



# **Biomonitoring of Air Pollution Exposure and Pathological Changes in Individuals**

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Professor of Global and Environmental Health

# Highlights

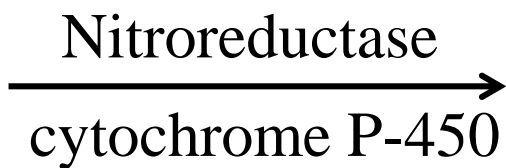
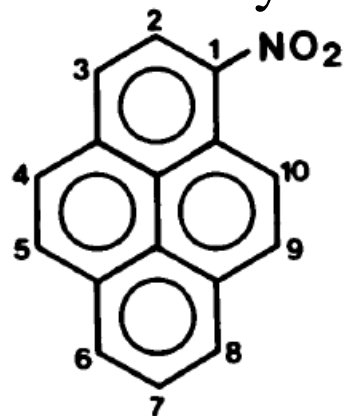
- Exposure Biomarker for diesel nitro-PAHs
  - Urine (CEF published work)
  - Urine (HEART study)
  - Hb-adducts of *BaP* and *nitro-PAHs*
- Biomarkers of physiological response/pathway
  - MDA*
  - 8-OHdG*
  - nitrite*

# Exposure Biomarker for diesel nitro-PAHs

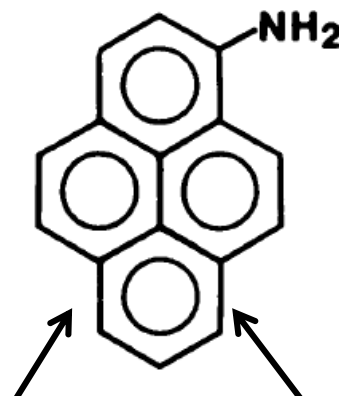
## Urine

- Diesel exhaust (DE) is a significant source of air pollution that has been linked to respiratory and cardiovascular morbidity and mortality.
- Nitro-PAHs have been detected from diesel exhaust particles, and appear to be a more specific marker of DE exposure.
- Nitro-PAHs, once inhaled, can be partially metabolized to the corresponding amino-PAHs and excreted in urine.

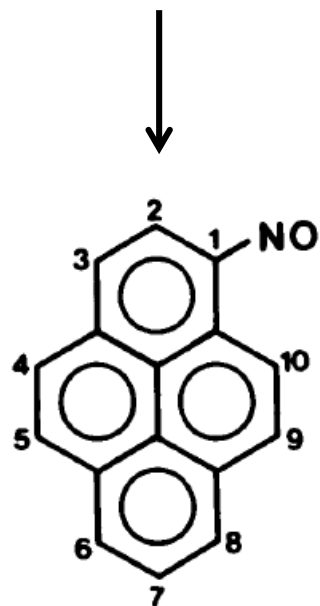
1-Nitro-Pyrene



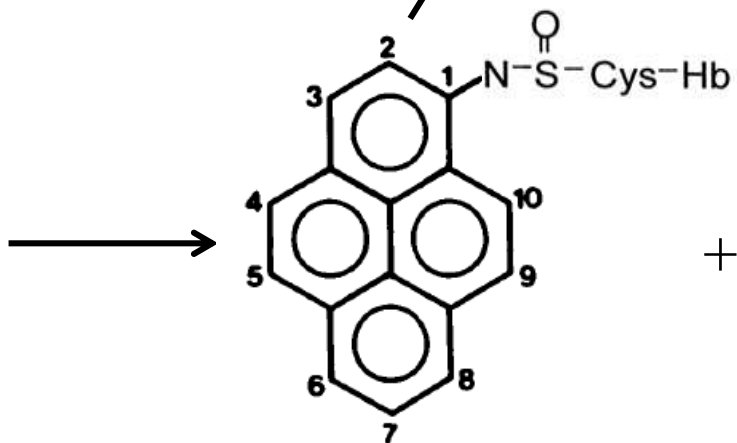
1-Amino-Pyrene



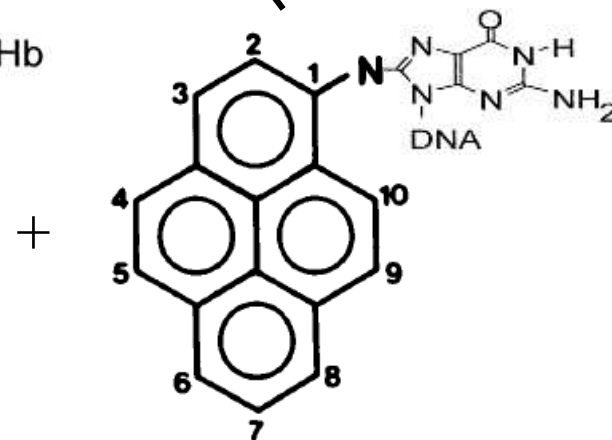
Hydrolysis Hydrolysis



1-Nitroso-Pyrene



Hemoglobin adducts



DNA adducts

# Exposure Biomarker for diesel nitro-PAHs CEF study

PAPER

www.rsc.org/jem | Journal of Environmental Monitoring

## Quantification of 1-aminopyrene in human urine after a controlled exposure to diesel exhaust

Robert Laumbach,<sup>a</sup> Jian Tong,<sup>b</sup> Lin Zhang,<sup>b</sup> Pamela Ohman-Strickland,<sup>ab</sup> Alan Stern,<sup>bc</sup> Nancy Fiedler,<sup>a</sup> Howard Kipen,<sup>a</sup> Kathie Kelly-McNeil,<sup>a</sup> Paul Lioy<sup>a</sup> and Junfeng Zhang<sup>\*ab</sup>

- An **HPLC-fluorescence** system was used to analyze **1-aminopyrene** in human urine samples collected prior to and during 24 h following the start of 1 h controlled exposure to DE (target concentration 300  $\mu\text{g}/\text{m}^3$  as  $\text{PM}_{10}$ ) and clean air control.

# Exposure Biomarker for diesel nitro-PAHs Beijing Olympic study

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Urinary polycyclic aromatic hydrocarbon metabolites as biomarkers of exposure to traffic-emitted pollutants



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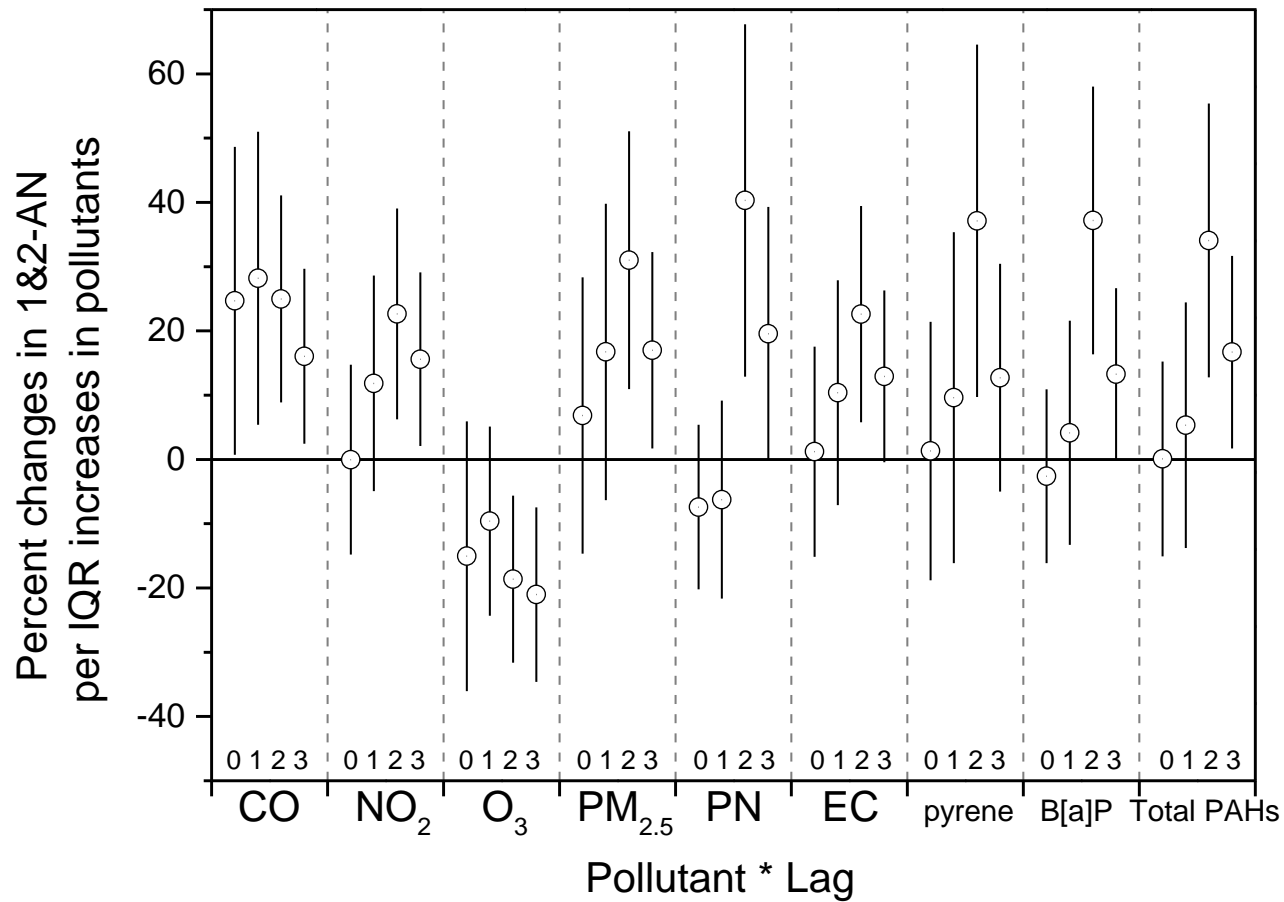
<sup>c</sup> Rutgers Robert Wood Johnson Medical School, Department of Environmental and Occupational Medicine, Piscataway, NJ, USA

<sup>d</sup> University of Rochester, School of Medicine and Dentistry, Rochester, NY, USA

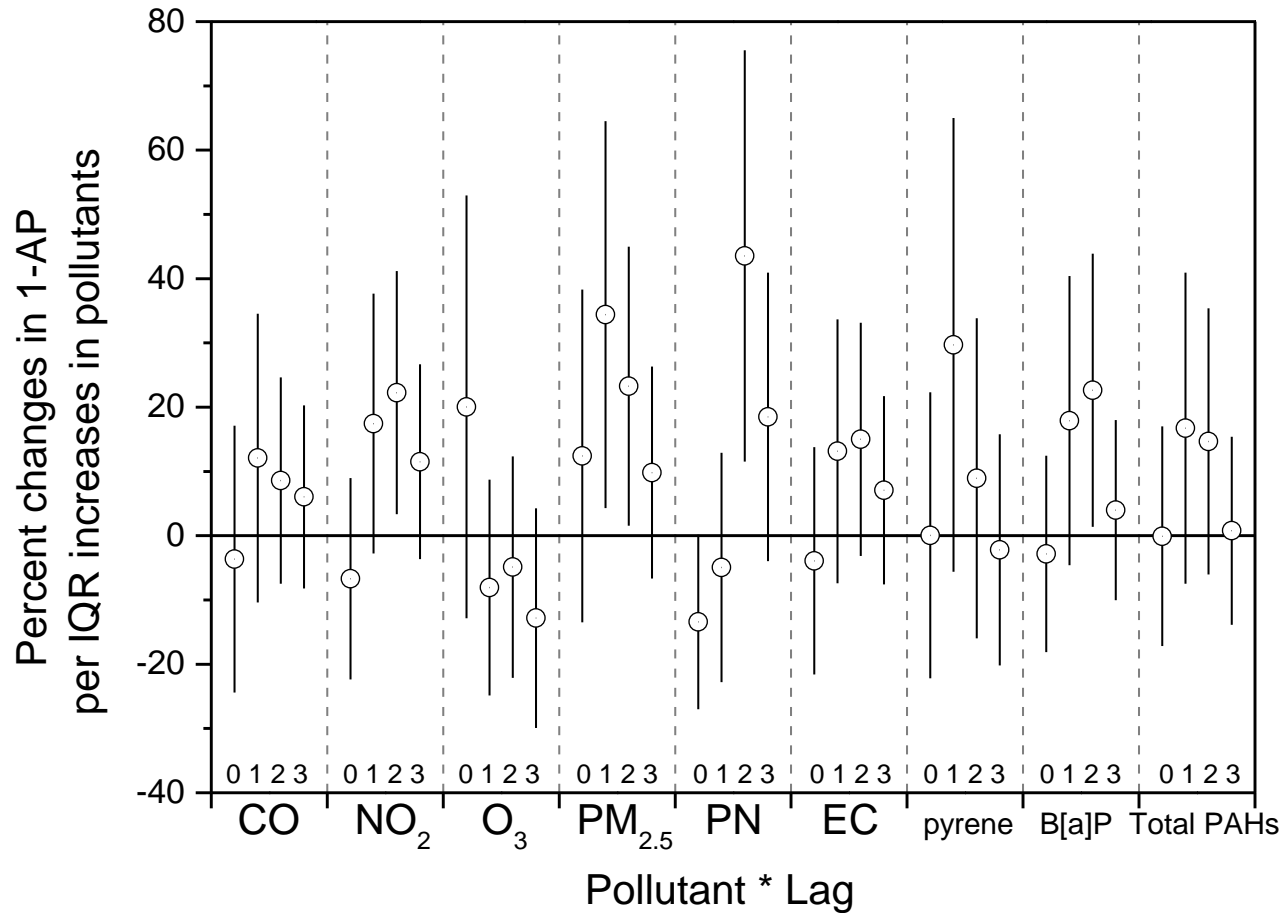
<sup>e</sup> Peking University, School of Public Health, Department of Occupational and Environmental Health and Institute of Environmental Medicine, Beijing, China

<sup>f</sup> University of Southern California, Keck School of Medicine, Department of Preventive Medicine, Los Angeles, CA, USA

# 1&2-amino-naphthalene

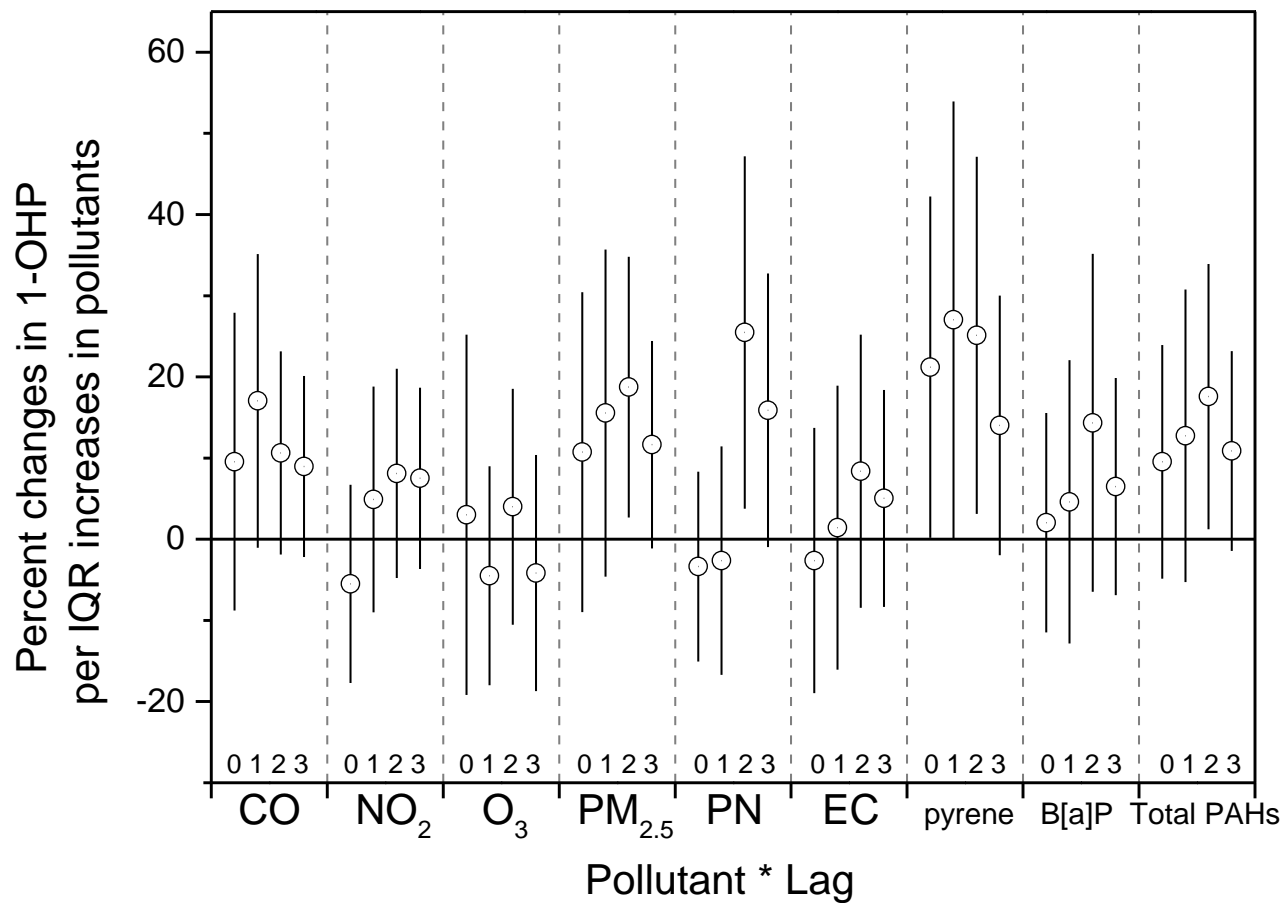


# 1-amino-pyrene





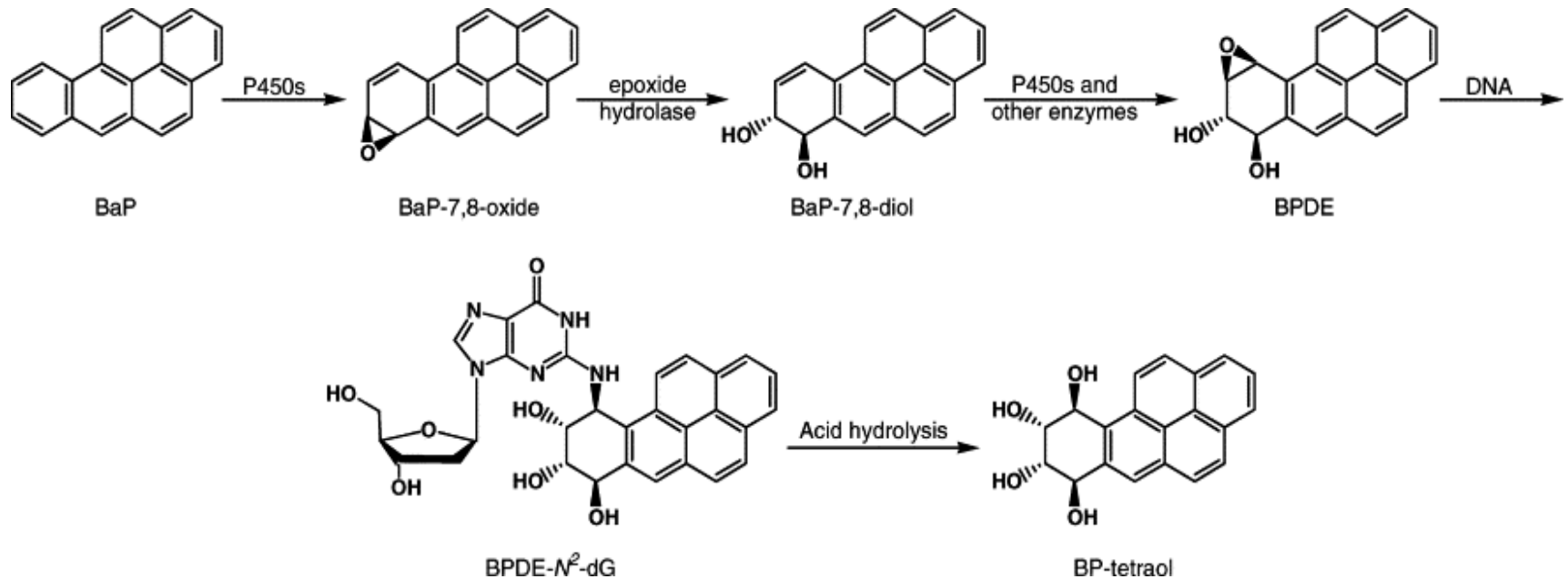
# 1-OH-pyrene



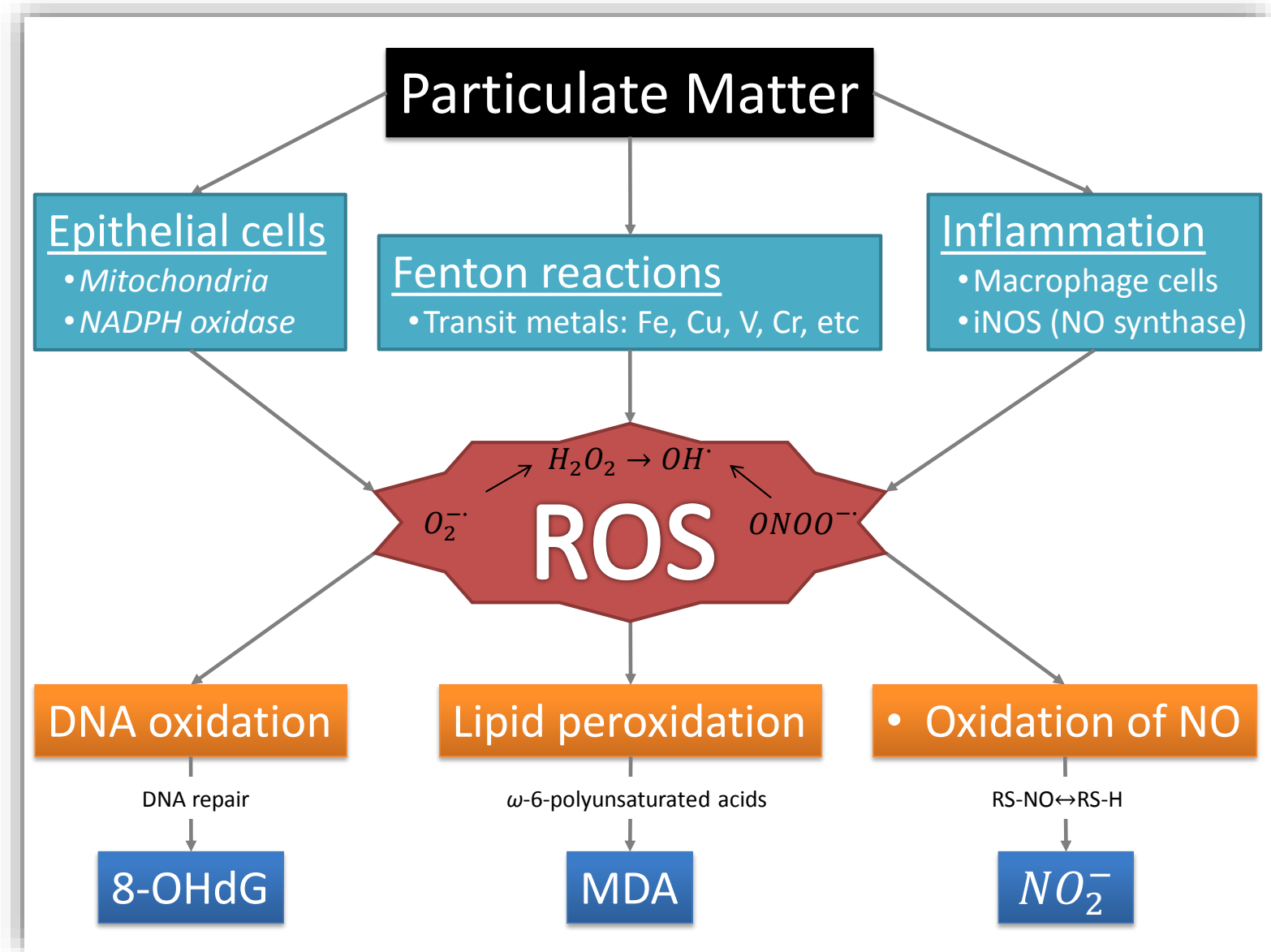
# Exposure Biomarker for diesel nitro-PAHs

## Hemoglobin adducts

- The formation of DNA and protein adducts from benzo[a]pyrene



# Biomarkers of physiological response / pathway



# Biomarkers of physiological response / pathway malondialdehyde (MDA)

Spectrophotometry  
(TBARS)

Rapid  
Easy  
Economical

Less specific  
Less sensitive  
Less reproducible

HPLC-FL

Specific  
Reproducible  
Easily available

Require  
derivatization

GC-MSMS

Specific  
Reproducible  
Sensitive

Pre-treatment  
required  
On-fibre  
derivatization

LC-MSMS

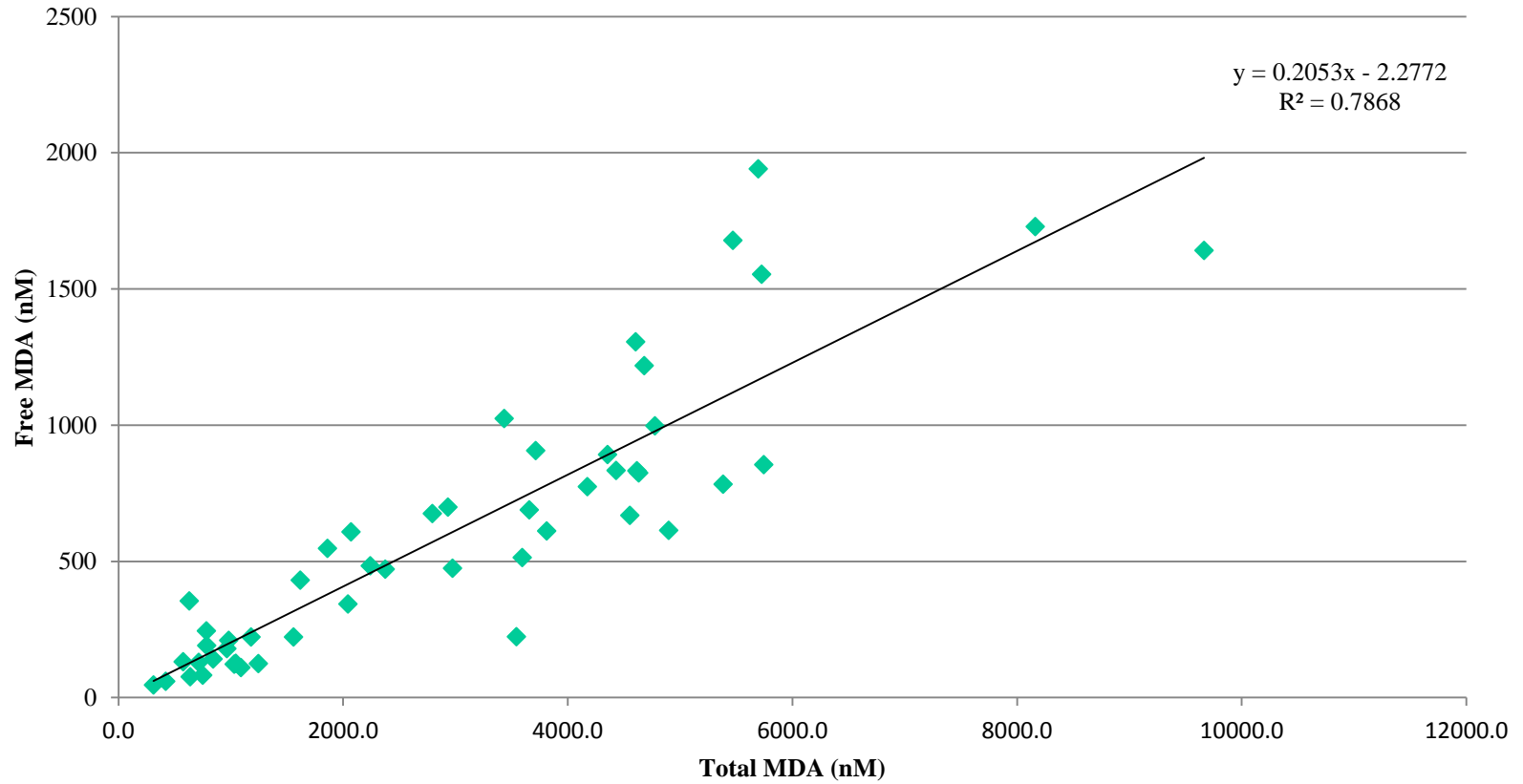
Specific  
Reproducible  
Sensitive

Costly  
Derivatization  
required

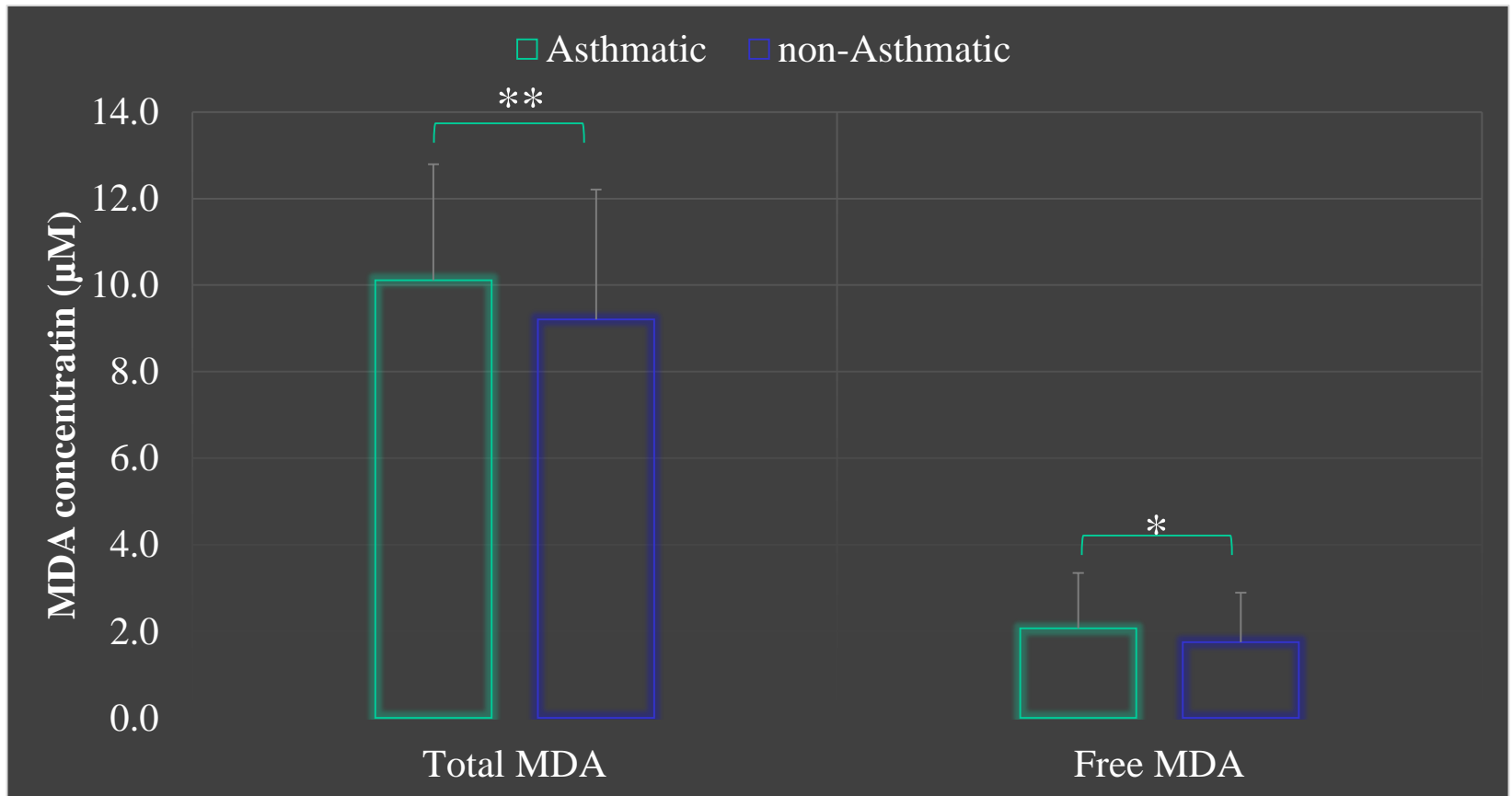
# Biomarkers of physiological response / pathway malondialdehyde (MDA)

- Free MDA VS Total MDA
  - Broncho-alveolar lavage fluid (BALF)
  - Urine
  - Serum

# Free and total MDA Urine

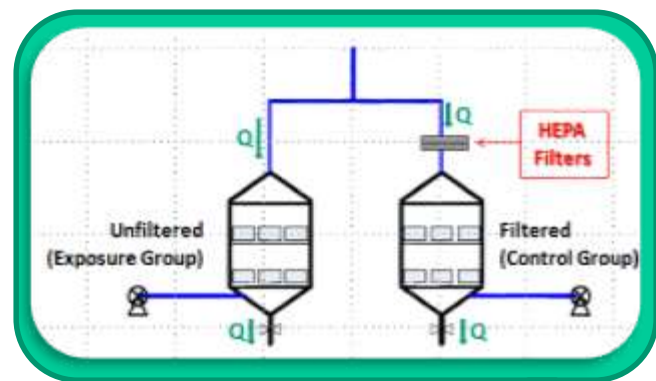


# Free and total MDA Serum



# Biomarkers of physiological response / pathway

## Animal Inhalation Chambers



**Flow rate= 35 L/min**

**Velocity= 0.0004 m/s**

**Temp=  $24 \pm 1$  °C**

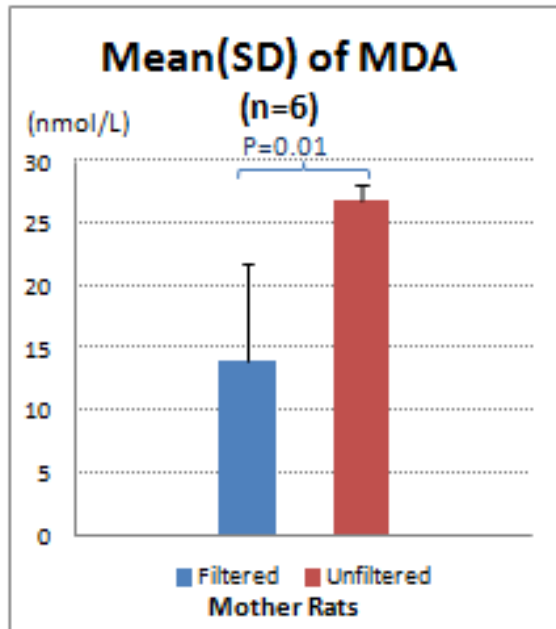
**Lighting= natural day/night cycle**



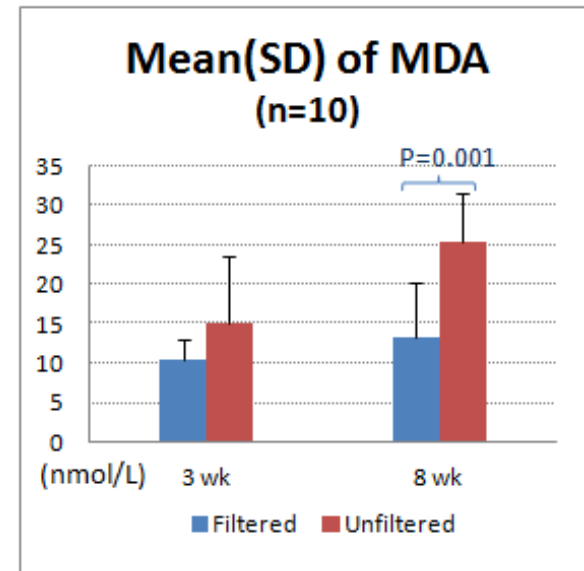
# Biomarkers of physiological response / pathway

## MDA: Animal Inhalation Chambers

Pregnant rats after  
14 day exposure

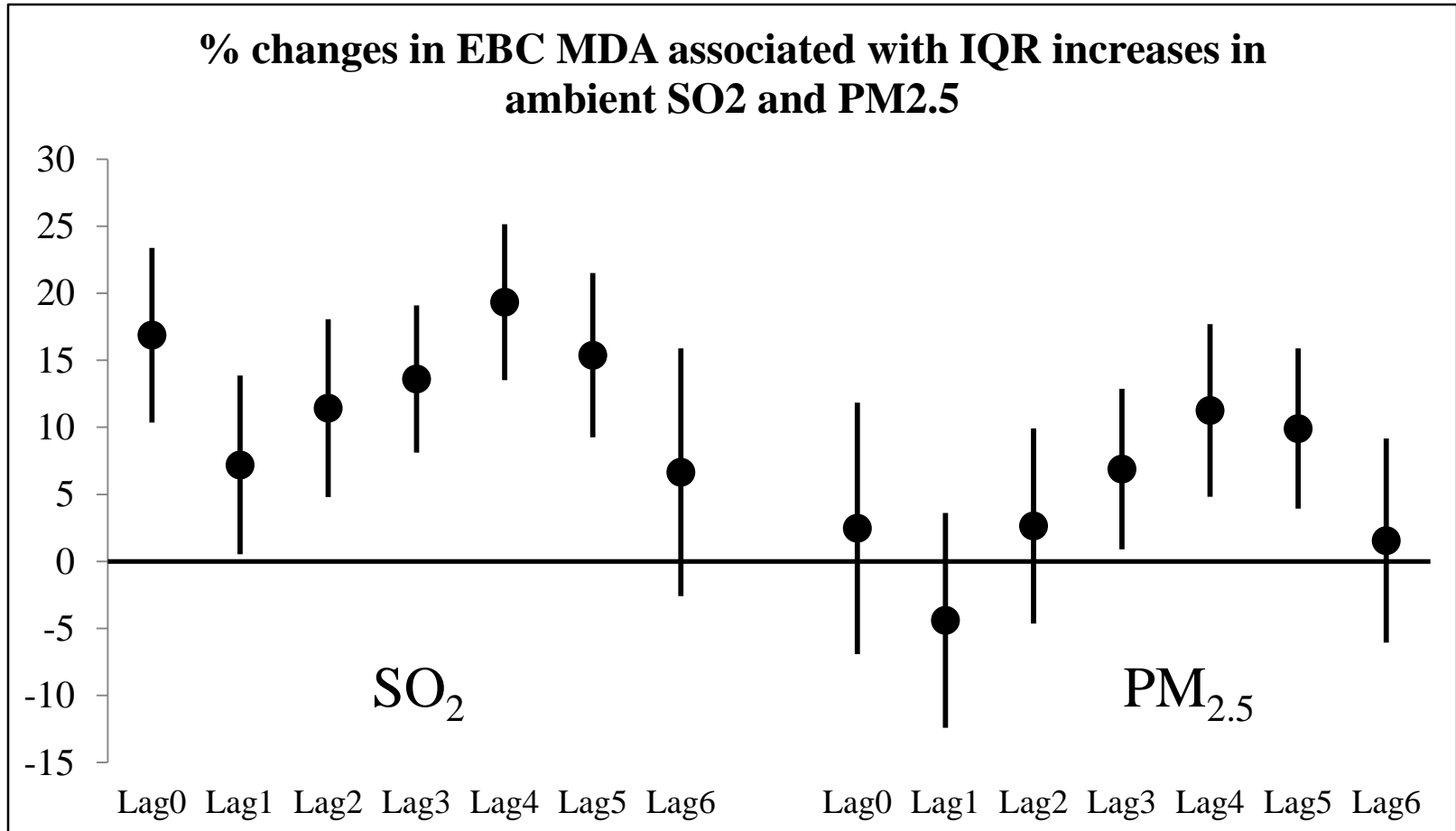


Pups at 3 or 8 wks  
old (male + female)



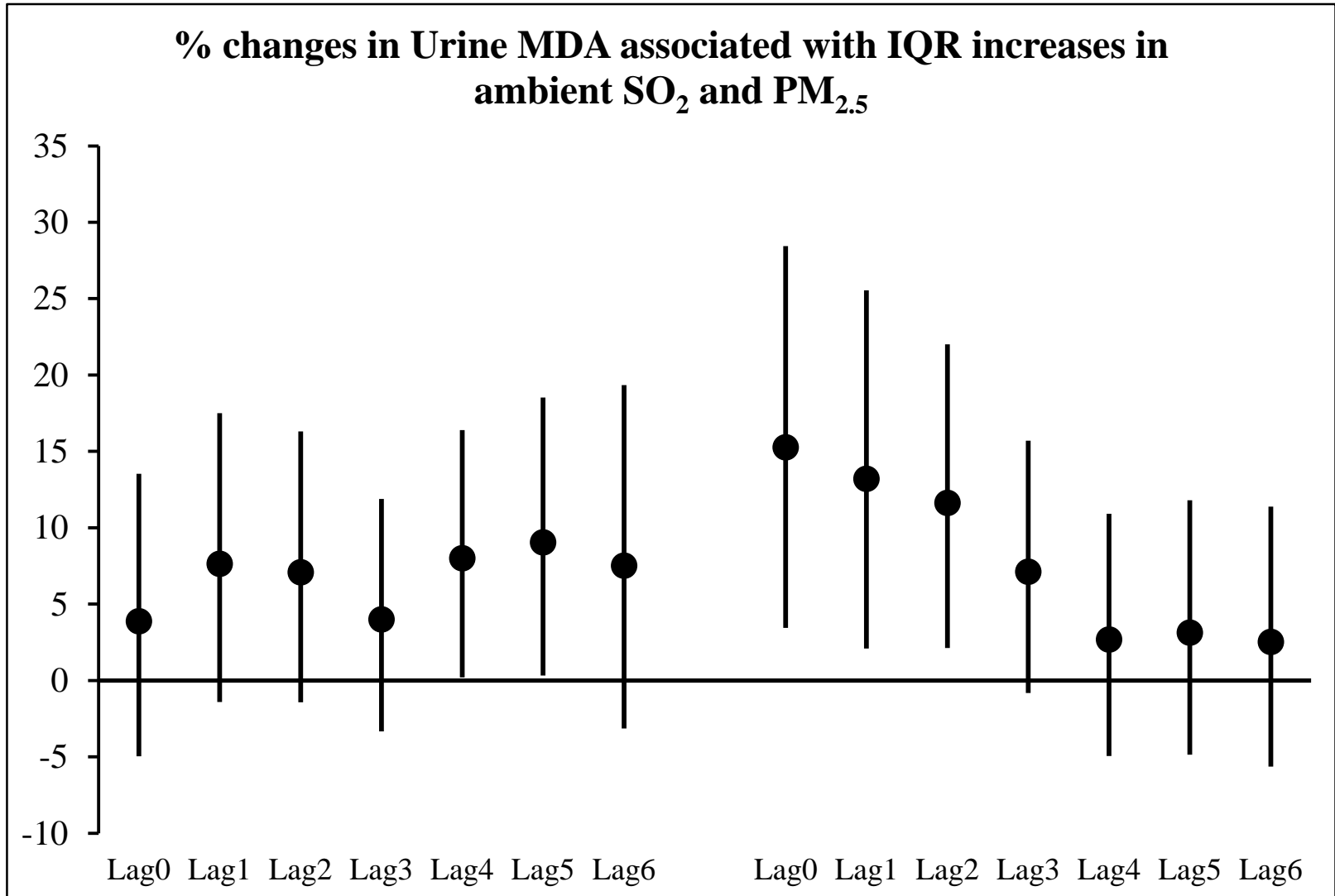
# Biomarkers of physiological response / pathway

## MDA: Beijing Olympic study



# Biomarkers of physiological response / pathway

## MDA: Beijing Olympic study



# Biomarkers of physiological response / pathway

## 8-hydroxy-2'-deoxyguanosine (8-OHdG)

- Analyzing methods



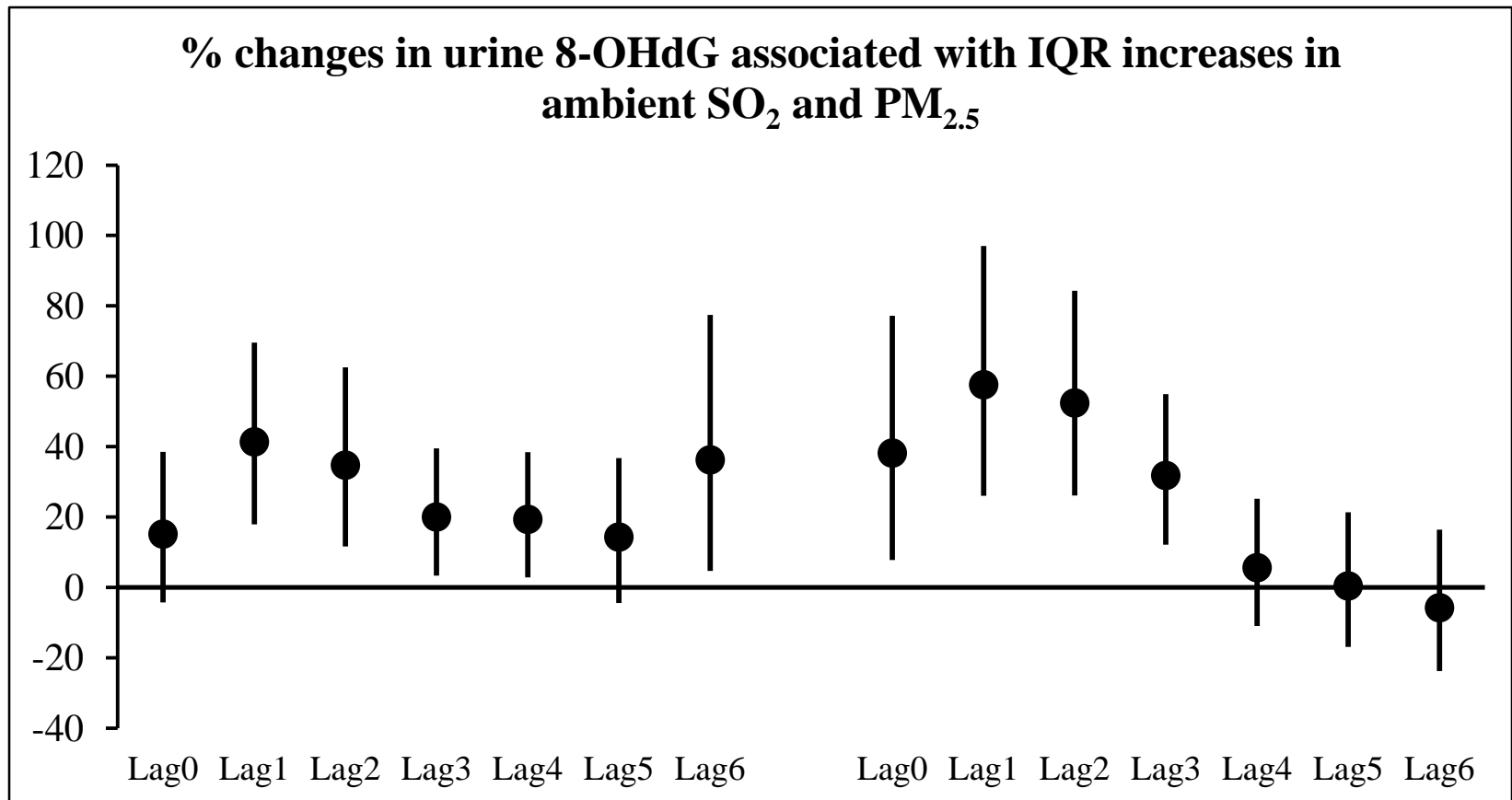
- Easy to perform
- Non-specific
- Lower reproducibility

- Specific
- Sensitive
- Possible interferences from the biological matrix

- Specific
- More sensitive

# Biomarkers of physiological response / pathway

## Urinary 8-OHdG: Beijing Olympic study



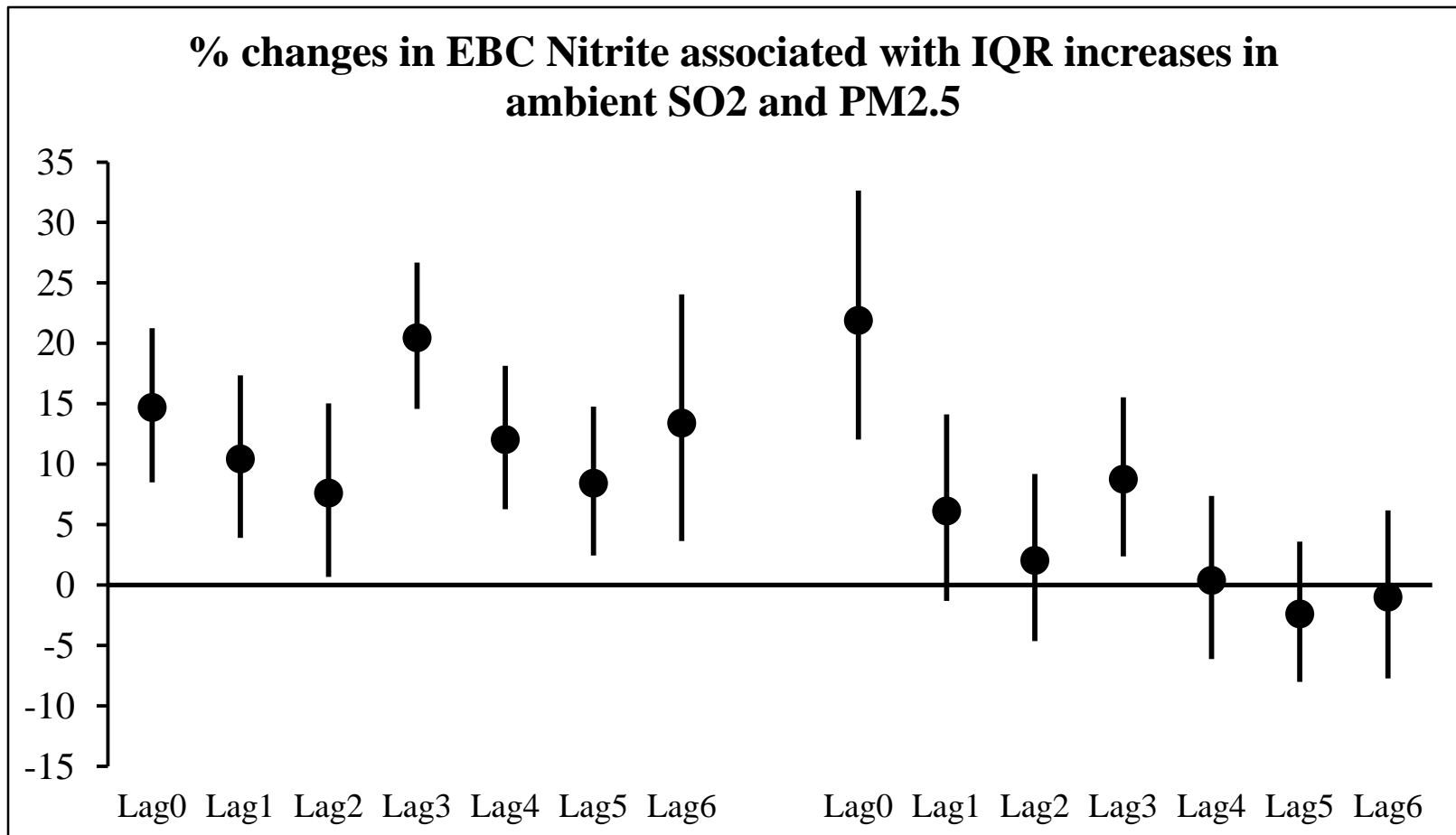
# Biomarkers of physiological response / pathway

## Nitrite

- HPLC-UV
  - Sensitive
  - Reproducible
  - Easy to perform (no pretreatment required for exhaled breath condensate and BALF samples)

# Biomarkers of physiological response / pathway

## Nitrite: Beijing Olympic study



# Thank you

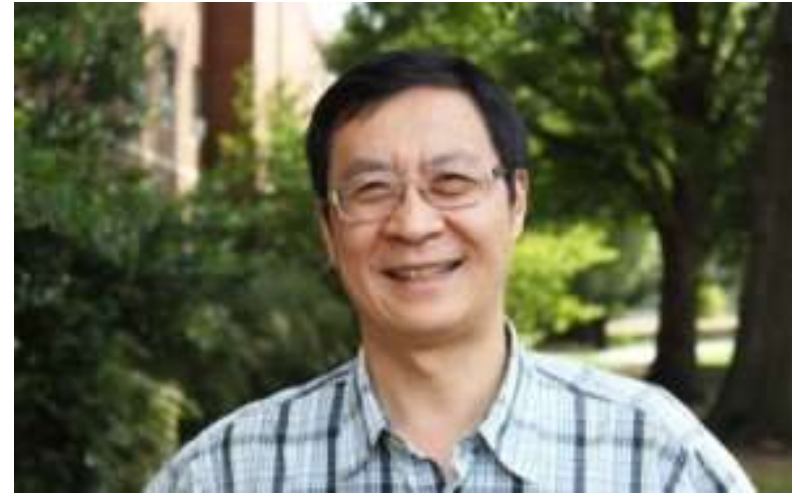
Jake Chung



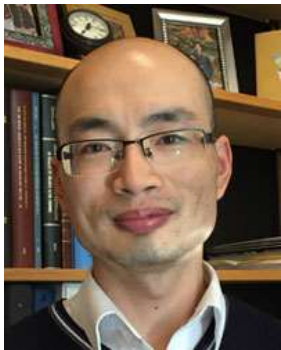
Xiaoxing Cui



Marlyn Duarte



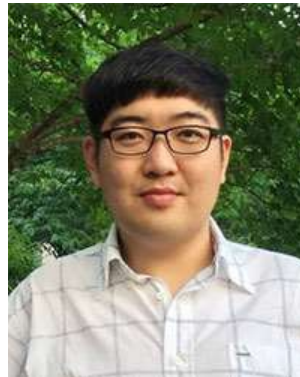
PI: Junfeng (Jim) Zhang



Mingquan Li



Drew Day



Hailong Han



Jicheng Gong



Linchen He