

2011
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International
Society of
Exposure Science
Annual Meeting,
Baltimore

Reflections on the Future of Exposure Science

KR Smith, UC Berkeley

WHAT IS PAST
IS PROLOGUE

The Tempest
W. Shakespeare



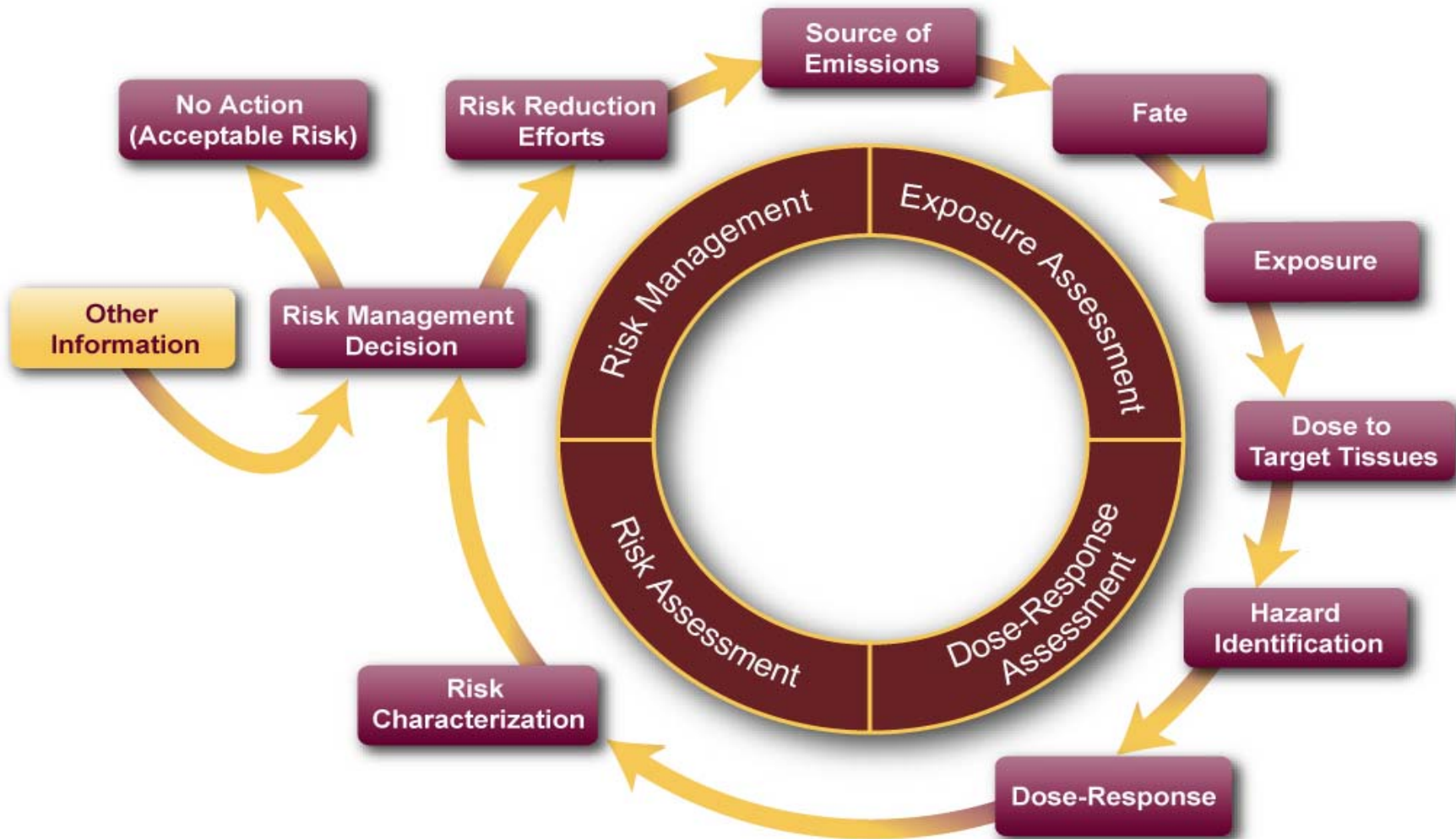
Exposure Science: Protecting Us from Chemical, Physical, and Biological Agents

www.isesweb.org



**Exposure Science Digests:
Demonstrating How Exposure Science
Protects Us From Chemical, Physical, and
Biological Agents**

Human Health Risk Assessment and Management



What Is Exposure Science?

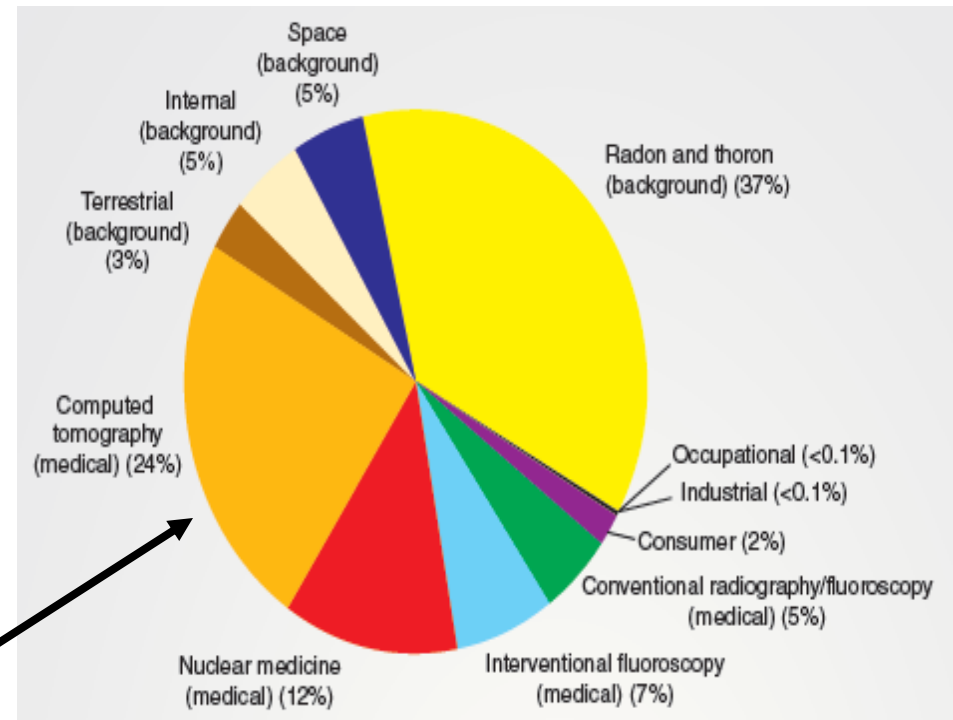
- The bridge between the sources of chemical, physical and biological agents and human health
 - Provides crucial information to estimate real-life risks to health and to identify the most effective ways to prevent and reduce these risks.
- JESEE series provides 10 short but concrete case-studies of the success of applying exposure science or the problems of not doing so.

Better Radiation Exposure Estimation for the Japanese Atomic-Bomb Survivors Enables Us to Better Protect People from Radiation Today

- Knowledge of dose-response crucial to protection
- Better exposure assessment has been key

Medical exposure of US population to ionizing radiation now half of annual exposures

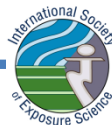
Sources of Radiation Exposure to the US Population



Cullings & Smith, JESEE 20:575, 2010

Atomic-Bomb Survivors have provided largest, best studied, cohort of radiation health effects

- Ongoing innovations in exposure assessments of Japanese atomic-bomb survivors continue to improve radiation health effect estimates – 120,321 in database
 - Better estimates of bomb emissions
 - Good questionnaires of population when event was fresh
 - Spatial modeling of location of each person in relation to bomb including trees, buildings, etc.
 - Effect of personal behavior: how each was standing, clothing worn, what they ate for breakfast
 - Biomarkers: e.g., chromosomal aberrations and carboxyl radicals in teeth
 - Cross check with physical exposure markers in pavement, walls, etc. around each person
 - Integrated modeling of all the above
- Result is that radiation is one of the best understood environmental health stressors – because of exposure assessment



Superfund: Is It Safe to go Home?

- 1980 Superfund law directs EPA to clean up abandoned hazardous waste sites.
- Estimate: 1 in 4 Americans lives within 4 miles of Superfund site; approx. 10 million under 12 years old

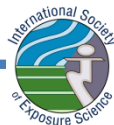


Lioy & Burke. JESEE 20:113, 2010

Superfund: Is It Safe to go Home? (2)

- Superfund law does not effectively address exposure of residents near sites
- Conversely, exposure science results are essential to
 - Prioritize listed sites based upon those that pose the highest risks
 - Develop effective cleanup plan (e.g., water, air, house dust?) that prevents future exposures
 - Determine whether the clean up actually has reduced the potential exposures and risks sufficiently to go home safely
- Exposure science results can be used to effectively protect public health at lowest possible cost

Lioy & Burke. JESEE 20:113, 2010



Out of the Frying Pan and Out of the Fire

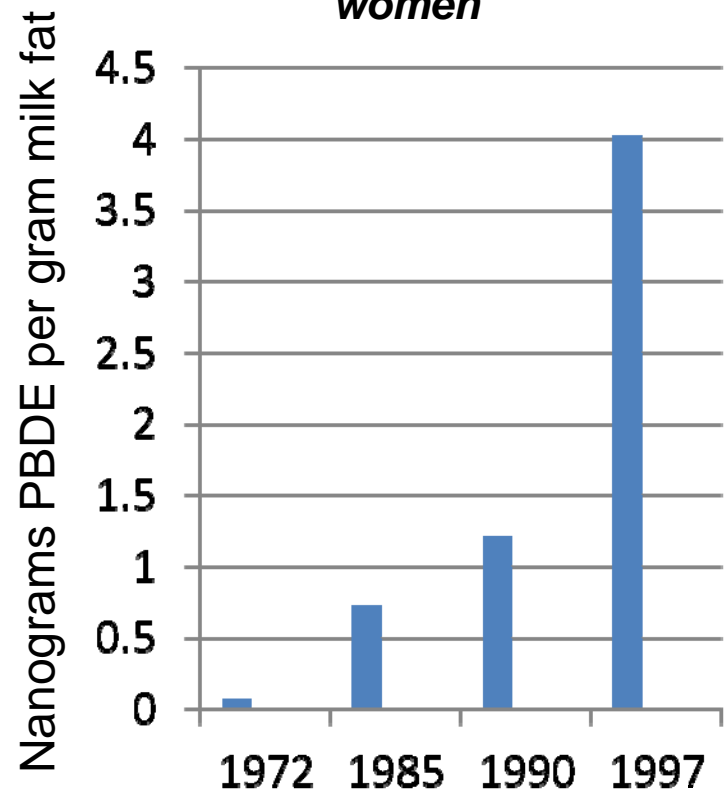
- Many laws and consumer demands lead to reduction or ban of chemicals, but their function is still needed
- Which is riskier: the “banned” chemical or the “replacement” chemical?
- We often know more about the banned chemical
- Exposure science indispensable to avoid unwanted exposures to replacement chemicals
 - We may go out of the frying pan, but we need to stay out of the fire.

Out of the Frying Pan and Out of the Fire (2)

- Flame retardants reduce fire incidence and severity
- One class of retardants (PBDE) was a replacement chemical in the 1970's and widely used until unexpected exposure occurred, resulting in bans and voluntary phase-outs
- Exposure to replacements for PBDEs now occurring
- Need exposure science to be proactive when evaluating replacements to avoid unexpected exposures

LaKind & Birnbaum JESEE 20:113, 2010

Dramatic increase in PBDE flame retardants in breast milk of Swedish women



Protecting Children from Pesticides and Other Toxic Chemicals

- Exposure science breakthrough in 1990's: recognition by policy makers of unique exposures and vulnerabilities of fetuses, infants, and children to many chemicals
- Result: new laws and policies (e.g., Food Quality Protection Act focuses on protecting children)

Boys Bathing in Recycled Pesticide Drum

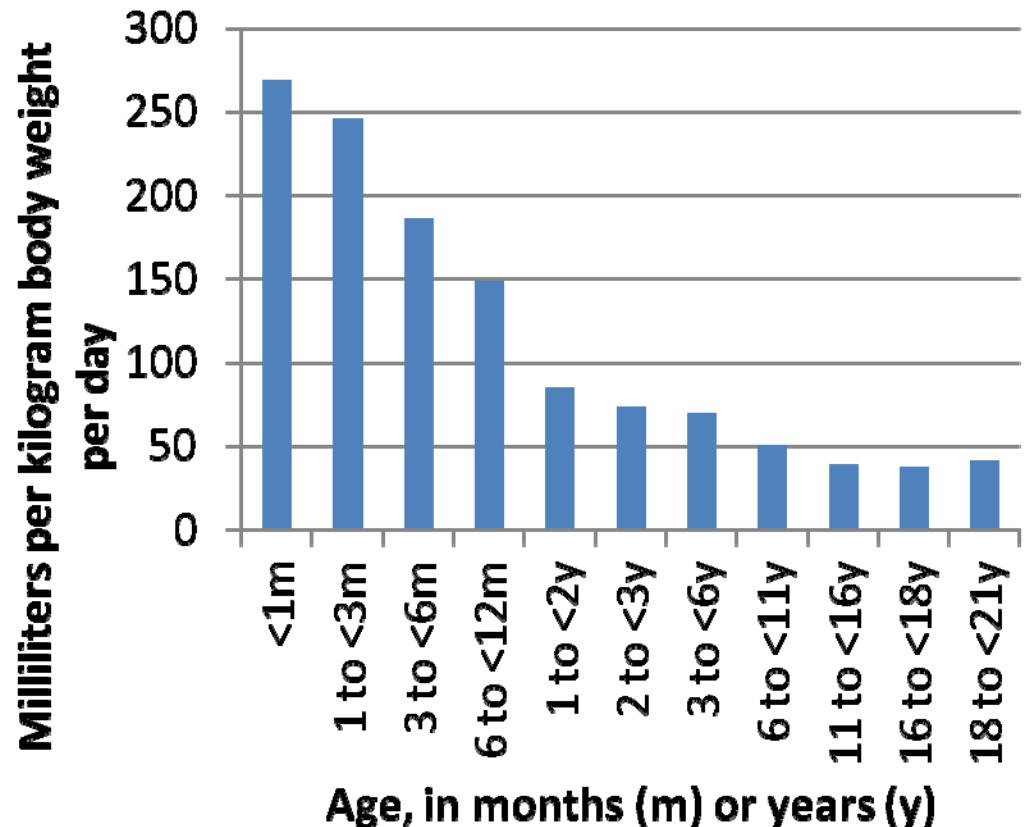


Landrigan & Goldman, JESEE, 21:117, 2011

Protecting Children from Environmental Risks Throughout Each Stage of their Childhood

- Children breath, eat, and drink proportionally more than adults, especially early in life
- Age-related differences in behavior (e.g. hand-to-mouth activity) impact exposure
- Toxicological sensitivity varies by age (from conception up) – thus, important to identify and account for “windows of susceptibility”
- U.S. EPA incorporating lifestage susceptibility into its risk assessments and policies

Total water ingestion (all sources),
95th percentile



MTBE: a Poster Child for Exposure Assessment as Central to Effective TSCA Reform

- U.S. Toxic Substances Control Act (TSCA) being revised by Congress to be more health-protective
- Advanced assessment of all major exposure pathways vital to improving TSCA
- Recent history of MTBE (an oxygenated fuel additive intended to reduce exposures to carbon monoxide and ozone) demonstrates need for exposure science

MTBE: a Poster Child for Exposure Assessment as Central to Effective TSCA Reform (2)

- MTBE legally required based on very poorly founded assumptions about health benefits
- 100 million Americans exposed before adequate knowledge of exposure and health effects available
- MTBE leaked from tanks, contaminating drinking water, with economic & potential health impacts
- Problems could have been avoided if exposure predictions acted upon *before* wide use

Leaking Underground Fuel Storage Tank

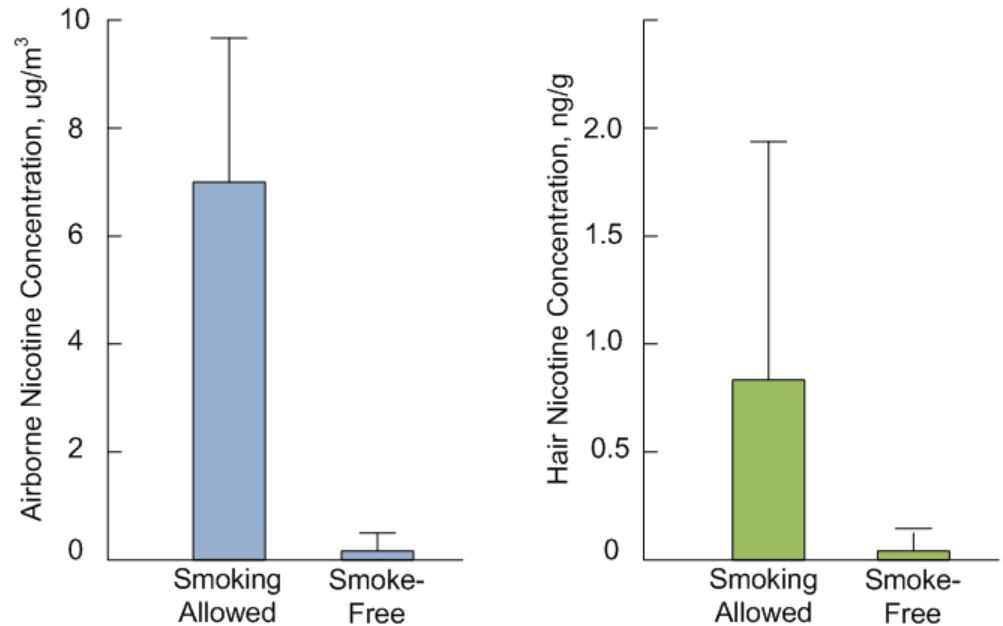


Goldstein, *JESEE* 20:229, 2010

The Smoking Gun: Working to Eliminate Tobacco Smoke Exposure

- Science indicates there is no risk-free level of exposure to second-hand smoke (SHS) (US DHHS, 2006, Surgeon General Rpt)
- Exposure science basic to develop and implement smoke-free legislation around the world (e.g., graphic)

Air nicotine and hair nicotine in non-smoking employees by smoking status of bars recruited in Baltimore before enactment of smoke-free legislation (Median and 75 percentile of the distribution).

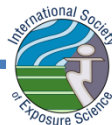


Breyse & Navas-Acien, *JESEE* 20:397, 2010

The Smoking Gun: Working to Eliminate Tobacco Smoke Exposure (2)

- Exposure science shows:
 - Locations (e.g., restaurants, bars, casinos) with elevated SHS levels, providing guidance for behavior and laws
 - Mechanical ventilation systems and separate nonsmoking sections in public places are insufficient to protect non-smokers
 - Personal exposures of the general populace and specific groups, driving policies/laws and allowing evaluation of efficacy of or compliance with exposure reduction actions

Breyse & Navas-Acien, JESEE 20:397, 2010



Exposure Science: Why Does it Matter?

- Exposure information is crucial to protecting health
- Exposure science is required to put hazard data into perspective
- Predictive exposure science is fundamental to identifying emerging trends and preventing and reducing public health risks from environmental agents in the upcoming decades
- Supporting exposure science now will pay major dividends in the future

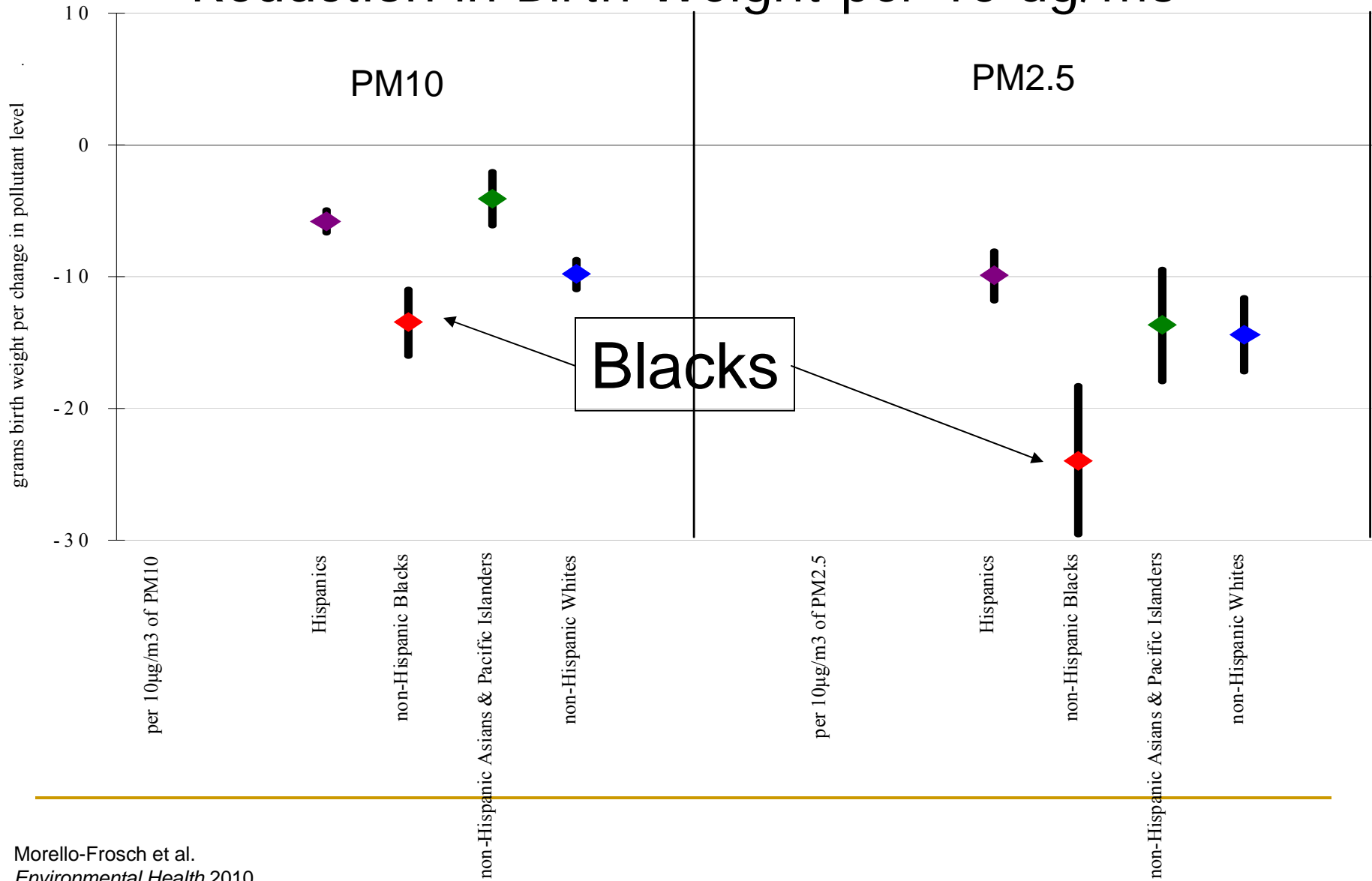
MORE INFORMATION

- The *Digests* which formed the foundation for this presentation are available for free download at:
 - <http://www.nature.com/jes/webfocus/esdigests/index.html>
- Please visit www.isesweb.org for more information.

Personal Reflections*

*Data slides courtesy of Rachel Morello-Frosch

Certain Racial Groups are More Vulnerable Reduction in Birth Weight per 10 $\mu\text{g}/\text{m}^3$



Disparate Impact of Heat-Related Mortality by Race/Ethnicity

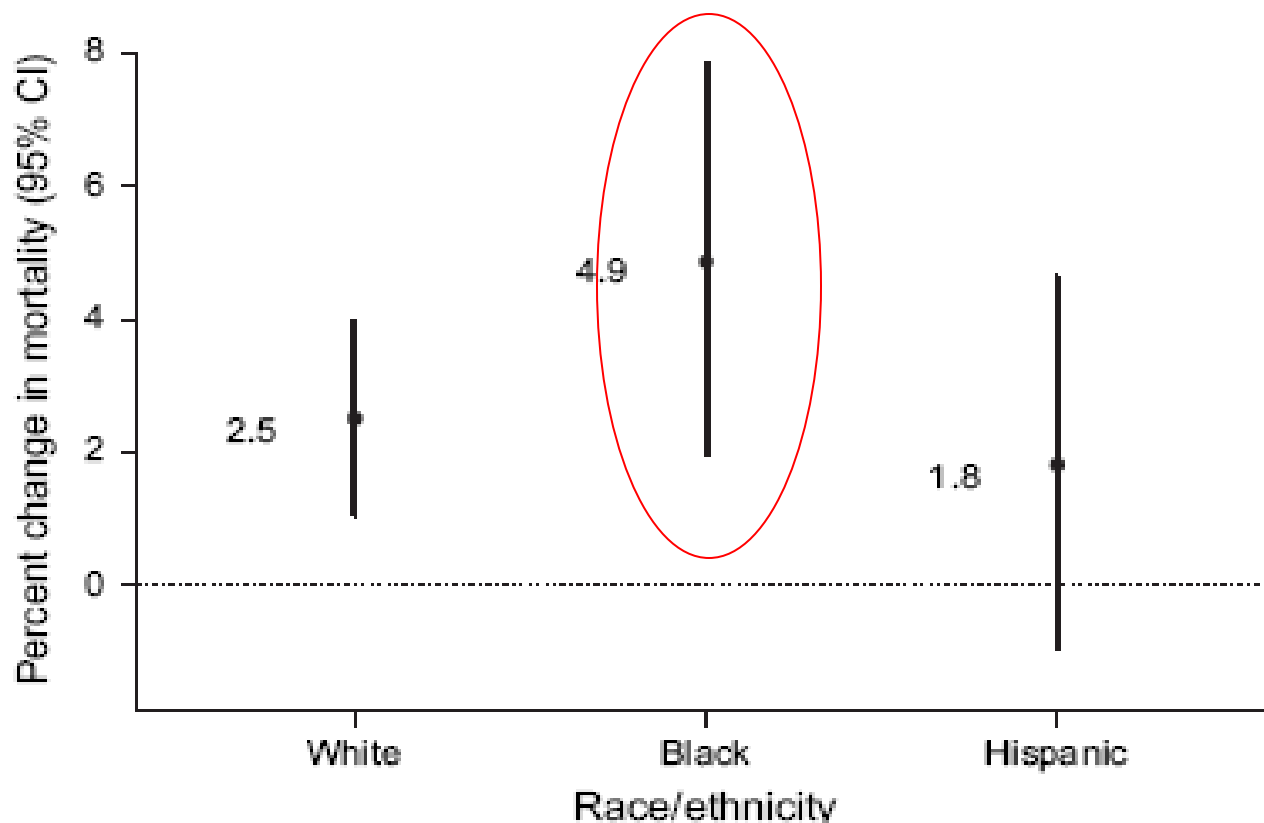
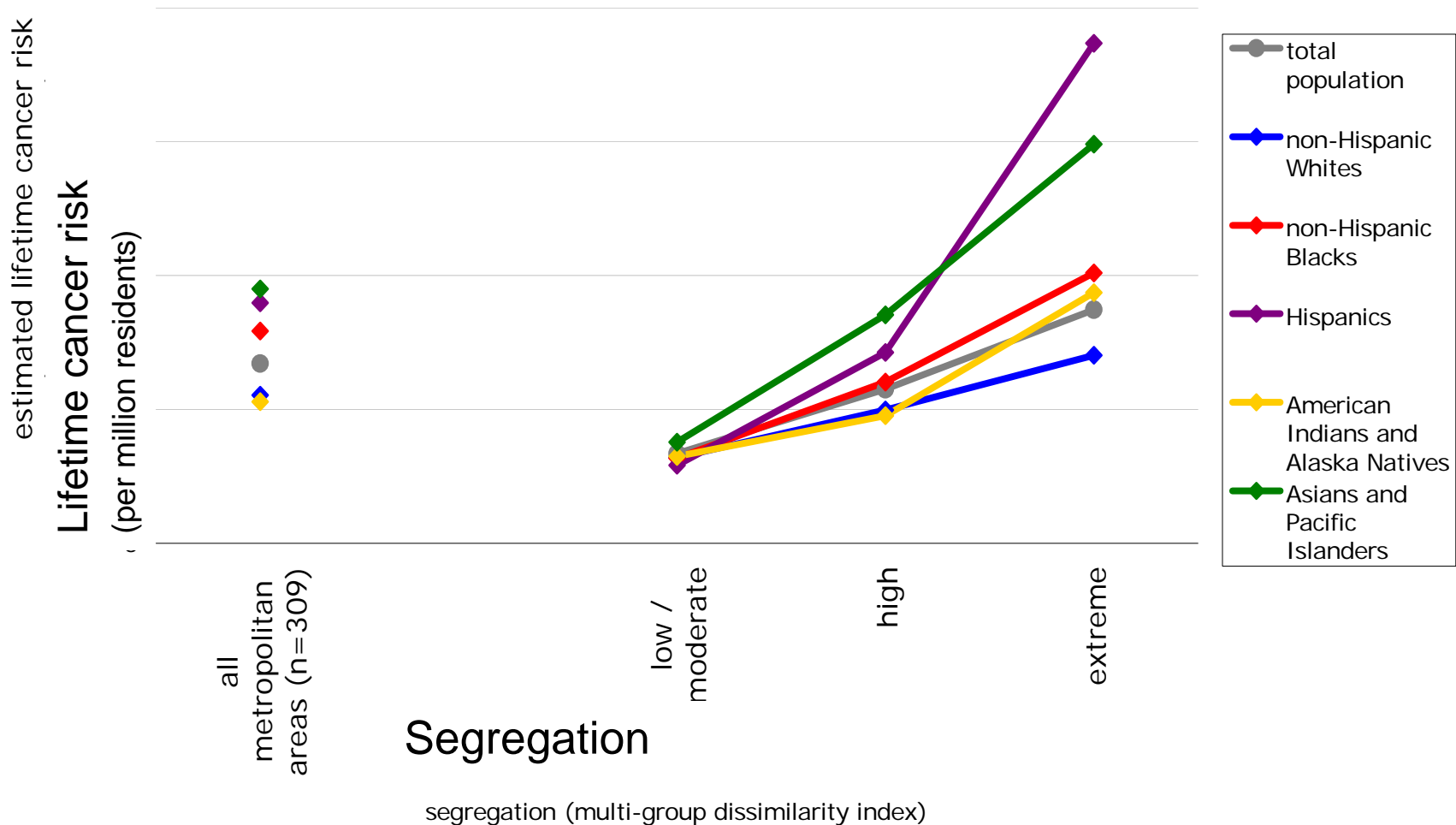


FIGURE 3. Estimated percent change associated with a 10°F (4.7°C) increase in mean daily apparent temperature and nonaccidental mortality by race/ethnic group in nine counties, California, May through September, 1999–2003. CI, confidence interval.

California, 1999-2003

Estimated cancer risk associated with ambient air toxics by race/ethnicity and racial/ethnic residential segregation, continental United States metropolitan areas

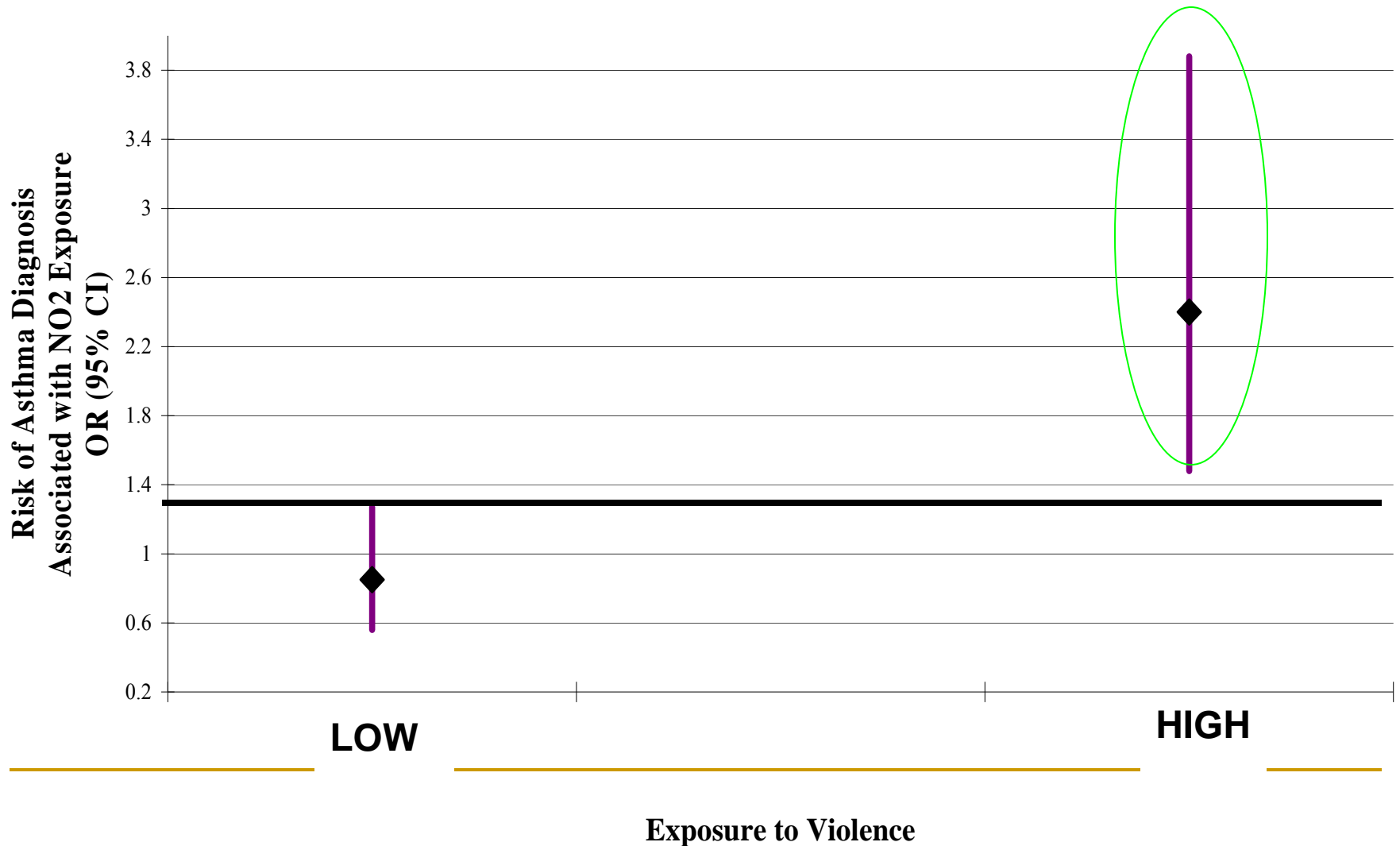


Vulnerability Due to Psycho-social Stress

Effect Modification: Exposure to Violence and Risk of Asthma Diagnosis

Associated with Traffic-Related Air Pollution (NO₂)

(Clougherty et al., EHP 2007)



Principles of Exposure

- Like is like
 - Exposure metrics should be blind to ethnicity, religion, class, status, and wealth
 - Only variation is by age and sex, universally parts of the human experience
 - Only in this way can they be coherent in time and space
 - And the non-stable influences be elucidated
- All places with people are equal: “Measure where the people are”
 - All microenvironments are counted and equally protected
 - No discounting of exposure in special locations, such as indoors
 - Or from special sources, e.g., “voluntary” exposures
 - Or special activities, such as occupations

A man with grey hair and a beard, wearing a dark jacket over a blue shirt, stands in front of a stone wall. The wall features a large, rectangular stone relief with the inscription "WHAT IS PAST IS PROLOGUE". Below the main inscription, there are smaller, less legible carvings. The background is a solid blue color.

**National Archives Building
Washington, DC**

YASNY and Thanks

The Tempest
W. Shakespeare



SCIENCE FOR BETTER ENVIRONMENTAL HEALTH

This presentation and all articles cited from Journal of Exposure Science and Environmental Epidemiology (JESEE) are available for free at www.isesweb.org; for articles click on Exposure Digests