of obstructive respiratory diseases (asthma, COPD) with air pollutants**
  - Forced expiratory volume on first second (FEV_1) negatively correlated with $PM_{2.5}$
  - Peak exploratory flow (PEF) was negatively correlated with $PM_{2.5}$ and NO_2

- **eNO did not correlate with air pollutants**
  - Inclusion methods did not account for participants with asthma

Discussion



- **Positive correlation between air pollutants and obesity outcomes**
  - Possible mechanisms: environmental and neighborhoods conditions
- **Positive correlation between fasting glucose and particulate matter**
  - Possible mechanisms: oxidative stress and inflammation cause by air pollution exposure

Limitations

- CAMS stations vs. on-site measurements
- Indoor environment variations

Summary

- Respiratory outcomes were associated to air pollution exposure
  - Future studies: clinical classifications of obstructive respiratory outcomes (asthma, COPD)
- This study might be the first to find associations of short-term exposure to air pollutants with obesity
  - Future studies: Consider obesity, neighborhood and socioenvironmental conditions with long-term exposure
- Fasting glucose was associated with short-term effects of air pollution exposure
  - Future studies: expand on glycated hemoglobin and diabetes diagnosis

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- The contents of this presentation are solely the responsibility of the authors and do not necessarily represent the official views of the U.S. DOT

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“Interdisciplinary health research involves devotion
to lifelong learning and collaboration;
only by working together we will solve complex
problems and set standards of healthcare and
disease prevention for everyone”

Thank you !