Personal Monitoring Needs for Ozone Exposure Assessment and Health Effects Evaluations

June 26, 2018

George D. Thurston, ScD.
Professor
NYU School of Medicine
Topics of Discussion

• Past Ozone Monitoring in Health Effects Studies
• Personal Exposure Assessment Challenges using Central Site Monitoring
• Future Performance Needs, from a Health/Air Pollution Epidemiology Perspective
Limitations in Past Central-Site Ozone Exposure Estimation for Population-Based Health Effects Studies

• Limited number of sites outdoors (e.g., 4 in DC)
• Quenching near NO Sources (e.g., Traffic): [NO + O₃ → NO₂ + O₂]
• Rooftop locations
• Differences between Indoors and Outdoors due to Ozone’s high reactivity
Population Studies Were Informative, but Limited To Citywide Rooftop O₃ Avg. Exposures

**Figure 4.** New York City, New York, race-specific relative risks (based upon the maximum minus mean increment) and their 95% CI for hospital admissions outcomes.

**Figure 6.** White and nonwhite O₃ relative risks (based upon the maximum minus mean increment) and their 95% CI for respiratory hospital admissions by insurance status in New York City, New York.

Outdoor Concentrations Differ
Indoor vs. Outdoor, High vs. Low Traffic

FIG. 5. TOTAL OXIDANT CONCENTRATIONS OUTSIDE AND INSIDE AN AIR-CONDITIONED HOSPITAL (from ref. 13)

Heuss, Kahlbaum, and Wolff

![Graph showing outdoor concentrations for different days of the week with labels for Sunday and Saturday.](image)

(Expressed as ozone, 1 ppm = 21.4 μg/m³)

Figure 1. Average hourly O₃ concentrations vs. day of week for Los Angeles CMSA monitor 060371701 (Pomona), 1997-1999 O₃ seasons.
Outdoor Concentrations Differ With Height of Measurement

Fig. 6. Comparison of O₃ data, daily 1-h maxima, 2001.

Outdoor Concentrations Vary Widely Spatially and Over Time
Field Panel Studies Helped Reduce Exposure Misclassification
The Fairview Lake, NJ Study Found Lung Function Decreases Even With Ozone Levels Below the 1-Hr. Legal Limits, and With Larger Impacts than found in 1-hr. Exposure Chamber Studies.
Daily Asthma Attacks in Children Increase as Pollution Levels Rise

(Thurston et al., JRCCM 1997)
Personal Health Measures Have Also Improved Over Time

<-- THEN: Mechanical Peak Flow meters

NOW: Shirt Measurements ->
- ECG & Heartbeat monitor (HRV), and Heart Rate Recovery
- Breathing Rate (RPM), Minute Ventilation (L/min)
- Activity intensity, peak acceleration, steps, cadence, positions and sleep tracker
- Bluetooth connectivity
Portable Ozone Monitoring Options, Each with Advantages and Disadvantages, Include:

- Electrochemical Ozone Sensor Systems
- UV Absorption Monitors
- Heated Metal Oxide Sensor Cell (HMOS)
- Badge/strip
Ozone Monitoring Performance Needs for the Next Generation of Health Studies at the Personal Level

**Technical Performance Aims**

- Meet Federal Reference Method Equivalence Req’mts*
- Short time resolution (e.g., 1 minute to 1-hr)
- Minimal Indoor HC, NO$_2$, or Humidity interferences (e.g., many aromatic compounds absorb 254-nm UV light).
- Low Minimum O$_3$ Detection limit (e.g., down to below ambient background levels, <10 ppb).

* e.g., 2B POM in Federal Register / Vol. 80, No. 165 / Wednesday, August 26, 2015
Ozone Monitoring Performance Needs for the Next Generation of Health Studies at the Personal Level

*Health Research Performance Aims*

- Convenient portability and reasonable cost (e.g., < $1000 per unit)
- Long battery life, easy recharge
- Synchronous Geospatial Info (e.g., with Smartphone)
- Integration with continuous digital personal health metric monitoring (e.g., respiratory and cardiac), rather than only once or twice per day health data.