Are Aging Adults at Risk from Exposure to Environmental Stressors?

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Contributing Organizations: NERL, NHEERL, NCEA, Office of Children's Health Protection and Environmental Education

LTG 3 Poster 09

Science Questions

Why be concerned about the aging population? Aging adults are the fastest growing segment of the population. In contrast to children, aging-related susceptibility has received relatively little attention in regulatory decision making.

What would make aging adults more susceptible? Aging involves an increase in frailty, a decrease in repair or compensatory mechanisms, and changes in activity patterns. At the same time variability typically increases between (and within) individuals.

Do we have enough evidence? Research on the exposure and effects of particulate matter and waterborne pathogens demonstrate the susceptibility of older adults. For the vast majority of environmental stressors, however, there is little information on exposure and susceptibility in older adults.

What data do we need? An integrated approach to aging-related changes in exposures, activity patterns, toxicokinetics and health outcomes.

Research Goals

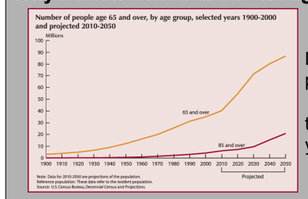
The goal of this ORD-wide research program is to:

- **Conduct research to understand environmental health hazards that affect older adults.**
- **Translate research findings into practical public health prevention strategies.**
- Reduce uncertainties and characterize variability surrounding the exposures of older adults to environmental stressors and the health effects resulting from exposure.
- Define physiological parameters and biological mechanisms of aging-related susceptibility.
- Develop biologically-based quantitative models of susceptibility for EPA's regulatory offices to use in setting exposure standards, including population variability and multi-organ physiological models.
- Provide the scientific basis and technical support for educational outreach activities to raise public awareness of the environmental threats to older adults and promote healthy environments for the aging population.

Findings and Conclusions

- **Our knowledge of susceptibility in aging adults pales in comparison to the size of the US population that is > 65 years old.**
- **Aging-related changes in activity patterns and physical activity can affect environmental exposures.**
- **Aging-related physiological parameters are needed to link environmental exposures to internal doses.**
- **There are strong indications aging adults are at greater risk than young adults for adverse health effects from environmental stressors.**
- **ORD provides leadership in raising public awareness and assessing the risks of environmental exposures to older adults.**

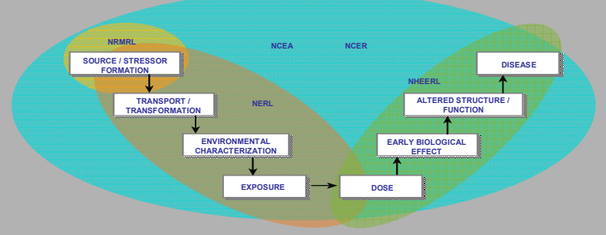
Why be concerned about the aging population?



Demographic imperative: The US and world populations are aging:
"By 2100 there is a 50% probability that one third of the world's population will be 60+ years of age. (Lutz et al., 2008)

- Legislative imperative: EPA is mandated to protect the most susceptible among us
- Considerable attention has focused on protecting the health of children. Much less is known about the susceptibility of the aging population.
- Susceptibility: Can we sufficiently characterize the determinants of variability and sensitivity due to lifestage-specific processes to ensure that risk assessments adequately protect all segments of the population?
  - What are the key factors that contribute to variability in environmental exposures and responses to those exposures?
  - What is the variability present in the older adult population? Can we characterize that variability?
  - Which older adults?

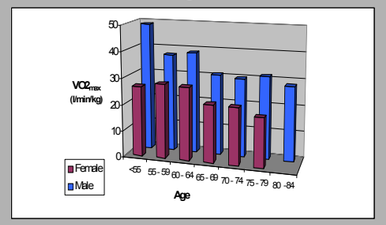
What would make aging adults more susceptible?



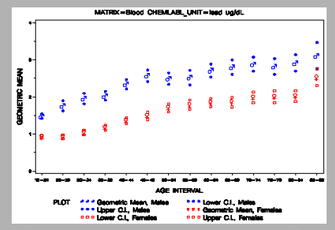
- Where are older adults living and what are the important pollution sources in those locations?
- What activities are older adults engaged in that bring them into contact with these pollutants? Where do older adults spend their time? How does that activity affect physiological processes?
- What happens to those contaminants inside the body? What are the target tissues? What are the determinants of tissue dose and clearance?
- What are the critical adverse health effects and adverse outcomes?
- How do we integrate information across this continuum, across biological scales and targets?

Methods/Approach

Do we have enough evidence?



Decreases in $VO2_{max}$ with age must be accounted for in air pollutant exposure modeling.



Five-year age interval plots for NHANES 1999 – 2002 blood lead concentrations show increasing body burden with age.

At risk. Studies with elderly volunteers have shown that slight changes in out door particle levels can change heart rate variability.

ORD sponsors environmental health research on older adults in the Human Health program and as part of the Air research program and through Science to Achieve Results (STAR) grants.

Databases for Lifestage Physiological Data

- Early Development: Developing rodents http://www.epa.gov/comptox/parameters.html
  - Childhood: http://rsi.ilsi.org/Projects/Physio_Parameters_db.htm
- Adult lifestage: humans and laboratory animals (not yet released)
- Aging lifestage: http://www.epa.gov/aging

Literature-Based Environmental Stressor Outcome Information for Older Adults

Stressor	Reported Outcomes
Particulate Matter ($PM_{2.5}$, PM_{10}, aerosol)	Pulmonary inflammation; Chronic obstructive pulmonary disease (COPD); CV disease; Asthma; Mortality
Criteria Pollutants (O_3, NO_2, SO_2, CO)	Reduced pulmonary function; Heart rate variability; Eye, airway irritation; Mortality
Environmental Tobacco Smoke	Chronic respiratory symptoms; Respiratory infection; CV disease; Stroke; Asthma exacerbation
Volatile Organic Compounds (VOCs)	
Trichloroethylene	Kidney disease
Benzene, toluene, formaldehyde	Acute respiratory disease; Neurobehavioral effects
Metals	
Lead	Decline in cognitive function; Impaired renal function; Increased blood pressure/increased risk of hypertension; Hyperuricemia and gout
Cadmium	Decreased bone density; Renal tube damage
Mercury	Peripheral nerve damage (no association with dementia or other measures of cognitive function)
Water and Foodborne Pathogens	
Viral (Norwalk-like, hepatitis A, rotavirus, caliciviruses)	Vomiting with fever and diarrhea
Bacterial/Parasitic: E. Coli O157:H7; Vibrio spp, Cryptosporidium	Noninflammatory and inflammatory diarrhea with and without fever and bloody stool
Bioaerosols and Bioallergens	
Allergens	Allergy, asthma, and other respiratory problems
Endotoxins	Potentiates asthma, and other respiratory problems such as emphysema, COPD
Fungi	Endemic mycoses; Infection (filamentous fungi)
Little information was found for persistent organochlorines, pesticides, and water disinfection by-products	

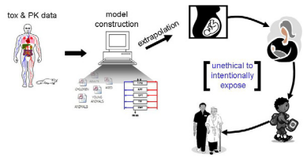
Impact and Outcomes

- EPA has established a cross-ORD research program to address the susceptibility of older adults.
- The Agency has built on its considerable experience with children's risk to define critical areas for investigation of the environmental health of older adults.
- ORD has documented physiological changes with advancing age, and incorporated these into a database to enhance our ability to model how these changes may increase susceptibility to environmental stressors.
- ORD has provided technical expertise to OCHPEE to generate tools for educational outreach that detail what we know about environmental threats to older adults.
- EPA and ORD have established a leadership role in protecting the health of the aging population.

Future Directions

What data do we need?

- Merge separate research efforts on risk during early development, to children, adolescents, younger and older adults into a single program investigating lifespan susceptiblity.
- Provide quantitative estimates of risk at the population level that can be used to identify greater at-risk subgroups.



- Incorporation of Activity, Exposure, and Physiological factors with what we learn about aging-related mediators of susceptibility into full body physiology models to predict effects in susceptible populations.

Contributors

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Susceptible Populations

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