MARKERS OF EXPOSURE ASSOCIATED WITH BUSY TRAFFIC ROAD

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BACKGROUND

- Why are we concerned about exposure
  - Air pollution global challenge
  - Health effects – AQO is based on health effects
  - Particulate Matter the ELEPHANT IN THE ROOM

- What are BIOMARKERS and uses
  - Biological markers (biomarkers) are indicators of signalling events in biological systems or samples they are “cellular, biochemical or molecular alterations that are measurable in biological media such as human tissues, cells, or fluids” (The Committee on Biological Markers of the National Research, 1987, Hulka, 1991).
  - **Biomarker is a characteristic that is objectively measured and evaluated as an indicator of normal biological processes, pathogenic processes, or pharmacological responses to a therapeutic intervention (Mateos and Bravo, 2007).**
  - Biomarkers can be used to measure exposure and have the ability to provide information on the absorption and metabolism of the exposure (Mayeux, 2004). Therefore products of oxidative stress, inflammation, or tissue damage can be used as biomarkers for early indication of adverse effects of PM exposure (Nel, 2005).

BACKGROUND

- How they are formed?
  - Narrowing it to environmental factors as in this case, exposure to air pollution – exogenous sources
  - PM – Not just size but substances bound on them i.e. chemical component
  - PM – Primary toxicity in the respiratory and cardiopulmonary system
  - When they get into the lungs could cause oxidative stress as a result of the production of ROS/RNS
  - Where production of ROS exceeds the natural antioxidant capacity
  - This oxidative stress may lead to the damage of the DNA, protein, lipids, disturbance of multiple signalling pathways, activation of cellular defence, aging, inflammation and cell death pathways
- Biomarkers of exposure to air pollution from different studies
  - Such as; EBC-nitrate, EBC-nitrite, EBC- pH, urinary 8-oxodG
- Personal and mobile monitoring and exposure
    - Personal and portable sensors
- Objective of this study is to evaluate acute respiratory effects from short-term busy roadside and traffic related exposure in health humans.

METHODOLOGY

Sampling Location: Busy Traffic site - Bristol Road (Belgrave Middleway A38 Bristol road/street junction) and control site - Calthrope Park (Edward Road). . Both sites are located in Birmingham

Volunteers: 15 non-smoking healthy volunteers were selected to participate in this study.

Pollutants measured: The pollutants ultrafine particles (UFP) measured as particle number concentration (PNC), particulate matter 2.5 ($PM_{2.5}$) and black carbon (BC) were measured using real-time personal sensors.
UFP: Measured with DiSCmini (Miniature Diffusion Size Classifier)
$PM_{2.5}$: Measured with MicroPEM v3.2 (Micro-Personal Exposure Monitoring)
BC: Measured with Microaethalometer AE-51

Biomarker sampled: Biomarkers of inflammation: EBC-nitrate, EBC-nitrite and EBC-pH were measured in Exhaled Breath Condensate (EBC). 8-oxodG was measured in urine. Autonomic function (systolic and diastolic blood pressure, pulse rate) and lung function (FEV_1, FEV_6, FEV_1/FEV_6, FEF_{25-75}%) were measured.

Sampling pattern: Participants in groups of 3 walked for 2 hours (during peak hour 3pm -5pm)) in a circle around Bristol Road (Belgrave Middleway A38 Bristol road/street junction). Those same volunteers on a different day walked for 2 hours (same time) in Calthrope Park (Edward Road) as the control site.

METHODOLOGY

Biomarker sampling: Before exposure at both sites, volunteers were rested for 30 mins in an indoor location away from traffic sources. Exhaled Breath Condensate (EBC) and urine were collected immediately before and immediately after exposure. Biomarkers of inflammation were measured as changes in the before and after biomarker concentration of EBC-nitrate, EBC-nitrite, EBC-pH, and urinary 8-oxodG. Also changes in before and after systolic , diastolic blood pressure and pulse rate, lung function were measured.

- The Blood pressure was measured with a digital monitor arm-type blood pressure monitor by Value health
- The vitalograph lung monitor was used to measure the lung function.

Urine samples: Urine samples were collected, frozen at -80^{0}C and then shipped to Chung Shan Medical University, Taichung Taiwan for 8-oxodG and creatinine analysis. LC-MS/MS technique was used for the analysis.

EBC samples: EBC in simple terms is cooling down of breath. EBC was collected and frozen and then Ion chromatography was used to analyse the EBC for nitrate and nitrite. EBC- pH analysis was performed with a thin and sensitive glass electrode (Thermo scientific Orion semi micro glass probe) and pH meter (Thermo Orion 3 star). EBC sample before pH measurement was de-aerated with nitrogen gas to remove CO_2 in order to standardise the sample and enhance stability of the EBC-pH.)

SAMPLING SITE

Park: Calthrope Park Edward road Birmingham (Picture from Google Earth)

Busy traffic site: Belgrave Middleway A38 Bristol road/street Birmingham (Picture from Google Earth)

RESULTS

Concentrations measured in the Busy roadside/traffic site and Control site

	Bristol				PARK			
	UFP (#/cm^3)	SIZE (nm)	BC (µg/m^3)	$PM_{2.5}$ (µg/m^3)	UFP (#/cm^3)	SIZE (nm)	BC (µg/m^3)	$PM_{2.5}$ (µg/m^3)
Average	12713	44.78	5.12	20.26	2741	44.28	0.76	31.64
SD	4409	3.53	2.04	6.33	1053	4.22	0.34	10.69
Minimum	6607	39.84	2.01	12.39	1425	40.04	0.34	13.98
Median	12427	45.43	4.98	19.07	2502	43.56	0.76	32.79
Maximum	19052	49.55	8.11	25.08	4239	51.02	1.32	42.49

- UFP measured as PNC and BC concentrations were significantly higher in the busy road traffic site measurements
- $PM_{2.5}$ concentration was higher in the Park measurements

Results

Summary of EBC and urine biomarkers

	Busy traffic site			Park (control site)		
	Before	After	Wilcoxon	Before	After	Wilcoxon
NO_3^- (μM) Mean (SD)	6.83 (7.1)	34.20 (44)	0.01	7.65 (8.65)	1.51 (2.50)	0.03
NO_2^- (μM) Mean (SD)	2.44 (0.05)	2.64 (0.18)	0.01	0.67 (0.17)	0.59 (0.06)	0.05
pH Mean (SD)	7.61 (0.14)	7.71 (0.19)	0.10	7.62 (0.19)	7.68 (0.13)	0.30
8-oxodG (ng/mg Creatinine) Mean (SD)	3.30 (1.39)	3.41 (1.42)	0.49	3.26 (1.50)	3.33 (1.46)	0.46

Wilcoxon used to test difference of mean and significant at $P \leq 0.05$. 2-tailed probability test.

- After 2 hours of exposure, EBC nitrate and nitrite concentrations were significantly higher in the after busy traffic site measurement as compared to before. While the park showed further reduction after exposure.
- EBC-pH and urinary 8-oxodG did not show significant changes

RESULTS

Summary of blood pressure and pulse rate function

	Before-exposure				After-exposure			
Location	Systolic (mmHg)	Diastolic (mmHg)	Pulse rate (bpm)	VE-HR (L)	Systolic (mmHg)	Diastolic (mmHg)	Pulse rate (bpm)	VE-HR (L)
Busy traffic Mean (SD)	117 (12)	78 (8)	76 (8)	17 (3)	116 (15)	79 (11)	73 (11)	16 (4)
Park Mean (SD)	117 (13)	78 (9)	77 (16)	18 (7)	117 (12)	82 (9)	74 (16)	17 (6)

We did not find any significant changes in the blood pressure and lung function parameters. This could be that these measurements may be less sensitive especially in healthy subjects like in the case of this study.

RESULTS

Summary of lung function

Busy traffic site

	Before exposure	1 hour into exposure	2 hour into exposure	After exposure
FEV_1 (L)	2.01	2.24	2.32	2.37
FEV_6 (L)	2.00	2.47	2.48	2.70
FEV_1/FEV_6	0.98	0.95	0.97	0.97
$FEF_{25-75\%}$ (L/s)	3.74	2.52	3.73	4.07

Park

	Before exposure	1 hour into exposure	2 hour into exposure	After exposure
FEV_1 (L)	2.30	2.29	2.32	2.32
FEV_6 (L)	2.45	2.59	2.40	2.48
FEV_1/FEV_6	0.97	0.96	0.97	0.96
$FEF_{25-75\%}$ (L/s)	4.43	4.14	4.14	4.07

CONCLUSION

- The result indicates that short-term exposure can induce inflammatory response because of the significant changes we observed in the EBC-nitrate and EBC-nitrite.
- Over longer exposure period outcome could be different.

ANY QUESTIONS!!!!