Occupational Health in the 21st Century: Romance, Separation, Counseling, Remarriage

"Rest after Work" Vincent Van Gogh, 1890
Wikipedia.org

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Words of my PhD advisor

"Most occupational and environmental issues are rarely solved, instead they are just revisited every 20 years or so."

To which I would add

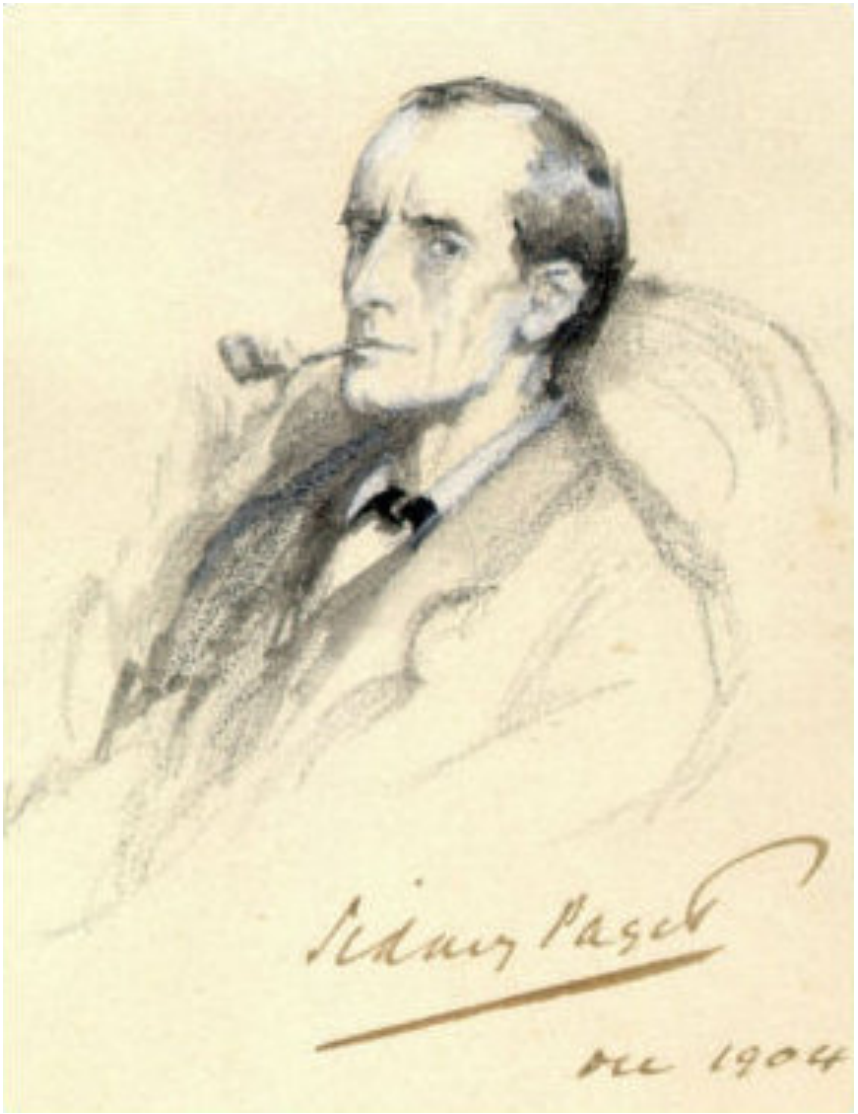
"That's a nice invention, you know they came up with that idea over 100 years ago, right?"

1. Romance

“Colebrookedale by night”
Philip James de Loutherbourg, 1801
Wikipedia.org

The Romance of Occupational Health:

Using science to solve mysteries,
protect others, and render aid



Wikipedia.org

"All things are poison and nothing is without poison. It is the dose that makes a thing poisonous."

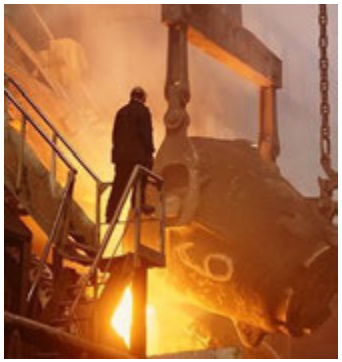
- Paracelsus, 16th Century Pharmacologist

Copy of Quentin Metsys original
Wikipedia.org

Alchemystical Adept (Paracelsus) Lecturing on the Elixir Vitae
David Scott, 1838. Royal Gallery of Scotland

Paradigm of Exposure (Dose) → Response

Exposure Assessment



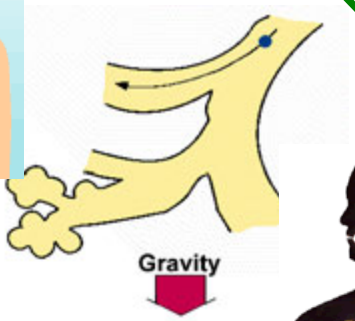
Toxicology & Exposure Biology

Emission

Exposure

Engineering Control & Source Apportionment

Intake



Deposition

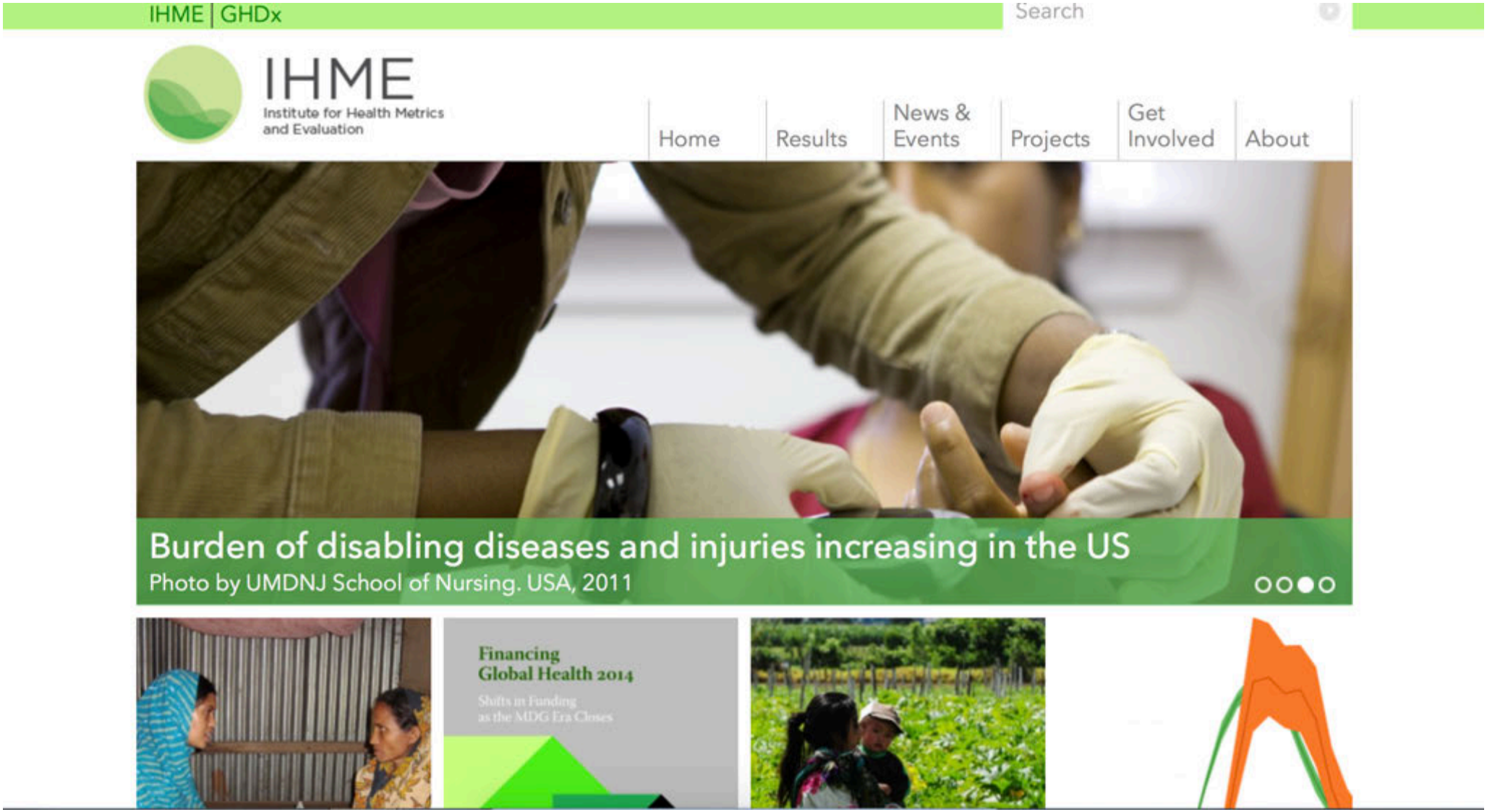
Epidemiology

Dose

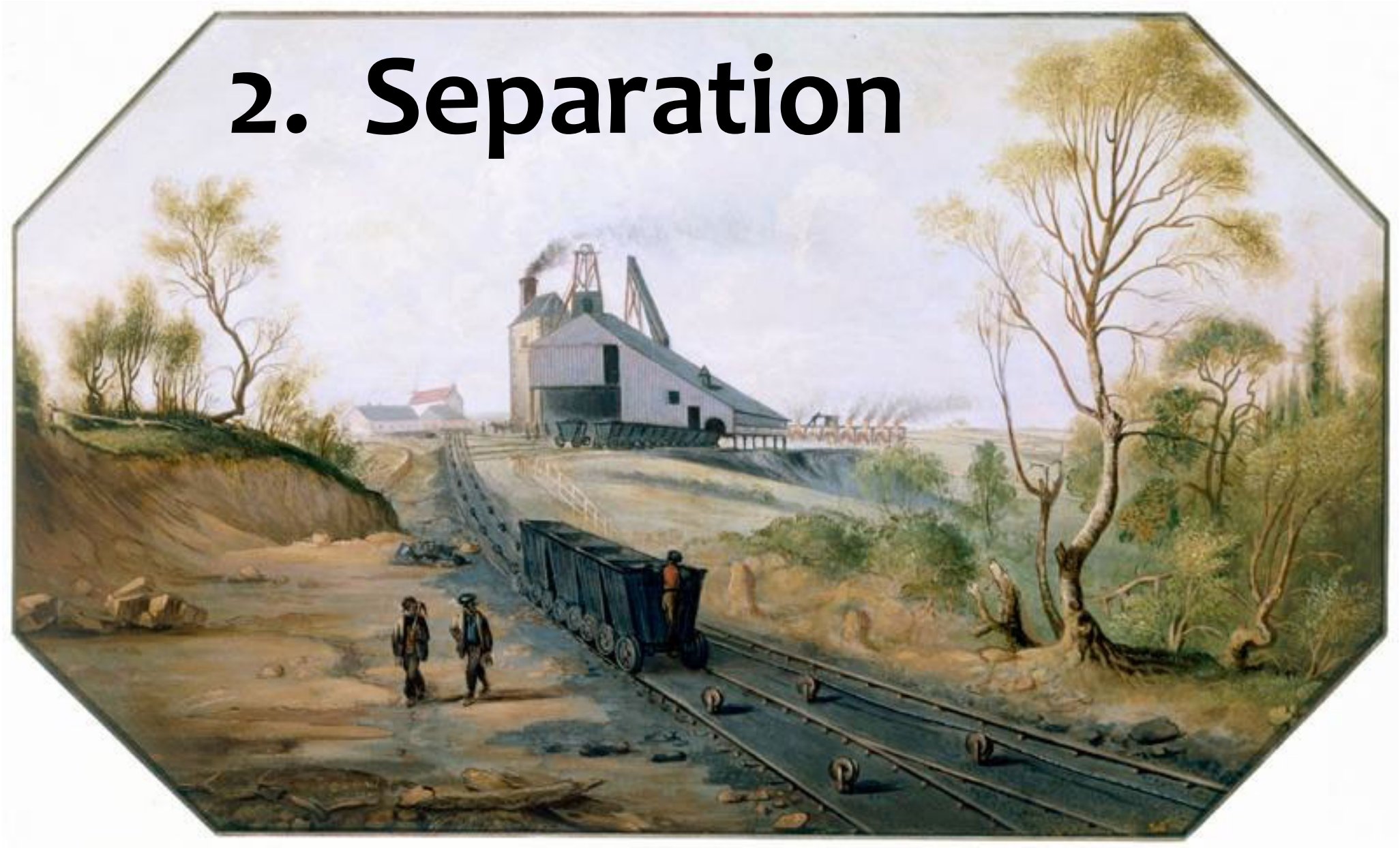
Health Effect

Occupational Medicine

The Global Burden of Disease: Occupational Risk Factors



2. Separation



"Colliery and wagonway, Northumberland and Durham coalfield"
W. Wheldon, 1845

http://blog.sciencemuseum.org.uk/collections/tag/numsciencemuseum1987-510/

par·a·digm

/ˈperəˌdīm/

noun

1. *technical*
   a typical example or pattern of something; a model.
   "there is a new paradigm for public art in this country"
   synonyms: model, pattern, example, exemplar, template, standard, prototype, archetype
   "why should your sets of values be the paradigm for the rest of us?"

There Are Serious Problems with Our Paradigm for Assessing Worker Exposure to Hazards

-Coverage

-Cost

MEASURING DUST EXPOSURE WITH THE THERMAL PRECIPITATOR IN COLLIERIES AND FOUNDRIES

BY

S. A. ROACH*

BJIM 16(4) 1959

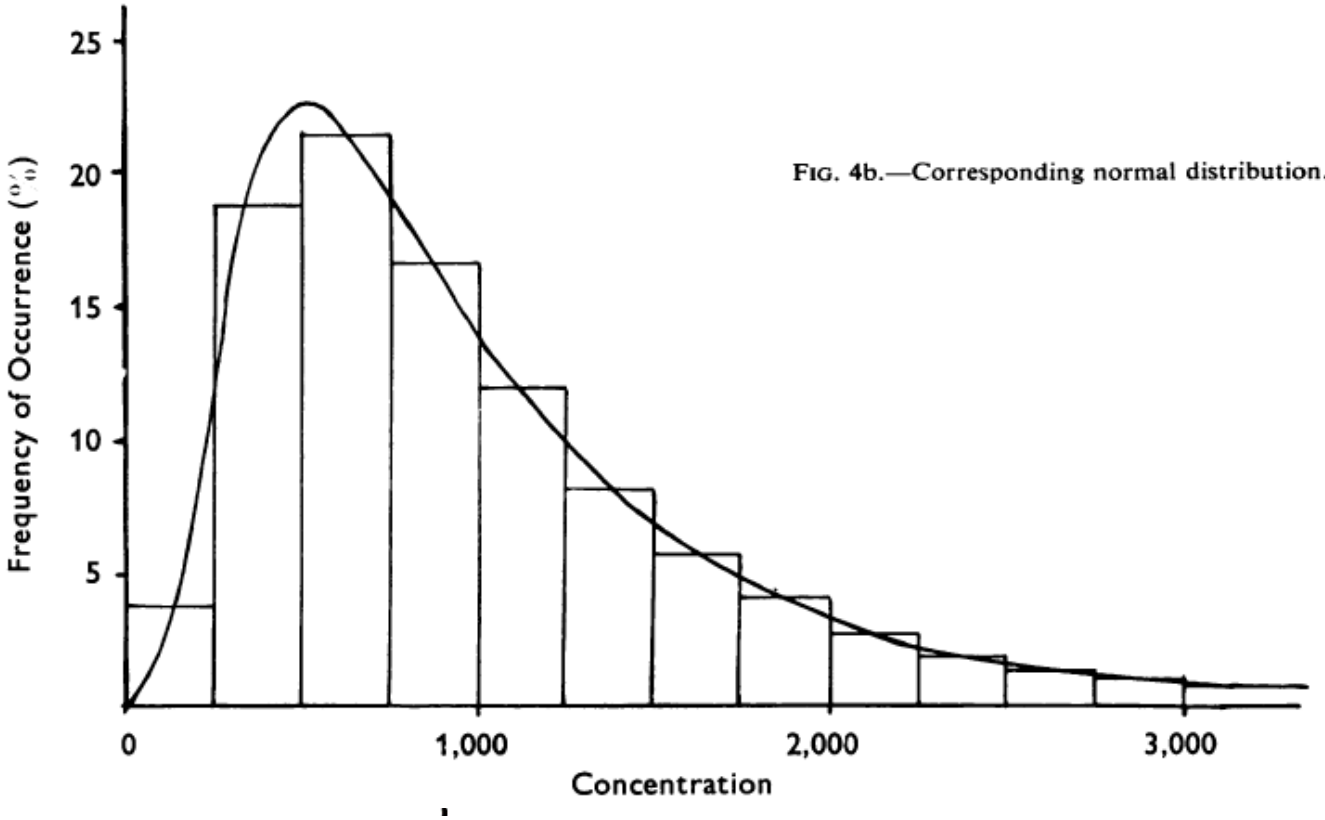


FIG. 4b.—Corresponding normal distribution.

Examples of Lognormal Exposures Across Industries

Hazard, Industry/NORA Sector	Sample Size (n)	GSD [a] Range	Reference
Chemical industry, various	96	2.5	(Kromhout et al. 1993)
EMF radiation, services	491	1.6–4.0	(Bowman et al. 2007)
Mercury, various	592	1.4–2.1	(Waters et al. 1991)
Silica, construction	151	1.9–4.7	(Rappaport et al. 2003)
Diesel exhaust, transportation [b]	217	1.6–3.3	(Groves and Cain 2000)
Wood dust, construction	>372	2.1–3.1	(Kauppinen et al. 2006)
Metalworking fluid, machining [c]	723	2.0–2.8	(Piacitelli et al. 2001)
Endotoxin, agriculture	587	8.6	(Spaan et al. 2006)
Benzene, aviation	69	3.5	(Smith et al. 2010)

a GSD: Geometric Standard Deviation of the measured exposure distribution(s)

b Estimated as elemental carbon by NIOSH method 5040

c Extractable particulate mass from turning, grinding, milling operations in small machine shops

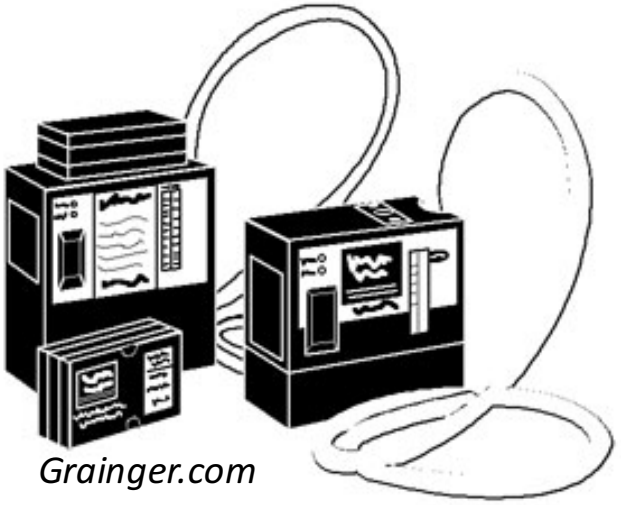
Coverage: Not Enough of It

- How many samples are needed to characterize a log-normal distribution (μ, σ_g)?
  - 30 samples per environment? *(Buringh & Lanting, AIHAJ 1991)*
- What about within/between worker variability for compliance-based sampling?
  - 20+ samples, 2-5 per worker *(Rappaport et al., AOH 1995)*
- How many samples are typically collected per visit?
  - OSHA 21D Consultation Programs: 0 – 3
- How many (full-shift) personal samples could one super-hygienist collect in a day?

Cost
State-of-the-Art for Metals: ICP-AES

- **Instrument cost:**
  - $50,000 - $150,000

- **Personal Sampling Pumps:**
  - $500 - $3,000 each!



Grainger.com

- **Sample analysis cost:**
  - $100 for the first metal, $20 for each additional one

Cost Perspective

- The 2010 U.S. Census estimates a population of 466,400 welders, cutters, solderers, brazers nationally.

- Cost to measure each individual's exposure to one metal just once per year:
  - ~ $50M USD in analytical costs
  - ~ $10M in capital costs
  - ~ $10M in personnel costs

~$70M per year

Separation Science: Want vs. Need

What we want:
(what's being funded)

- Highly Sensitive & Specific
- High Accuracy & Precision
- Portable
- Real-time
- GPS, Wi-Fi,
  Brushed-aluminum housing

What we need:
More Samples!

- Ultra-low cost
- Simple
- High Throughput
- Medium accuracy
- High specificity
- Medium sensitivity
- VERY time-integrated
  (weeks, months, years)

Pop Quiz: What Drives the Development of New Exposure Limit Standards?

a) Mechanistic toxicology
b) Valid exposure data
c) Causal inference epidemiology ←
d) None of the above, OSHA hasn't published a new exposure limit standard since 2006

Reflecting on Exposure Science

- We're not taking enough samples to support defensible epidemiology
- Our methods are inefficient and R&D seems headed in the wrong direction
- It's all too expensive anyway

3. Counseling

P.J. de Loutherbourg, 'Colebrook Dale' (engraved by William Pickett), 1805

There are known knowns…there are known unknowns…but there are also unknown unknowns. - D. Rumsfeld

The known known: We are not good at guessing

"*desktop qualitative judgments [on worker exposure] were little better than random chance*"

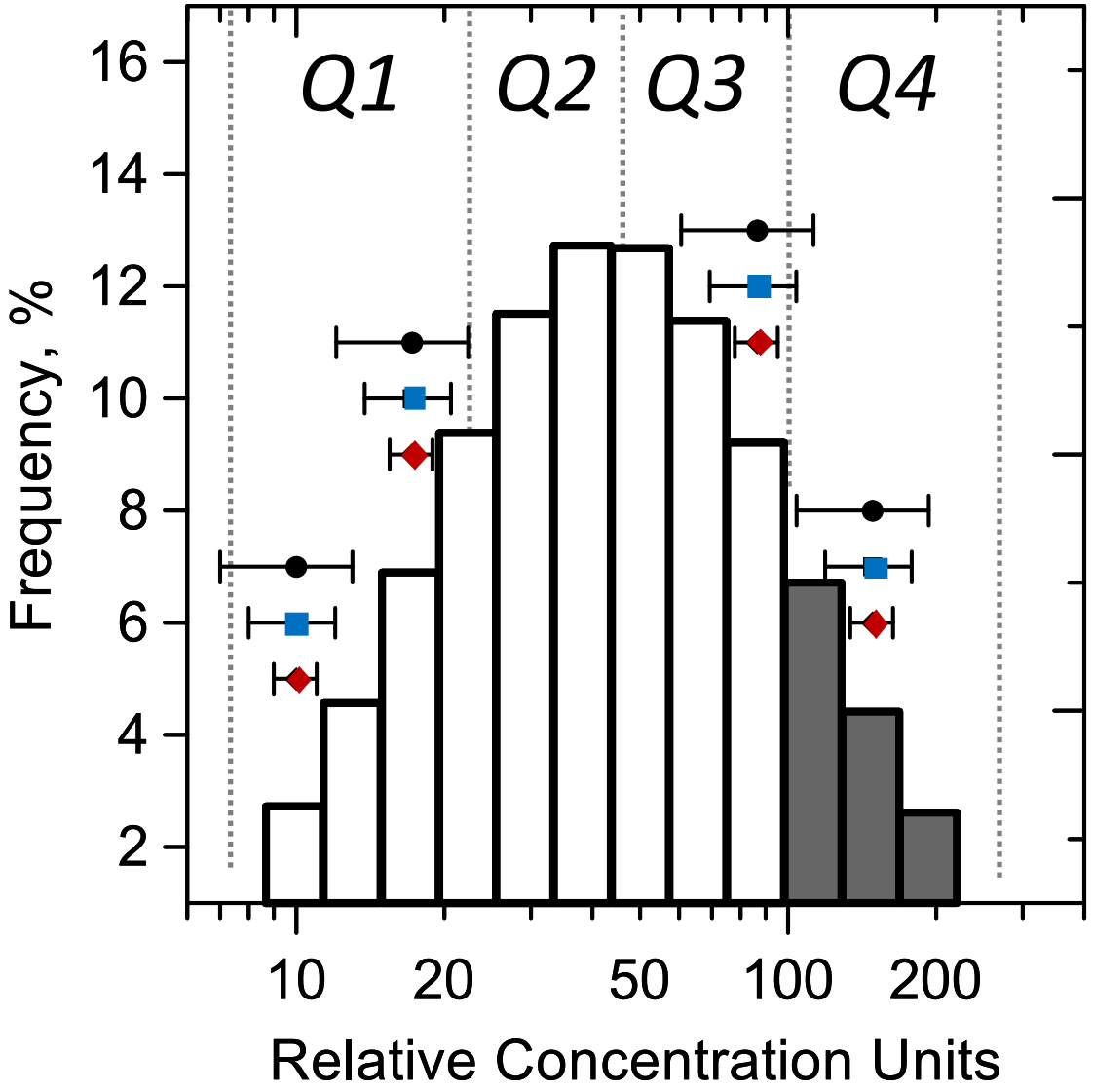
Logan, Ramachandran, et al. Annals Occ. Hyg. (2009)

The known unknown:

We don't have the exposure data we desire; we must economize the data we do have

- Similarly exposed groups
  Oldham (1952); Roach (1977)
- Job-Exposure Matrices
  Hoar (1980)
- Variance components, within/between worker variation
  Kromhout (1987); Rappaport (1991)
- Control Banding
  HSE (1998)
- Bayesian frameworks for exposure estimation
  Ramachandran (1999); Schinkel (2013)

The unknown known (S. Žižek):
Linear Thinking in a Lognormal World



Measurement Uncertainty

Misclassification Rate

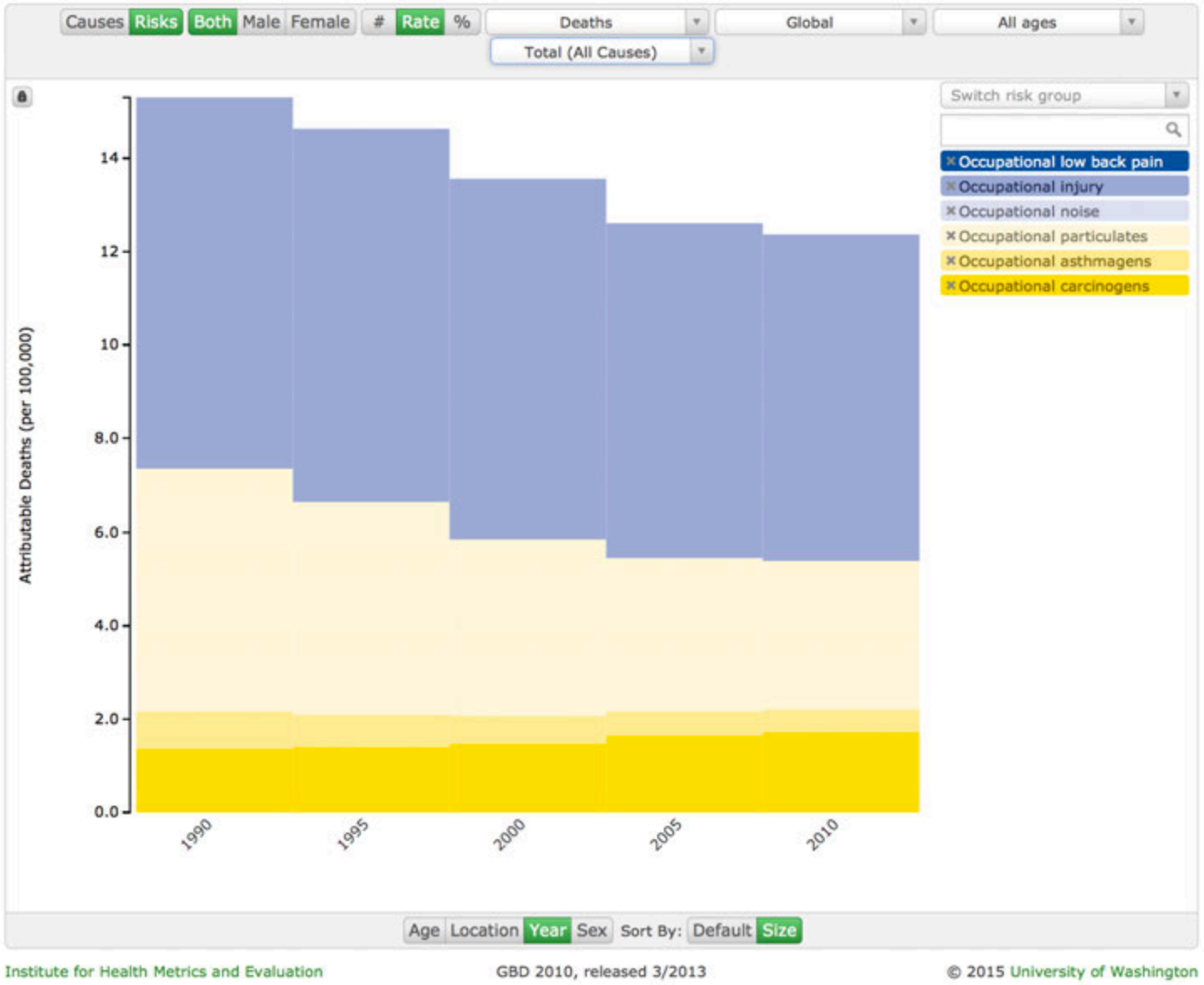
10% → ***5%***

20% → ***9%***

30% → ***13%***

The unknown unknown:

The Future of OH Research: Risk Factors as of September 2015



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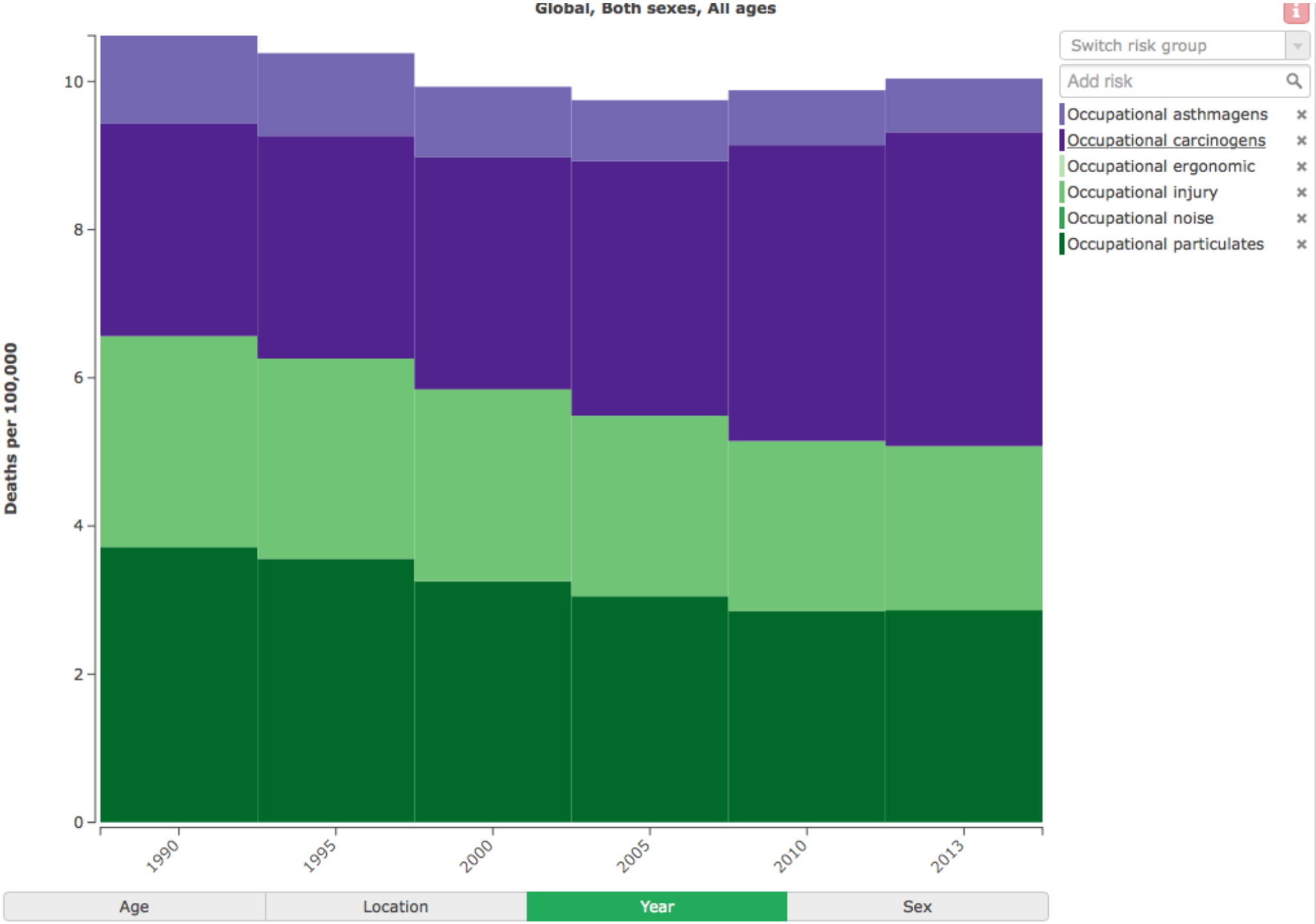
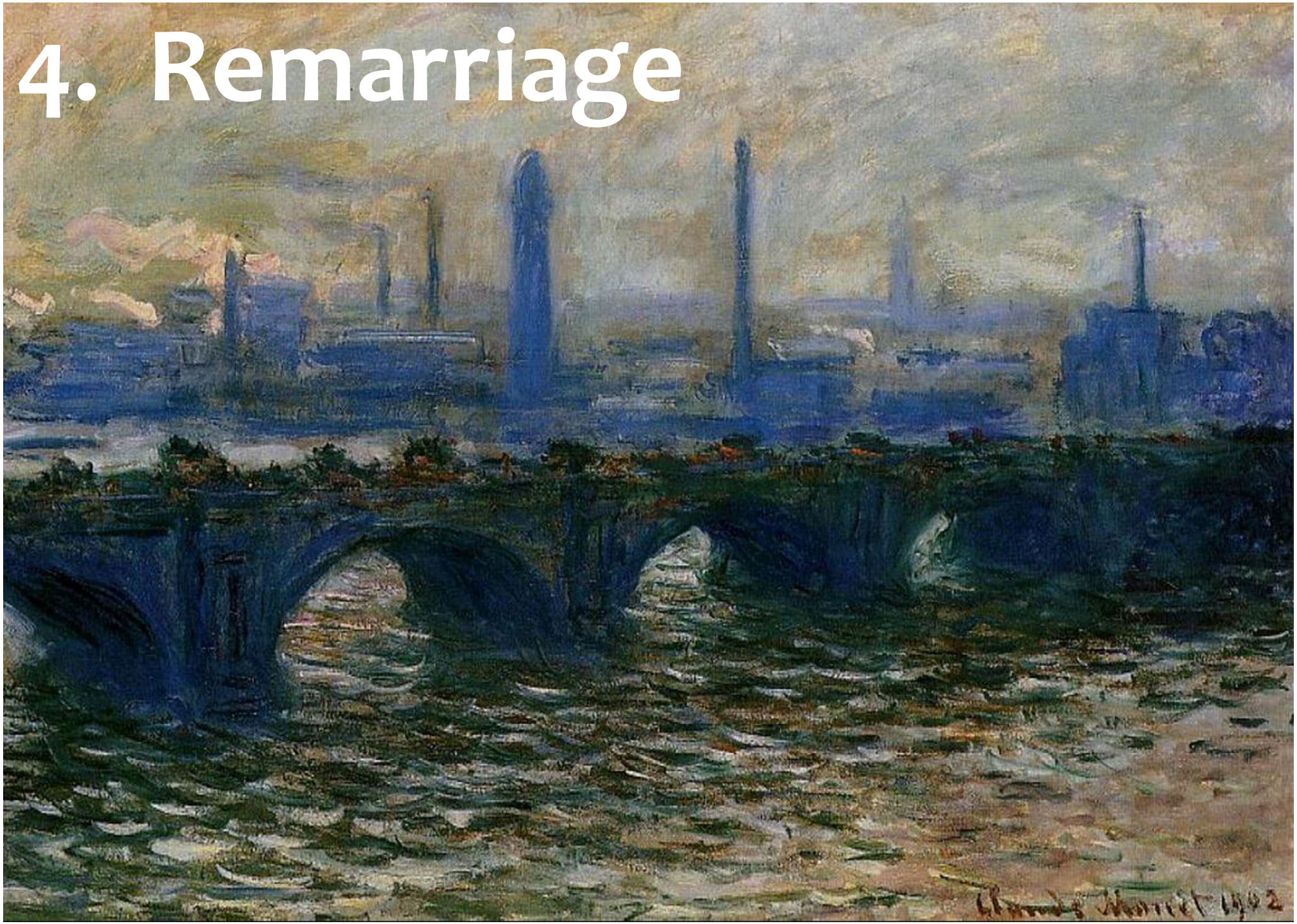

Global, Both sexes, All ages
Deaths per 100,000
0
2
4
6
8
10
1990
1995
2000
2005
2010
2013
Switch risk group
Add risk
Occupational asthmagens
Occupational carcinogens
Occupational ergonomic
Occupational injury
Occupational noise
Occupational particulates
Age
Location
Year
Sex

4. Remarriage



C. Monet, ‘Waterloo Bridge', 1902

Wikipedia.org

Occupational Health in the 21st Century
What Should the Future Hold for You?

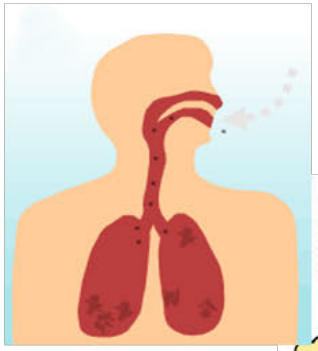
1. Learn to speak another language

Exposure Assessment

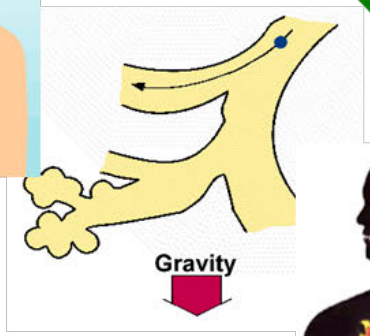
Emission

Exposure

Engineering Control & Source Apportionment



Intake



Deposition

Dose

Toxicology & Exposure Biology

Epidemiology

Health Effect

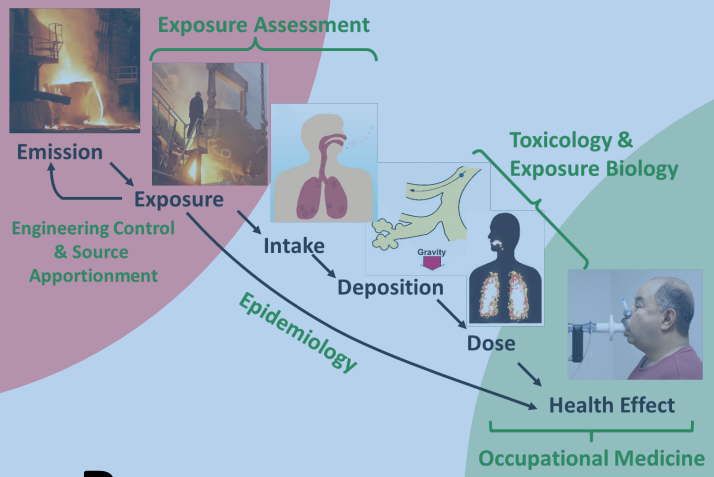
Occupational Medicine

How do you define impact?

Health Behavior

Human Factors
Safety Culture
Avoidance Behavior

Exposure



Response

Health Impact Analysis

Cost of Injury and Illness
Value of OH Profession

- **Changing laws**
- **Changing awareness**
- **Changing behaviors**
- **Improved wellness**

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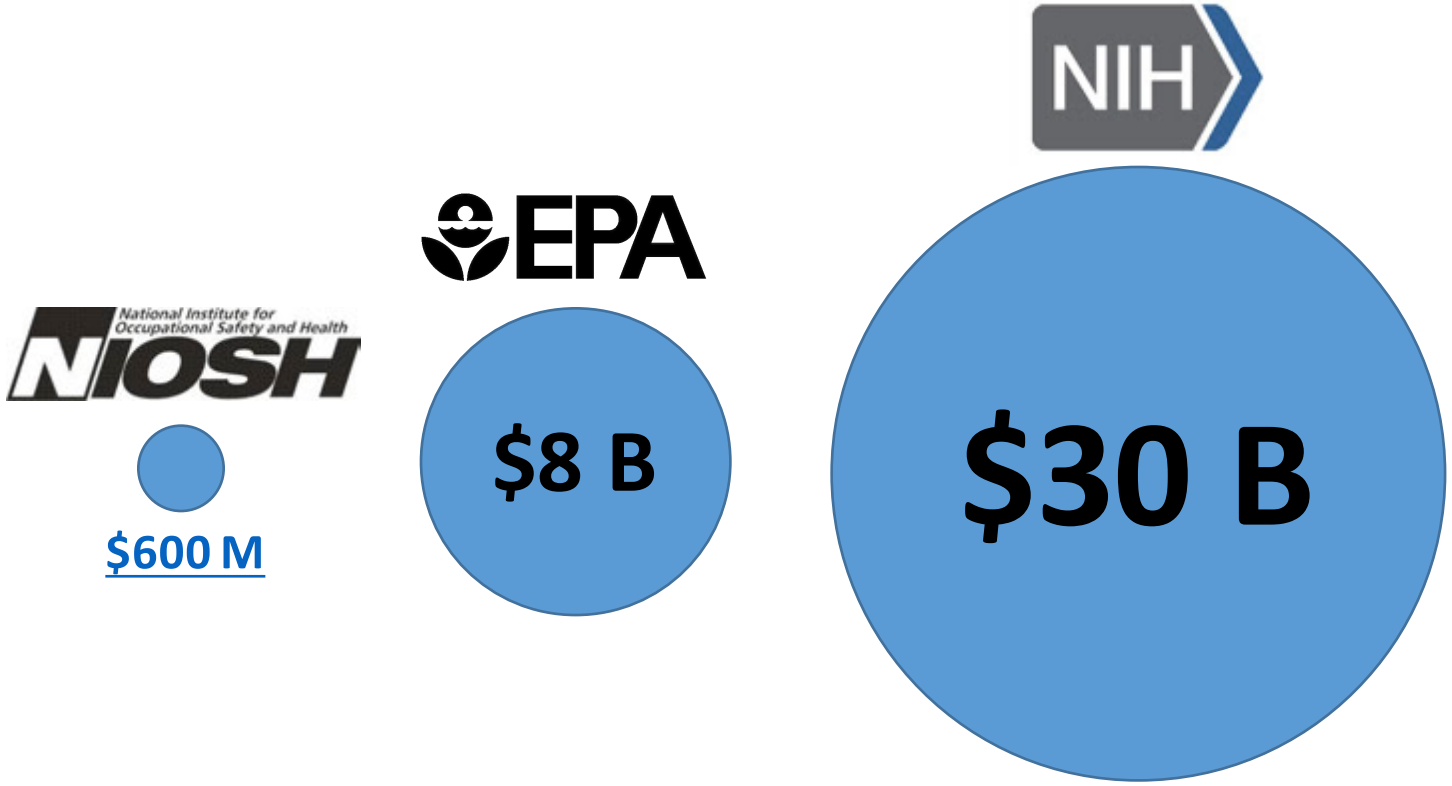
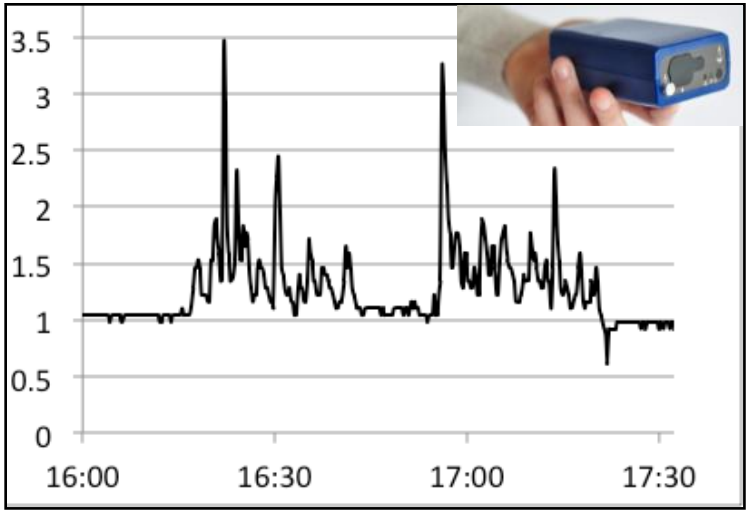
2. Embrace total (environmental) health
   - Indoor & outdoor environment, behavior, wellness

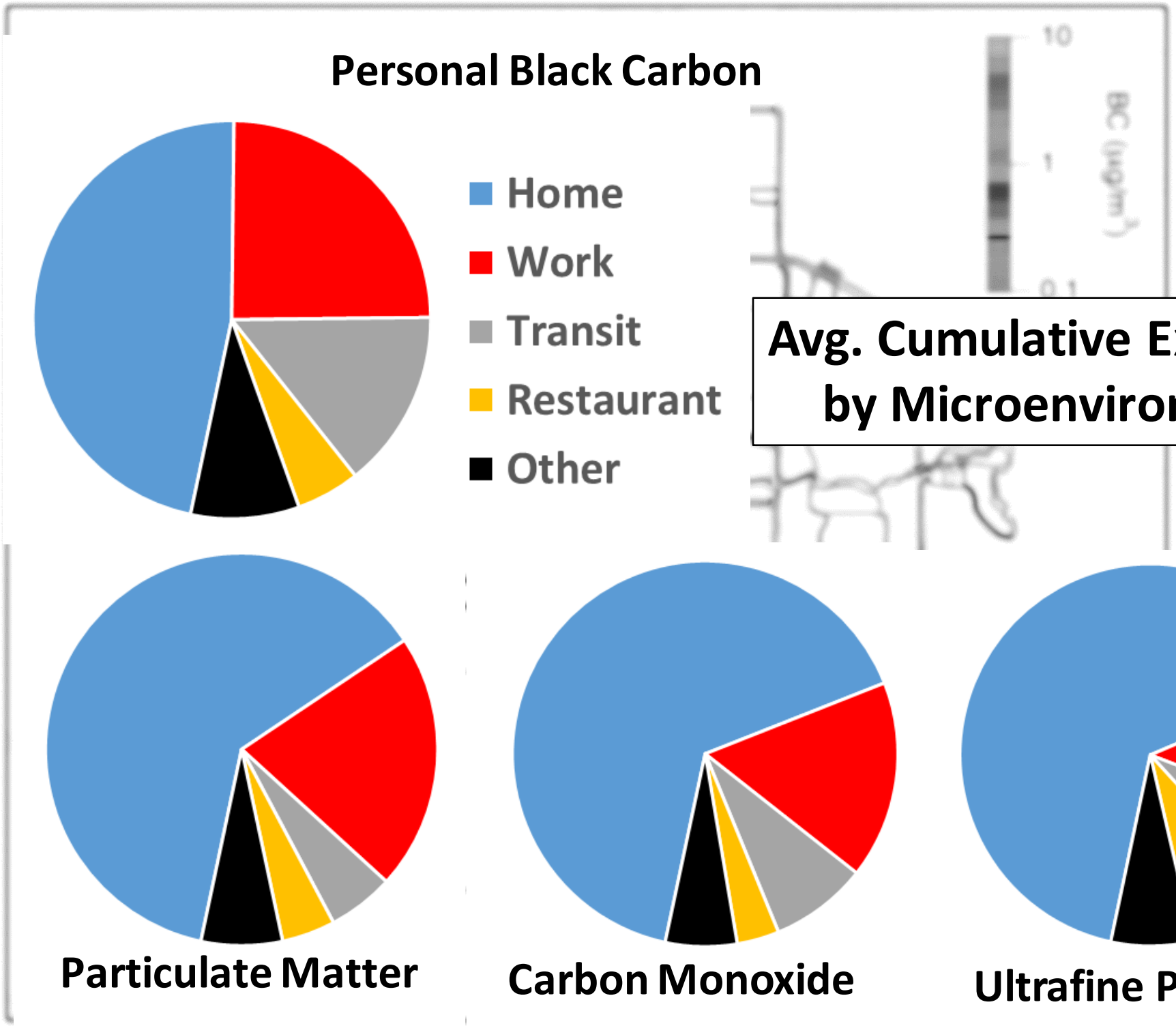


The Fort Collins Commuter Study

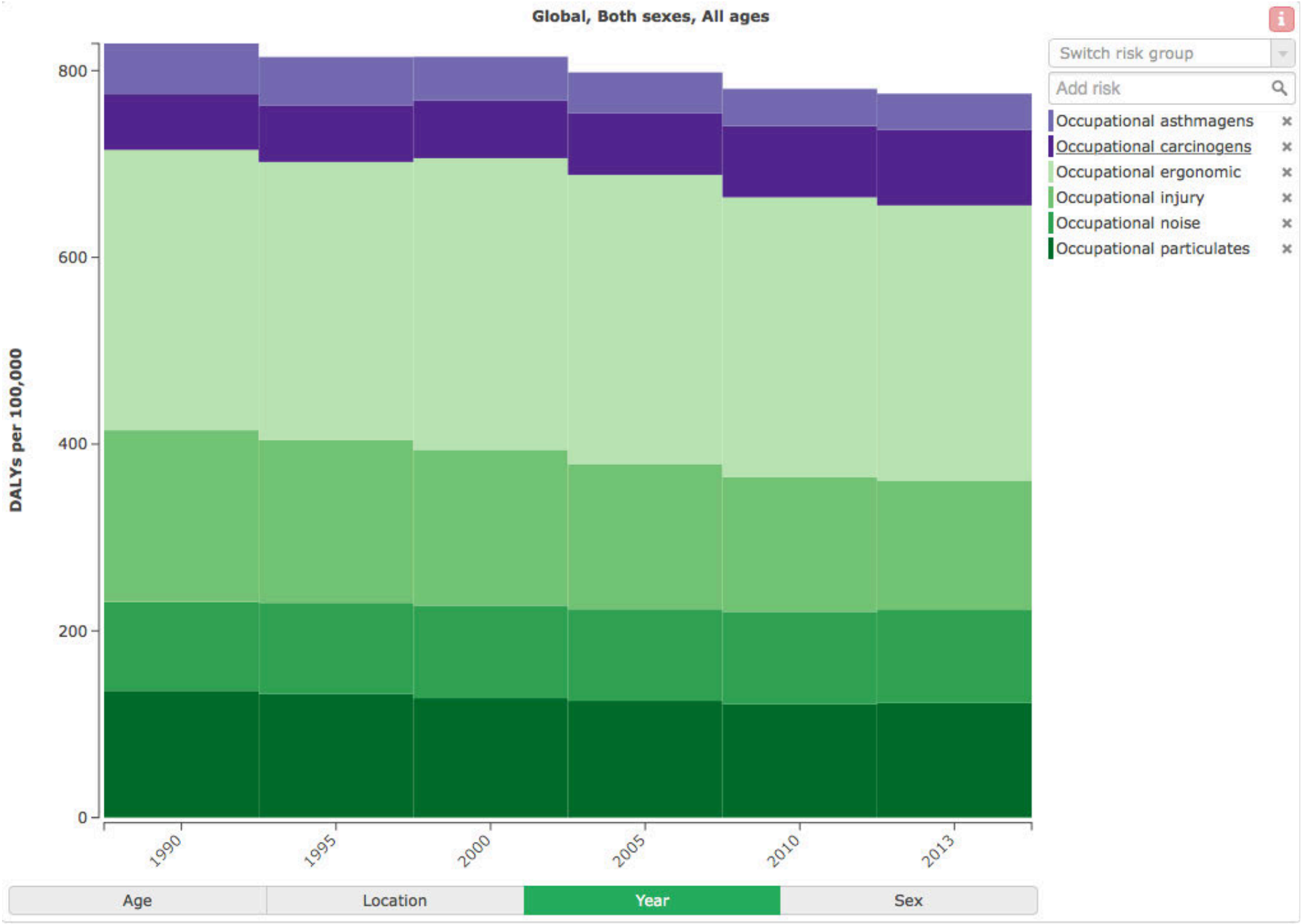
(*an 'exposome' study funded by NIH*)

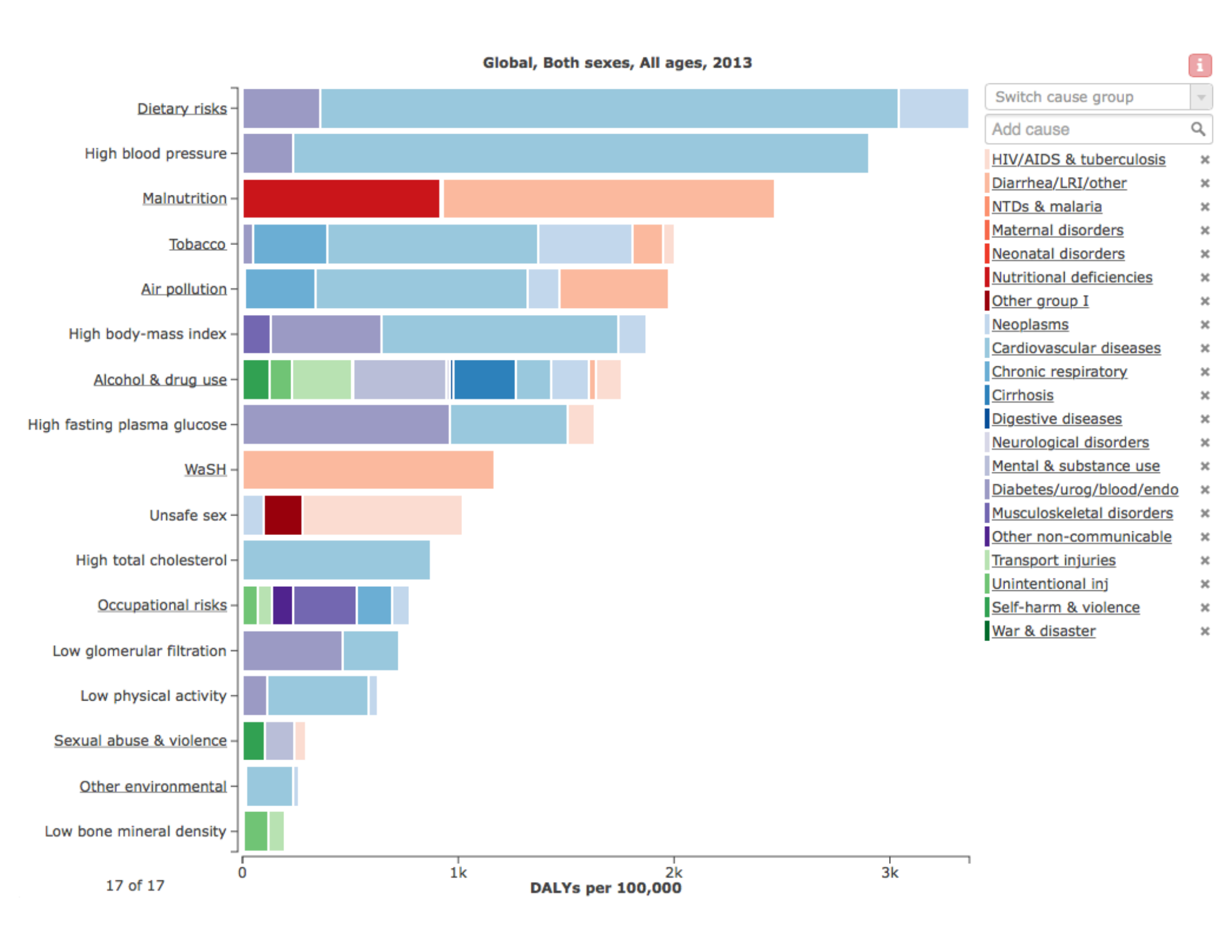


Good et al. JESSE (2016) doi:10.1038/jes.2015.68


Personal Black Carbon
Home
Work
Transit
Restaurant
Other
Avg. Cumulative Exposure by Microenvironment
Particulate Matter
Carbon Monoxide
Ultrafine Particles

Where does your job end? What are your responsibilities?




Global, Both sexes, All ages, 2013
Dietary risks
High blood pressure
Malnutrition
Tobacco
Air pollution
High body-mass index
Alcohol & drug use
High fasting plasma glucose
WaSH
Unsafe sex
High total cholesterol
Occupational risks
Low glomerular filtration
Low physical activity
Sexual abuse & violence
Other environmental
Low bone mineral density
17 of 17
0
1k
2k
3k
DALYs per 100,000
Switch cause group
Add cause
HIV/AIDS & tuberculosis
Diarrhea/LRI/other
NTDs & malaria
Maternal disorders
Neonatal disorders
Nutritional deficiencies
Other group I
Neoplasms
Cardiovascular diseases
Chronic respiratory
Cirrhosis
Digestive diseases
Neurological disorders
Mental & substance use
Diabetes/urog/blood/endo
Musculoskeletal disorders
Other non-communicable
Transport injuries
Unintentional inj
Self-harm & violence
War & disaster

Occupational Health in the 21st Century
What Should the Future Hold for You?

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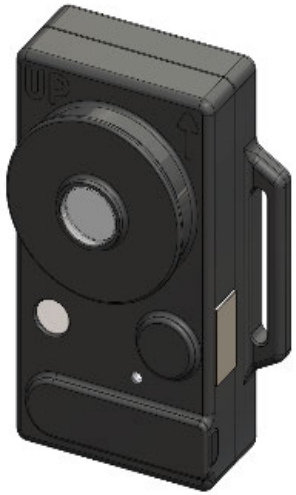
2. Embrace total (environmental) health
   - Indoor & outdoor environment, behavior, wellness
3. Less precision, more data!

Goal: Personal Exposure Assessment That's Actually Affordable

Sampling



$50

Analysis

$2

Interpretation

Me $$$

Cate et al. *Annals of Occ. Hyg.* (2014) 58 (4): 413-423

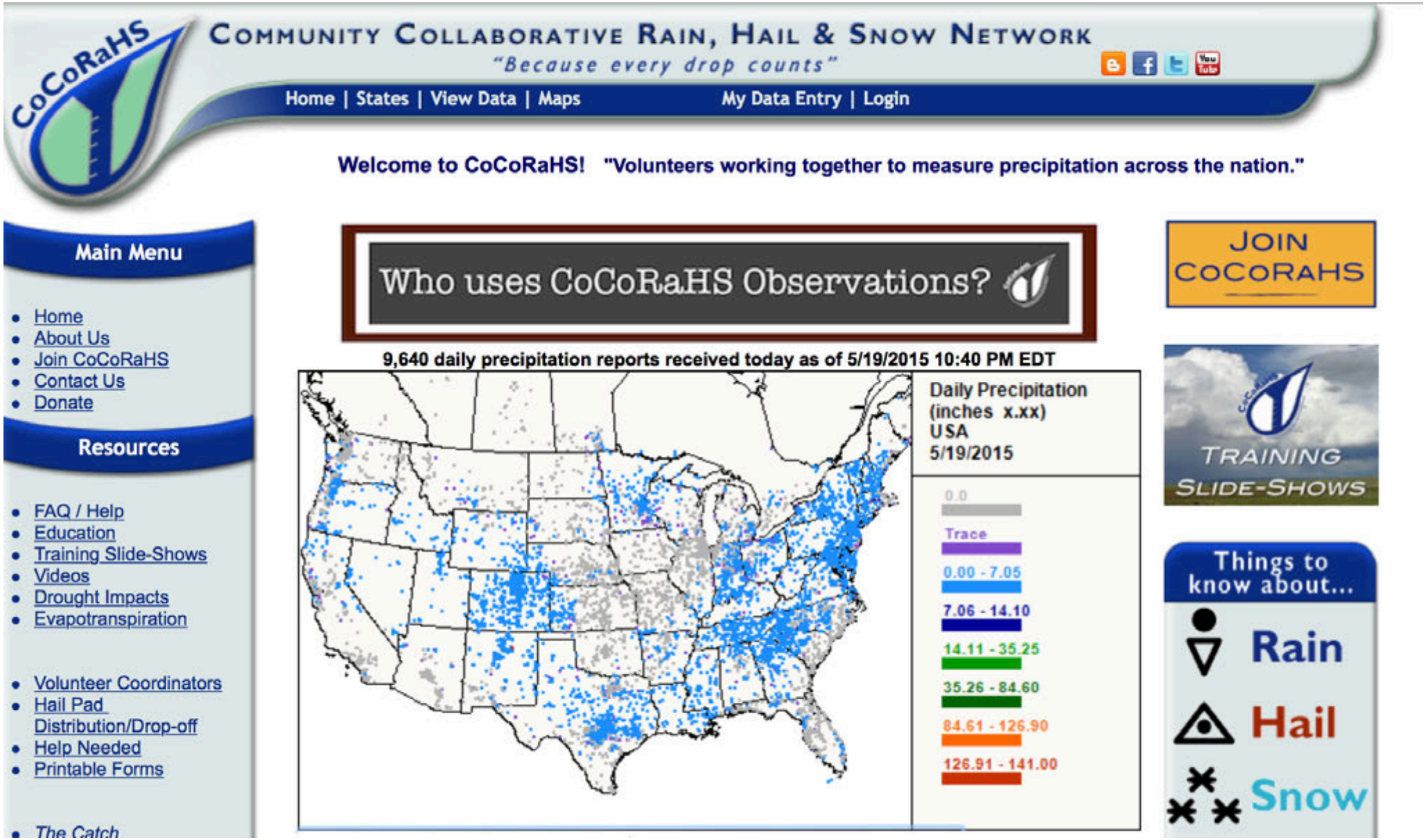
Technology to Empower Awareness, Knowledge, Action

- 100 years ago you went to the doctor to have your temperature taken

- 25 years ago you did the same to find out if you were pregnant

- 10 years ago you needed official credentials to be called a journalist

‘Big-Data’ can Pay Big Dividends



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4. Mixtures, Susceptibility, Allostasis
   - McEwen & Stellar (1993)

"The **Environment** and Genes Initiative"

“Shimmering Substance” Jackson Pollock, 1946