What Is The Relationship Between Personal Exposure And Ambient Fixed Site Measurements?

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Background

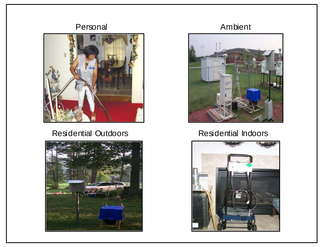
- Previous epidemiology studies linked adverse health effects with PM levels measured at a fixed site community monitor.
- However, there was very little information about relationship between PM as measured at a community monitor and actual personal exposure.
- People spend the majority of their time indoors and it is not clear how well PM, or its components, penetrate indoors.
- There is also little previous information as to whether the behavior of subpopulations susceptible to PM may also alter their exposure to this pollutant.

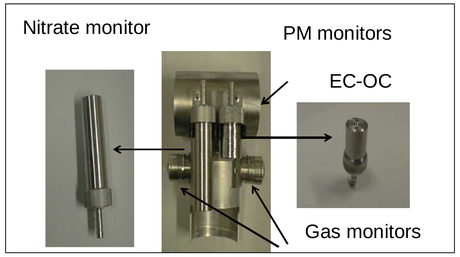
Research Goals

- Describe the magnitude and variability of the relationships between personal exposures, residential indoor, residential outdoor, and ambient-based measurements.
- Quantify personal exposures and residential exposures for PM/gases in susceptible populations.
- Examine the inter-and intrapersonal variability of the relationships for PM and gases.
- identify and model the factors that contribute to the inter- and intrapersonal variability in the spatial relationships.
- Determine the contribution of ambient concentrations to indoor air/personal exposures for PM/gases.
- Examine the effects of airshed (location, season), population demographics, and residential settings on the resulting statistical relationships

Methods/Approach

Coordinated human exposure field studies in Baltimore, Fresno, Atlanta, Boston, Los Angeles, Seattle, New York, Research Triangle Park were conducted. These longitudinal panel studies involved personal, residential and ambient particulate matter and criteria gas pollutant monitoring. The following pictures document sampling at the personal, residential indoor, residential outdoor and ambient levels.



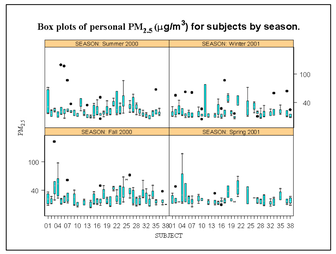


In some instances, new personal exposure monitors, like Harvard's Multipollutant Personal Sampler had to be developed to meet the study design. These samplers were used by both Harvard and the University of Washington research teams and permitted simultaneous PM and criteria gas pollutants to be measured.

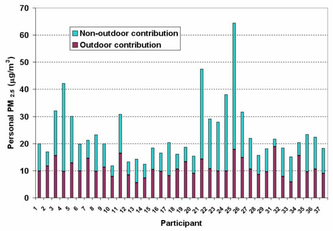
Results

Site	N (Personal)	Personal	Indoor	Outdoor
Raleigh/Chapel Hill	712	23.0	19.1	19.3
Atlanta--Fall	141	16.6	14.3	14.7
Atlanta--Spring	142	15.0	19.8	22.0
Boston--Winter	55/47	17.6/12.5	10.4	11.4
Boston--Summer	63/31	9.4/12.0	12.7	12.8
Los Angeles--Winter	87	19.6	16.9	13.5
Los Angeles--Summer	92	25.1	18.1	19.3
Seattle--COPD	307	10.5	8.5	9.2
Seattle--healthy	183	9.3	7.4	9.0
Seattle--CHD	325	10.8	9.5	12.6
Seattle—asthmatic kids	263	13.3	9.2	11.3
Baltimore retirement home	325	13.0	10.0	22.0
Fresno retirement home	120	13.3	9.7	20.5

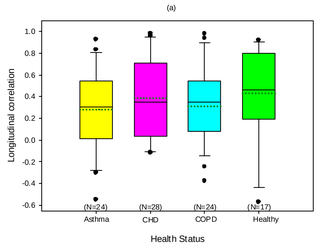
Panel studies were performed from 1998 to 2003 with variations of location, subpopulation and season



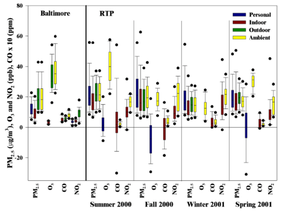
Data from the RTP studies indicated that personal PM2.5 exposures could be highly variable



Sulfate proved to be a useful marker in identifying the contribution of ambient PM to Total personal PM2.5 exposures



Disease state of Seattle participants was shown to have little impact on PM mass relationships



Gaseous co-pollutants of data from Baltimore and the RTP were not observed to be confounders of PM2.5 mass. Similar results were often observed in the others cities

Conclusions

- Successful data collection on a variety of sensitive subpopulations in a number of highly variable geographic settings,
- The collection of a total of 15,000 personal, residential indoor, residential outdoor and ambient-based PM mass measurements,
- Recruitment of more than 200 participants and 4000 total days of exposure monitoring.

- Results indicated relatively little difference in personal exposures between healthy and disease cohorts.
- Mean $PM_{2.5}$ personal exposures ranged between 9 and 23 µg/m^3; mean indoor ranged from 7.4 -20 µg/m3 , and mean outdoor concentrations were 9 to 22 µg/m^3.
- Median longitudinal correlations of personal PM2.5 exposures with outdoor measurements ranged from 0.1 to 0.65.
- Even so, all study groups showed some individuals with very high correlations indicating the impact of activities and household factors upon this correlation.
- $PM_{2.5}$ infiltration factors ranged from 0.4 to 0.5 during heating season and 0.45 to 0.79 during non-heating seasons.
- The contribution of PM of ambient origin upon total personal exposure was often on the order of 50%.

Future Directions

- The assemblage of a combined dataset from all of the studies and release of this dataset to the scientific community at-large,
- Performance of source apportionment on the collected speciation data and characterization of the source impact upon residential and potentially personal settings,
- Evaluation of environmental and human exposure factors that will provide guidance on future research designs to reduce the uncertainty of using ambient-based measurements in population-based health studies

Impact and Outcomes

- Determined that health status might not be a primary factor in relation to total personal $PM_{2.5}$ exposures and therefore potentially less of a consideration in the establishment of future standards.
- Determination that the ambient routinely contributes less than 50% to an individual's total personal PM exposure and that indoor sources such as cooking generated aerosols can be large overall contributors,
- Ambient-based $PM_{2.5}$ sulfate concentrations were highly correlated to both indoor and personal sulfate concentrations and thus appears to be a useful marker in establishing ambient PM contributions to other settings
- The development of a large number of peer-reviewed findings from the various studies were crucial to defining the current state of the science in the US EPA's 2004 National Ambient Air Quality Particulate Matter Criteria Document

Data collected from these studies are being used to develop PM human exposure models needed to reduce the uncertainty of current risk assessments

Health and Exposure